Towrie Development (PL1059)

Significant Species Management Plan

December 2021

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Abbreviations and Units

Acronym	Description
ALA	Atlas of Living Australia
CAMBA	China-Australia Migratory Bird Agreement
CE	Critically Endangered
CSG	Coal Seam Gas
E	Endangered
EA	Environmental Authority
ECP	Environmental Control Plan
EHSMS	Santos Environment, Health, Safety & Management System
EMP	Environmental Management Plan
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographical Information System
GLNG	Gladstone Liquefied Natural Gas
HERBRECS	Queensland Herbarium database
JAMBA	Japan-Australia Migratory Bird Agreement
LNG	Liquefied Natural Gas
LZ	Land Zone
M	Migratory
MNES	Matters of National Significance
NC Act	*Nature Conservation Act 1992*
NT	Near Threatened
QLD	Queensland
RE	Regional Ecosystem
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROW	Right of Way
SEQ	South East Queensland
SEVT	Semi-evergreen Vine Thicket
SMP	Species Management Program
SSMP	Significant Species Management Plan
TEC	Threatened Ecological Communities
V	Vulnerable

1.0 Introduction

Santos CSG Pty Ltd (Santos) is proposing to construct and operate up to 116 gas well on Petroleum Lease (PL) 1059 in Arcadia Valley (known as the Towrie development).

PL 1059 (the development area) comprises 8,695 hectares (ha) of land located in the Surat/Bowen Basins of eastern Queensland, approximately 60 kilometres (km) north north-east of Injune. The tenure is immediately west of existing coal seam gas (CSG) wells and infrastructure within the Arcadia gas field authorised as part of the Santos Gladstone Liquefied Natural Gas (GLNG) project and later expansion of that project known as the GLNG Gas Field Development (GFD) project.

A number of significant species (comprised of both threatened flora and fauna and migratory fauna species) and Threatened Ecological Communities (TECs) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have the potential to occur within the development area. The referral assessed the potential impacts of the proposed action on these Matters of National Environmental Significance (MNES) based on proposed maximum disturbance limits, or complete avoidance, of each ecological community, significant flora species or significant fauna species' habitat.

Given the iterative nature of the planning and development for infrastructure within the development area, this Significant Species Management Plan (SSMP) has been prepared to enable the considered management of significant species and TECs as they are encountered. The SSMP in conjunction with the *Environmental Protocol for Constraints Planning and Field Development* (the Protocol) provides Santos with the tools to systematically identify significant species and implement management measures during the course of conducting activities in the development area.

1.1 Purpose and Scope of the SSMP

This SSMP has been prepared for the development area (PL 1059) to guide the management of impacts from petroleum activities that have the potential to impact on a significant species (EPBC listed) or its habitat, or a TEC. All planning-related considerations, including measures to avoid ecological constraints, are addressed in the Protocol.

This plan includes the following scope:

- measures to be taken to avoid, mitigate and manage impacts to EPBC threatened species and EPBC migratory species and their habitat, and EPBC communities during construction, operation and decommissioning of the action;
- details of how the Protocol will be applied to avoid and minimise impacts to EPBC threatened and migratory species, and their habitats, and EPBC communities during construction, operation and decommissioning of the action
- a monitoring program to determine the success of mitigation and management measures to ensure adaptive management for the duration of the Towrie development
- details of review timeframes for the plan
- discussion of relevant conservation advice, recovery plans and threat abatement plans and how measures proposed in the SSMP take into account relevant conservation advice and are consistent with the measures contained in relevant recovery plans and threat abatement plans'.

2.0 Legal and Other Requirements

2.1 Legal Requirements

Santos must comply with all relevant Commonwealth and Queensland legislation and approvals in carrying out the Towrie development. A summary of primary legislation in relation to the management of significant species and TECs is presented in Table 1.

Table 1: Summary of applicable legislation

Act or Strategy	Summary of Act or Strategy
Environmental Protection and Biodiversity Conservation Act 1999 **(EPBC Act)**	The EPBC Act provides a legal framework to protect and manage nationally and internationally important fauna species and ecological communities. The EPBC Act focuses Commonwealth Government interests on the protection of Matters of National Environmental Significance (MNES), with the states and territories having responsibility for matters of state and local significance. MNES includes listed migratory species as well as threatened species and communities.
Environmental Protection Act 1994 **(EP Act)** ***Environmental Protection Regulation 2008*** **(EP Reg)**	Petroleum activities within the Towrie development area will require an Environmental Authority (EA) issued under the EP Act. The EA will condition how activities must be carried out in order to safeguard environmental values. The EP Act also requires Santos to take all reasonable and practicable measures to prevent or minimise environmental harm.
Nature Conservation Act 1992 **(NC Act)** ***Nature Conservation (Wildlife Management) Regulation 2006*** **(Qld) (NC Regulation)**	The primary purpose of the NC Act is to conserve biodiversity by protecting wildlife and its habitat. Permits are required for the taking and/or relocation of protected flora and fauna under this Act. No permits / management programs are anticipated to be required for the taking of protected plants within the development area given the avoidance strategy identified in the Protocol. Active breeding places will only be interfered with in accordance with an approved DES Species Management Program (SMP).

This SSMP is also informed by advice contained within the standards and guidelines provided in Table 2.

Table 2: Summary of applicable standards and guidelines

Standards and Guidelines	
Title	Author
Approved Conservation Advices for the potentially impacted species summarised in Section 3.0 of this plan.	TSSC
BONN Convention (1983)	CMS 2012
China-Australia Migratory Bird Agreement (CAMBA) (1988)	Government of Australia 1988
Collecting and preserving plant specimens, a manual: Queensland Herbarium	Queensland Herbarium 2013
Draft Koala Referral Guidelines for the Vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)	DOTE 2013
EPBC Act referral guideline for the endangered northern quoll *Dasyurus hallucatus*	DOTE 2016

Standards and Guidelines	
Title	Author
Draft Referral guidelines for the nationally listed Brigalow Belt reptiles	DSEWPC 2011
Draft Queensland Brigalow Belt Reptile Recovery Plan 2008-2012	Richardson 2008
Draft Survey Guidelines for Australia's Threatened Orchids	DOTE 2013
Guidelines for the Translocation of Threatened Species in Australia	Vallee *et al* 2004
Japan-Australia Migratory Bird Agreement (JAMBA) (1981)	Government of Australia 1981
Republic of Korea- Australia Migratory Bird Agreement (ROKAMBA) (2007)	Government of Australia 2007
Wildlife Conservation Plan for Migratory Shorebirds	DOTE 2006
The Action Plan for Australian Birds	Garnett *et al* 2010
The Action Plan for Australian Bats	Environment Australia 1999
Draft Conservation Advice (including listing advice) for the Poplar Box Grassy Wodland on Alluvial Plains	DAWE 2019
Recovery Plan for the Brigalow (*Acacia harpophylla*) Dominant and Co-Dominant Endangered Ecological Community	Butler 2007b
National Recovery Plan for The "Semi-Evergreen Vine Thickets of the Brigalow Belt (North And South) And Nandewar Bioregions" Ecological Community	Mcdonald 2010
National Multi-Species Recovery Plan for the Cycads, *Cycas Megacarpa, Cycas Ophioplitica, Macrozamia Cranei, Macrozamia Lomandroides, Macrozamia Pauli-Guilielmi* and *Macrozamia Platyrachis*	Queensland Herbarium 2007
National Recovery Plan for the *Bertya sp*. (Cobar-Coolabah) (This Recovery Plan Encompasses *Bertya opponens*)	NPWS 2002a
Recovery Plan for the Community of Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin	Fensham *et al* 2010
(Draft) National Recovery Plan for the South-Eastern Long-Eared Bat (*Nyctophilus corbeni*)	Schulz & Lumsden 2010
National Recovery Plan for the Black-Breasted Button-Quail (*Turnix Melanogaster*)	Mathieson & Smith 2009
National recovery plan for the large-eared pied bat *Chalinolobus dwyeri*	DERM 2011
National Recovery Plan for the Murray Cod *Maccullochella peelii peelii*	National Murray Cod Recovery Team 2010
National Recovery Plan for the Northern Quoll *Dasyurus hallucatus,*	Hill & Ward 2010
National Recovery Plan for the Red Goshawk (*Erythrotriorchis Radiatus*)	DERM 2012
Survey Guidelines for Australia's Threatened Bats	DEWHA 2010a
Survey Guidelines for Australia's Threatened Birds	DEWHA 2010b
Survey Guidelines for Australia's Threatened Mammals	DEWHA 2011a
Survey Guidelines for Australia's Threatened Reptiles	DEWHA 2011b
Threat Abatement Plan for competition and land degradation by unmanaged goats	DEWHA 2008
Threat Abatement Plan for competition and land degradation by rabbits	DEWHA 2008

Standards and Guidelines	
Title	Author
Threat Abatement Plan for predation by the European red fox	DEWHA 2008
Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	DoEE 2015
Threat abatement plan for predation by feral cats	DoE 2015
Threat Abatement Plan for the biological effects, including lethal toxic ingestion, caused by cane toads,	DSEWPAC 2011
Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses	DSEWPAC 2012

3.0 Significant Species in the Towrie development area

3.1 Overview

Species of significant flora, fauna and TECs are either known to occur, or have the potential to occur within the development area. The likelihood of each species occurring within the development area has been determined through the detailed review of multiple resources including State and Commonwealth databases and Geographical Information System (GIS) data, peer-reviewed literature and previous studies, results of field assessments, current (known) distribution range and the presence and condition of suitable habitat within the tenure.

Each species was assessed against the categories defined below.

- **Known**: Species was positively identified and recorded in the development area during the field surveys; or previous, reliable records occur within the development area.
- **Likely**: Species was not recorded during the field surveys or previously, however there are known records within the nearby surrounding area and suitable habitat exists in the development area.
- **Potential**: Species was not recorded during the field surveys or previously, however known records occur in the surrounding area and habitat in the development area is marginal or degraded.
- **Unlikely**: Habitat in the development area might be marginally suitable; however, species was not recorded during the field surveys, and no known records of the species exist within the surrounding area.

The following sections provide an overview of the significant species and TECs and their likelihood of occurrence within the development area. These species are subject to the requirements of the SSMP should they or their habitat be proposed to be impacted by development activities.

This SSMP provides detailed profiles for each of the species and TECs discussed in Section 8.0. Habitat descriptions have been developed based on available scientific information, expert advice contained within the Department of Agriculture, Water and the Environment's (DAWE) Species Profile and Threats Database and the relevant Conservation Advice and Listing Advice documents.

Should an EPBC threatened species, TEC or migratory species be identified within the development area that is not contained in this plan, then activities that may impact the newly identified value must not occur until such time that this plan is updated and approved by the Minister.

3.2 Significant Flora

Significant flora species identified by the DAWE Protected Matters Search Tool as possibly occurring in the development area are presented in Table 3. Table 3 also provides the following summary information:

- the conservation status of each species under both the Commonwealth EPBC Act and the Queensland NC Act
- the likelihood of occurrence (refer Section 3.1); and
- cross-references to species profiles within this SSMP.

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Table 3: Significant flora species within the development area

Species	Common Name	Likelihood in Development Area	Status		Species Profile
			EPBC Act	NC Act	
Terrestrial Flora					
Acacia grandifolia	-	Potential	V	-	Section 8.1
Arthraxon hispidus	Hairy-joint grass	Unlikely	V	V	Section 8.2
Bertya opponens	Coolabah bertya	Potential	V	-	Section 8.3
Cadellia pentastylis	Ooline	Known	V	V	Section 8.4
Dichanthium setosum	Bluegrass	Unlikely	V	-	Section 8.4
Thesium australe	Austral toadflax	Unlikely	V	V	Section 8.6
Tylophora linearis	-	Unlikely	E	E	Section 8.7
Xerothamnella herbacea	-	Likely	E	E	Section 8.8

Table notes: E = Endangered, V = Vulnerable

3.3 Significant Fauna

Significant fauna species (including migratory species) identified by the DAWE's Protected Matters Search Tool as possibly occurring in the development area are presented in Table 4. Table 4 also provides the following summary information:

- the conservation status of each species under both the Commonwealth EPBC Act and the Queensland NC Act
- the likelihood of occurrence (refer Section 3.1); and
- cross-references to species profiles within this SSMP.

Table 4: Significant fauna and migratory bird species within the development area

Species	Common Name	Likelihood in Development Area	Status		Species Profile
			EPBC Act	NC Act	
Calidris ferruginea	Curlew sandpiper	Unlikely	CE	-	Section 8.9
Erythrotriorchis radiatus	Red goshawk	Potential	V	E	Section 8.10
Geophaps scripta scripta	Squatter pigeon (southern)	Potential	V	V	Section 8.11
Grantiella picta	Painted honeyeater	Potential	V	V	Section 8.12
Hirundapus caudacutus	White-throated needletail	Potential	V, M	SLC	Section 8.13
Neochmia ruficauda ruficauda	Star finch (eastern)	Unlikely	E	E	Section 8.14
Rostratula australis	Australian painted snipe	Potential	E	V	Section 8.15

Species	Common Name	Likelihood in Development Area	Status		Species Profile
			EPBC Act	NC Act	
Falco hypoleucos	Grey falcon	Potential	V	V	Section 8.17
Chalinolobus dwyeri	Large-eared pied bat	Known	V	V	Section 8.17
Dasyurus hallucatus	Northern quoll	Potential	E	-	Section 8.18
Nyctophilus corbeni	South-eastern long-eared bat	Likely	V	V	Section 8.19
Petauroides Volans	Greater glider	Potential	V	V	Section 8.20
Phascolarctos cinereus	Koala	Potential	V	V	Section 8.21
Delma torquata	Adorned delma	Potential	V	V	Section 8.22
Denisonia maculate	Ornamental snake	Potential	V	V	Section 8.23
Egernia rugosa	Yakka skink	Potential	V	V	Section 8.24
Elseya albagula	White-throated snapping turtle	Unlikely	CE	E	Section 8.25
Furina dunmalli	Dunmall's snake	Likely	V	V	Section 8.26
Rheodytes leukops	Fitzroy River turtle	Unlikely	V	V	Section 8.27
Apus pacificus	Fork-tailed swift	Potential	M	SLC	Section 8.28
Plegadis falcinellus	Glossy ibis	Known	M	SLC	Section 8.29
Cuculus optatus	Oriental cuckoo	Potential	M	SLC	Section 8.30
Motacilla flava	Yellow wagtail	Unlikely	M	SLC	Section 8.31
Myiagra cyanoleuca	Satin flycatcher	Potential	M	SLC	Section 8.32
Rhipidura rufifrons	Rufous fantail	Likely	M	SLC	Section 8.33
Actitis hypoleucos	Common sandpiper	Unlikely	M	SLC	Section 8.34
Calidris acuminata	Sharp-tailed sandpiper	Unlikely	M	SLC	Section 8.35
Calidris melanotos	Pectoral sandpiper	Unlikely	M	SLC	Section 8.36
Gallinago hardwickii	Latham's snipe	Potential	M	SLC	Section 8.37
Pandion haliaetus	Osprey	Unlikely	M	SLC	Section 8.38

Table notes: CE = Critically Endangered, E = Endangered, V = Vulnerable, NT = Near Threatened, M = Migratory, SLC = Special Least Concern

3.4 Threatened Ecological Communities

TECs identified by the DAWE's Protected Matters Search Tool as possibly occurring in the development area are presented in Table 5. Detailed profiles of these TECs are provided in Section 8 of the SSMP.

The spatial extent of TECs within the development area has been estimated using a combination of field-validated data, desktop information and extrapolated field survey results. The mapping of non-field validated potential TEC vegetation was further assisted through the review of recent aerial imagery and LiDAR data.

Table 5: TECs within the development area

Threatened Ecological Community	Likelihood in Development Area	EPBC Status	Species Profile
Brigalow (*Acacia harpophylla* dominant and sub-dominant)	Known	Endangered	Section 8.39
Coolibah – Black box woodlands of the Darling Riverine Plains and the Brigalow Belt south bioregions	Unlikely	Endangered	Section 8.40
Semi-evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions (SEVT)	Known	Endangered	Section 8.41
Poplar Box Grassy Woodland on Alluvial Plains	Known	Endangered	Section 8.42
Weeping Myall Woodlands	Unlikely	Endangered	Section 8.43

4.0 Management of Significant Species and TECs

4.1 Management Hierarchy

Due to the iterative nature of field development, gas field planning and management around ecological values is constraints based. Planning and management of disturbances is undertaken utilising a set of hierarchical management principles designed to avoid, minimise, mitigate and remediate/rehabilitate impacts to known environmental values (including significant species and TECs). These management principles are applied using the following hierarchy:

1. Avoidance – Avoiding direct and indirect adverse environmental impacts where reasonable and practicably possible;
2. Minimise – Minimise direct and indirect adverse environmental impacts where impacts cannot be avoided;
3. Mitigate – Implement mitigation measures to minimise direct, indirect and cumulative adverse environmental impacts;
4. Remediation and Rehabilitation – Actively remediate and rehabilitate impacted areas to promote and maintain long-term recovery; and
5. Offset significant residual impacts – Where required, Santos provides offsets for activities that result in an unavoidable significant residual adverse impact to MNES. As the Towrie development will not cause significant residual impacts to MNES, no offsets are proposed.

Each of these principles in relation to significant species and TECs are discussed further in the following sections.

4.1.1 Avoid and Minimise

4.1.1.1 Constraints Based Management of Ecological Impacts

Santos proposes to implement an *Environmental Protocol for Constraints Planning and Field Development* (the Protocol) for siting infrastructure. This document outlines the approach Santos uses when locating project disturbances, to identify, assess and then avoid or minimise potential impacts to MNES, including significant species and TECs. Ecological constraints are grouped based on the nature of development that can occur within each of the ecological constraints.

The Protocol outlines the internal steps necessary to locate development disturbances. These steps include:

- Desktop assessments that assess the location of proposed infrastructure against the development constraints using GIS datasets of TECs and significant species locations and habitat;
- As determined necessary following a field scout, detailed ecoloigcal assessments will be undertaken to confirm the location of TECs, significant species and habitats in proposed disturbance areas; and
- Development of any zones of restriction, exclusion or mitigation (where appropriate) to adequately protect identified environmental values.

4.1.2 Mitigate

This step in the hierarchy primarily involves the application of the SSMP, once a decision has been made in accordance with the Protocol, to progress a disturbance to land that will have a potential adverse impact on a significant species and/or a TEC. The SSMP outlines practical mitigation measures to be

implemented on the ground to mitigate and manage the risk of adverse impacts to significant species, their habitats and TECs. Mitigation measures specific to significant species and TECs are discussed further in Section 4.2.

4.1.2.1 Rehabilitate

Where a direct or indirect impact has occurred to a significant species or TEC, Santos will apply rehabilitation measures as appropriate for the impacted species / area, to minimise cumulative impacts throughout the life of the Towrie development. Santos undertakes three forms of rehabilitation:

1. Stabilisation of exposed construction disturbances – this occurs during the construction phase and is designed to minimise the area of disturbance exposed, thereby minimising the potential for soil loss, erosion and sedimentation of the surrounding areas. This may involve some revegetation but is predominantly about contouring and stabilisation.
2. Reduction of the construction footprint – at the cessation of construction, there may be scope for the construction footprint to be reduced to an operational footprint. This can either involve further stabilisation as described above, designed to prevent adverse impacts such as erosion and to protect the asset or in some cases may be the commencement of rehabilitation of vegetation with the view to reach final rehabilitation objectives (i.e. progressive rehabilitation)
3. Final rehabilitation – this most commonly occurs at the end of life of an operational asset and coincides with the activities undertaken as part of decommissioning and well sealing/abandonment. Final rehabilitation will be completed in accordance with the conditions of the Environmental Authority with the view of achieving pre-determined and agreed rehabilitation objectives and standards with the landholder. This may include the landholder taking ownership of certain infrastructure for ongoing private use. Rehabilitation undertaken within or in proximity to MNES will utilise local provenance native species to achieve rehabilitation targets.

4.1.2.2 Decommissioning

Similar to final rehabilitation, decommissioning and abandonment is asset and site-specific. Consequently, development of decommissioning and abandonment plans will commence during planning for any one asset's operational lifetime. This will ensure that the planning is fit-for-purpose in terms of agreed rehabilitation outcomes and that the decommissioning and abandonment proposal and process is in line with the regulatory standards and legislation of the day. Decommissioning and abandonment activities will be completed within the pre-existing disturbed footprint where the footprint and nature of the activity allows for it.

4.2 Mitigation and Monitoring

4.2.1 Mitigation

An Environmental Management Plan (EMP) has been prepared for the Towrie development which includes a range of Environmental Control Plans (ECPs). These ECPs have been developed to document site specific environmental management measures to be implemented throughout the Towrie development to achieve ongoing environmental compliance with regulatory requirements and best practice environmental management strategies.

A brief summary of each ECP is available in **Error! Reference source not found.**.

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Table 6: Environmental Control Plans

ECP	Key Content
1. Construction site management	Measures for general construction site management to minimise risks to environmental values from site establishment through to demobilisation and hand over
2. Soil resource management	Management measures to minimise the risk of degrading soil resources during construction works. Includes consideration of erosion and sediment control, contaminated land and acid sulfate soils
3. Water resource management	Management measures to minimise the risk of degrading the quantity and quality of water (surface water and groundwater) resources during construction works
4. Flora and fauna management	N/A – this SSMP has been prepared instead of a detailed ECP
5. Weed and pest management	Measures to reduce the risk of invasive plant and animal introduction and spread at the site or onto surrounding lands
6. Air, vibration, light and noise management	Measures to reduce the risk of environmental harm from air, light, vibration and noise emissions during construction works
7. Liquid and solid waste management	Measures to manage regulated, general and recyclable wastes from the construction works in accordance with the waste management hierarchy
8. Cultural heritage management	Measures to protect the cultural heritage values of the site and surrounding area
9. Hazardous substances use and management	Measures for hazardous substance storage, handling, use and disposal to minimise the risks of environmental contamination
10. Plant and equipment management	Measures for the maintenance and operation of plant and equipment during construction to minimise the risk of environmental harm
11. Environmental emergency preparedness and response	Measures to minimise the impacts of the three environmental emergencies that could reasonably be expected to occur at the site at some time: major chemical spill (fuel), dangerous weather events (heavy rainfall/flooding/cyclone) and bushfire
12. Sustainability action plan	Measures to minimise construction-related environmental impacts to the greatest extent practicable

As discussed in Section 4.1.2, this SSMP outlines a series of mitigation measures designed to minimise and/or mitigate potential impacts to significant species and TECs. This document, along with the EMP, will be used to ensure the direct and indirect impacts to significant species and TECs is minimised across the life of the development.

Mitigation measures have been grouped into the following categories:

- Flora – Section 4.2.1.1;
- Birds – Section 4.2.1.2;
- Reptiles – Section 4.2.1.3;

- Mammals – Section 4.2.1.4;
- Aquatic Fauna – Section 4.2.1.5;
- Migratory Birds – Section 4.2.1.6; and
- TECs – Section 4.2.1.7.

Mitigation measures presented in the following Sections have been further grouped into phases:

- Pre-construction;
- Construction;
- Operation; and
- Decommissioning and abandonment.

Most measures fall within the preconstruction and construction phases. This is when the greatest risk of adverse impacts to MNES is apparent.

4.2.1.1 Significant Flora

Table 7 identifies measures for to mitigate potential impacts on significant flora species.

Table 7: Mitigation measures for significant flora species

Activity	Mitigation Measure
Pre-Construction Phase	
Site Preparation	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Any significant flora species should be identified and the extent mapped during pre-clearance surveys.
	Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
	The project team should identify and map clear no-go zones to avoid unauthorised disturbance of potential habitat for significant flora species.
	Existing breaks between patches of potential significant flora species habitat will be utilised as much as practical to minimise habitat fragmentation.
Site Induction and Work Instruction	All personnel will receive flora awareness training as part of the site induction.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in proximity to the threatened flora.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
Clearing	Clearing must occur only within the approved and demarcated areas.
	Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
	All vegetation clearing within identified threatened flora habitat must comply with clearing related approval conditions.
	Areas of exclusion will remain adequately marked until the conclusion of construction activities.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative[1].
Dust Management	Dust suppression strategies will be implemented to manage the risk of adverse impacts associated with excessive dust deposition and the smothering of threatened flora. Strategies include the watering of roads and disturbed areas during construction activities and enforcing vehicle speed limits.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.

[1] Environmental representative is the general term used to describe suitably qualified environmental personnel being on site for the range of possible mitigation / management measures being deployed and would include qualified fauna spotter / catchers, aquatic and terrestrial ecologists and environmental advisors.

Activity	Mitigation Measure
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened flora will be stored within containment areas that are designed and managed in accordance with relevant regulatory requirements and Australian standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Contaminated areas will be managed as required.
Erosion and Sediment Control	Control measures commensurate to the risk of erosion and sediment release caused by the construction activity will be implemented as required.
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where threatened flora habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.

Activity	Mitigation Measure
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.
Fire Management	Threat of wildfire caused by Santos activities will be minimised through maintenance of firebreaks around ignition sources as appropriate.
	Fire management and response will be conducted in accordance with the relevant Santos emergency procedures and in consultation with local regulatory authorities.
	Key Santos personnel will be trained in the use of fire fighting equipment.
	A permitting system for use of external ignition sources (eg cameras, mobile phones etc) at operational facilities will be implemented.
Hazardous Substances Management	Hazardous substances with the potential to impact threatened flora will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Erosion and Sediment Control	Control measures commensurate to the ongoing risk of erosion and sediment release caused by the operation of the activity will be implemented as required.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.
Final Rehabilitation	Disturbed areas of MNES will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.

4.2.1.2 Significant Threatened Birds

Table 8 identifies measures to mitigate potential impacts on threatened bird species.

Table 8: Mitigation measures for significant threatened bird species

Activity	Mitigation Measure
Pre-Construction Phase	
Site Preparation	Construction works will be scheduled to avoid breeding periods, where work delivery schedules are sufficiently flexible to do so.
	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Disturbance in and around wetlands will be avoided or minimised.
	Existing breaks between patches of potential habitat for significant threatened birds will be utilised as much as practical to minimise habitat fragmentation.
	Efforts will be made to retain mature trees.
	Water extraction will be conducted at an alternative location within the development area should an Australian painted snipe be identified utilising the habitat.
	Spotter-catchers will scout the area to be disturbed for the presence of fauna species immediately prior to the commencement of disturbance and relocate the fauna to similar habitat within an undisturbed location.
	Any significant habitat features (including abandoned raptor stick nests that may be suitable for grey falcon) to be avoided or relocated within the marked extent of disturbance will be identified and delineated.
	Maximum clearance widths for linear infrastructure will be implemented in accordance with the EA.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	All personnel will receive fauna awareness training as part of the site induction.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in or within proximity to the threatened fauna / habitat.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
	The use of barb wire will be minimised when erecting fencing. Where barb-wire fencing is unavoidable, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs or the top strand of the barb-wire will be made visible to fauna through the use of tagging.
	Restricted zones will be established around breeding places / nests that have become active after construction has commenced.
	In restricted zones, vehicles must reduce speed and thoroughfare will be limited to critical site specific construction activities. Alternative routes will be sought and utilised for all other project traffic.
	Construction activities that may result in loud sudden noise will be not permitted in proximity to areas determined to contain potential breeding habitat for significant species.

Activity	Mitigation Measure
	Night works within or adjacent to areas of MNES will be avoided where possible. Where night works are required, lights will be directed to minimise light spill into adjacent habitats.
Clearing	Clearing must occur only within the approved and demarcated areas.
	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions.
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	Clearing activities will aim to avoid trees that contain mistletoe (to mitigate impacts to painted honeyeater), and large trees that occur along watercourses (to mitigate impacts to grey falcon).
	All clearing will be conducted with a suitably qualified spotter catcher present. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	Active breeding places will only be interfered with in accordance with an approved DES Species Management Program (SMP).
	Where habitat trees need to be removed the following measures will be implemented: • Non-hollow bearing trees will be removed before hollow-bearing (or potential habitat) trees, allowing fauna an opportunity to self-relocate from the potential habitat trees. This applies in the instance when the fauna cannot be relocated, and it is evident that an animal exists within the trees; • Habitat trees will be inspected by spotter-catchers to determine occupancy. Where fauna is present, spotter-catchers will encourage the fauna to leave by reasonable means or capture and relocate it in the local environment prior to felling and trimming; • Habitat trees will be felled gently or lowered to the ground and trees will be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further processing of the trees. After this time the spotter-catchers will thoroughly check the tree to ensure there are no injured animals; • Displaced fauna will then be relocated to a suitable, previously identified recipient site provided the animal did not sustain any injuries. Any injured animals (native or introduced) will be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area.
Blasting	Blasting will be minimised around areas with congregations of birds, such as wetlands or breeding areas.
	Prior to blasting, spotter-catchers will survey the area surrounding the blast zone and remove / disperse identified fauna.
	All reasonable and feasible noise mitigation measures during noise generating activities will be implemented.
Water Management	Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels.
	Appropriate erosion and sediment controls will be installed and maintained around significant disturbance areas.

Activity	Mitigation Measure
	Authorised releases will be carried out in a manner that ensures no runoff to surface waters, ponding or damage to vegetation.
	Water quality monitoring downstream of works in watercourses will occur to confirm compliance with release limits specified under the Environmental Authority.
	A 50 m buffer between sewage effluent irrigation areas and watercourses, wetlands or significant vegetation will be maintained and a 100 m buffer from potable water supply or stock drinking water.
Dust Management	Dust suppression strategies will be implemented to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat. Strategies include the watering of roads and disturbed areas during construction activities and enforcing vehicle speed limits.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up- to-date Weed Hygiene Declaration.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be remediated as required.
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where threatened fauna habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of

Activity	Mitigation Measure
	areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up- to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Emissions Management	Lighting disturbances will be reduced / minimised especially near threatened habitat areas and active breeding places.
	To reduce noise and vibration, equipment will be regularly maintained to be in good working order.
Fire Management	Threat of wildfire caused by Santos activities will be minimised through maintenance of firebreaks around ignition sources as appropriate.
	Fire management and response will be conducted in accordance with the relevant Santos emergency procedures and in consultation with local regulatory authorities.
	Key Santos personnel will be trained in the use of fire fighting equipment.
	A permitting system for use of external ignition sources (eg cameras, mobile phones etc) at operational Santos facilities will be implemented.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Site Management	Fencing of drilling sites will be implemented to prevent access by terrestrial fauna.
	Movement within the development area will be via approved access tracks only with speed limits enforced. The requirement to enter and traverse the development area will be minimised where possible and limited to those required for essential activities.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.
Final Rehabilitation	Disturbed areas of MNES will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.

4.2.1.3 Significant Reptiles

Table 9 identifies measures to mitigate potential impacts on threatened reptile species.

Table 9: Mitigation measures for significant reptile species

Activity	Mitigation Measure
Pre-construction Phase	
Site Preparation	Construction works will be scheduled to avoid breeding periods where work delivery schedules are sufficiently flexible to do so.
	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Disturbance in and around rocky habitat and log piles will be avoided or minimised.
	Efforts will be made to retain mature trees.
	Exclusion zones will be established around identified fauna habitat features to be retained (eg mature trees, rocky habitat, log piles).
	Spotter-catchers will scout the area to be disturbed for the presence of fauna species immediately prior to the commencement of disturbance and relocate the fauna to an undisturbed location.
	Clearing works will prioritise avoiding gilgai formations.
	Survey works conducted prior to clearing will include yakka skink colony searches in areas of potential yakka skink habitat. A 200 m exclusion buffer will be demarcated for any identified colonies.
	Maximum clearance widths for linear infrastructure will be implemented in accordance with the EA.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	All personnel will receive fauna awareness training as part of the site induction.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in or within proximity to the threatened fauna / habitat.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
	Restricted zones will be established around breeding places / nests that have become active after construction has commenced.
	In restricted zones, vehicles must reduce speed and thoroughfare will be limited to critical site specific construction activities. Alternative routes will be sought and utilised for all other project traffic.
	Construction activities that may result in loud sudden noise will be not permitted in proximity to areas determined to contain potential breeding habitat for significant species.
	Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create ‘ladders’ to enable fauna to exit and to provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.

Activity	Mitigation Measure
	Night works within or adjacent to areas of significant species habitat will be avoided where possible. Where night works are required, lights will be directed to minimise light spill into adjacent habitats.
Clearing	Clearing must occur only within the approved and demarcated areas.
	Clearing works that occur in areas of potential ornamental snake habitat will prioritise avoiding gilgai formations.
	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions.
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative.
	All clearing will be conducted with a suitably qualified spotter catcher present. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	Active breeding places will only be interfered with in accordance with an approved DES SMP.
	Microhabitat features such as fallen logs will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing where practicable.
Pipeline Construction	The period of time that trenches and other excavations are open, will be minimised, particularly in known areas of MNES habitat.
	Pipe string ends will be capped nightly to prevent access to threatened fauna.
	Open trenches will be checked for trapped fauna in the morning and at the end of the day.
	Measures such as trench ladders, ramps, sticks, ropes and the use of moist hessian sacks at regular intervals (or similar) will be utilised to help trapped fauna escape and/or survive until removed by fauna spotter-catchers.
	Prior to backfilling, trenches will be checked for fauna and removed accordingly.
Dust Management	Dust suppression strategies will be implemented to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat. Strategies include the watering of roads and disturbed areas during construction activities and enforcing vehicle speed limits.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up- to-date Weed Hygiene Declaration.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.

Activity	Mitigation Measure
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be remediated as required.
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where threatened fauna habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	
Fire Management	Threat of wildfire caused by Santos activities will be minimised through maintenance of firebreaks around ignition sources as appropriate.
	Fire management and response will be conducted in accordance with the relevant Santos emergency procedures and in consultation with local regulatory authorities.
	Key Santos personnel will be trained in the use of fire fighting equipment.
	A permitting system for use of external ignition sources (eg cameras, mobile phones etc) at operational Santos facilities will be implemented.
Emissions Management	Lighting disturbances will be reduced / minimised especially near threatened habitat areas and active breeding places.
	To reduce noise and vibration, equipment will be regularly maintained to be in good working order.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.

Activity	Mitigation Measure
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Site Management	Fencing of drilling sites will be implemented to prevent access by terrestrial fauna.
	Movement within the development area will be via approved access tracks only with speed limits enforced. The requirement to enter and traverse the development area will be minimised where possible and limited to those required for essential activities.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority, except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.
Final Rehabilitation	Disturbed areas in MNES will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the relevant Environmental Authority except where ownership of the asset has been transferred to the landholder.

4.2.1.4 Significant Mammals

Table 10 identifies measures to mitigate potential impacts on threatened mammal species.

Table 10: Mitigation measures for significant mammal species

Activity	Mitigation Measure
Pre-construction Phase	
Site Preparation	Construction works will be scheduled to avoid breeding periods where work delivery schedules are sufficiently flexible to do so.
	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Disturbance in and around cave structures and rocky outcrops will be avoided.
	Efforts will be made to retain mature trees.
	Exclusion zones will be established around identified fauna habitat features to be retained (eg mature trees, rocky outcrops, cave structures, etc).
	A spotter-catcher will scout the area to be disturbed for the presence of fauna species immediately prior to the commencement of disturbance and relocate the fauna to an undisturbed location.
	Any significant habitat features to be avoided or moved within the marked extent of disturbance will be identified and delineated.
	Where clearing is required in an area of potential greater glider habitat comprising narrow linear patches, clearing will not reduce the size of patches so that gaps between become greater than 100 m.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	All personnel will receive fauna awareness training as part of the site induction.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in or within proximity to the threatened fauna / habitat.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
	The use of barb wire will be minimised when erecting fencing. Where barb wire fencing is unavoidable, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs or the top strand of the barb-wire will be made visible to fauna through the use of tagging.
	Restricted zones will be established around breeding places / nests that have become active after construction has commenced.
	In restricted zones, vehicles must reduce speed and thoroughfare will be limited to critical site specific construction activities. Alternative routes will be sought and utilised for all other project traffic.
	Construction activities that may result in loud sudden noise will be not permitted in proximity to areas determined to contain potential breeding habitat for significant species.
	Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create ‘ladders’ to enable fauna to exit and to

Activity	Mitigation Measure
	provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.
	Night works within or adjacent to areas of significant species habitat will be avoided where possible. Where night works are required, lights will be directed to minimise light spill into adjacent habitats.
Clearing	Clearing must occur only within the approved and demarcated areas.
	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions.
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	All clearing will be conducted with a suitably qualified spotter catcher present.
	Active breeding places will only be interfered with in accordance with an approved DES SMP.
	Where habitat trees need to be removed the following measures will be implemented: • Non-hollow bearing trees will be removed before hollow-bearing (or potential habitat) trees, allowing fauna an opportunity to self-relocate from the potential habitat trees. This applies in the instance when the fauna cannot be relocated, and it is evident that an animal exists within the trees; • Habitat trees including hollow logs will be inspected by a spotter-catcher to determine occupancy. Where fauna is present, the spotter-catcher will encourage the fauna to leave by reasonable means or capture and relocate it in the local environment prior to felling and trimming (except if a koala is located, see below); • Habitat trees will be felled gently or lowered to the ground and trees will be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further processing of the trees. After this time the spotter-catcher will thoroughly check the tree to ensure there are no injured animals; • Displaced fauna will then be relocated to a suitable, previously identified recipient site provided the animal did not sustain any injuries. Any injured animals (native or introduced) will be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area.
	Koalas may not be forcibly removed prior to construction. Clearing must be carried out in a way that ensures any koala present have time to move out of the clearing site without human intervention.
	Microhabitat features such as large fallen logs will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing where practicable.
	Cleared vegetation and construction equipment and pipes shall be stockpiled in a manner that does not significantly impede fauna movements.
Blasting	Blasting will be minimised around sandstone ridges with caves, overhangs or old mine shafts.
	Prior to blasting, spotter-catchers will survey the area surrounding the blast zone and remove / disperse identified fauna.

Activity	Mitigation Measure
	All reasonable and feasible noise mitigation measures during noise generating activities will be implemented.
Pipeline Construction	The period of time that trenches and other excavations are open, will be minimised, particularly in known areas of MNES habitat.
	Pipe string ends will be capped nightly to prevent access to threatened fauna.
	Open trenches will be checked for trapped fauna in the morning and at the end of the day.
	Measures such as trench ladders, ramps, sticks, ropes and the use of moist hessian sacks at regular intervals (or similar) will be utilised to help trapped fauna escape and/or survive until removed by a fauna spotter-catcher.
	Prior to backfilling, trenches will be checked for fauna and removed accordingly.
Dust Management	Dust suppression strategies will be implemented to manage the risk of adverse impacts associated with excessive dust deposition on threatened fauna habitat. Strategies include the watering of roads and disturbed areas during construction activities and enforcing vehicle speed limits.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be remediated as required.

Activity	Mitigation Measure
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where threatened fauna habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	
Emissions Management	Lighting disturbances will be reduced / minimised especially near threatened habitat areas and active breeding places.
	To reduce noise and vibration, equipment will be regularly maintained to be in good working order.
Fire Management	Wildfire caused by Santos activities will be prevent through maintenance of firebreaks around ignition sources as appropriate.
	Fire management and response will be conducted in accordance with the relevant Santos emergency procedures and in consultation with local regulatory authorities.
	Key Santos personnel will be trained in the use of fire fighting equipment.
	A permitting system for use of external ignition sources (eg cameras, mobile phones etc) at operational Santos facilities will be implemented.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Site Management	Fencing of drilling sites will be implemented to prevent access by terrestrial fauna.
	Movement within the development area will be via approved access tracks only with speed limits enforced. The requirement to enter and traverse the development area will be minimised where possible and limited to those required for essential activities.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.

Activity	Mitigation Measure
Final Rehabilitation	Disturbed areas in will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the Environmental Authority, except where ownership of the asset has been transferred to the landholder.

4.2.1.5 Significant Aquatic Fauna

Table 11 identifies measures to mitigate potential impacts on threatened aquatic fauna.

Table 11: Mitigation measures of significant species of aquatic fauna

Activity	Mitigation Measure
Pre-construction Phase	
Site Preparation	Construction works will be scheduled to avoid breeding periods where work delivery schedules are sufficiently flexible to do so.
	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Watercourse and wetland crossings will be selected to avoid areas containing deep pools and river sandbanks likely to be suitable for breeding places where constructability constraints in surrounding areas allow it
	Width of linear infrastructure corridors across watercourses will be reduced as much as reasonably possible.
	Any significant habitat features to be avoided or moved within the marked extent of disturbance will be identified and delineated.
	Microhabitat such as semi-submerged logs and snags will be relocated to undisturbed areas prior to disturbance.
Site Induction and Work Instruction	All personnel will receive fauna awareness training as part of the site induction.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in or within proximity to the threatened fauna / habitat.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
	Construction activities that may result in loud sudden noise will be not permitted in proximity to areas determined to contain potential breeding habitat for significant species.
Clearing	Clearing must occur only within the approved and demarcated areas.
	All vegetation clearing within identified threatened fauna habitat must comply with clearing related approval conditions.
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	All clearing will be conducted with a suitably qualified spotter catcher present. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	Active breeding places will only be interfered with in accordance with an approved DES SMP.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative.
Blasting	Blasting will be minimised around watercourses.
	Prior to blasting, spotter-catchers will survey the area surrounding the blast zone and remove / disperse identified fauna.

Activity	Mitigation Measure
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Erosion and Sediment Control	Control measures commensurate to the risk of erosion and sediment release caused by the construction activity will be implemented as required to reduce sedimentation of watercourses, manage turbidity and maintain flow rates.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be remediated as required.
Water Management	Where approved, Santos may extract water from select farm dams for construction purposes. Santos will only take water where available supplies provide continuity of habitat function and quality.
	Waterways crossings to be designed to ensure uninterrupted fish passage during periods of flows.
	Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels.
	Per waterbody, a single access point will be utilized for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.
	Authorised releases will be carried out in a manner that ensures no runoff to surface waters, ponding or damage to vegetation.
	Water quality monitoring downstream of works in watercourses will occur to confirm compliance with release limits specified under the Environmental Authority.

Activity	Mitigation Measure
	A 50 m buffer between sewage effluent irrigation areas and watercourses, wetlands or significant vegetation will be maintained and a 100 m buffer from potable water supply or stock drinking water.
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where threatened fauna habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	
Emissions Management	Lighting disturbances will be reduced / minimised especially near threatened habitat areas and active breeding places.
	To reduce noise and vibration, equipment will be regularly maintained to be in good working order.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.
Final Rehabilitation	Disturbed areas of MNES will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.+

4.2.1.6 Significant Migratory Birds

Table 12 identifies measures to mitigate potential impacts on migratory bird species.

Table 12: Mitigation measures for significant species of migratory birds

Activity	Mitigation Measure
Pre-construction Phase	
Site Preparation	Construction works will be scheduled to avoid breeding periods where work delivery schedules are sufficiently flexible to do so.
	Prior to construction works commencing, the spotter catcher will ensure no migratory birds are roosting in proximity that may be disturbed by the activity.
	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Disturbance in and around wetlands will be minimised.
	Efforts will be made to retain mature trees.
	Water extraction will be conducted at an alternative location within the development area should a migratory wetland bird be identified utilising the habitat.
	A spotter-catcher will scout the area to be disturbed for the presence of migratory species immediately prior to the commencement of disturbance and relocate the fauna to an undisturbed location.
	Construction works that will occur in the direct vicinity of the constructed wetland should only be conducted outside of the migratory bird period (August to May).
	Any significant habitat features to be avoided or moved within the marked extent of disturbance will be delineated.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	All personnel will receive fauna awareness training as part of the site induction.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in or within proximity to the migratory species / habitat.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
	The use of barb wire will be minimised when erecting fencing. Where barb wire fencing is unavoidable, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs or the top strand of the barb-wire will be made visible to fauna through the use of tagging.
	Restricted zones will be established around breeding places / nests that have become active after construction has commenced.
	In restricted zones, vehicles must reduce speed and thoroughfare will be limited to critical site specific construction activities. Alternative routes will be sought and utilised for all other project traffic.
	Construction activities that may result in loud sudden noise will be not permitted in proximity to areas determined to contain potential breeding habitat for significant species.

Activity	Mitigation Measure
	Night works within or adjacent to areas of significant species habitat will be avoided where possible. Where night works are required, lights will be directed to minimise light spill into adjacent habitats.
Clearing	Clearing must occur only within the approved and demarcated areas.
	All vegetation clearing within identified migratory species habitat must comply with clearing related approval conditions.
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative.
	Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the clearing activities and into adjacent natural areas.
	All clearing will be conducted with a suitably qualified spotter catcher present. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	Active breeding places will only be interfered with in accordance with an approved DES SMP.
	Where habitat trees need to be removed the following measures will be implemented: • Non-hollow bearing trees will be removed before hollow-bearing (or potential habitat) trees, allowing fauna an opportunity to self-relocate from the potential habitat trees. This applies in the instance when the fauna cannot be relocated, and it is evident that an animal exists within the trees; • Habitat trees will be inspected by a spotter-catcher to determine occupancy. Where fauna is present, the spotter-catcher will encourage the fauna to leave by reasonable means or capture and relocate it in the local environment prior to felling and trimming; • Habitat trees will be felled gently or lowered to the ground and trees will be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further processing of the trees. After this time the spotter catcher will thoroughly check the tree to ensure there are no injured animals; • Displaced fauna will then be relocated to a suitable, previously identified recipient site provided the animal did not sustain any injuries. Any injured animals (native or introduced) will be taken to receive veterinary attention immediately. Once recovered, animals will be relocated to an area of similar habitat in proximity to the disturbance area.
Blasting	Blasting will be minimised around areas with congregations of birds, such as wetlands or breeding areas.
	Prior to blasting, spotter-catchers will survey the area surrounding the blast zone and remove / disperse identified fauna.
	All reasonable and feasible noise mitigation measures during noise generating activities will be implemented.
Water Management	Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels.
	Appropriate erosion and sediment controls will be installed and maintained around significant disturbance areas.
	Authorised releases will be carried out in a manner that ensures no runoff to surface waters, ponding or damage to vegetation.

Activity	Mitigation Measure
	Water quality monitoring downstream of works in watercourses will occur to confirm compliance with release limits specified under the Environmental Authority.
	A 50 m buffer between sewage effluent irrigation areas and watercourses, wetlands or significant vegetation will be maintained and a 100 m buffer from potable water supply or stock drinking water.
Dust Management	Dust suppression strategies will be implemented to manage the risk of adverse impacts associated with excessive dust deposition on migratory species habitat. Strategies include the watering of roads and disturbed areas during construction activities and enforcing vehicle speed limits.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be remediated as required.
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where MNES habitat was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	

Activity	Mitigation Measure
Fire Management	Threat of wildfire caused by Santos activities will be minimised through maintenance of firebreaks around potential ignition sources as appropriate.
	Fire management and response will be conducted in accordance with the relevant Santos emergency procedures and in consultation with local regulatory authorities.
	Key Santos personnel will be trained in the use of fire fighting equipment.
	A permitting system for use of external ignition sources (eg cameras, mobile phones etc) at operational Santos facilities will be implemented.
Emissions Management	Lighting disturbances will be reduced / minimised especially near threatened habitat areas and active breeding places.
	To reduce noise and vibration, equipment will be regularly maintained to be in good working order.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect threatened fauna will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the relevant Environmental Authority except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.
Final Rehabilitation	Disturbed areas in MNES will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the Environmental Authority except where ownership of the asset has been transferred to the landholder.

4.2.1.7 Threatened Ecological Communities

Table 13 identifies measures to mitigate potential impacts on TECs.

Table 13: Mitigation measures for TECs

Activity	Mitigation Measure
Pre-construction Phase	
Site Preparation	The limits of works will be clearly marked or communicated to all personnel to minimise the potential for disturbance to environmental values outside the approved development area.
	Clearing works will not exceed approved clearing limits, intersect or dissect a patch of Brigalow TEC in a way that reduces the patch size below 0.5 ha.
	Clearing works will not exceed approved clearing limits, intersect or dissect a patch of Poplar Box TEC in a way that reduces the patch size below 1 ha.
	No clearing within the SEVT TEC, Weeping Myall Woodlands TEC and Coolibah – Black Box Woodlands TEC will occur.
Site Induction and Work Instruction	All personnel will receive TEC awareness training as part of the site induction, including the significance of these communities and location relevant to construction site.
	Site personnel, including contractors, will be made aware of the extent of any authorised area in which they will be working and where necessary, be advised of any specific limitations appropriate to the construction works being conducted in or within proximity to the TECs.
Construction Phase	
Access	Access to and from different locations will occur along designated access tracks only.
Clearing	Clearing must occur only within the approved and delineated area.
	All vegetation clearing within identified TEC's must comply with clearing related approval conditions.
	The clearing footprint and areas of exclusion will remain adequately marked for the duration of the clearing activities.
	Clearing activities in areas of MNES will be supervised by an Environmental Representative.
Dust Management	Dust suppression strategies will be implemented to manage the risk of adverse impacts associated with excessive dust deposition on plants within the TEC. Strategies include the watering of roads and disturbed areas during construction activities and enforcing vehicle speed limits.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with the construction activity.
	Vehicle access will be restricted in areas containing weed infestations. If necessary, the infestation will be controlled / treated during construction to minimise exposure of equipment to weed propagules.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.

Activity	Mitigation Measure
Hazardous Substances Management	Hazardous substances with the potential to affect TEC's will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
	Storage and handling of chemicals, fuels and oils will occur in accordance with applicable Australian Standards.
	Residual drilling materials will only be applied to the development area under specific conditions to ensure no run-off impacts.
	Permanent and/or mobile spill kits will be available on sites where significant volumes of hazardous substances are being stored and/or utilised.
	Storage areas and refuelling stations will be located away from surface waters.
	Machinery and equipment will be regularly maintained to ensure it remains in working order and to avoid opportunity for leaks.
	Emergency response procedures will be implemented in the event of a large spill. Such procedures will include stopping the spill source and taking action to protect and/or minimise impacts to nearby MNES values such as creating earthen diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be remediated as required.
Erosion and Sediment Control	Control measures commensurate to the risk of erosion and sediment release caused by the construction activity will be implemented as required.
Progressive Rehabilitation / Stabilisation	To minimise erosion, areas where TEC was cleared or impacted during construction will be graded and contoured to ensure that the area is safe, stable and non-polluting as far as practicable.
	Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species within the patch.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabilitation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority.
Operational Phase	
Fire Management	Threat of wildfire caused by Santos activities will be minimised through maintenance of firebreaks around ignition sources as appropriate.
	Fire management and response will be conducted in accordance with the relevant Santos emergency procedures and in consultation with local regulatory authorities.
	Key Santos personnel will be trained in the use of fire fighting equipment.
	A permitting system for use of external ignition sources (eg cameras, mobile phones etc) at operational Santos facilities will be implemented.
Pest and Weed Management	Pest and weed management strategies will be implemented to minimise the introduction and/or spread of pest and weed species associated with operational activities.
	Vehicles and other equipment will be risk assessed to determine the necessary level of inspection, washdown and certification when travelling to or between locations within the development area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	Access tracks and operational assets will be maintained to be free of declared or significant weeds to avoid contamination of vehicles and machinery.

Activity	Mitigation Measure
	Putrescible waste storages will be covered to minimise vertebrate fauna access to food scraps.
Hazardous Substances Management	Hazardous substances with the potential to affect TEC's will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and standards.
Progressive Rehabilitation / Stabilisation	Rehabilitation of areas of MNES that are no longer subject to ongoing operational or maintenance requirements will commence to achieve the planned final land use and as required by the conditions of the Environmental Authority, except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of infrastructure will be conducted as per relevant internal processes and regulatory requirements.
Final Rehabilitation	Disturbed areas of MNES will be offset and/or rehabilitated to achieve the planned final land use and as required by the conditions of the Environmental Authority, except where ownership of the asset has been transferred to the landholder.

4.2.2 Monitoring and Corrective Actions

Table 14 below provides an overview of monitoring requirements and corrective actions to assess the effectiveness of the mitigation measures implemented during all phases. Corrective actions will be adapted where they do not resolve identified issues to ensure the ongoing minimisation of impacts to MNES values.

Monitoring activities will be focussed on higher risk activities and higher risk disturbances. A higher risk activity or higher risk disturbance includes a disturbance to MNES that is:

- large in scale (e.g. greater than 5 ha);
- occurring adjacent to watercourses or wetland;
- occurring in a MNES with a constraints category of B as defined in the Protocol; or
- occurring on slopes greater than 10%.

Monitoring will be conducted most frequently during the construction phase where the risks to MNES are most apparent.

Monitoring activities during the operational phase will be conducted less frequently, and also focussed on higher-risk areas.

Intermittent monitoring of lower risk sites will be undertaken with representative samples being used to detect potential issues for similar disturbances / activities across the development area.

To evaluate the effectiveness of the monitoring activities, trigger levels and corrective actions Santos will:

- Conduct internal and third party audits to formally assess the level of compliance with both regulatory requirements and with Santos procedures. Audit outcomes will be used to develop / alter corrective actions that may include changes to this plan and/or other procedures.
- Analyse all relevant data collected for negative and/or undesirable trends that may be prevented by procedural changes or by implementing another measure or process.

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Table 14: Monitoring requirements and corrective actions

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
Pre-Construction Phase					
Site Preparation	Clearing extent in MNES is delineated.	Check that clearing extent is delineated.	Prior to clearing or disturbance.	Clearing extent is not clearly delineated.	Re-instate clearing area delineation where necessary.
	MNES specimens and habitat features to be retained are identified and delineated.	Check if MNES specimens and habitat features to be retained are identified and delineated.	Prior to clearing or disturbance.	Features to be retained have not been identified and delineated.	Identify / delineate specimens and features to be retained.
Construction Phase					
Access	No unplanned impacts to MNES	Monitor for evidence of vehicles leaving designated accesses.	Daily onsite transit observations Intermittent review of IVMS data	Disturbance to MNES outside of approved area.	Implement measures to improve compliance with site access.
Clearing	No unplanned impacts to MNES Destruction of significant habitat features by construction activities is minimised as far as practicable. Active breeding places are not destroyed as a result of construction activities. No injury to, or fatalities of threatened fauna species as a result of construction activities.	Monitor clearing activities in areas of MNES to ensure clearing is being undertaken in a sequential manner, inside demarcated areas and in accordance with any relevant approval conditions. Inspect active breeding places for breeding activity or signs of distress. Inspect trenches and/or other excavations prior to commencement of works for trapped fauna. Review fauna spotter catcher data / release information. Ensure records of MNES are entered into the WebGIS.	Daily inspections of clearing area during clearing events.	Disturbance to MNES outside of approved area. Injury to, or fatality of threatened fauna species Destruction of active breeding place or identified significant habitat feature	Reinstate clearing area delineation where it has failed. Reinforce need to conduct activity in designated and approved areas during site toolbox / induction meetings. Recalculate impacts / deduction from statutory disturbance limits where disturbance has exceeded that approved prior to construction. Reinstate clearing area delineation where it has failed. Reinforce need to conduct activity in designated and approved areas during site toolbox / induction meetings.

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
					Reiterate vehicle speed limits during toolbox meetings. Utilise spotter catcher to remove and relocate fauna from construction site prior to recommencement of works. Review the circumstances that death or injury occurred and update fauna spotter catcher procedures if death was avoidable. Update fauna habitat mapping where fauna identified in unmapped areas. Ensure fauna habitat mapping reflects results of the spotter catcher work.
Dust Management	No adverse impacts to MNES from dust caused by construction activities.	Assess dust deposition on vegetation adjoining the construction area. Monitor implementation of watering of unsealed / disturbed areas. Monitor compliance with vehicle speed limits.	Monthly / quarterly inspections during programmed site inspections (site / seasonal dependent).	Adjacent vegetation exhibits signs of distress when compared to vegetation in areas away from construction activities.	Increase frequency of road watering where necessary. Provide cover on soil stockpiles that are proposed to be exposed for a prolonged period. Review appropriateness of vehicle speed limits and reduce if necessary. Review options for irrigating adjacent vegetation to simulate a rain event (dust removal).
Pest and Weed Management	No new or increased infestations of declared and significant weed species in MNES as a result of construction activities.	Conduct checks on vehicles and machinery to ensure they hold a valid and up-to-date Weed Hygiene Declaration.	Daily / weekly project vehicle checks during construction. Monthly / quarterly weed infestation	New weed infestations present in Santos construction areas caused by Santos activities. A significant proportion of machinery and vehicles do	Prevent vehicle and materials access on site if they have not been certified as weed free. Reiterate the importance of Weed Hygiene Declaration process

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
	Pest animals have no access to supplementary food sources from Santos activities	Monitor for new weed infestations in MNES resulting from construction activities. Inspect camp / waste facilities to ensure putrescible wastes are appropriate covered and contained.	checks during programmed site inspections (site dependent).	not possess up-to-date Weed Hygiene Declarations. Significant pest population present in Santos operational camps / waste areas.	during toolbox meetings / inductions. Implement a control program for any new infestation identified in the construction area to prevent further spread. Rectify storages where pest animals can gain access to contents. If, pest fauna species increase in numbers, a feral fauna control program will be developed and implemented in consultation with local government and the relevant landholders
Hazardous Substances Management	No release of hazardous substances to MNES. No deaths or injuries to MNES as a result of exposure to hazardous substances.	Inspect containment areas in proximity to MNES to ensure they are functional and working correctly. Inspect spill kits to ensure they contain correct materials. Inspect on-site machinery and equipment for any leaks / releases. Inspect construction areas for signs of soil contamination.	Monthly / quarterly during programmed site inspection (site dependent).	Release of hazardous substances to areas of MNES. Injury to, or death of MNES from exposure to hazardous substances.	Determine the cause of the release and put in place new process / procedure if required. Assess the effectiveness of any spill / emergency response plan and update if required. Remediate any areas of contaminated soil.
Erosion and Sediment Control	No unauthorised release of sediment to surface waters in MNES. Soil erosion in MNES is minimised as far as practicable.	Inspect on-site erosion and sediment control devices in areas of MNES to ensure they are fully operational / effective. After heavy rainfall, check surface waters adjacent to exposed disturbance areas for signs of sediment release in areas of MNES.	Daily / weekly during programmed site inspection (risk dependent).	Release of sediment to surface waters. Significant soil erosion evident.	Repair and/or modify erosion and sediment control devices if they have failed / not working correctly. Install new or additional erosion and sediment control measures where soil erosion or sediment release is evident.

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
Stabilisation	Areas not needed for ongoing operational purposes in MNES are being actively stabilised.	Check if stabilisation activities have commenced on non-operational areas in MNES.	Quarterly / annually during programmed site stabilisation inspections (risk dependent).	Stabilisation of on-going operational areas has not commenced.	Schedule stabilisation activities to commence.
Operational Phase					
Pest and Weed Management	No new or increased infestations of declared and significant weed species in MNES as a result of operational activities. Pest animals have no access to supplementary food sources from Santos activities.	Conduct checks on vehicles and machinery to ensure they hold a valid and up-to-date Weed Hygiene Declaration. Monitor for new weed infestations in MNES resulting from operational activities. Monitor the effectiveness of any weed control programs implemented in MNES. Inspect major accesses to ensure free of declared and/or significant weeds. Inspect camp / waste facilities to ensure putrescible wastes are appropriately covered and contained.	Monthly / quarterly (weed infestation checks) during programmed site inspections (site dependent).	New declared or significant weed infestations present or expanding in Santos operational areas in MNES caused by Santos activities. Machinery, vehicles and other materials do not possess up-to-date Weed Hygiene Declarations. Significant pest population present in Santos operational camps / waste areas.	Prevent vehicle and materials access on site if they have not been certified as weed free. Reiterate the importance of Weed Hygiene Declaration process during toolbox meetings / inductions. Reiterate the importance of utilising designated access tracks only during toolbox meetings / inductions. Rectify storages where pest animals can gain access to contents. If, pest fauna species increase in numbers, a feral fauna control program will be developed and implemented in consultation with local government and the relevant landholders.
Stabilisation	Ongoing operational areas in MNES are stabilised.	Inspect any stabilised areas in MNES for any instability, erosion or lack of cover.	Quarterly / annually during programmed site stabilisation inspections (site dependent).	Stabilised area showing signs of instability and/or lacking groundcover.	Commence remedial actions to ensure site remains stable.

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
Progressive Rehabilitation	Rehabilitated areas in MNES progressing to final rehabilitation target.	Inspect rehabilitated areas in MNES for instability, erosion and vegetative growth and diversity.	Annually during programmed site rehabilitation inspections (site dependent).	Rehabilitated areas are unstable, eroded or lack of vegetative growth / diversity present.	Conduct additional plantings and/or treatment (fertiliser, watering etc) to achieve planned rehabilitation target.
Decommissioning Phase					
Decommissioning and Abandonment	No unplanned impacts to MNES.	Check decommissioning activities remain within approved areas. Monitor that exclusion demarcation remains intact.	Daily / weekly during programmed site inspection (site dependent).	Disturbance to MNES outside of approved area. Exclusion zones or features to be retained are not adequately delineated.	Reinstate delineation markers where they have failed Reinforce need to conduct activity in designated and approved areas during toolbox meetings. Recalculate impacts / deduction from statutory disturbance limits where disturbance has been exceeded
Final Rehabilitation	Decommissioned and abandoned assets in MNES are being actively rehabilitated. Rehabilitated areas in MNES progressing to final rehabilitation target.	Monitor decommissioned and abandoned assets in MNES to ensure rehabilitation activities have commenced Inspect rehabilitated areas in MNES for instability, erosion and vegetative growth and diversity.	Annually during programmed site rehabilitation inspections (site dependent).	No rehabilitation of areas no longer required for construction or operational activities. Rehabilitated areas are unstable, eroded or lack of vegetative growth / diversity present.	Schedule rehabilitation activities to commence. Undertake necessary works to ensure area is stable. Conduct additional plantings and/or treatment (fertiliser, watering etc) to achieve planned rehabilitation target.

5.0 Threats to Significant Species and Threatened Ecological Communities

The activities required for the Towrie development have the potential to cause an adverse impact to significant flora, fauna and TECs. The potential for adverse impacts to MNES to be caused by development activities is greatest, and largely restricted to construction activities, during the construction phase when clearing and earthworks are carried out. Risks to MNES during all other phases are considered minimal. The potential threats to significant species and TECs posed by the activities within the development area are summarised in Table 15.

Table 15: Potential impacts to significant species and TECs

Potential Impact	Description
Habitat Loss	The clearing of vegetation for the construction of infrastructure has the potential to result in a direct loss of habitat for significant species and TECs. Clearing also has the potential to degrade the quality of existing habitat where the construction of infrastructure has resulted in fragmentation and the creation of edge effects. Clearing will predominantly occur during the construction phase and will be limited to the extent essential to allow for safe construction and operations (e.g. trees may be lopped and not felled to allow construction vehicle access).
Fragmentation	Clearing required for the construction of infrastructure within the development area has the potential to result in fragmentation of habitat and contiguous vegetation communities. This can interrupt species movements and result in the formation of 'islands' and thereby population fragmentation. The development area is already highly fragmented due to clearing associated with historic grazing practices. An intact stand of contiguous vegetation remains along the western escarpment; however, Santos does not propose any activities within this area. Project-related clearing will predominantly occur during the construction phase and will be limited to the extent essential to allow for safe construction and operations (e.g. trees may be lopped and not felled to allow construction vehicle access).
Injury / Mortality / Entrapment	The development of track and road networks during the construction phase and their continued use throughout the operational phase has the potential to result in injury / mortality of fauna. Injury and mortality is likely to be limited to smaller, less mobile fauna such as reptiles, amphibians and mammals, and some bird species such as Squatter pigeon. In addition, other infrastructure, including markers and fencing, pipeline trenches and fluid containment structures, has the potential to cause injury and/or mortality for some more active fauna species.
Introduction of pests and weeds	Pests and weeds can be spread across a landscape either intentionally or unintentionally via both anthropogenic and natural mechanisms. Activities conducted throughout the development area have the potential to inadvertently introduce and spread pest and weed species throughout the tenure and surrounding region, primarily through poor weed hygiene practices and the movement of vehicles between 'clean' and 'dirty' regions. There is also potential for increased movement of pest fauna that are already present in the area through habitat modification, and supplementary food sources as a result of generated wastes from facilities.
Disturbance of behaviour / movement	Construction and operations have the potential to disturb the behaviour and movements of some fauna. Disturbances may include some disruption of breeding activities. Some disturbance of fauna movement and behaviour is unlikely to have more than minimal impact on populations. However, when combined with the loss of habitat, changes in behaviour may

Potential Impact	Description
	increase the risk of predation and the sustainability of populations. Most disturbances will be short-term and occur predominantly during construction.
Dust	Prolonged deposition of dust on foliage can impact on a plant's ability to photosynthesise, thereby inducing stress in the plant and the potential for death. Potential impacts associated with dust are most likely to occur during the construction phase where there is significant vehicle movement and earth-breaking activities. Construction and clearing activities have the potential to create small areas of relatively high but localised airborne dust loads with implications for the surrounding flora and fauna. Dust from operational activities is envisaged to be minimal. Areas impacted by dust will predominantly be small (i.e. areas directly bordering construction and clearing activities or track or road verge) and impacts will be short term. Impacts as a result of dust are likely to be limited to sensitive flora species, TECs located close to dust sources and fauna with minimal mobility (e.g. aquatic fauna, amphibians and small reptiles).
Noise, Lighting, Vibration	Excessive noise, bright lighting and vibration have the potential to disturb fauna inhabiting the immediate vicinity of construction activity, particularly whilst breeding or preparing to breed. Potential impacts of noise, lighting and vibration will be more prevalent during the construction phase and will therefore be relatively short-term. Sensitive fauna are likely to temporarily leave impacted areas, but some acclimation may occur. Fauna are likely to return to impacted areas on cessation of the disturbance activities.
Sediment Transport	Clearing and construction activities have the potential to result in localised erosion and thereby sediment transport, particularly where activity occurs on slopes or in the vicinity of landform features such as gullies, outcrops and drainage lines. Following significant rain events, run-off from disturbed areas may result in the build-up of sediment in watercourses and waterholes. Sediment deposition to land or waterways has the potential to have an impact on flora, with some potential impact on aquatic fauna possible. Many surface waterways in the region have naturally high turbidity after significant rain events and under normal flow conditions, due to the nature of the soils and the existing disturbed nature of landscapes. Therefore, significant impacts are not anticipated.
Fire	Fire can result in the potential loss (either temporary or permanent) of vegetative cover or microhabitat, thereby impacting on terrestrial flora, fauna and TECs. Altered fire regimes (i.e. increased frequency) caused by development activities may over time also result in vegetation changes, further equating to the loss of habitat. The risk of fire associated with development activities is considered unlikely.
Soil Contamination	Soil contamination has the potential to occur as result of spillage of hydrocarbons from construction machinery, particularly during refuelling, or from fuel or chemical storage tanks. Flora and fauna can be adversely affected by soil contamination. Any soil contamination is expected to be infrequent and localised.
Surface Water Degradation	Construction near waterways and in particular the construction of linear infrastructure across waterways may result in alteration of flows and increased sedimentation and turbidity. This has the potential to adversely impact aquatic fauna and flora. Contamination of waterways resulting from the spillage of hydrocarbons is unlikely, although some flow into waterways may occur following a large spill. Contamination of waterways will also pose a risk to aquatic flora and fauna. Impacts to waterways are most likely to occur during the construction phase and is anticipated that direct impacts would be small and localised.
Groundwater Degradation	Contamination of shallow groundwater has the potential to occur during the construction phase as result of any prolonged spillage of hydrocarbons (fuels, hydraulic oils and lubricants), however this is considered to be localised and limited.

6.0 Recording and Reporting Requirements

6.1 Recording MNES

Records of flora and fauna individuals sighted in the development area will be maintained in the Santos GIS. Specifically, sightings will include the following information:

- Species name;
- Kingdom (flora or fauna);
- EPBC Act classification;
- *Nature Conservation Act 1992* classification;
- Number of individuals counted;
- Date of sighting;
- Details of who recorded the sighting;
- Co-ordinates of the sighting; and
- Any other relevant comments to the record.

Records of identified TECs will also be maintained in the Santos GIS with the following information:

- Community Name
- EPBC Act classification;
- Regional Ecosystem identifier;
- Regional Ecosystem classification;
- Confirmation if community is comprised of regrowth; and
- Co-ordinates and extent of community.

6.2 Recording and Tracking Disturbances to MNES

For disturbances to significant species and TECs, the following details will be recorded:

- The location and extent of the disturbance and the type of infrastructure or activity responsible for the disturbance;
- Details of the areas identified as containing the significant species and TECs;
- The significant species and/or TEC disturbed; and
- The effect on any disturbance limits for the significant species and TECs as set out in the approval documents.

Disturbances will be frequently updated in Santos GIS so that predicted disturbances can be analysed with actual disturbances and records updated to accurately reflect cumulative disturbance levels. Similarly, disturbances in MNES will be acquitted against disturbance limits, to ensure compliance with the EPBC Approval.

A record of all documents required by the SSMP will be kept for the life of the Towrie development.

6.3 Reporting

Santos will comply with environmental reporting requirements imposed by the Queensland Government under the Environmental Authority and any conditions imposed by the Commonwealth Government in making a decision under Division 2 of the EPBC Act.

Details of any impact or presumed impact to a significant species or TEC along with a record of any assessments required will be kept, and submitted to the administering authority as required.

7.0 Review

The SSMP shall be reviewed every three years or when any of the following occur:

- The plan is not adequately managing the issue - an unauthorised direct or indirect impact to significant species and/or TEC is identified as a result of activity in the development area;
- Legislative requirements, including relevant conditions of approval change;
- The area of activity changes;
- If a threatened species, community or migratory species that was listed at the time of the referral is identified within the development area and is not included in the SSMP;
- Details of specific Species Profile and Threats profiles, threat abatement plans and conservation advices change; or
- A written request from the Minister for the SSMP to be reviewed.

8.0 Species and Community Profiles

8.1 *Acacia grandifolia*

8.1.1 Status

Vulnerable – listed 16 July 2000

8.1.2 Biology and ecology

8.1.2.1 Characteristics

Acacia grandifolia is a tree growing to about 8 m high with flowers in long golden spikes (Orchard & Wilson 2001).

Plate 1: *Acacia grandifolia* (Source: Fagg n.d)

8.1.2.2 Known distribution

This species is endemic to south-east Queensland and is restricted to a small area around Gayndah, Mundubbera, Coulston Lakes and Proston in the Burnett District (Qld CRA/RFA Steering Committee 1998; QDNR 2000).

The type specimen is from 54 km south of Mundubbera and another specimen is from 12 km east of Gayndah (Pedley 1987). The species occurs in State Forest 132 (Brovinia), State Forest 220 (Malmaison), State Forest 249 (Wigton), State Forest 255 (Woroon) and State Forest 1344 (Boompa) (QDNR 2000). This species also occurs in State Forest 210 and on Brian Pastures Research Station. It

is also recorded from leasehold land and road verges in the area (Qld CRA/RFA Steering Committee 1998). Outlying records also occur within the Carnarvon (ALA 2015) and Dawson Ranges (DSITI 2015).

The literature does not specify how many populations exist, though its existence near three towns and in five state forests (QDNR 2000), suggests around eight populations. The species occurs as large colonies or as scattered individuals (QDNR 2000). It covers a range of approximately 100 km and encompasses an area of occurrence of approximately 4,200 km^2 (Qld CRA/RFA Steering Committee 1998).

There are no records of this species from a conservation reserve or a protected area (Briggs & Leigh 1996; Qld CRA/RFA Steering Committee 1998; QDNR 2000).

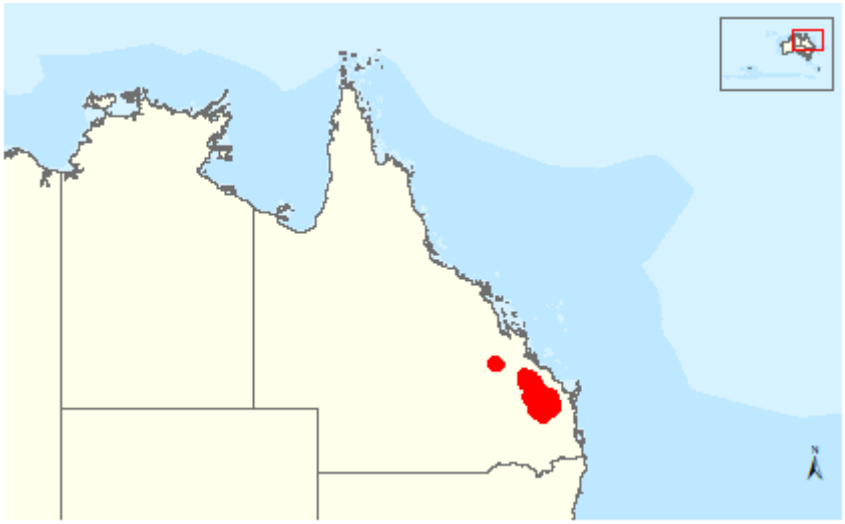

Figure 1: Mapped distribution of *Acacia grandifolia* (Source: DOTE 2014d)

8.1.2.1 Habitat description

The species grows on hilly terrain of varying aspects and slope, on hillcrests, in gullies on plains (Qld CRA/RFA Steering Committee 1998). The species appears to flourish in disturbed ground and grows well on roadsides. At the type locality the species forms open stands on sand, among large sandstone boulders. It has also been recorded on shallow stony soils derived from basalt (Pedley 1978, 1987; Orchard & Wilson 2001).

It occurs in ironbark gum and spotted gum forests and woodlands (QDNR 2000). The most frequently recorded associated tree species are *Eucalyptus crebra*, *Corymbia citriodora*, *Corymbia trachyphloia* and *Eucalyptus exserta* (Qld CRA/RFA Steering Committee 1998).

8.1.2.2 Biology and reproduction

This species flowers from July to October and mature pods have been collected from October to November. Seeds are dormant when released from mature pods and accumulate as a persistent seed bank between fires. It is not known how long seeds remain viable in the soil (DOTE 2014d). Although not confirmed, it is suspected that these plants usually seed irregularly (Leverington *et al* 2003).

Rare species occurring within a restricted geographical location typically exhibit low levels of genetic diversity; this is so for *A. grandifolia*. Its genetic profile suggests that it may have been geographically isolated from near relatives and has developed in isolation (Leverington *et al* 2003).

The plant appears to respond well to disturbance, with records of good regeneration in disturbed areas and by roadsides. It appears to be highly fire tolerant with populations expanding after fire (Leverington *et al* 2003).

8.1.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. Field surveys confirmed the presence of Eucalypt open forests and woodlands on hilly terrain within the development area and the LiDAR assessment indicated that these areas also occur in the areas not surveyed in association with the western ridgeline and Middle Hill. Two records from 2002 are located west at Boxvale State Forest, within 30 km of the development area (from a centre coordinate).

8.1.4 Anticipated threats and potential impacts from the development

No known individuals of *Acacia grandifolia* are expected to be impacted by the development. Survey works conducted prior to construction will confirm any individuals of *Acacia grandifolia* and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed *Acacia grandifolia* habitat. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.1.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Siting of infrastructure should aim to minimise fragmentation of potential habitat as much as possible (i.e. clear edges rather than dissect patches) to maintain core patch and population viability.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.2 *Arthraxon hispidus*

8.2.1 Status

Vulnerable – listed 16 July 2000

8.2.2 Biology and ecology

8.2.2.1 Characteristics

Arthraxon hispidus, Family Poaceae, also known as Hairy-joint grass, is a slender tufted creeping grass that roots at the nodes, with erect to semi-erect stems (Leigh et al 1984; DECC NSW 2005). The leaves are reddish to purplish with long white hairs around the edge, broad at the base and tapering abruptly to a sharp point (DECC NSW 2005).

The fruit is a caryopsis (simple, dry single seeded fruit, with seed fused to the wall of the fruit and remaining closed at maturity) (Leigh et al 1984). The seed-heads are held above the plant on a long fine stalk (DECC NSW 2005).

Plate 2: *Arthraxon hispidus* (Source: Ausgrass2 n.d)

8.2.2.2 Known distribution

In Australia, the species has been recorded from scattered locations throughout Queensland and on the northern tablelands and north coast of New South Wales (DECC NSW 2005; Bostock & Holland 2007). In Queensland this species occurs north to Port Douglas and west to disjunct occurrences around mound springs in Carnavon National Park; however, most occurrences are from Noosa southwards (TSSC 2008n).

This species occurs within the Border River–Gwydir, Northern Rivers (NSW), Fitzroy, Border Rivers–Maranoa Balonne, Condamine, South East, Burnett Mary and Wet Tropics (Queensland) Natural Resource Management Regions (TSSC 2008n). *Arthraxon hispidus* is known to be reserved in Carnarvon Cooloola National Park, Noosa National Park, Carnarvon National Park and Daintree National Park (TSSC 2008n).

Figure 2 Mapped distribution of *Arthraxon hispidus* (Source: DOTE 2014f)

8.2.2.3 Habitat description

In NSW and Queensland, *Arthraxon hispidus* is found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps, as well as woodland (TSSC 2008n). In south-east Queensland, *Arthraxon hispidus* has also been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks and on sandy alluvium in creek beds in open forests and also with bog mosses in mound springs (TSSC 2008n).

8.2.2.4 Biology and reproduction

Flowers appear in March to July (Harden 1993) and summer to autumn (Jacobs & Wall 2007). This species was once considered an annual, but is now thought to be a perennial that tends to die down in winter (TSSC 2008n).

8.2.3 Likelihood of occurrence within the Towrie development area

This species is considered unlikely to occur within the development area. No records occur within the vicinity of the development area. Whilst the development area contains potentially suitable habitat in the form of Eucalypt woodland on alluvium, this habitat is considered highly marginal due to the level of cattle disturbance and exotic grass incursion that was observed in this habitat type. *Arthraxon hispidus* is particularly susceptible to these impacts.

8.2.4 Anticipated threats and potential impacts from the development

No known individuals of *Arthraxon hispidus* are expected to be impacted by the development. Survey works conducted prior to construction will confirm any individuals of *Arthraxon hispidus* and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed *Arthraxon hispidus* habitat. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.2.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.3 *Bertya opponens*

8.3.1 Status

Vulnerable – listed 16 July 2000

8.3.2 Biology and ecology

8.3.2.1 Characteristics

Bertya opponens (Coolabah bertya) is a slender shrub or small tree to 4 m high and consists of either slender, multiple stems or a single trunk. The branches and stems are covered with whitish to brown, dense, intertwined hairs. The upper surface is dark-green and hairless and the under-surface is velvety-woolly (NPWS 2002a).

Flowers lack stalks and have one to three female and male flowers clustered together and surrounded by four thick, yellowish to golden brown, hairy bracts. Flowering is thought to primarily occur between July and August however, this may be dependent on the individual site characteristics (NPWS 2002a).

The fruit capsule is ovoid to globose, 8 to 9 mm long with dense, long weak hairs and contains two to three seeds (NPWS 2002a).

Plate 3: *Bertya opponens* (Source: Wain 2011)

8.3.2.2 Distribution

In Queensland, *Bertya opponens* distribution generally extends from Toowoomba to Charleville, north to Emerald and then towards the coast, south of Gladstone. The species is known to occur at Chesterton Range National Park, Palmgrove National Park and Thomby Range. The species has also been identified on Lonesome Holding, Kentucky Holding and during pre-clearance surveys at Baffle Creek (Atlas of Living Australia 2014).

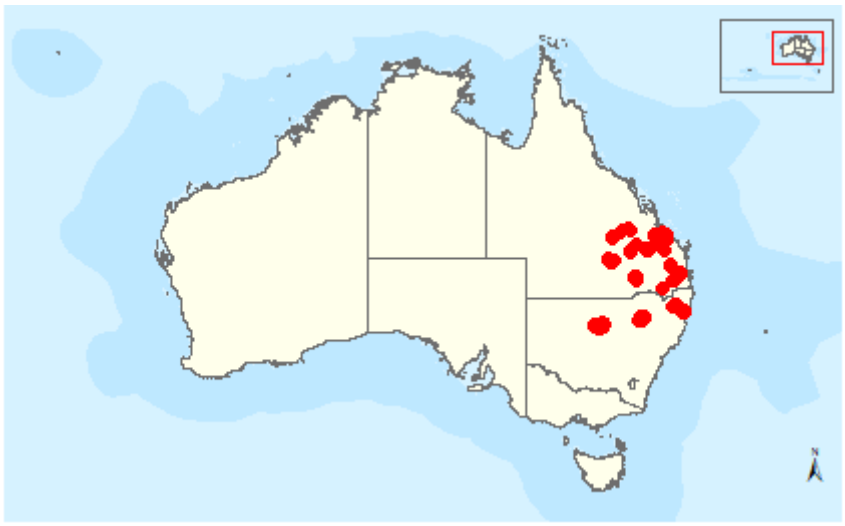

Figure 3: Mapped distribution of *Bertya opponens* (Source: DSEWPaC 2011b)

8.3.2.1 Habitat description

The known populations of *Bertya opponens* within New South Wales occur in a number of different habitats, ranging from stony mallee ridges and cypress pine forests of the inland, to cliff edges in the high rainfall eastern fall areas of the Great Dividing Range (NPWS 2002a). The wide variation in habitat type between the populations makes the identification of critical habitat very difficult (NPWS 2002a).In Queensland, the species has been identified on the crest of a sandstone massif in a dense thicket (circa 4 m high) in association with *Alstonia constricta*, *Alphitonia excelsa*, *Erythroxylum* sp., *Jasminum simplicifolium* and *Bursaria spinosa* with scattered *Callitris glaucophylla*, *Callitris endlicheri* and *Eucalyptus crebra* on sandy loam (Atlas of Living Australia 2014).

The species has also been identified in *Acacia shirleyi* woodland on a steep sandstone ridge with sandy substrate associated with scattered *Eucalyptus decorticans* with a grassy ground layer dominated by *Cleistochloa* sp. (Atlas of Living Australia 2014).

At Baffle Creek, the species was identified in open woodland amongst sandstone boulders between the base of the cliffline and the north side of creek in heavy shade (Atlas of Living Australia 2014).

8.3.2.2 Biology and reproduction

The primary mechanism for pollen dispersal in *Bertya opponens* is probably wind given that the flowers lack chemical and colour attractants and the styles and anthers are exposed. However, European honeybees have been observed visiting *Bertya opponens* flowers (NPWS 2002a).

Flowering is generally believed to occur between July and August (Harden 1990), although timing is more dependent on the individual site characteristics and it has been observed flowering as early as June (NPWS 2002a).

8.3.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. Suitable habitat for this species occurs within the western portion of the development area in the areas of SEVT, *Eucalyptus* and *Acacia* woodland. Atlas of Living Australia (ALA) records occur at four locations south of the development area within and near Lonesome National Park (within 50 km). Two post-1980's records occur within 25 km of the development area as detailed on the Wildlife Online report.

8.3.4 Anticipated threats and potential impacts from the development

No known individuals of *Bertya opponens* are expected to be impacted by the development. Survey works conducted prior to construction will confirm any individuals of *Bertya opponens* and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed *Bertya opponens* habitat. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.3.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Siting of infrastructure should aim to minimise fragmentation of potential habitat as much as possible (i.e. clear edges rather than dissect patches) to maintain core patch and population viability.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.4 *Cadellia pentastylis*

8.4.1 Status

Vulnerable – listed 16 July 2000

8.4.2 Biology and ecology

8.4.2.1 Characteristics

Cadellia pentastylis (Ooline) is a tree to 10 m (occasionally 25 m) high with a bushy crown and dark grey bark which is hard and fissured (Threatened Species Scientific Committee (TSSC) 2008b: Santos 2007). Leaves are alternate, simple (undivided) on short hairy stalks (petioles) which are 2 to 7 mm long, glossy (including when juvenile), green on top, paler and dull underneath. The leaf blades are obovate (egg-shaped) to elliptical usually 1 cm to 7 cm long and 1.5 cm to 2 cm wide with broad rounded tips. Veins are prominent on both sides when dry (TSSC 2008b; Harden et al 2006).

The flowers are single with five petals and approximately 20 mm in diameter. Flowers are usually white in colour, but may also appear greenish or reddish. The main flowering period is usually between October and November, but the timing of flower may vary depending on environmental factors (TSSC 2008b; Santos 2007). Fruit is brownish in colour with a wrinkled surface. Fruit are presented in a cluster of 3 to 5 balls (drupes) at the centre of the old flower. Each segment is 3 to 5 mm long and contains a single, hard-coated seed (Santos 2007).

Plate 4: ***Cadellia pentastylis*** **(Source: Stark 2014)**

8.4.2.2 Distribution

The range of *Cadellia pentastylis* extends from the western edge of the New South Wales north-west slopes, from Mt Black Jack near Gunnedah to west of Tenterfield into Queensland to the Carnarvon Range and Callide Valley, south-west of Rockhampton (TSSC 2008b).

Figure 4: Mapped distribution of *Cadellia pentastylis* (Source: DSEWPaC 2011c)

8.4.2.1 Habitat description

Cadellia pentastylis occurs in a range of vegetation types, and often associates with *Acacia harpophylla* (Brigalow), *Casuarina cristata* (Belah), *Acacia catenulata* (Bendee) and *Lysiphyllum carronii* (Red bauhinia) species in dry rainforest, semi-evergreen vine thicket and sclerophyll communities. *Cadellia pentastylis* may be observed as the locally dominant species within such communities. This species is found on clay plains, sandstone slopes, and ridgelines between 200 and 500 m above sea level, often on the moderately fertile soils preferred for agriculture and pasture development (TSSC 2008b; Santos 2007).

8.4.2.2 Biology and reproduction

The primary flowering period for *Cadellia pentastylis* in Queensland is October through to November, although the intensity and timing of flowering often varies between years (Santos 2007). Fruiting has been recorded between November and December. Dispersal of seed is likely to occur as a result of "passive fall" or from birds. Seeds show a high rate of infertility, although they have been successfully germinated using heat application (TSSC 2008b). *Cadellia pentastylis* has the capacity to resprout and coppice, hence the number of genetic individuals in some stands may be much lower than the number of stems present (NSW Scientific Community 1998).

8.4.3 Likelihood of occurrence within the Towrie development area

Field surveys confirmed the presence of this species in the northern development area. Suitable habitat occurs in the form of SEVT and brigalow-dominated open forests. The LiDAR assessment indicated that these areas also occur in the areas that were not surveyed. Areas of regrowth vegetation that have not been ground-truthed are also conservatively considered potential habitat for this species.

8.4.4 Anticipated threats and potential impacts from the development

A maximum of 5.0 ha of potential and/or known *Cadellia pentastylis* habitat may be cleared for the development. Confirmed occurrences of *Cadellia pentastylis* in the lower plains of the development area recorded the trees to be in average to poor condition due to their highly isolated nature. Siting of infrastructure will maximise use of existing gaps between and within areas of habitat; as such, direct

impacts will be focused to habitat patch edges or isolated individuals. This will also ensure habitat patches are able to maintain their microclimates.

Potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.4.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Siting of infrastructure should aim to minimise fragmentation of potential habitat as much as possible (i.e. clear edges rather than dissect patches) to maintain core patch and population viability.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.5 *Dichanthium setosum*

8.5.1 Status

Vulnerable – listed 16 July 2000

8.5.2 Biology and ecology

8.5.2.1 Characteristics

Dichanthium setosum (Bristly bluegrass) is an upright perennial grass to 1 m tall, with mostly hairless leaves 2 to 3 mm wide. The flowers are densely hairy and clustered together along a cylinder shape stalk (TSSC 2008d).

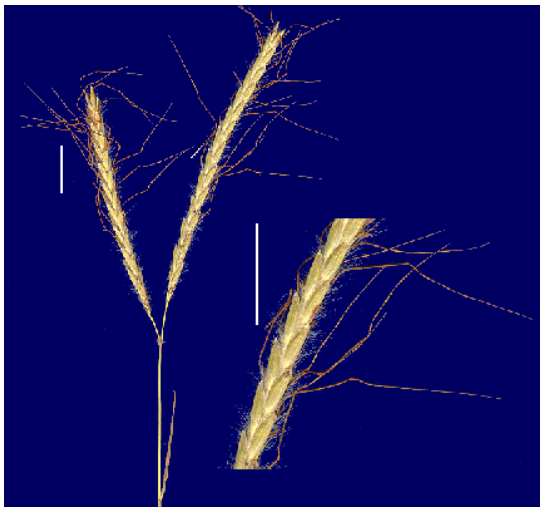

Plate 5: *Dichanthium setosum* (Source: Queensland Herbarium 2002)

8.5.2.2 Distribution

In Queensland, this species has been recorded from the Leichhardt, Moreton, North Kennedy and Port Curtis pastoral districts.

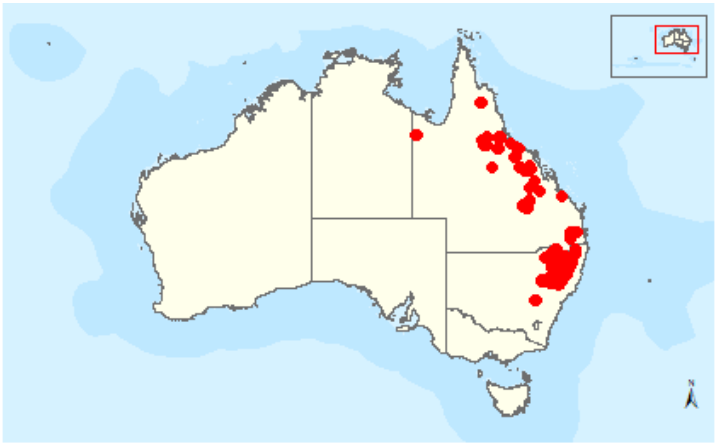

Figure 5: Mapped distribution of *Dichanthium setosum* (Source: DSEWPaC 2011f)

8.5.2.1 Habitat description

Dichanthium setosum is associated with heavy basaltic black soils and stony red-brown loam with clay subsoil and has been observed in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pastures (TSSC 2008d).

8.5.2.2 Biology and reproduction

The flowers are densely hairy and clustered together along a cylinder shaped stalk and appear mostly during summer. The species can form pure swards or occur as scattered clumps (TSSC 2008d).

8.5.3 Likelihood of occurrence within the Towrie development area

Dichanthium setosum is considered unlikely to occur within the development area. Soils within the development area are not basaltic and as such no suitable habitat occurs. A single record occurs approximately 60 km to the north west in Boxvale State Forest.

8.5.4 Anticipated threats and potential impacts from the development

No known individuals of *Dichanthium setosum* are expected to be impacted by the development. Survey works conducted prior to construction will confirm any individuals of *Dichanthium setosum* and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed *Dichanthium setosum* habitat. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.5.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.6 *Thesium australe*

8.6.1 Status

Vulnerable – listed 16 July 2000

8.6.2 Biology and ecology

8.6.2.1 Characteristics

Thesium australe (Austral toadflax) is a hairless, yellowish-green perennial herb with slender, wiry stems to 40 cm high and tiny, white flowers (George 1984; Harden 1992).

Plate 6: *Thesium australe* (Source: Office of Environment and Heritage n.d.)

8.6.2.2 Known distribution

Thesium australe occurs in New South Wales, the Australian Capital Territory, Queensland and Victoria (Scarlett *et al* 2003; NSW OEH 2013). Its current distribution is sporadic but widespread, occurring between the Bunya Mountains in south-east Queensland to north-east Victoria (Scarlett *et al* 2003) and as far inland as the southern, central and northern tablelands in New South Wales and the Toowoomba region (ALA 2012). There is an outlier in Carnarvon National Park on the Consuelo Tableland of the southern Brigalow Belt (ALA 2012). It had been recorded once in Tasmania from the Derwent River valley in 1804, but is considered extinct in the state (TAS DPIWE 2003). Many other previously known sites do not have recent records (ALA 2012; Leigh & Briggs 1984).

Thesium australe was considered extinct in Queensland prior to the mid-1980s (Griffith 1996). Collections since the 1990s have been made from Kumbia, Glen Rock Regional Park, Carnarvon National Park, Crows Nest, Clifton, Warwick, Greenmount, Cambooya, Dalby, the Bunya Mountains, Blackbutt and Imbil (ALA 2012). In the 1990s, the species was described as common at a site at Clifton and rare at sites at Mt Moffatt National Park, Bunya Mountains and Blackbutt (ALA 2012).

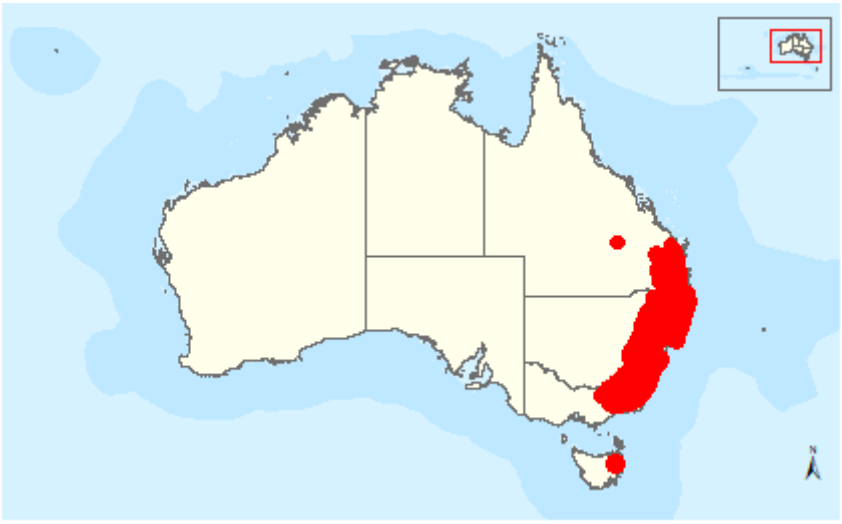

Figure 6: Mapped distribution of *Thesium australe* (Source: DOTE 2014n)

8.6.2.1 Habitat description

Thesium australe is semi-parasitic on roots of a range of grass species, notably Kangaroo grass (*Themeda triandra*) (Scarlett *et al* 1994). It occurs in subtropical, temperate and subalpine climates over a wide range of altitudes. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils including black clay loams to yellow podzolics and peaty loams (Leigh & Briggs 1984; Hunter *et al* 1999; Cohn 2004).

It occurs in shrubland, grassland or woodland, often on damp sites (George 1984; Harden 1992). Vegetation types include open grassy heath dominated by Swamp myrtle (*Leptospermum myrtifolium*), Small-fruit hakea (*Hakea microcarpa*), Alpine bottlebrush (*Callistemon sieberi*), Woolly grevillea (*Grevillea lanigera*), Coral heath (*Epacris microphylla*) and *Poa* spp. (Griffith 1991); Kangaroo grass grassland surrounded by *Eucalyptus* woodland; and grassland dominated by Barbed-wire grass (*Cymbopogon refractus*) (Leigh & Briggs 1984; Hunter *et al* 1999).

8.6.2.2 Biology and reproduction

Thesium australe flowers and fruits throughout the year on the coast and during summer at higher altitudes (Cohn 2004; Griffith 1996). In subalpine and tableland climates, the species dies back to rootstock during winter and resprouts in spring. In coastal areas the species persists all year round and may live for longer than two years (Cohn 2004).

The species appears to cope well with but does not require frequent disturbance. The existence of buds near the soil surface allows the species to resprout after disturbance. It is observed to germinate well after fire; however fire is not essential for germination (Scarlett *et al* 1994).

8.6.3 Likelihood of occurrence within the Towrie development area

Thesium australe is considered unlikely to occur within the development area. No native grasslands occur within the development area and native grasses were largely only dominant in the dry Eucalypt woodlands and open forests of the western ridgeline where cattle grazing was prohibited and historical land clearing had not occurred. The substrate in this area is categorised as coarse-grained sedimentary and due to the terrain does not provide 'damp' conditions. A population occurs at the Carnarvon National Park but is considered an outlier. No ALA records occur within 50 km of the development area.

8.6.4 Anticipated threats and potential impacts from the development

No known individuals of *Thesium australe* are expected to be impacted by the development. Survey works conducted prior to construction will confirm any individuals of *Thesium australe* and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed *Thesium australe* habitat. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.6.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.7 *Tylophora linearis*

8.7.1 Status

Endangered – listed 16 July 2000

8.7.2 Biology and ecology

8.7.2.1 Characteristics

Tylophora linearis, Family Asclepiadaceae, is an herbaceous climber with clear latex that grows to about 2 m long. The stems are cylindrical, up to 3 mm in diameter with internodes up to 100 mm long. Leaves are dark green, linear, up to 100 mm long and 4 mm wide and extra-floral nectaries are absent from the base of the leaf. Flowers are clustered in radiating groups of three to eight. Flowers are 6 to 22 mm in diameter, with petals olive-green externally, dark purple internally and with short hairs internally concentrated towards the tip. Fruits form follicles 95 to 100 mm long and 5 mm wide (Forster 1992; Forster *et al* 2004).

Plate 7: *Tylophora linearis* (Source: © Carr n.d.)

8.7.2.2 Known distribution

Tylophora linearis has rarely been collected and is known from eight localities in the Dubbo area and Mount Crow near Barraba in NSW, and “Myall Park” near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo State Forest, Pilliga West State Forest and Coolbaggie Nature Reserve (TSSC 2008r).

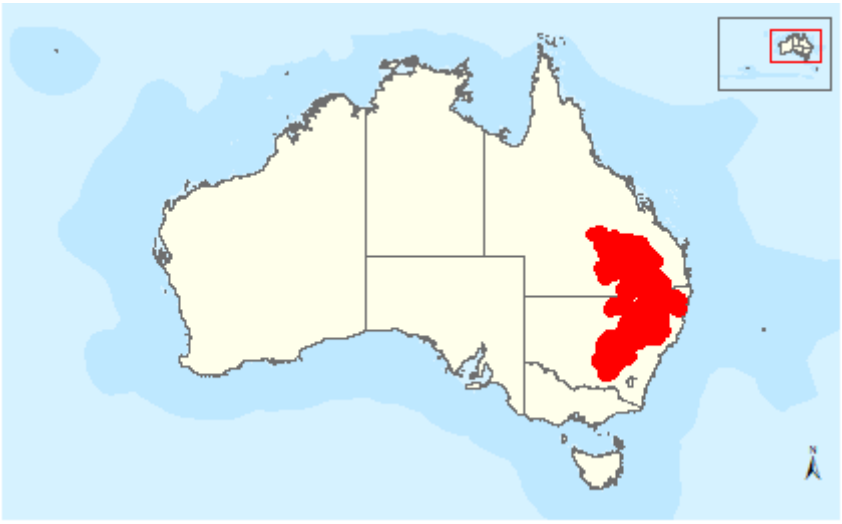

Figure 7: Mapped distribution of *Tylophora linearis* (Source: DOTE 2014o)

8.7.2.3 Habitat description

Tylophora linearis grows in dry scrub, open forest and woodlands associated with *Melaleuca uncinata*, *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla, Allocasuarina luehmannii, Acacia hakeoides, Acacia lineata, Myoporum spp. and Casuarina spp.* (NSW OEH 2014; Forster et al 2004). This species occurs within the Border Rivers–Gwydir, Central West, Namoi (NSW), and Border Rivers Maranoa–Balonne (Queensland) Natural Resource Management regions (TSSC 2008r).

8.7.2.4 Biology and reproduction

Flowers in spring, with flowers recorded in November or May with fruiting probably two to three months later (NSW OEH 2014).

8.7.3 Likelihood of occurrence within the Towrie development area

Tylophora linearis is considered unlikely to occur within the development area. The development area does not occur within or in proximity to one of the species' known eight localities and no suitable woodland communities with the compositional mix of flora species that are associated with *Tylophora linearis* occur. No records occur within 75 km.

8.7.4 Anticipated threats and potential impacts from the development

No known individuals of *Tylophora linearis* are expected to be impacted by the development. Survey works conducted prior to construction will confirm any individuals of *Tylophora linearis* and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed *Tylophora linearis* habitat. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.7.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.8 *Xerothamnella herbacea*

8.8.1 Status

Endangered – listed 16 July 2000

8.8.2 Biology and ecology

8.8.2.1 Characteristics

Xerothamnella herbacea, Family Acanthaceae, is a sparse, sprawling, perennial herb growing to a height of 30 cm. Stems arise from a central point but can root at the nodes where they contact the soil. Leaves in opposite pairs are soft, linear to narrowly ovate in outline, dark green above and paler beneath. Flowers are small, bright pink to mauve, two lipped, to 6.5 mm long, and occur in the upper leaf axils (Barker 1986).

Plate 8: *Xerothamnella herbacea* (Source: Queensland Herbarium 2007)

8.8.2.2 Distribution

Xerothamnella herbacea is known from a site north-west of Theodore Brigalow Research Station, a site south-east of Medlow, at Burraburri Creek, west of Durong, at two sites north east of Chinchilla, at a site on the Millmerran-Goondiwindi road, north-east of Kindon and at a site near Yelarbon, east of Goondiwindi, Queensland (Atlas of Living Australia 2012).

This species occurs within the Condamine, Border Rivers Maranoa–Balonne and Fitzroy (Queensland) Natural Resource Management Regions (TSSC 2008i).

This species is not known to occur in any conservation reserves. Some of the known populations occur in cleared areas or non- remnant vegetation that are not protected under the *Vegetation Management Act 1999* (Queensland) (TSSC 2008i).

In November 2011, *Xerothamnella herbacea* was identified at the Santos GLNG Gas Transmission Pipeline right-of-way crossing location in Gratz Gully on Lonesome Holding, in the southern end of Arcadia Valley by Boobook Ecological Consulting (Boobook). Samples were sent to Queensland Herbarium for verification and the population at Gratz Gully represented a newly recorded and outlying location for the species in Queensland.

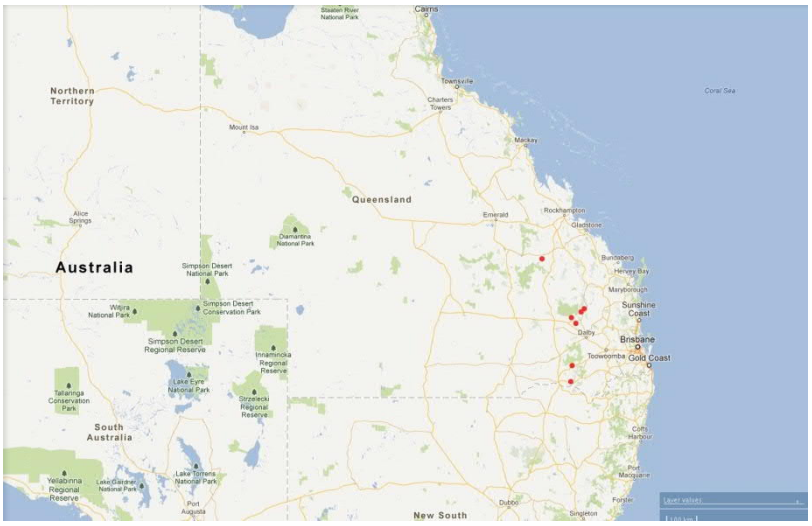

Figure 8: Publicly available records of *Xerothamnella herbacea* (Source: Atlas of Living Australia 2012)

8.8.2.3 Habitat description

Xerothamnella herbacea occurs in Brigalow (*Acacia harpophylla*) dominated communities in shaded situations, often in leaf litter and is associated with gilgais (shallow ground depressions). Soils are heavy, grey to dark brown clays (Queensland Herbarium 2008a).

The preferred habitat of *Xerothamnella herbacea* at Gratz Gully (Boobook 2012) appeared to be:

- Floodplain flats, channel banks and beds, no greater than 0.5 m elevation above the channel; usually within 50 cm elevation of the top of the ditch/channel ie mounds, low ridges and rises between drainage ditches, gutters, rills and channels, and flood ponds
- Soils with high clay content
- Shade of greater than 40%
- Shade provided by Brigalow (*Acacia harpophylla*) and Wilga (*Geijera parviflora*) most often, and Poplar box (*Eucalyptus populnea*) to a lesser degree (more often on the southern side of small shade patches)
- Areas of notable leaf litter coverage
- Sometimes associated with gilgais (shallow ground depressions).

Associated herbaceous species most frequently detected with *Xerothamnella herbacea* included Blue trumpet (*Brunoniella australis*), Slender sedge (*Cyperus gracilis*), Curly windmill grass (*Enteropogon ramosus*), Creeping shade grass (*Oplismenus aemulus*) and Pink tongues (*Rostellularia adscendens*) (Boobook 2012).

Xerothamnella herbacea plants look similar to *Brunoniella australis* and *Rostellularia adscendens*, two very common forbs throughout the search area. *Xerothamnella herbacea* plants are distinguishable from a distance by a neater, more symmetrical leaf arrangement, more glabrous (smooth or hairless) foliage and stems, lighter and more consistent shade of green, a thinner more delicate appearance to leaves,

fruit spade shaped (*Brunoniella australis* fruit rod shaped), flowers arising together in heads, corolla with distinct upper petals (*Rostellularia adscendens* upper petals absent or not obvious, flowers arranged along spikes 2 to 7 cm long) (Boobook 2012).

8.8.2.4 Biology and reproduction

There is no published information on the fruiting and flowering period for this species however it has been recorded flowering during the pre-clearance surveys in November/December (Ecologica 2012).

Based on visual observations, Aurecon noted that *Xerothamnella herbacea* could have the ability to propagate from cuttings and/or grown from seeds based on its ability to colonise recently disturbed areas as evident between the September and November 2012 survey periods.

Xerothamnella herbacea plants were suspected to be in the process of dying-off during a survey in March and April 2012 where soil moisture was declining. It is suspected that the species relies on available soil moisture in the top 30 cm of soil (Boobook 2012).

8.8.3 Likelihood of occurrence within the Towrie development area

Xerothamnella herbacea is considered likely to occur within the development area. Field surveys confirmed the presence of Brigalow-dominated vegetation and gilgai communities. The LiDAR assessment indicated that these areas also occur in the areas not surveyed (namely brigalow communities) on the undulating plains of the valley floor. Majority of Brigalow-dominated vegetation communities that were field validated were found to have a disturbed understory that is likely to impact on the quality of habitat present for this species. Therefore, more intact Brigalow (i.e. remnant and high value regrowth vegetation) on alluvium is considered potential habitat for this species. Multiple records also occur within 30 km of the development area (Wildlife Online and ALA).

8.8.4 Anticipated threats and potential impacts from the development

No known individuals of *Xerothamnella herbacea* are expected to be impacted by the development; however a maximum of 2.0 ha of potential habitat may be cleared as part of the development. Potential habitat that was field validated in the development area was generally found to be in average condition due to exotic grass incursion and ongoing cattle grazing impacts.

Other potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.8.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.1, the following species-specific mitigation measures are recommended:

- Any populations should be identified and the extent mapped during pre-clearance surveys. Confirmation of population avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.

- Siting of infrastructure should aim to minimise fragmentation of potential habitat as much as possible (i.e. clear edges rather than dissect patches) to maintain core patch and population viability.
- Rehabilitation works should utilise appropriate native species to reduce the potential proliferation of harmful species.

Indirect impacts will also be managed in accordance with the EMP.

8.9 Curlew sandpiper

8.9.1 Status

Critically Endangered – listed 26 May 2015

8.9.2 Biology and ecology

8.9.2.1 Characteristics

The Curlew sandpiper (*Calidris ferruginea*) is a small grey-brown shorebird with a long, tapering, down-curved bill and relatively long black legs, growing to a length of 18 to 23 cm. Non-breeding adults have a brownish-grey crown and nape with brownish streaking on the crown, an indistinct grey-brown eye strip and dark smudge in front of the eye and an off-white face. Upperparts are greyish brown with indistinct brown streaks, while underparts are white with grey wash with fine brown streaks across the breast. Breeding adults have a rufous-brown head, neck and underbelly with a white chin at the base of the bill. Upperparts are black with large rufous-brown spots with mottled white tips. Juveniles have similar plumage to non-breeding adults but with darker underparts (Geering et al., 2007).

Plate 9: Curlew Sandpiper (nonbreeding adult) (Source: Dan Weller)

8.9.2.2 Known distribution

The Curlew sandpiper spends the non-breeding season in Africa, southern Asia and Australasia (Geering et al., 2007). It has been recorded in all Australian states, and many non-breeding one-year old birds remain throughout the year. In Australia, curlew sandpiper occurs around the coasts and are less commonly inland (DAWE, 2020).

In Queensland, scattered records occur in the Gulf of Carpentaria, with widespread records along the coast south of Cairns. There are sparsely scattered records inland (Higgins & Davies 1996).

Figure 9: Mapped distribution of curlew sandpiper (source: BirdLife International)

8.9.2.3 Habitat description

Curlew sandpiper mainly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are recorded less often inland including around ephemeral and permanent lakes, dams, waterholes and bore drains. The species occurs in both fresh and brackish waters (Higgins & Davies 1996).

The species forages on mudflats and nearby shallow water. In non-tidal wetlands they usually wade in water 15–30 mm, but up to 60 mm, deep. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy shores. At high tide, they forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated saltflats. Occasionally they forage on wet mats of algae or waterweed, or on banks of beachcast seagrass or seaweed. They rarely forage on exposed reefs (Higgins & Davies 1996).

Curlew sandpipers roost in open situations with damp substrate, especially on bare shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands. The occasionally roost in dunes during very high tides and in saltmarsh (Higgins & Davies, 1996).

8.9.2.4 Biology and reproduction

The Curlew sandpiper forages mostly on invertebrates, such as worms, molluscs, crustaceans and insects, as well as seeds. The species is recorded to eat annelid worms (*Ceratonereis eurythraeensis* and *Nereis caudata*), molluscs (Kellidae), gastropods (Rissoidae, Cerithiidae, Fossaridae, *Polinices* sp., *Salinator fragilis*, Hydrococcidae, Hydrobiidae, *Assiminea brazieri*, *A. tasmanica*), crustaceans (*Cymadusa* sp., *Paracorophium* sp., Brachyurans; Sentinel Crab (*Macrophthalamus latifrons*), insects ((Diptera (Stratiomyidae, Chironomidae), adults, larvae and pupae), larvae (of Coleoptera, Dytiscidae and Scarabaeidae) and Plants (*Ruppia* seeds).

The breeding range of the Curlew sandpiper is mainly restricted to the Arctic of northern Siberia. They are a passage migrant through Europe, north Africa, Kazakhstan, west and south-central Siberia, Ussuriland, China, Taiwan, Japan, the Philippines, west Melanesia, Wallacea and New Guinea (DAWE, 2020).

This species is gregarious, often occurring in large flocks. They mix freely with other small waders when feeding and roosting (Higgins & Davies 1996).

Curlew sandpiper does not breed in Australia (DAWE, 2020).

8.9.3 Likelihood of occurrence within the Towrie development area

The Curlew sandpiper is considered unlikely to occur within the development area. This species is primarily coastal, and the development area is approximately 250 km inland. No suitable habitat occurs within the development area and no nearby records occur.

8.9.4 Anticipated threats and potential impacts from the development

No disturbance to the Curlew sandpiper is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.9.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no migratory birds are roosting in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a migratory wetland bird be identified utilising the habitat.
- Construction works that will occur in the direct vicinity of the constructed wetland should only be conducted outside of the migratory bird period (August to May).
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.10 Red goshawk

8.10.1 Status

Vulnerable – listed 16 July 2000

8.10.2 Biology and ecology

8.10.2.1 Characteristics

The Red goshawk (*Erythrotriorchis radiates*) is a large, swift and powerful rufous-brown hawk, growing to a length of 45 to 60 cm, with a wingspan of 100 to 135 cm (DSEWPaC 2011m). The two sexes of this species are quite different in size and appearance (NPWS 2002). The females weigh approximately 1.1 kg, the males approximately 0.63 kg. The Red goshawk is boldly mottled and streaked, with rufous scalloping on the back and upper wings, rufous underparts that are brightest and lack streaking on the thighs, and with massive yellowish legs and feet, and boldly barred underwings. Females are larger, more powerfully built, paler and more heavily streaked below, showing some white on the under body. Juveniles have redder upper-parts, and the head and underparts are rich rufous with fine dark streaks. The juvenile's rufous head distinguishes it from adults (DSEWPaC 2011m).

The Red goshawk can further be distinguished from other similar raptors by its broad 'six-fingered' wings that are held at slightly angled planes when soaring, the lack of pale markings on upperparts, the heavy and dark streaking on the head and chest, the flat head, the deep bill (female), the broad deep chest, and the long tail which is square-tipped to slightly rounded at the tip (DSEWPaC 2011m).

The Red goshawk is solitary and very thinly dispersed. It is usually observed singly, and occasionally in pairs or family groups (DSEWPaC 2011m). Red goshawk pairs are believed to remain within the nesting territory all year, but some may expand their home range when not breeding (Aumann & Baker-Gabb 1991, Debus & Czechura 1988).

Plate 10: Red goshawk (Source: Baker-Gabb 2008)

8.10.2.2 Known distribution

It was estimated that there were 1000 breeding birds in 2000 and this estimate was made with medium reliability (Garnett & Crowley 2000).

The Red goshawk is endemic to Australia. It is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley Division (north of 19°S) to north-eastern NSW

(north of 33°), and occasionally on continental islands (Aumann & Baker-Gabb 1991; Marchant & Higgins 1993).

There appears to have been a recent coastal contraction of the range in parts of eastern Australia, and a northward contraction of about 500 km in NSW where it is now virtually extinct (Blakers *et al* 1984; Debus & Czechura 1988b; Debus 1991; Debus *et al* 1993; Marchant & Higgins 1993).

The estimated extent of occurrence is likely to be stable at 1,000,000 km and the estimated area of occupancy is suspected to be 200,000 km², though the reliability of this estimate is low (DSEWPaC 2011m).

The area of occupancy has declined since European settlement. While this decline cannot be quantified, the lack of any breeding records in NSW over the last 50 years, and the decline in sightings of Red goshawk further from the coast especially in Queensland suggest that fewer areas are now being used for breeding (Debus & Czechura 1988b). It is suggested that since European settlement, development and habitat alteration have rendered about 20% of the predicted Red goshawk's range unsuitable for breeding, especially in coastal Queensland (Aumann & Baker-Gabb 1991).

The distribution of the Red goshawk is not severely fragmented. It is suspected that there is some fragmentation (BirdLife International 2004), but there is no evidence that fragmentation in the Red goshawk distribution is severe. However, some fragmentation may have occurred in the more heavily settled and cleared regions of the species range, such as in the coastal lowlands of eastern Queensland (DSEWPaC 2011m).

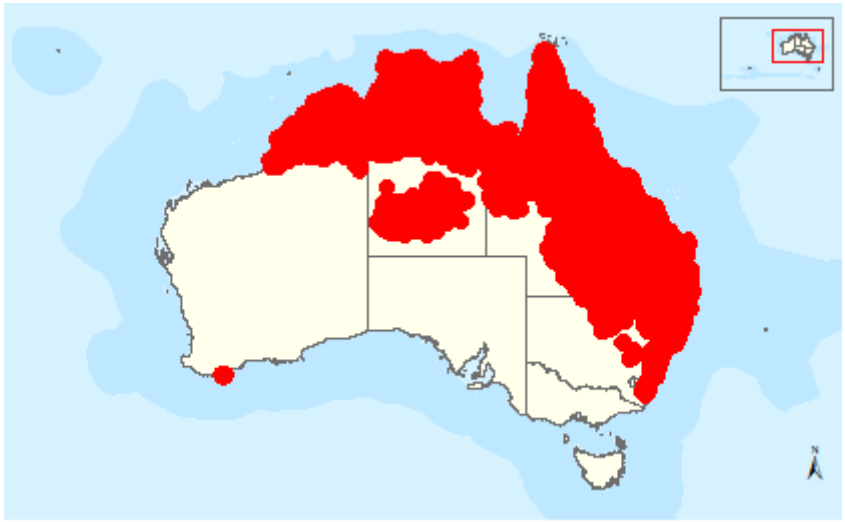

Figure 10: Mapped distribution of Red goshawk (Source: DSEWPaC 2011m)

8.10.2.3 Habitat description

The Red goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia (Marchant & Higgins 1993). Riverine forests are also used frequently (Debus 1991, 1993). Such habitats typically support high bird numbers and biodiversity, especially medium to large species which the goshawk requires for prey. The Red goshawk nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within one kilometre of permanent water (Aumann & Baker-Gabb 1991; Debus & Czechura 1988).

The Red goshawk occurs over wooded and forested lands of tropical and warm-temperate Australia, coastal and sub-coastal (Marchant & Higgins 1993).

This species prefers forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water. The vegetation types include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins (DSEWPaC 2011m).

Habitat has to be open enough for fast attack and manoeuvring in flight, but provide cover for ambushing of prey. Therefore, forests of intermediate density are favoured, or ecotones between habitats of differing densities, eg between rainforest and eucalypt forest, between gallery forest and woodland, or on edges of woodland and forest where they meet grassland, cleared land, roads or watercourses (DSEWPaC 2011m). They avoid very dense and very open habitats (Marchant & Higgins 1993). These habitats provide appropriate foraging conditions for the large Red goshawk, and a diversity and abundance of the medium to large birds taken as food (Aumann & Baker-Gabb 1991).

Immature birds have been reported from mangroves, open river floodplains, low open woodland, agricultural land and pasture, but such habitats are not used regularly (Marchant & Higgins 1993).

Nests are in tall trees within one kilometre of and often beside, permanent water (river, swamp, pool), usually in fairly open, biologically rich forest or woodland. The average distance of the nest tree to water was 164 m. Nest trees were significantly taller, with larger crown diameters, greater girth at breast height, and the height of the lowest live branch was higher than the tallest trees found in the immediate vicinity of random locations along rivers. Nest trees had an average height of 31.4 m, and an average girth at breast height of 2.9 m. Trees in 0.2 ha plots around the nest tree also had significantly higher canopy height, fewer small trees (girth less than 0.5 m), and more large trees (girth greater than 1 m) than random plots (Aumann & Baker-Gabb 1991). Nests tend to be placed on a substantial horizontal limb often against a vertical branch arising from it (DSEWPaC 2011m).

This species is a local migrant throughout Australia and inhabits coastal areas, islands, estuaries, inlets, rivers and inland lakes. The species will overfly a variety of terrestrial habitats (such as coastal dunes, tidal flats, grasslands, heathlands, woodland, eucalypt forests, rainforests and urban areas) but will also forage over wide expanses of open water (DSEWPaC 2011m).

8.10.2.4 Biology and reproduction

Ages of sexual maturity, life expectancy and natural mortality remain very poorly known (Marchant & Higgins 1993). The generation length was estimated at 10 years, but this estimate has low reliability as there is no reliable life history data to base it on. The estimate was made primarily based on data from other taxa (Garnett & Crowley 2000).

The breeding season for Red goshawks is long with courtship starting as early as April and young not leaving their natal territories until as late as the end of December (Aumann & Baker-Gabb 1991). Breeding occurs generally in the spring with eggs laid between May and October in the north (Aumann & Baker-Gabb 1991), and between August and October in the southeast of its range (Debus & Czechura 1988).

The Red goshawk breeds solitarily, in forested or wooded areas, within one kilometre of permanent water, and in a large (over 20 m tall) tree. They are probably monogamous (Aumann & Baker-Gabb 1991). Breeding pairs use the same nesting territories year after year, renovating the nest used in the previous year or nesting nearby (Aumann & Baker-Gabb 1991). Conspecific interactions have been observed with Wedge-tailed eagles and Black-breasted buzzards which appear to prey on goshawk nests (Aumann & Baker-Gabb 1991).

Courtship is first observed 110 to 120 days before egg-laying. Nest-building and refurbishment is done 50 to 70 days before eggs are laid. The nest is a large structure (0.6 to 1.2 m across) made of dead sticks with a saucer-shaped hollow at top, thickly lined with finer twigs and green eucalyptus leaves. There is no conclusive information about clutch size, but it is probably one or two eggs (DSEWPaC

2011m). The female carries out incubation exclusively, but the male may shelter a clutch when the female is off the nest. The male appears to bring all the food from about 25 days before egg-laying through the incubation period. The incubation period is 39 to 43 days. The male also provides most of the food for nestlings, with two to five deliveries per day, during the first 25 to 40 days. The female guards the chick(s) constantly for the first 10 to 14 days. The nestling period is 51 to 53 days, probably slightly longer for females (DSEWPaC 2011m). Fledglings depend on the parents and remain in natal territory for 25 to 30 days, frequently being fed by the nest, and continue to be at least partially food dependent for 70 to 80 days after fledging (Aumann & Baker-Gabb 1991).

8.10.3 Likelihood of occurrence within the Towrie development area

The Red goshawk is considered to have the potential to occur within the development area. There is the potential for the Red goshawk to be inhabiting the surrounding ranges (Carnarvon and Expedition) and the large tracts of vegetation at Middle Hill and the western ridgeline may provide suitable foraging and dispersal habitat. No breeding habitat is present within the development area. No ALA records occur within 50 km of the development area, and a single undated record with a high degree of spatial uncertainty occurs approximately 80 km north of the development area.

8.10.4 Anticipated threats and potential impacts from the development

Maximum disturbance to Red goshawk habitat from development activities is 2.0 hectares (foraging and dispersal only). However, given the vast areas of suitable habitat within the development area and adjacent (the Carnarvon Ranges), these impacts are expected to be low and inconsequential to the foraging success of the species. As this species is highly mobile and construction works will be completed in phases, areas of disturbance can be temporarily avoided.

Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.10.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.2 and within the EMP will manage any direct and indirect impacts to this species.

8.11 Squatter pigeon – southern subspecies

8.11.1 Status

Vulnerable - listed 16 July 2000

8.11.2 Biology and ecology

8.11.2.1 Characteristics

The Squatter pigeon (southern) (*Geophaps scripta scripta*) is a medium sized ground dwelling pigeon (approximately 30 cm long). Both sexes are of similar appearance. Adults are generally grey-brown in colour with black and white stripes on the face and throat, blue-grey skin around the eyes, dark brown (with some patches iridescent green or violet) wings, a blue-grey lower breast and white flanks and lower belly. The species has a black bill, dark brown iris, and dull purple feet and legs. Juveniles are duller in colour with patchy and less distinctive black and white facial stripes and paler facial skin. The Squatter pigeon (southern) is typically seen in pairs or small groups up to 20 or more individuals (DSEWPaC 2011n).

Plate 11: Squatter pigeon (southern) (Source: Dreis 2010)

8.11.2.2 Known distribution

The total population of the Squatter pigeon (southern) is estimated to be 40,000 breeding birds, however this is considered to be of low reliability (DSEWPaC 2011n). Despite this the species is thought to occur as a single, contiguous and stable population (DSEWPaC 2011n).

The Squatter pigeon (southern) occurs on the inland slopes of the Great Dividing Range. The species distribution extends from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Port Curtis (near Gladstone), and south to scattered sites throughout south-eastern Queensland (eg south of the Carnarvon Range). The distribution extends from 19° 00’ S to 29° 00’S, and 141° 00’ E to 153° 30’ E. The extent of occurrence is estimated to be 440,000 km^2 while the area of occupancy is estimated to be 10,000 km^2 (DSEWPaC 2011n).

Population decline is considered to have slowed and the Squatter pigeon remains locally abundant in parts of Queensland, for example, groups of up to 30 are still observed in Central Queensland (Curtis *et al* 2012).

No populations have been identified as being especially important to the long-term survival or recovery of the Squatter pigeon. It has been claimed that the southern and northern subspecies of the Squatter pigeon cross-breed in a hybrid zone centred around the Burdekin-Lynd Divide in central Queensland (DSEWPaC 2011n).

The Action Plan for Australian Birds 2010 also noted that the reasons for not including the Squatter pigeon was there were no recent declines between 2000 and 2010 and the species occurs across numerous sites within its broad distribution (Garnett *et al* 2010).

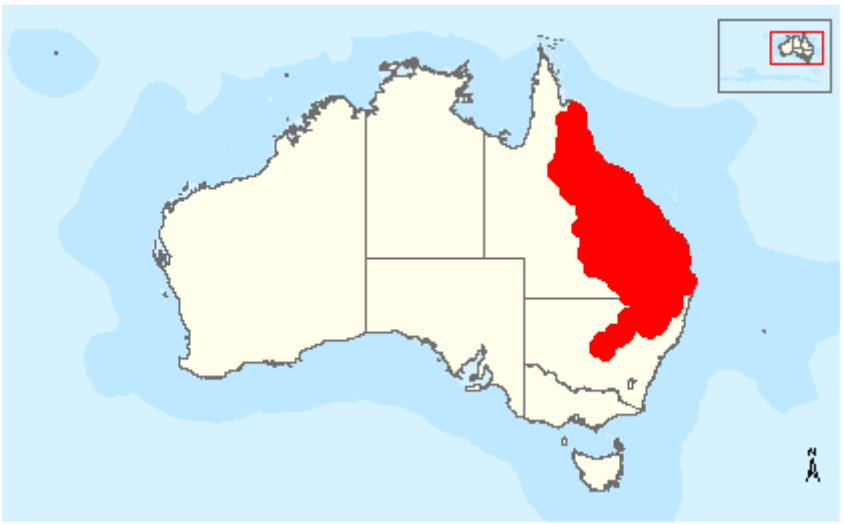

Figure 11: Mapped distribution of Squatter pigeon (southern) (Source: DSEWPaC 2011n)

8.11.2.3 Habitat description

Well-draining, gravelly, sandy or loamy soils support the open-forest to woodland communities with patchy, tussock-grassy understories that support the subspecies' foraging and breeding requirements. Given that the subspecies nests in shallow depressions in the ground, it requires well-draining soils. The subspecies also prefers to forage and dust-bathe on bare ground under an open canopy of trees (Squatter Pigeon Workshop 2011).

Natural foraging habitat for the Squatter pigeon (southern) is any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species, on sandy or gravelly soils, within 3 km of a suitable, permanent or seasonal waterbody (Squatter Pigeon Workshop 2011).

Breeding habitat occurs on stony rises occurring on sandy or gravelly soils, within 1 km of a suitable, permanent waterbody (Squatter Pigeon Workshop 2011).

Typically, the ground covering vegetation layer in foraging and breeding habitat is considerably patchy consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This patchy, ground layer of vegetation rarely exceeds 33% of the ground area. The remaining ground surface consisting of bare patches of gravelly or dusty soil and areas lightly covered in leaf litter and coarse, woody debris (eg fallen trees, logs and smaller debris). The patchiness of the ground layer

vegetation in patches of foraging and breeding habitats tends to be variable over a given area (Squatter Pigeon Workshop 2011).

In Queensland, Squatter pigeon (southern) foraging and breeding habitat is known to occur on well-draining, sandy or loamy soils on low, gently sloping, flat to undulating plains and foothills (ie Queensland Regional Ecosystem Land Zone 5), and lateritic (duplex) soils on low 'jump-ups' and escarpments (ie Queensland Regional Ecosystem Land Zone 7) (Squatter Pigeon Workshop 2011).

The Squatter pigeon (southern) is known to access suitable waterbodies to drink on a daily basis. Waterbodies suitable for the subspecies include permanent or seasonal rivers, creeks, lakes, ponds, waterholes and artificial dams. The subspecies prefers to drink where there is gently sloping, bare ground on which to approach and stand at the water's edge. While patchy to moderate ground covering vegetation may occur along the banks of suitable water bodies, a small patch (less than a square metre) of bare ground at the water's edge is all that the bird requires (Squatter Pigeon Workshop 2011).

Squatter pigeon (southern) dispersal habitat is any forest or woodland occurring between patches of foraging or breeding habitat, and suitable waterbodies. Such patches of vegetation tend not to be suitable for the subspecies' foraging or breeding, but facilitate the local movement of the subspecies between patches of foraging habitat, breeding habitat and/or waterbodies, or the wider dispersal of individuals in search of reliable water sources during the dry season or during droughts (Squatter Pigeon Workshop 2011).

8.11.2.4 Biology and reproduction

Squatter pigeons (southern) are typically seen in pairs or small groups of up to 20 or more individuals (DSEWPaC 2011n). Whilst predominantly terrestrial (ie feeding, resting and nesting on the ground), this species is also known to roost in trees (Curtis *et al* 2012).

The squatter pigeon is a granivore but will supplement its diet with invertebrates subject to season resource availability (Curtis *et al* 2012).

This species will breed throughout the year, however breeding is influenced by heavy rainfall and most commonly occurs during the dry season between May and June (Pizzey & Knight 2007). The Squatter pigeon incubation period is approximately 17 days and chicks will remain in the nest for a further 2 to 3 weeks after hatching, however they appear capable of only short flights for up to four weeks after fledging and remain dependent on their parents during this period (DSEWPaC 2011n). Nests are usually shallow depressions in the ground lined with grass and leaves (NPWS 1999a; Pizzey & Knight 1997).

8.11.3 Likelihood of occurrence within the Towrie development area

Squatter pigeons (southern) are considered to have the potential to occur within the development area. Whilst permanent water occurs within the development area as well as woodland communities, these occur on clay soils. Sandy or gravel soils that the species requires for breeding and foraging habitat that is associated with land zone 5 and 7 do not occur within 1 km of these water sources or within the development area, however the species can utilise a range of habitat types whilst dispersing between breeding and foraging habitat. Connected regrowth, high value regrowth and remnant communities within the development area provide suitable dispersal habitat for the species. Six records dating from 1978 to 2014 occur within 25 km of the development area.

8.11.4 Anticipated threats and potential impacts from the development

A total of 13.0 ha of potential dispersal habitat will be directly impacted via vegetation clearing. However, given the vast areas of suitable habitat within the development area and wider local area, this reduction in habitat is inconsequential.

Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- weed and pest incursion
- mortality from moving vehicles and machinery.

8.11.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.2 and within the EMP will manage any direct and indirect impacts to this species.

8.12 Painted honeyeater

8.12.1 Status

Vulnerable – 8 July 2015

8.12.2 Biology and ecology

8.12.2.1 Characteristics

The Painted Honeyeater (*Grantiella picta*) is a medium-sized honeyeater that reaches a total length of 14-15 cm with a wingspan of 16 cm (Rowland, 2012). The species has white underparts with light black streaking, the back is glossy black with bright yellow panels on the edge of the wing and tail feathers and has a little white patch under the ear. The eyes are red and bill is pink. The female has more brownish upperparts and is less colourful than the male (Pizzey &Knight, 1997).

Plate 12: Painted Honeyeater (male) (Source: BirdLife Australia)

8.12.2.2 Known distribution

Painted Honeyeater is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The species is most common, and all breeding records occur, south of 26º S, on inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland (DAWE, 2020a).

The Action Plan for Australian Birds (Garnett et al., 2011) notes that the species has declined significantly across its core range in eastern and south-eastern Australia and the population is less than 10,000 breeding birds. Declines in Victoria have been linked to clearance and fragmentation of habitat for agriculture, declines in Mistletoe in timber-production forests and loss of old, mistletoe-bearing trees on farmland (DESE, 1988).

In Queensland the species is most common west of the Great Dividing Range. Non-breeding individuals occasionally occur in coastal areas along the east coast (Rowland, 2012).

Figure 12: Mapped distribution of Painted honeyeater (Source: BirdLife Australia)

8.12.2.3 Habitat description

Painted honeyeater inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of black box and river red gum, box-ironbark-yellow gum woodlands, acacia-dominated woodlands, paperbarks, casuarinas, callitris, and trees on farmland or gardens. The species prefers habitat with more mature trees that host more mistletoes, particularly mistletoes in the genus *Amyema*. It is more common in wider blocks of remnant woodland than in narrower strips (Garnett et al., 2011).

The species is most common in woodlands dominated by Acacia spp. (e.g. brigalow *Acacia harpophylla*, weeping myall *A. pendula*, and mulga *A. aneura*), Belah (*Casuarina cristata*) and Bull-oak (*Allocasuarina luehmannii*) (Rowland, 2012). It also occurs in riparian woodland communities dominated by eucalypt species such as *Eucalyptus camaldulensis* (DoE, 2015a).

8.12.2.4 Biology and reproduction

Painted honeyeater is a highly specialised honeyeater, being almost wholly dependent on mistletoe fruits (e.g. Maiden's mistletoe *Amyema maidenii*) but may also feed on nectar and insects (Ward, 2012). Birds have also been recorded feeding on similar sized fruit from other plant species, such as the introduced pepper-corn tree (*Schinus molle*) and grapes (*Vitis vinifera*) (Rowland, 2012).

Painted Honeyeater nests typically occur in drooping branches of trees in the vicinity of fruiting mistletoes. The nest consists of a flimsy cup nest made of plant-fibre, spiders' webs and rootlets in the outer foliage of trees anywhere from 3 m to 20 m above the ground. Breeding is thought to be timed in response to mistletoe fruiting, with peak fruit abundance coinciding with fledging (Rowland, 2012).

The species often occurs singly or in pairs, and less frequently in small flocks (DoE, 2015a).

8.12.3 Likelihood of occurrence within the Towrie development area

Painted honeyeaters are considered to have the potential to occur within the development area. Although the majority of the development area comprises non-remnant grazing land, regrowth and remnant woodland areas generally have an abundance of mistletoe (at least two species recorded). The development area occurs north of the known breeding habitat for the species, therefore the development area is considered to contain foraging and dispersal habitat only. The closest ALA record of the species is approximately 60 km north-west of the development area.

8.12.4 Anticipated threats and potential impacts from the development

A total of 12.0 ha of potential foraging and dispersal habitat may be cleared for the development, which may also result in further fragmentation of potential habitat within the development area. The Brigalow open forest and Brigalow low open forest recorded within the development area commonly support grey mistletoe, a mistletoe species known to be of importance to the species. Other related potential indirect impacts relevant to the painted honeyeater includes:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- pest incursion
- fauna mortality via strike from moving vehicles and machinery.

8.12.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.2, the following species-specific mitigation measure is recommended:

- Retain tree's that contain mistletoe where possible.

Indirect impacts will also be managed in accordance with the EMP.

8.13 White-throated needletail

8.13.1 Status

Vulnerable; Marine and Migratory (CAMBA/JAMBA/ROKAMBA)

8.13.2 Biology and ecology

8.13.2.1 Characteristics

This large swift has long curved wings and white markings. The plumage of the White-throated needletail (*Hirundapus caudactus*) is predominantly grey-brown, glossed with green and the wings are long and pointed. The tail is short and square, with the protruding feather shafts giving a spiky appearance. The throat and undertail are white (Birds in Backyards 2006).

Plate 13: White-throated needletail (Source: Bridger 2010)

8.13.2.2 Known distribution

The White-throated needletail is usually a summer migrant to Australia and is widespread in eastern Queensland. Migration usually occurs from the breeding grounds of the Northern Hemisphere (Pizzey & Knight 2007).

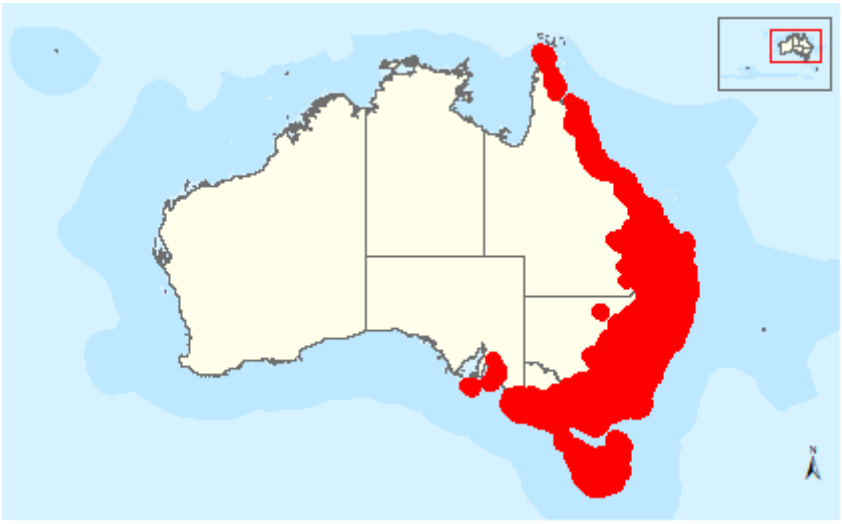

Figure 13: Mapped distribution of White-throated needletail (Source: DSEWPaC 2011ah)

8.13.2.3 Habitat description

This species is regularly observed flying over forests, woodlands, pastoral areas, floodplains, lakes and coastlines (Pizzey & Knight 2007). Indicative habitat also includes near margins of wetlands and human settlements.

This species occurs over most types of habitat, as described above and may also fly between trees or in clearings, below the canopy, but are less commonly recorded flying above woodland (DSEWPaC 2011ah). Essential microhabitat is defined as forests, woodlands, lakes, coastlines and active nesting sites.

8.13.2.4 Biology and reproduction

During the non-breeding season in Australia, the White-throated needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, wasps, flies, termites, moths, locusts and grasshoppers (DSEWPaC 2011ah).

White-throated needletails are non-breeding migrants in Australia. Breeding takes place in northern Asia. The eggs are laid on a platform of sticks placed in a hollow or similar crevice high in a tall conifer. Little else is known of the breeding behaviour of this species except that courtship displays consist of a series of vertical flights and that copulation is believed to take place in flight (Birds in Backyards 2006).

8.13.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. White-throated needletail roost in trees that are on elevated landforms that allow the species to drop into flight. Woodland communities on the western ridgeline may provide suitable roosting habitat, and since this species is an aerial forager, it may forage and disperse above the development area. Four ALA records also occur within 50 km of the development area however two are unlikely to be reliable (undated and/or has a high degree of spatial uncertainty). The other two records both occur within the Expedition National Park and are dated 2003 and 2014.

8.13.4 Anticipated threats and potential impacts from the development

A total of 13.0 ha of potential habitat may be cleared for the development. This species is predominately aerial and is unlikely to be directly impacted by development activities. Potential indirect impacts relevant to the species includes:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.13.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.2 and within the EMP will manage any direct and indirect impacts to this species.

8.14 Star finch (eastern)

8.14.1 Status

Endangered – listed 16 July 2000

8.14.2 Biology and ecology

8.14.2.1 Characteristics

The Star finch (eastern) or Star finch (southern) (*Neochmia ruficauda ruficauda*) is a small and compact bird. Adults of both sexes are greyish-olive with a red face and bill, bold white spots on the head, breast and flanks, a cream belly and vent, and a crimson tail. The males and females are not known to differ in appearance, although the other more common and better-known subspecies of the Star finch, *Neochmia ruficauda clarescens* and *Neochmia ruficauda subclarescens*, are sexually dimorphic (ie the sexes differ in appearance) (Higgins *et al* 2006), and it is highly likely that the Star finch (eastern) is sexually dimorphic as well, but this dimorphism is yet to be recorded (TSSC 2008s).

The Star finch (eastern) occurs in pairs and in small flocks of up to 20 (or rarely, 50) birds. No information is available on the breeding dispersion but, like other subspecies of the Star finch, it probably nests in loose colonies (Higgins *et al* 2006).

The total population of the Star finch (eastern) is estimated to consist of 50 or less breeding birds. This estimate is considered to be of low reliability. No permanent populations (or, more specifically, areas of permanently occupied habitat) have been identified (Garnett & Crowley 2000).

Plate 14: Star finch (*Neochmia ruficauda ruficauda*) (Source: Harrison n.d)

8.14.2.2 Known distribution

The Star finch (eastern) occurs in central Queensland and its population is extremely limited. Garnett and Crowley (2000) considered it critically endangered and Higgins *et al* (2006) considered it had an estimated total population of 50 individuals. This taxon is extinct in New South Wales (TSSC 2008s).

The distribution of this subspecies is poorly known, and it has disappeared from much of its former range. The most recent records occur in an area from near Wowan, north to Bowen, west to beyond Winton. It is possible that the subspecies could occur (or occurred) north of Bowen, based on historic records of Star finches at Mount Surprise and in the Cloncurry- Mount Isa region, but these records cannot be definitively attributed to the eastern subspecies. The Star finch (eastern) is suspected to occur in four discrete subpopulations (Holmes 1996 & 1998)

The Star finch (eastern) occurs within the Desert Channels, Burdekin and Fitzroy (Queensland) Natural Resource Management Regions. It has been recorded from damp grasslands, sedgelands or grassy woodlands near permanent water or areas of regular inundation. Occasionally, individuals have been reported in disturbed habitat and suburban areas (TSSC 2008s).

The extent of occurrence is estimated to be 300,000 km². However, this estimate, which is based on published maps, is considered to be of low reliability. The distribution of the Star finch (eastern) is probably severely fragmented (Garnett & Crowley 2000).

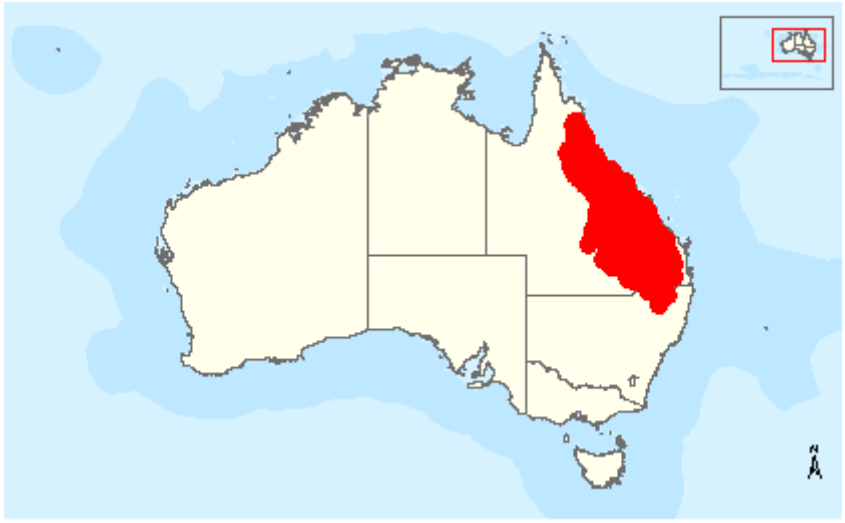

Figure 14: Mapped distribution of Star finch (Source: DOTE 2014t)

8.14.2.3 Habitat description

The Star finch (eastern) occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water (Garnett 1993; Gould 1865; Holmes 1996). It also occurs in cleared or suburban areas such as along roadsides and in towns (Baldwin 1975; Cayley 1932; Holmes 1996 & 1998; Marshall 1932).

The Star finch (eastern) was observed on the Namoi River in New South Wales, on sloping river banks covered with grass and herbs, and amongst beds of rushes growing along the side of the river (Gould 1865).

Studies at nine former sites of the Star finch (eastern) found that the habitat consisted mainly of woodland. These habitats are dominated by trees that are typically associated with permanent water or

areas that are regularly inundated; the most common species are *Eucalyptus coolabah*, *Eucalyptus tereticornis*, *Eucalyptus tessellaris*, *Melaleuca leucadendra*, *Eucalyptus camaldulensis* and *Casuarina cunninghamii* (Holmes 1996).

Sites from which recent records have been obtained have been dominated by grasses or have been in areas where the native vegetation has been partially cleared (DOTE 2014t). For example, at Wowan, the Star finch (eastern) was recorded near a road running through grassland (formally eucalypt woodland interspersed with vine forest) with some scattered shrub regrowth, and at Aramac, it was recorded in the grounds of a hotel (Holmes 1996 & 1998).

These latter records support earlier reports from Blackall in Queensland, where the Star finch (eastern) was said to have foraged in the streets and yards of the township (Cayley 1932; Marshall 1932), and at Inverell in New South Wales, where 20 were observed feeding in fig trees near a house (Baldwin 1975).

The distribution of the Star finch (eastern) overlaps with the following EPBC Act listed threatened ecological communities (TSSC 2008s):

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin
- Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South)
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

8.14.2.4 Biology and reproduction

The Star finch (eastern) has been recorded nesting in November (Holmes 1996; Storr 1984). The single clutch recorded contained four eggs (Storr 1984). Its breeding biology is otherwise unknown, although a likely but uncertain record from the Cardwell district in Queensland described the nests as 'bottle-shaped' and said that the nests were often placed in trees at heights of ten to thirty feet (approximately 3 to 9 m) above the ground (DOTE 2014t).

Other aspects of the breeding biology of the Star finch (eastern) are likely to be similar to those described for the Star finch at the species level (DOTE 2014t).

At the species level, the Star finch is a monogamous species (Higgins *et al* 2006; Immelmann 1982). It breeds in loose colonies that often include nests of the Chestnut-breasted mannikin (*Lonchura castaneothorax*).

It has been recorded breeding in all months of the year, although eggs have only been recorded from February to May and in September (Higgins *et al* 2006).

The Star finch builds a globular (or possibly bottle-shaped) nest that is made from grass and placed in a shrub or tree or amongst grass, sedges or reeds (Campbell 1900; Coate *et al* 2001; Higgins *et al* 2006; Holmes 1998; Immelmann 1982).

The female lays three to six or seven white eggs that are incubated by both sexes for a period of approximately 13 days (Campbell 1900; Higgins *et al* 2006; Immelmann 1982; Robinson 1939).

8.14.3 Likelihood of occurrence within the Towrie development area

This species is considered unlikely to occur within the development area. No records occur within the area surrounding the development area. As detailed on the Species Profile and Threats database, this

species is now thought to be extinct from southern Queensland areas where the development area is situated. This is largely based on the findings of Holmes (1996, 1998), who determined records of the species occur only from scattered sites in central Queensland (i.e. between 21°S and 25°S, and 141°E and 150°E).

8.14.4 Anticipated threats and potential impacts from the development

No disturbance to the Star finch (eastern) is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, direct impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- weed and pest incursion
- mortality from moving vehicles and machinery.

8.14.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.2 and within the EMP will manage any direct and indirect impacts to this species.

8.15 Australian painted snipe

8.15.1 Status

Endangered – listed 15 May 2013

Marine and Migratory (CAMBA)

8.15.2 Biology and ecology

8.15.2.1 Characteristics

The Australian painted snipe (*Rostratula australis*) is a stocky wading bird around 220 to 250 mm in length with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye and a white crown stripe, and metallic green back and wings, barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down its upper back The adult female is slightly larger and more brightly coloured than the male (DSEWPaC 2011o).

This species is generally seen singly or in pairs, or less often in small flocks (Marchant & Higgins 1993). Flocking occurs during the breeding season, when adults sometimes form loose gatherings around a group of nests. Flocks can also form after the breeding season, and at some locations small groups regularly occur (DSEWPaC 2011o).

Plate 15: Australian painted snipe (Source: Aviceda 2002a)

8.15.2.2 Known distribution

The Australian painted snipe has been recorded at wetlands in all states of Australia (Barrett *et al* 2003; Blakers *et al* 1984; Hall 1910b). It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia (DSEWPaC 2011o).

The extent of occurrence of the Australian painted snipe is estimated, with low reliability, to be 4,500,000 km² (Garnett & Crowley 2000).

The total population size of the Australian painted snipe is effectively unknown, but tentative estimates range from a few hundred individuals to 5,000 breeding adults (Garnett & Crowley 2000; Lane & Rogers 2000; Oring *et al* 2004; Watkins 1993).

The Australian painted snipe is considered to occur in a single, contiguous breeding population (Garnett & Crowley 2000).

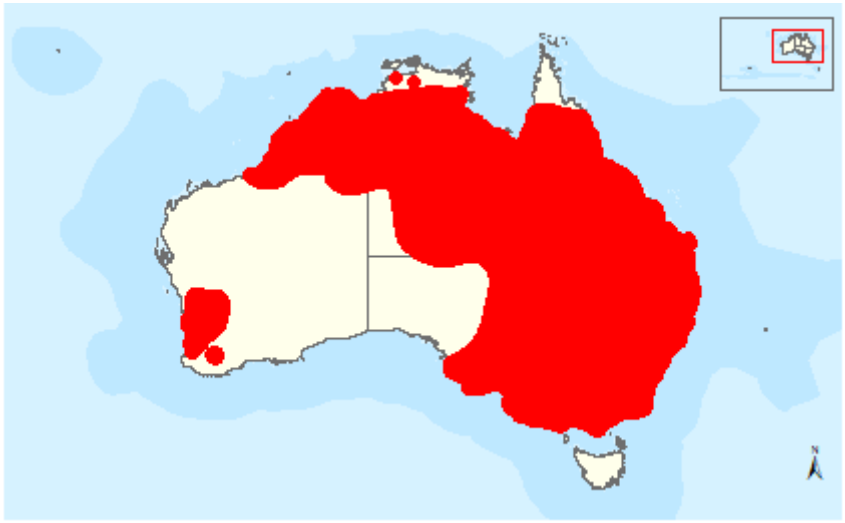

Figure 15: Mapped distribution of Australian painted snipe (Source: DSEWPaC 2011o)

8.15.2.3 Habitat description

The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*) (DSEWPaC 2011o). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (Marchant & Higgins 1993).

This species requires suitable wetland areas even in drought conditions. The species can move to suitable habitat if necessary (Marchant & Higgins 1993).

8.15.2.4 Biology and reproduction

The Australian painted snipe may breed in response to wetland conditions rather than during a particular season. It has been recorded breeding in all months in Australia. In southern Australia most records have been from August to February. Eggs have been recorded from mid-August to March, with breeding in northern Queensland also recorded between May and October (Marchant & Higgins 1993).

Australian painted snipe breeding habitat requires shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby, and nests usually occur on or near small islands in freshwater habitats (DSEWPaC 2011o).

The Australian painted snipe loafs on the ground under clumps of lignum, tea-tree and similar dense bushes (Marchant & Higgins 1993).

In some situations this species is loosely colonial, although nests are widely separated (Lowe 1963). The Australian painted snipe often breeds near nesting Red-necked Avocets (*Recurvirostra*

novaehollandiae), Banded Stilts (*Cladorhynchus leucocephalus*), Red-kneed Dotterels (*Erythrogonys cinctus*) and Black-tailed Native-hens (*Gallinula ventralis*) (Lowe 1963).

The Australian painted snipe has also been recorded nesting in and near swamps, canegrass swamps, flooded areas including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch (*Paspalum*), saltbush (*Halosarcia*) and grass, also in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (Marchant & Higgins 1993).

The nest is usually placed in a scrape in the ground (Pringle 1987), and either has scant lining or is a shallow bowl-shaped nest of dry grass or other plant material (Marchant & Higgins 1993). The Australian painted snipe can also use modified habitats, such as low-lying woodlands converted to grazing pasture, sewage farms, dams, bores and irrigation schemes (Marchant & Higgins 1993).

Rostratula benghalensis and the Australian painted snipe are known to lay two to six (usually three or four) eggs and females may lay up to four clutches in a year. Incubation takes 15 to 21 days (DSEWPaC 2011o).

The female Australian painted snipe mostly breed every two years (del Hoyo *et al* 1996; Marchant & Higgins 1993).

8.15.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. When inundated, a wetland within the development area contains exposed islands made from constructed embankments. As these are not natural island features, the presence of native aquatic vegetation is limited. However, these areas may provide nesting habitat for the species. Additionally, the wetland and some farm dams provide fringing aquatic vegetation suitable in providing coverage whilst the species forages and for dispersal. The gilgai areas may also provide temporary foraging resources when inundated from large rainfall events. Although no ALA records occur within 50 km of the development area, a number of unreliable (undated and/or have a high degree of spatial uncertainty) records occur within 200 km that are a similar distance from the coast.

8.15.4 Anticipated threats and potential impacts from the development

A total of 5.0 ha of potential foraging (including temporary), roosting and dispersal habitat may be cleared as part of the development. Vegetation clearing and particularly the loss of fringing aquatic vegetation may result in further degradation of potential habitat within the development area. No significant impacts on the wetland hydrology or water quality will occur. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging and breeding behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.15.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.2, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no Australian painted snipes are breeding or roosting in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a bird be identified utilising the habitat.
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.16 Grey falcon

8.16.1 Status

Vulnerable – listed 09 July 2020

8.16.2 Biology and ecology

8.16.2.1 Characteristics

The grey falcon (*Falco hypoleucos)* is a medium-sized, compact raptor from the genus *Falco*. It is largely pale grey in colouration, with a heavy thick chest, long wings and dark wing tips. The chin, throat and cheeks are white in colour. The legs and toes, eye-ring, cere and base of the bill are bright orange-yellow. Juveniles are predominately white, with heavy dark streaks (TSSC, 2020). Grey falcon's exhibit reversed sexual dimorphism, with females weighing on average 30 % more than males (Schoenjahn 2011).

This species is elusive and rare, occurring at low densities across it's distribution (TSSC, 2020). The species consists of a single population of approximately <1000 mature individuals. It is considered the rarest of the six Australian members of the genus *Falco*.

Plate 16:Grey falcon (*Falco hypoleucos*) (Source: Gary Porter in J. Schoenjahn 2020)

8.16.2.2 Known distribution

The grey falcon is widely distributed across the arid and semi-arid regions of Australia, including the Murray-Darling Basin, Eyre Basin, central Australia and Western Australia (Marchant and Higgins 1993). The extent of occurrence is estimated at 6.1 million km^2.

The species appears to be absent from Cape York Peninsula, areas east of the Great Dividing Range in Queensland and New South Wales, south of the Great Dividing Range in Victoria, and south of latitude 26ºS in Western Australia (Schoenjahn 2018).

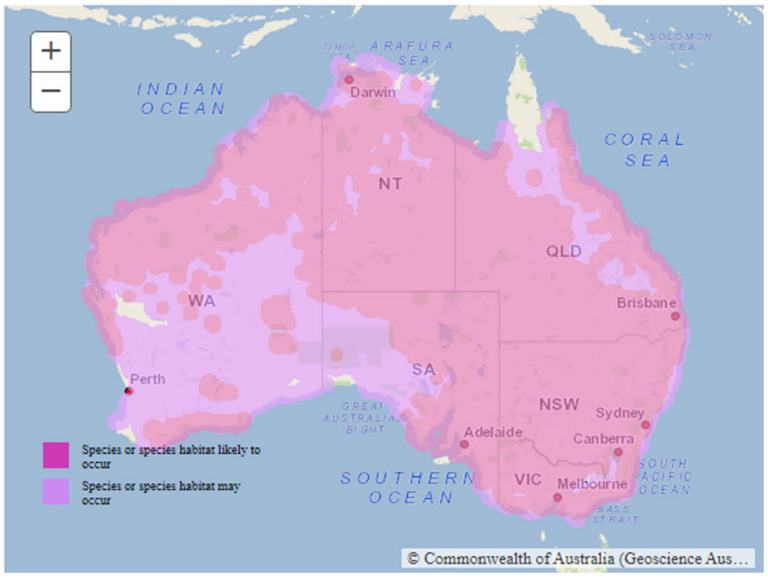

Figure 16 Mapped distribution of grey falcon (Source: DAWE 2021)

8.16.2.3 Habitat description

The grey falcon occurs in timbered lowland plains, particularly *Acacia* shrublands that are crossed by tree-lined water courses. It also frequents treeless areas, tussock grassland and open woodland (TSSC, 2020). At night, roosting may occur on areas of bare ground (Schoenjahn, 2018).

8.16.2.4 Biology and reproduction

Breeding occurs once a year, from June to November. When breeding this species utilises the disused nests of other raptors or corvids (TSSC, 2020). Nests that occur in the tallest trees along watercourses, particularly *Eucalyptus camaldulensis* and *E. coolabah*, are preferred. However, like other falcons this species may also nest in telecommunication towers.

Clutch sizes vary from one to four eggs, which require incubation for approximately 35 days. Young grey falcons generally stay with their parents for at least 12 months after fleging, even when the parents have new brood (Schoenjahnm 2018).

The grey falcon is reported to feed almost exclusively on other bird species.

8.16.3 Likelihood of occurrence within the Towrie development area

The grey falcon is considered to have the potential to occur within the development area. The development area contains woodlands dominated by *Eucalyptus camaldulensis* along Arcadia Creek, which also occur adjacent to Brigalow dominated regrowth to woodland communities. This riparian habitat could provide suitable breeding habitat. Additionally, riparian areas adjacent to regrowth shrubby areas as well as open cleared pasture are present which may provide suitable foraging and dispersal habitat. Although no ALA records occur within 50 km of the development area, records are located 125 km to the east near Glenmoral and 150 km to the north east at Springsure (undated and high spatial uncertainty). As this species occurs in low densities across its distribution, records of this species are generally rare.

8.16.4 Anticipated threats and potential impacts from the development

A total of 13.0 ha of potential foraging habitat may be cleared for the development, which may also result in further fragmentation of potential habitat within the development area. No nesting and breeding habitat will be impacted. Given the species' expansive range, the vast areas of suitable habitat within the development area and adjacent (the Carnarvon Ranges), habitat loss or fragmentation impacts are expected to be low. As this species is highly mobile and construction works will be completed in phases, areas of disturbance can be temporarily avoided.

Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.16.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.2, the following species-specific mitigation measure is recommended:

- Retain tall trees that contain bird nests (even if abandoned), especially where located along watercourses where possible.

Indirect impacts will also be managed in accordance with the EMP.

8.17 Large-eared pied bat

8.17.1 Status

Vulnerable – listed 4 April 2001

8.17.2 Biology and ecology

8.17.2.1 Characteristics

The Large-eared pied bat (*Chalinolobus dwyeri*) is a medium-sized insectivorous bat measuring a total length of approximately 100 mm and weighing 7 to 12 g (DSEWPaC 2011v). It has a shiny black coat with a white stripe on the flank (underside) of each wing. The ears are large and their facial lobes are located on the lower lip and between the corner of the mouth and the bottom of the ear (Hoye & Dwyer 1995, Ryan 1966). Its relatively short, broad wings suggest it flies slowly and with considerable manoeuvrability (DERM 2011a).

Plate 17: Large-eared pied bat (Source: Pennay 2006)

8.17.2.2 Known distribution

The former and current distribution of the Large-eared pied bat is poorly known (DSEWPaC 2011v). Large declines since the species was first described in northern NSW during 1966 have been suggested however it is not possible to evaluate these declines (DSEWPaC 2011v). Records for current distribution exist from Shoalwater Bay, north of Rockhampton in Queensland through to near Ulladulla in NSW. Despite this large range it is thought the species is uncommon and patchy within this area (DSEWPaC 2011v). The majority of the known distribution exists in NSW with the largest populations found within the sandstone escarpments and northern slopes of the Sydney basin (DSEWPaC 2011v).

Populations occur where suitable roosts are present. In particular, the populations in north-eastern NSW and south-east Queensland, Shoalwater Bay and Blackdown Tablelands are likely to be isolated with little interaction with their nearest populations (DSEWPaC 2011v).

Important populations supporting higher numbers of individuals include those present in the sandstone escarpments of Carnarvon, Expedition Ranges and Blackdown Tablelands Queensland (DSEWPaC 2011v). It is likely that these areas support a high proportion of the Queensland populations; however population estimates and distribution in these areas has not been established (DSEWPaC 2011v).

No maternity roost sites are known in Queensland (TSSC 2010)

The species extent of occurrence is approximately 570,000 km² based on the distribution range (Hoye and Dwyer 1995). The area of occupancy is approximately 9,120 km² (TSSC 2010).

Figure 17: Mapped distribution of Large-eared pied bat (Source: DSEWPaC 2011v)

8.17.2.3 Habitat description

Natural roosts may depend heavily on sandstone outcrops/escarpments and this species has been observed in disused mine shafts, caves, overhangs and disused Fairy martin (*Hirundo ariel*) nests for shelter and to raise young. The species also possibly roosts in the hollows of trees, dry and wet sclerophyll forest, Cyprus-pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country. In South-east Queensland, the species has primarily been recorded from higher altitude among moist tall open forest adjacent to rainforest (DSEWPaC 2011v).

Recent habitat modelling based on surveys in the southern Sydney region suggests that the Large-eared pied bat is largely restricted to the interface of sandstone escarpment for roost habitat and relatively fertile valleys for foraging habitat. Recent survey work in the Brigalow Belt South region of NSW supports this modelling (DSEWPaC 2011v).

Almost all records have been found within several kilometres of cliff lines or rocky terrain (QLD DERM 2011a).

The majority of records are from canopied habitat, suggesting a sensitivity to clearing, although narrow connecting riparian strips in otherwise cleared habitat are sometimes quite heavily used (NSW DECC 2007).

It is considered that some populations of this species would rely in part on Brigalow (*Acacia harpophylla* dominant and co-dominant) communities (DSEWPaC 2011v).

The Large-eared pied bat feeds on insects and usually flies at mid canopy level (6 to 10 m) from the ground but have also been documented flying low along creek lines (Curtis *et al* 2012).

8.17.2.4 Biology and reproduction

The diet and foraging behaviour of the Large-eared pied bat has not been well studied. The relatively short broad wings of this bat suggest that it is manoeuvrable and forages below the canopy (DERM

2011a). The species has been known to forage for insects at night around roost sites for a distance of up to several kilometres. However, it is not known if it targets particular groups of insects, such as moths (DERM 2011a).

Females can give birth at one year of age and males also appear capable of breeding at this age (DSEWPaC 2011v). Life expectancy and natural mortality have not been determined. Females have low fecundity giving birth to only one or two young per year (Hoye & Dwyer 1995).

Mating appears to occur in early winter. During autumn and early winter, males had enlarged testes and the muzzle glands of both sexes were swollen indicating that scent secreted from these glands may be a secondary sexual attractant during the mating period (Dwyer 1966). Females are pregnant in October and by early December they have all given birth and are lactating. Females most often have two young (average litter size of 1.8) with a juvenile sex ratio of males to females being 12:11. The nursery colony is established in September by both adult females and males with the majority of adult males leaving by the time the young are born in early summer. In late February and during March the juveniles have left the roost. The adult females leave the roost after the juveniles and the site is abandoned during the winter months (Dwyer 1966).

The generation life span has not been determined for the Large-eared pied bat. Based on the life expectancy of other bat species it is likely to be between two and ten years (DSEWPaC 2011v).

8.17.3 Likelihood of occurrence within the Towrie development area

The Large-eared pied bat is known within the development area. This species was confirmed to occur within the Eucalypt open forest on coarse grained sedimentary rocks and the Brigalow open forest on alluvial plains and sedimentary rock habitats within the development area via bat call analysis completed by Balance! Environmental. Sandstone escarpments that provide overhangs and caves were confirmed within the Eucalypt open forest habitat that occurs on the upper plateaus of the western ridgeline. Overhangs and caves are suitable for the roosting of this species. Woodland valley habitat occurs across the development area and is considered fertile especially where alluvial soils dominate. Areas of connected remnant and high value regrowth within the development area are considered to be of a condition to support foraging resources for the species, and dispersal may occur across the entire development area between roosting and foraging habitat.

8.17.4 Anticipated threats and potential impacts from the development

No direct impacts will occur to roosting habitat, however 4.0 ha of foraging habitat will be directly impacted via vegetation clearing. As the development area and wider Arcadia Valley is flanked by sandstone escarpments, habitat availability in the area is high and the removal of foraging habitat is not expected affect the species' persistence in the area. No known roost sites occur within the development area and as such no impacts to the species' breeding success is anticipated. This species is highly mobile, nocturnal and not considered sensitive to potential indirect impacts associated with the development.

8.17.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.4 and within the EMP will manage any direct and indirect impacts to this species.

8.18 Northern quoll

8.18.1 Status

Endangered – listed 12 April 2005

8.18.2 Biology and ecology

8.18.2.1 Characteristics

The Northern quoll (*Dasyurus hallucatus*) is the smallest of the four Australian quoll species. This species is the most arboreal and aggressive of the four quoll species (DSEWPaC 2011x). It has reddish brown fur dorsally, with cream coloured fur on its ventral surface. White spots are present on its back and rump although the tail is unspotted. The Northern quoll has a pointy snout. The Northern quoll is a solitary carnivorous marsupial that makes its dens in rock crevices, tree holes or occasionally termite mounds. This species is primarily nocturnal or may be crepuscular under certain situations.

The Northern quoll can weigh up to 1.2 kg, with the males being larger than the females (TSSC 2005). The body size for a male is approximately 270 to 370 mm and the female is approximately 249 to 310 mm (Van Dyck; Strahan 2008).

Plate 18: Northern quoll (Source: Ward 2010)

8.18.2.2 Known distribution

The Northern quoll was historically common across northern Australia, occurring almost continuously from the Pilbara, Western Australia, to near Brisbane, Queensland (Braithwaite & Griffiths 1994). The Northern quoll is now restricted to five regional populations across Queensland, the Northern Territory and Western Australia both on the mainland and on offshore islands.

Within Queensland, extant populations are highly fragmented and have experienced significant range reductions when compared to the species' former distribution (DSEWPaC 2011x).

The Northern quoll is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Cooktown in Queensland and extends as far west into central Queensland to the vicinity of Carnarvon Range National Park (Woinarski *et al* 2008). There are occasionally records as far south in Queensland as Maleny on the sunshine coast hinterland (DERM 2009).

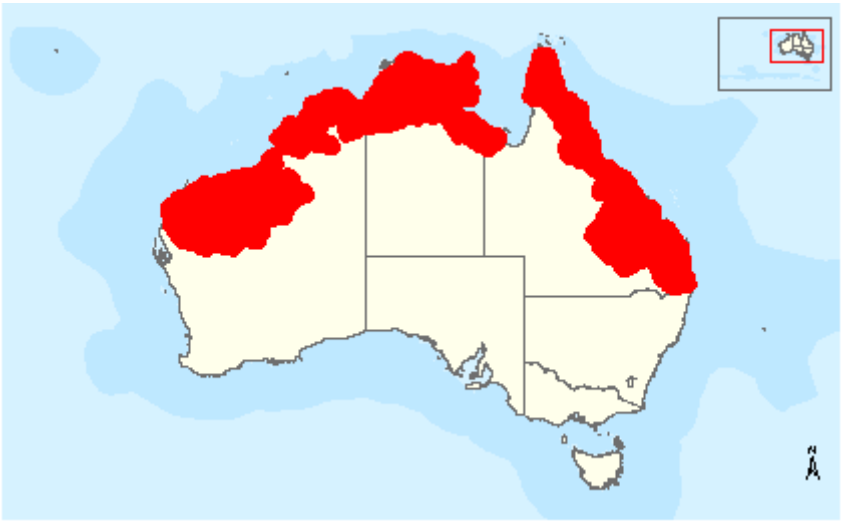

Figure 18: Mapped distribution of Northern quoll (Source: DSEWPaC 2011x)

8.18.2.3 Habitat description

The Northern quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert (Threatened Species Scientific Committee 2005aq). Northern quoll are also known to occupy non rocky lowland habitats such as beachscrub communities in central Queensland. Northern quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Rocky habitats are usually of high relief, often rugged and dissected but can also include tor fields or caves in low lying areas such as in Western Australia. Eucalypt forest or woodland habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes. Dens are made in rock crevices, tree holes or occasionally termite mounds (Threatened Species Scientific Committee 2005aq). Northern quolls sometimes occur around human dwellings and campgrounds. Northern quolls appear to be most abundant in habitats within 150 km of the coast (Braithwaite & Begg 1995).

Recent surveys throughout Queensland have suggested Northern quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and were closer to permanent water (Woinarski *et al* 2008).

Rocky habitats support higher densities and/or longer lived individuals within the species range, due to more protection from predators, better nutrition and less exposure to agricultural practices (Burnett 1997; Oakwood 2000). Rocky habitats also supported a higher density of Northern quoll dens (Oakwood 1997 in Oakwood 2000). Breeding success is higher in animals that have a den near a creek line (Braithwaite & Begg 1995).

8.18.2.4 Biology and reproduction

Northern quolls have short life spans, with males living for approximately one year and the oldest recorded female in the wild being three years of age (TSSC 2005).

Northern quolls breed once each year exhibiting synchronous reproduction within each year at each site (Nelson & Gemmell 2003, Oakwood 2008). Northern quolls produce on average seven young which are born after a gestation of 21 to 26 days. Females wean two to three young which become reproductively mature at 11 months (Oakwood 2008).

In the first year that females reproduce, the litters are larger and predominately male. If breeding occurs in the second year, litters are smaller and predominately female. As females rarely survive to reproduce in the third year, the breeding territory is probably inherited by one of her daughters, ensuring breeding success (Oakwood 2000).

Whilst still in the pouch, juveniles have a high rate of survival, but once they leave the pouch and are left in the den they are likely to suffer high mortality.

Young start to eat insects at four months old, and leave the den to forage at five months old, whilst still suckling from their mother. Juveniles are weaned at 6 months old, in November to early December. Once young are independent their survival is difficult to assess as they disperse to other areas. At this stage, they are in a size range that makes them vulnerable to a wide range of predators (Oakwood 2000).

The majority of male Northern quolls die after their first breeding season, which is unusual for a marsupial this large (Oakwood 2000).

The intense physical effort of male quolls (roving during the females onset of oestrus) appears to cause the physiological decline of males and subsequent die off at one year of age (Oakwood 2008). This male die-off in combination with the fact females usually breed only once makes local populations highly vulnerable to extinction.

8.18.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. A variety of denning opportunities occur within the Eucalypt open forest on coarse grained sedimentary rocks habitat including sandstone escarpments that provide overhangs and caves (upper western ridgeline) as well as rocky outcrops and screes (lower western ridgeline). The development area contains scattered patches of woodland vegetation that are within 1 km of suitable denning habitat. Patches that provide connectivity between denning habitat and water sources are considered suitable for the foraging and dispersal of this species. Although no ALA records occur within 50 km, the species is known to occur within Carnarvon National Park which is largely connected to Boxvale State Forest located directly west of the development area.

8.18.4 Anticipated threats and potential impacts from the development

No direct impacts will occur to denning habitat; however 3.0 ha of foraging and dispersal habitat may be directly impacted via vegetation clearing. This may also result in further fragmentation of potential habitat within the development area and direct mortality by entrapment in hollows or logs during vegetation clearing. Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- accidental entrapment in open excavations
- weed and pest incursion
- mortality from moving vehicles and machinery.

8.18.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.4, the following species-specific mitigation measures are recommended:

- Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create ‘ladders’ to enable fauna to exit and to provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.
- All hollow logs and potential denning sites will be inspected by a fauna spotter-catcher prior to clearing to identify any denning individuals.

Indirect impacts will also be managed in accordance with the EMP.

8.19 South-eastern long-eared bat

8.19.1 Status

Vulnerable – listed 4 April 2001

8.19.2 Biology and ecology

8.19.2.1 Characteristics

The head and body length of the South-eastern long-eared bat (*Nyctophilus corbeni*) is approximately 50 to 75 mm in length and its tail length is approximately 35 to 50 mm. The weight varies between genders with females (14 to 21 g) being heavier than males (11 to 15 g).

The South-eastern long-eared bat is distinguishable from other long-eared bats by its larger size as well as a broader skull and jaw. It is also geographically separated from other long-eared bats (van Dyck & Strahan 2008).

It should be noted that most of the data on this species is from studies undertaken outside of Queensland (Curtis *et al* 2012).

Plate 19: South-eastern long-eared bat (Source: Murphy 2005)

8.19.2.2 Known distribution

The South-eastern long-eared bat has a limited distribution restricted to the Murray-Darling Basin in south-eastern Australia (DSEWPaC 2011w). In Queensland, the majority of records for this species are from the Brigalow Belt South Bioregion, with the most easterly record from the Bunya Mountains National Park. The most northerly records are from the Expedition Range and Dawson River areas with the most westerly records from west of Bollon in the Mulga lands Bioregion (DSEWPaC 2011w; Schulz & Lumdsen 2010). The nearest records to the development area are from the Rundle Range, north of Gladstone and Expedition National Park on Melancholy Creek (DERM 2012; Atlas of Living Australia 2012).

Figure 19: Mapped distribution of South-eastern long-eared bat (Source: DSEWPaC 2011w)

8.19.2.3 Habitat description

Although commonly recorded in some areas such as the Brigalow Belt South and Nandewar Bioregions in north-eastern NSW, this species occurs in a range of inland woodland vegetation types, including box, ironbark, cypress pine, mallee, bull-oak, brigalow and belah woodlands/forests and will roost in tree hollows, crevices and under loose bark within these communities (DEC 2005a; DSEWPaC 2011w).The South-eastern long-eared bat forages within the understorey of the abovementioned communities, including the ground (DSEWPaC 2011xw; Schulz & Lumdsen 2010).

Limited information is available regarding the roosting ecology of this species, however surveys undertaken by others suggest that these bats may change roosting sites as frequently as each day (most roosts used for just a single day) and are likely to travel across large distances between consecutive roosts (up to 2 km). No information is available on maternity roosts where larger groups may form (DSEWPaC 2011w; Schulz & Lumdsen 2010).

8.19.2.4 Biology and reproduction

There is little information currently available on this species' reproductive biology, although it is thought that mating takes place during autumn and winter. Females are thought to store sperm until spring, when fertilisation and gestation occurs. Up to two young are born during late spring/early summer with young not fully weaned until mid-summer (DEC 2005a; Curtis *et al* 2012).

8.19.3 Likelihood of occurrence within the Towrie development area

Nyctophilus sp. was recorded within the development area based on the bat call analysis; however calls from this genus cannot be differentiated. Therefore, this species is considered likely to occur within the development area. Hollow-bearing trees and/or trees with loose bark were occasionally recorded during the field survey and as such habitat is considered suitable for roosting. The development area contains woodlands dominated by *Acacia harpophylla* and *Eucalyptus* sp. in both remnant and high value condition; these habitat types provide the more complex understorey that is suitable for foraging. Dispersal may occur across the development area between roosting and foraging areas. Although no ALA records occur within 50 km, the species is known to occur within Carnarvon National Park which is largely connected to Boxvale State Forest located directly west of the development area.

8.19.4 Anticipated threats and potential impacts from the development

A total of 4.0 ha of potential roosting and foraging habitat may be cleared for development. This may also result in further fragmentation of potential habitat within the development area and direct mortality by entrapment in hollows or bark fissures during vegetation clearing. Other potential indirect impacts relevant to the species includes:

- increased noise and light levels affecting foraging behaviours.

8.19.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.4, the following species-specific mitigation measure is recommended:

- All hollow-bearing trees will be inspected by a fauna spotter-catcher prior to clearing to identify any roosting individuals.

Indirect impacts will also be managed in accordance with the EMP.

8.20 Greater glider

8.20.1 Status

Vulnerable – listed 05 May 2016

8.20.2 Biology and ecology

8.20.2.1 Characteristics

The Greater Glider is the largest gliding possum in Australia with a head and body length of 35-46 cm, a long furry tail 45-60 cm long and weighs 900-1700 g. The species has thick fur that makes it appear larger than its actual size (TSSC, 2016). The fur is mostly dark grey, cream or mottled cream and grey above and whitish below. The species has a short snout, large ears with long hair on the outer surface that projects beyond the ear flap, and the gliding membrane extends from the forearm (Van Dyck et al., 2013).

Plate 20: Greater Glider (Source: Jasmine Zeleney)

8.20.2.2 Known distribution

The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria, with an elevational range from sea level to 1200 m above sea level. Isolated inland subpopulations occur in the Gregory Range west of Townsville, and in the Einasleigh Uplands (TSSC, 2016).

The area of occupancy of the species has decreased substantially, mostly due to land clearing. This decline continues today due to continued clearing, habitat fragmentation, fire and forestry (TSSC, 2016).

Figure 20: Mapped distribution of Greater glider (Source: ALA)

8.20.2.3 Habitat description

Greater glider typically occurs in abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. Greater glider favour forests with a diversity of Eucalypt species due to seasonal variation in its preferred tree species. Distribution can be patchy even in suitable habitat. The species does not occur in rainforests (TSSC, 2016).

8.20.2.4 Biology and reproduction

The Greater glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands. The species is primarily florivorous (leaf-eating), with a diet mostly comprising the leaves and flowers of Myrtaceae (e.g. eucalypt) trees. During the day, this species spends most of its time denning in hollowed trees, with each animal inhabiting up to twenty different dens within its home range (TSSC, 2016).

Home ranges are typically relatively small (1−4 ha) but are larger in lower productivity forests and more open woodlands. Males' ranges are typically larger than females, with male home ranges being largely non-overlapping (TSSC, 2016).

Females give birth to a single young during March to June. Sexual maturity is reached in the second year. Not all females breed each year. Life span has been estimated at 15 years, therefore generation length is estimated at 7−8 years. The relatively low reproductive rate makes this species sensitive to disturbances such as bushfire, and may render small isolated populations in small remnants prone to extinction (TSSC, 2016).

8.20.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. Trees bearing medium or large hollows were recorded during the field surveys, primarily in the Eucalypt riparian woodlands. Abundance of hollow-bearing trees was generally low and therefore is considered more marginal habitat. Foraging habitat is found in the woodlands and forests dominated by *Eucalyptus* sp. in both remnant and high-value regrowth condition. Dispersal habitat is also found along some tracts of connected Eucalypt woodland along the drainage lines and adjacent to Arcadia Valley Road. This habitat

is also present within the western ridgeline as a large contiguous patch. Three ALA records occur within 25 km of the development area, and several more within 50 km.

8.20.4 Anticipated threats and potential impacts from the development

A total of 1.0 ha of potential breeding, foraging and dispersal habitat may be cleared for development. This may also result in further fragmentation of potential habitat within the development area and direct mortality by entrapment in hollows during vegetation clearing. Other potential indirect impacts relevant to the species includes:

- increased noise and light levels affecting dispersal and foraging behaviours.

8.20.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.4, the following species-specific mitigation measures are recommended:

- All hollow-bearing trees will be inspected by a fauna spotter-catcher prior to clearing to identify any individuals.
- Where clearing is required in an area of potential greater glider habitat comprising narrow linear patches, clearing will not reduce the size of patches so that gaps between become greater than 100 m.

Indirect impacts will also be managed in accordance with the EMP.

8.21 Koala

8.21.1 Status

Vulnerable - listed 2 May 2012

8.21.2 Biology and ecology

8.21.2.1 Characteristics

The Koala (*Phascolarctos cinereus*) is an arboreal, herbivorous marsupial and is mostly nocturnal. However, unlike other arboreal mammals the Koala does not have a tail. They have a large round head, large round furry ears, a stout body, short legs and large feet. Both front and hind paws have long sharp claws. The Koala ranges between 67 to 74 cm in males and 64 to 73 cm in females. A male Koala on average weighs 6.5 kg, while a female Koala on average weighs 5.1 kg (Australian Koala Foundation 2012; Menkhorst & Knight 2004).

Plate 21: Koala (Source: Monkhouse 2005)

8.21.2.2 Known distribution

In Queensland, the Koala's distribution extends inland from the east coast: from the Wet Tropics interim biogeographic regionalisation of Australia (IBRA) bioregion, into the Einasleigh Uplands bioregion in the north of the state; from the Central Mackay Coast bioregion, through the Brigalow Belt North bioregion to the Desert Uplands and Mitchell Grass Downs bioregions, and from the Southeast Queensland bioregion, through the Brigalow Belt to the Mulga Lands and Channel Country bioregions in the south-west of the state (Patterson 1996; TSSC 2012).

The highest density of the Koala population occurs in south-east Queensland. Lower densities occur through central and eastern areas (Queensland EPA 2006).

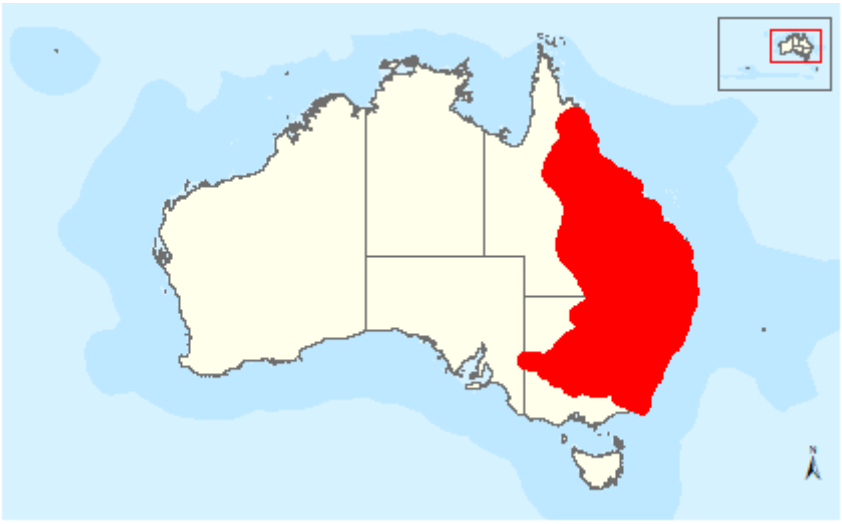

Figure 21: Mapped distribution of Koala (Source: DOTE 2014a)

8.21.2.3 Habitat description

Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species (Martin & Handasyde 1999).

Koala habitat can be broadly defined as any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. The distribution of this habitat is largely influenced by land elevation, annual temperature and rainfall patterns, soil types and the resultant soil moisture availability and fertility. Preferred food and shelter trees are naturally abundant on fertile clay soils.

Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by *Eucalyptus* species. In coastal lowlands in Queensland and New South Wales, Koalas are also found in vegetation communities dominated by *Melaleuca* or *Casuarina* species (TSSC 2012p).

On the western slopes, tablelands and plains in Queensland and New South Wales, Koalas are found in sub-humid *Eucalyptus*-dominated forests and woodlands in riparian and non-riparian environments, and some Acacia-dominated forests and woodlands in non-riparian environments (Melzer *et al* 2000).

In the dry, subtropical to semi-arid environments in the western parts of the species' range, Koalas inhabit *Eucalyptus*-dominated forests and woodlands, particularly in the vicinity of riparian environments, and *Acacia*-dominated forests, woodlands and shrublands (Melzer *et al* 2000; NSW DECC 2008; Sullivan *et al* 2003a).

Koalas are also known to occur in modified or regenerating native vegetation communities, as well as urban and rural landscapes where food trees or shelter trees may be highly scattered.

There is a growing body of evidence that identifies the importance of shelter (non-food) trees to koalas. Crowther and colleagues (2013) expand on this and suggest that shelter trees are equally important as food trees and should be weighted as such when assessing habitat suitability. Shelter trees play an essential role in thermoregulation and are likely to be selected based on height, canopy cover and elevation (ie trees occurring in gullies are preferable) (Crowther *et al* 2013). The difficulty in regards to shelter trees is that, unlike food trees, there is no identified sub-set of forest and woodland trees known to be shelter trees. The use of a particular tree species, or individual trees within a species is highly contextual and variable (Crowther *et al* 2013).

8.21.2.4 Biology and reproduction

Female Koalas can potentially produce one offspring each year with births occurring between October and May. The newly-born Koala lives in its mother's pouch for six to eight months and, after leaving the pouch, remains dependent on the mother, riding on her back. Young Koalas are independent from about 12 months of age (DOTE 2014a).

The Koala is a leaf-eating specialist that feeds primarily during dawn, dusk or night (Crowther *et al* 2013). Its diet is restricted mainly to foliage of *Eucalyptus* spp; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The Koala may, at times, supplement its diet with other species, including *Leptospermum* spp. and *Melaleuca* spp. (Martin & Handasyde 1999; Moore & Foley 2000).

8.21.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. The development area contains woodlands and forests dominated by *Eucalyptus* sp. in both remnant and high value condition; these vegetation communities are suitable for foraging. Additionally, field surveys confirmed the presence of *Eucalyptus populnea* as an occasional canopy tree or emergent in Brigalow woodlands on alluvial substrates. Although not dominated by Eucalypts, patches of this community may be used to forage while dispersing to areas of higher quality habitat. Two historical ALA records (1987 and 1988) occur within 25 km of the development area, and an additional three records occur within 50 km (dated 1996 and 2001).

8.21.4 Anticipated threats and potential impacts from the development

A total of 2.0 ha of potential refuge, foraging and dispersal habitat may be cleared as part of the development, which may also result in further fragmentation of potential habitat within the development area. Other potential indirect impacts relevant to the koala includes:

- pest incursion
- fauna mortality via strike from moving vehicles and machinery.

8.21.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.4, the following species-specific mitigation measure is recommended:

- Clearing must be carried out in a way that ensures any koala present have time to move out of the clearing site without human intervention.

Indirect impacts will also be managed in accordance with the EMP.

8.22 Adorned delma

8.22.1 Status

Vulnerable – listed 16 July 2000

8.22.2 Biology and ecology

8.22.2.1 Characteristics

The Adorned delma (*Delma torquata*), also known as the Collared delma, is endemic to Queensland and is the smallest member of the family Pygopodidae. This small legless lizard is generally uniform brown; but with belly shields that are darker at the margins, and a dark-brown banded head and neck with cream-yellow interspaces (DSEWPaC 2011s). The species has a maximum snout-vent length of 7 cm and maximum total length of approximately 19 cm (Peck & Hobson 2007). The species' average weight is about 2 g and the mid-body scales are in 16 rows. The snout is relatively short and blunt (Cogger 2000).

Plate 22: Adorned delma (Source: Peck 2006)

8.22.2.2 Known distribution

Despite difficulties in estimating the Adorned delma population size, it is known that the the species occurs in small isolated populations throughout its distribution (DSEWPaC 2011s). Important populations include Mt Crosby, the Toowoomba Range, stock route areas (especially the Donnybrook Stock Route region) and the Brisbane area (DSEWPaC 2011s).

The species has been recorded at the Bunya Mountains (approximately 200 km northwest of Brisbane), the Blackdown Tablelands National Park (approximately 200 km west of Rockhampton), Expedition National Park (Central Queensland), Western Creek (approximately 200 km south-west of Brisbane) and the Toowoomba Range. A large concentration of records come from the western suburbs of Brisbane (DSEWPaC 2011s).

Due to specific habitat requirements of Adorned delma, the species distribution is highly fragmented and restricted to only a few locations within the area that is defined by the habitat boundary (Peck 2003).

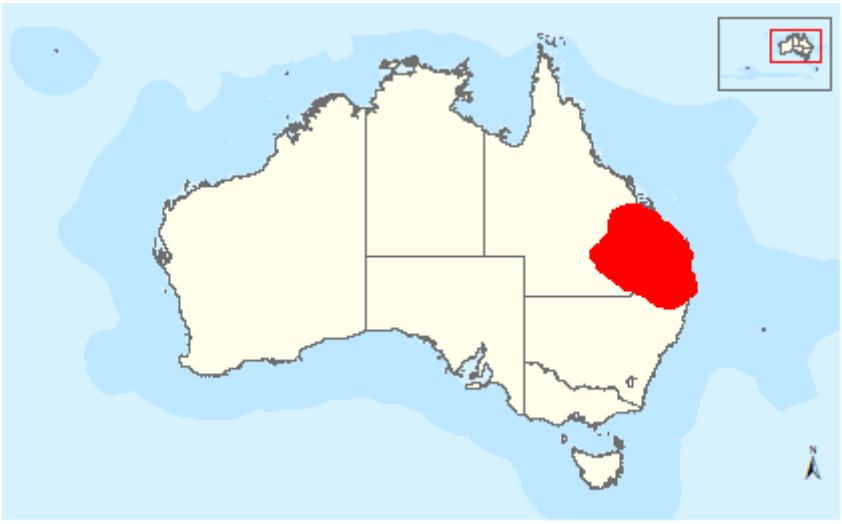

Figure 22: Mapped distribution of Adorned delma (Source: DSEWPaC 2011s)

8.22.2.3 Habitat description

The Adorned delma normally inhabits eucalypt-dominated woodlands and open-forests in Queensland Regional Ecosystem Land Zones (LZ) 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010).

The Adorned delma has been recorded from rocky areas associated with dry open forests. This species occurs in open eucalypt and acacia woodland with an understorey of native grasses and loose rocks. The Adorned delma has also been recorded from eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006).

The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of Adorned delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993).

8.22.2.4 Biology and reproduction

The Adorned delma feeds on insects and spiders, with small cockroaches the most common prey item. Some individuals have been captured in subterranean termite colonies (Davidson 1993; Porter 1998).

As with all members of the Pygopodidae family, the Adorned delma produces two small white, elongated eggs in December. These then hatch in February to March (Peck & Hobson 2007).

8.22.3 Likelihood of occurrence within the Towrie development area

This species is considered likely to occur within the development area. The development area contains Eucalypt woodlands and forests on Land Zones 3 and 10 as well as *Acacia* woodlands on Land Zone 9. Microhabitat features and native grass tussocks however were only abundant in the larger contiguous patches. This species is not known to have specific habitat requirements for breeding and as such is considered to breed in the same habitat suitable for foraging. Two ALA records from 2001 occur at Presho Forest Reserve, west of the development area within 50 km.

8.22.4 Anticipated threats and potential impacts from the development

A total of 1.0 ha of breeding and foraging habitat will be directly impacted via vegetation clearing. The Draft Referral guidelines for the nationally listed Brigalow Belt reptiles indicates that clearing one hectare or less of important habitat (providing that important habitat connectivity is not compromised) has a low

risk of significant impacts. Given the high availability of potential habitat within the development area and connecting areas to the west (the Carnarvon Ranges), the removal of this habitat is expected to have only minor impacts on the species. Potential indirect impacts on this species include:

- accidental entrapment in open excavations
- weed and pest incursion
- mortality from moving vehicles and machinery.

8.22.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.3, the following species-specific mitigation measure is recommended:

- Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create 'ladders' to enable fauna to exit and to provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.

Indirect impacts will also be managed in accordance with the EMP.

8.23 Ornamental snake

8.23.1 Status

Vulnerable – listed 16 July 2000

8.23.2 Biology and ecology

8.23.2.1 Characteristics

The Ornamental snake (*Denisonia maculata*) is a stout-bodied snake which grows to a total length of about 50 cm. The overall body colour is brown, greyish brown or almost black, under-surfaces are cream, often with darker streaks or flecks on the outer edges of the belly. The skin between the scales is black. The entire head, and at least the forebody, is very finely peppered with dark brown or black markings. Lips are distinctly barred. Scales are smooth and arranged in 17 rows at mid-body (Cogger 2000; Richardson 2006).

Important populations occur in remnant vegetation in close proximity to Gilgai mounds and depressions (DSEWPaC 2011r).

Plate 23: Ornamental snake (Source: Wilson 2008)

8.23.2.2 Known distribution

The species is endemic to Queensland and mostly occurs in the Brigalow Belt from Inglewood, north to Emerald and east to Gladstone (Cogger 2000). The centre of the species distribution lies within the drainage system of the Fitzroy and Dawson Rivers (DSEWPaC 2011r).

Known localities occur in Blackwater; Dysart, Peak Downs; Moranbah; Coppabella; Rockhampton region; east of Midgee; Yeppoon Crossing; Emerald; near Moura; the Dawson Valley; Charters Towers; Biloela; Duaringa; St Lawrence; St George; Goondiwindi; Dipperu National Park; and adjacent to South Walker Creek near Nebo (DSEWPaC 2011r).

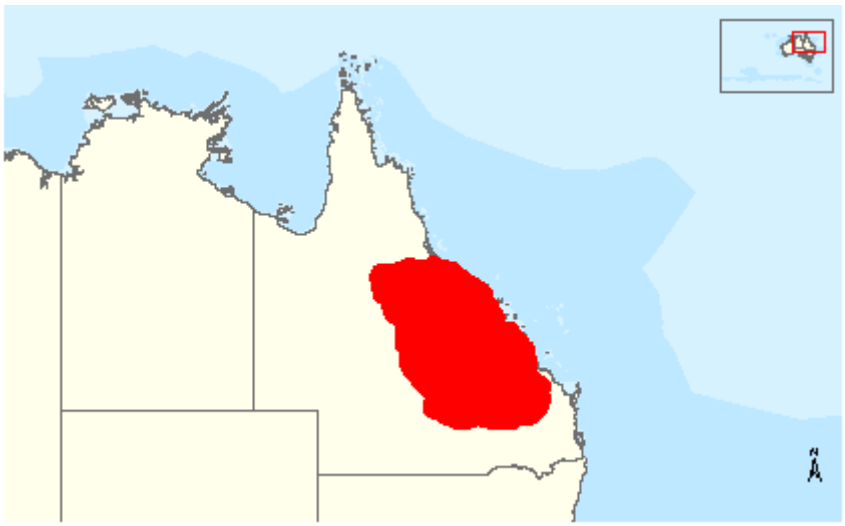

Figure 23: Mapped distribution of Ornamental snake (Source: DSEWPaC 2011r)

8.23.2.3 Habitat description

The species is associated with moist or ephemeral areas (eg floodplains, clay pans and water bodies), with appropriate resources in the form of shelter (eg fallen timber, deep cracking soils) and prey species (ie frogs) (Curtis *et al* 2012).

This species is known only within the Fitzroy and Dawson River drainage systems in the Brigalow Belt region of Queensland where it has been found to be most abundant in heavily gilgaied (melonhole) Brigalow (DSEWPaC 2011r). However, this species is also known from habitats without Brigalow.

This species tolerates relatively simple habitat structure (ie grasslands and cleared paddocks) and as such may be encountered within unmapped sections of the development area where shelter and frogs are present (Curtis *et al* 2012). During dry periods, the species seeks refuge within soil cracks on gilgai mounds (DSEWPaC 2011r).

Important microhabitats for this species are likely to include cracking soils and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber etc) (Richardson 2006).

Plate 24: Photo of habitat example (Source: Aurecon 2013)

8.23.2.4 Biology and reproduction

This species is nocturnal and feeds almost exclusively on frogs. The species is more active during the summer months, but may be encountered throughout the year. Activity peaks generally correlate to heavy rains when frogs congregate to breed, and later when young frogs emerge (Curtis *et al* 2012).

The Ornamental snake is a live-bearing species with an average of three to 11 young per litter produced between September to November (Cogger 2000; Curtis *et al* 2012).

8.23.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. Although highly degraded from cattle grazing, exotic grass incursion and in some locations historical blade ploughing, gilgai habitat is present within the development area and may be suitable for this species. Shallow gilgai were also rarely recorded in areas of *Acacia harpophylla* woodland on coarse-grained sedimentary rocks. A single record from 1998 occurs north of the development area within 50 km.

8.23.4 Anticipated threats and potential impacts from the development

Based on modelled habitat, a total of 2.0 ha of potential breeding and foraging habitat may be cleared as part of the development. Other potential indirect impacts relevant to the ornamental snake includes:

- pest incursion
- fauna mortality via entrapment in trenches
- erosion and sedimentation
- water contamination
- altered hydrology
- light disturbance.

8.23.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.3, the following species-specific mitigation measures are recommended:

- Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create 'ladders' to enable fauna to exit and to provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.
- Clearing works that occur in areas of potential ornamental snake habitat will prioritise avoiding gilgai formations.

Indirect impacts will also be managed in accordance with the EMP.

8.24 Yakka skink

8.24.1 Status

EPBC Act – Vulnerable

8.24.2 Biology and ecology

8.24.2.1 Characteristics

The Yakka skink (Egernia rugosa) is a large, robustly built skink with a notably thick tail and grows to a total length of about 40 cm with short legs and claws. A broad, dark brown to black stripe extends along the back from the nape to the tail. Individual scales within this stripe can be variegated with dark and medium brown. This dark stripe is bordered on either side by a narrow, pale fawn stripe. The upper lips are whitish to reddish brown, contrasting with darker adjacent scales. The belly and ventral surfaces are cream to yellowish orange and the throat often with blackish flecks. Scales are in 26 to 30 rows at mid-body (Cogger 2000; DEHP 2012; Richardson 2006).

Plate 25: Yakka skink (Source: DSEWPaC 2011t)

8.24.2.2 Known distribution

Important Yakka skink populations occur where colonies are identified or are within 5 km of known records of the species. Any contiguous patch of vegetation which is suitable for the long-term persistence of a population, or for maintaining genetic diversity across the landscape, is important habitat for the species (Brigalow Belt Reptiles Workshop 2010).

The distribution of the Yakka skink is highly fragmented and spans from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. Included in this range are sections of the Brigalow Belt (North and South), Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet tropics and Cape York Peninsula Biogeographical Regions (DSEWPaC 2011t).

This species is known from Fairview and Arcadia gas fields and has been recorded from Arcadia Valley, Lonesome Holding and Mt. Hutton (DEHP 2012c; Queensland Museum 2011). The Yakka skink is also known from remnant vegetation communities which are contiguous with the communities within the gas fields, including Expedition National Park (URS 2009a), unprotected lands near the Dawson Highway and Leichardt Highway junction, a number of unprotected areas in Arcadia Valley and also from the Burnett Highway to the north of Biloela (Richardson 2006).

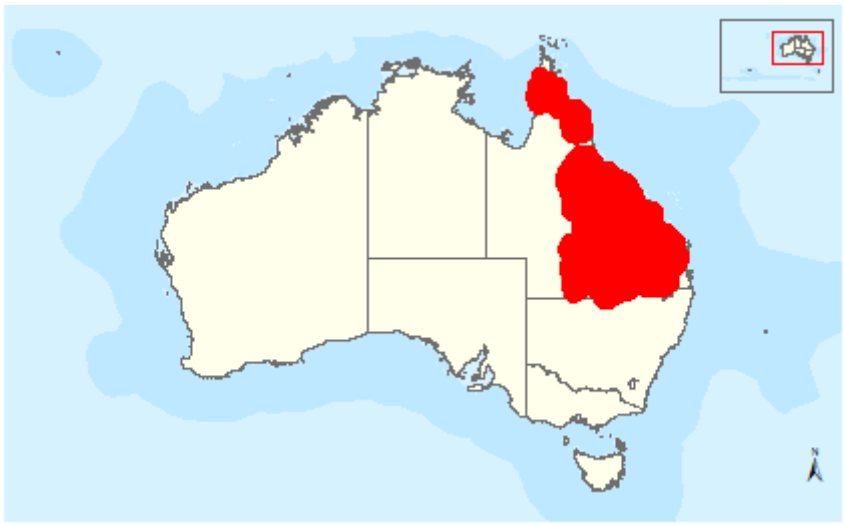

Figure 24: Mapped distribution of Yakka skink (Source: DSEWPaC 2011t)

8.24.2.3 Habitat description

Yakka skink habitat is amongst dense ground vegetation, fallen timber or rock outcrops in open dry sclerophyll forest (ironbark) or woodland, Brigalow forest, open shrub land, and lancewood forest on coarse gritty soils in the vicinity of low ranges, foothills and undulating terrain with good drainage (Cogger 2000; DEHP 2012; Richardson 2006).

Important microhabitats for this species include rocky outcrops, hollow logs, animal burrows and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber etc) (Richardson 2006).

Colonies have been found in large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes. However, the species is not generally found in trees or rocky habitats (DSEWPaC 2011t).

This species can occur in Brigalow communities as listed under the EPBC Act and in habitats which also support the Brigalow scaly-foot (DSEWPaC 2011t).

8.24.2.4 Biology and reproduction

The Yakka skink is a gregarious terrestrial species which is active during the morning, and from dusk through the early evening. The colony/group consists of both adults and juveniles and a wide variety of body sizes (Curtis *et al* 2012; DSEWPaC 2011t).

The species is omnivorous feeding on plant material (including fruits) and a wide variety of invertebrates (eg beetles, grasshoppers and spiders). The species also uses a regular defecation site and is known to retreat quickly to shelter (Curtis *et al* 2012; DSEWPaC 2011t).

The species shows a high site-fidelity and limited capacity to disperse from a colony site (DSEWPaC 2011t).

The Yakka skink produces live young and rarely bears more than six per litter. The breeding season for this poorly known species has not been recorded (DEHP 2012c; Richardson 2006).

8.24.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. Suitable woodland habitat dominated by core habitat canopy species is present within the development area. However, most patches were found to have a high level of disturbance from exotic grass, grazing and edge effects. Microhabitat features needed to support colonies were only abundant in the larger contiguous patches of habitat (western ridgeline and Public Reserve) as such these areas are considered to provide potential habitat. Three ALA records occur within 50 km of the development area, however these are likely unreliable (pre-1980's, a high degree of spatial uncertainty or missing information).

8.24.4 Anticipated threats and potential impacts from the development

A maximum of 2.0 ha of potential breeding and foraging habitat may be cleared as part of the development. Other potential indirect impacts relevant to the yakka skink includes:

- pest incursion
- fauna mortality via entrapment in trenches
- erosion and sedimentation
- light disturbance.

8.24.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.3, the following species-specific mitigation measures are recommended:

- Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create 'ladders' to enable fauna to exit and to provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.
- Survey works conducted prior to clearing will include colony searches in areas of potential yakka skink habitat.

Indirect impacts will also be managed in accordance with the EMP.

8.25 White-throated snapping turtle

8.25.1 Status

Critically endangered – November 2014

8.25.2 Biology and ecology

8.25.2.1 Characteristics

The White-throated snapping turtle (*Elseya albagula*) is the largest species of snapping turtle (Elseya spp.). This freshwater turtle is dark brown above, sometimes with scattered darker flecks and blotches. It is greyish below, with a few dark blotches. The head is dark brown above, without stripes, and the lower half of the head is whitish, or has whitish patches. The head shield is deeply furrowed in adults. The carapace is broadly oval, but somewhat squared-off in front, and reaches a length of 420 mm (Cogger, 2014; DES, 2020).

Plate 26: White-throated snapping turtle (Source: DEE, 2017)

8.25.2.2 Known distribution

White-throated snapping turtle occurs within the catchments of the Fitzroy, Bennett and Mary Rivers and associated drainages in south-east Queensland. It occupies approximately 3,300 km of riverine habitat. Total area of occupancy of the species is estimated at less than 500 km^2 (DEE, 2017).

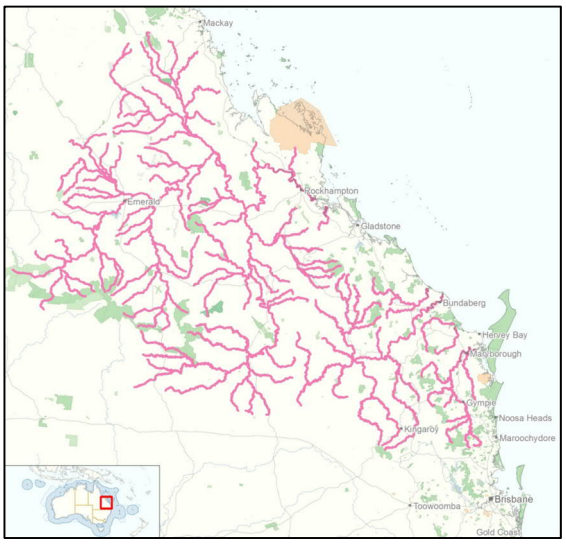

Figure 25: Mapped distribution of White-throated snapping turtle (Source: DEE, 2017)

8.25.2.3 Habitat description

The species is a habitat specialist, preferring clear, flowing, well-oxygenated waters. It occurs in non-flowing densities at much lower densities. It seems to be suited to the aerobic margins of large slow-flowing reaches and large non-flowing pools and is less suited to the deeper habitats of larger pools with low dissolved oxygen (DEE, 2017).

The White-throated snapping turtle is found in sections of stream characterised by steep undercut banks, rocky or sandy substrates, submerged boulders or logs for refuge and usually in proximity to riffle zones (DEE, 2017).

8.25.2.4 Biology and reproduction

The White-throated snapping turtle is a benthic foraging species. It is mainly herbivorous, feeding on fruit and buds of riparian vegetation that falls into water, leaves and stems of terrestrial plants, tree roots, filamentous algae and instream macrophytes. The species changes from being largely carnivorous (feeding on invertebrates) when young to herbivorous as an adult. Adults will occasionally feed on animal material such as freshwater sponges, carrion, cane toads and insect larvae (DEE, 2017).

Most adult female turtles breed each year, unless injured or riverine habitat resources are depleted (DEE, 2017). Timing of breeding for the species varies between locations with most breeding occurring during autumn and winter. Most turtles lay one clutch per year (average 13 eggs). Nests are laid within a shallow digging on a sloping riverbank in sand and loam alluvial deposits from previous flooding events. Hatchlings emerge in December or January after an incubation period of approximately 24 weeks (DES, 2020).

8.25.3 Likelihood of occurrence within the Towrie development area

This species is considered unlikely to occur within the development area. No suitable habitat is present within the development area and no ALA records occur within 50 km.

8.25.4 Anticipated threats and impacts from the development

No disturbance to the White-throated snapping turtle is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development

area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging and breeding behaviour.

8.25.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.3, the following species-specific mitigation measures are recommended:

- Water extraction will be conducted at an alternative location within the development area should a White-throated snapping turtle be identified utilising the habitat.
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.26 Dunmall's snake

8.26.1 Status

Vulnerable – listed 16 July 2000

8.26.2 Biology and ecology

8.26.2.1 Characteristics

Dunmall's snake (*Furina dunmalli*) is a venomous snake that belongs to the Elapidae family. Dunmall's snake is found only in Australia (Cogger 2000; Ehmann 1992).

Dunmall's snake has a uniform dark grey-brown colour above that fades to white at the lower flanks. The scales are smooth and light edged, with most of the scales near the upper lip having pale blotches (Cogger 2000; Ehmann 1992). The snake is small to medium sized, growing to a length to 60 cm. The head is large and distinct from the neck (Cogger 2000; Ehmann 1992).

Observations of a captive specimen suggest it is nocturnal, docile and terrestrial. It appears to favour dark places (Queensland CRA/RFA Steering Committee 1997).

Plate 27: Dunmall's snake (Source: Wilson 2009)

8.26.2.2 Known distribution

Given the rarity and difficulty of detecting this declining species, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats (DSEWPaC 2011q). Similarly, any suitable remnant vegetation or vegetation corridors within the range of Dunmall's snake is considered important habitat for the species (Brigalow Belt Reptiles Workshop 2010).

Whilst Dunmall's snake has been recorded in Expedition National Park and Lake Broadwater Conservation Park, the species is not actively managed in these reserves (Cogger *et al* 1993; Covacevich *et al* 1996; Covacevich *et al* 1988; McDonald *et al* 1991).

The distribution of Dunmall's snake extends from near the Queensland border throughout the Brigalow Belt South and Nandewar bioregions, as far south as Ashford in New South Wales (DSEWPaC 2011q).

Dunmall's snake occurs primarily in the Brigalow Belt region in the south-eastern interior of Queensland. Records indicate sites at elevations between 200 to 500 m above sea level. The snake is very rare or secretive with limited records existing (DSEWPaC 2011q). It has been recorded at Archokoora, Oakey,

Miles, Glenmorgan, Wallaville, Gladstone, Lake Broadwater, Mount Archer, Exhibition Range National Park, roadside reserves between Inglewood and Texas, Rosedale, Yeppoon and Lake Broadwater Conservation Park (Cogger *et al* 1993; Covacevich *et al* 1988; Covacevich *et al* 1996; McDonald *et al* 1991).

The distribution of Dunmall's snake is highly fragmented due to cropping and grazing, especially in the Darling Downs. As a result, the species has declined dramatically and is considered to be of particular conservation significance (Covacevich 1995).

Figure 26: Mapped distribution of Dunmall's snake (Source: DSEWPaC 2011q)

8.26.2.3 Habitat description

Dunmall's snake has been found in a broad range of habitats, including:

- Forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow (*Acacia harpophylla*), other Wattles (*A. burowii, A. deanii, A. leioclyx*), native Cypress (*Callitris* spp.) or Bull-oak (*Allocasuarina luehmannii*) (Brigalow Belt Reptiles Workshop 2010; Covacevich *et al* 1988; Stephenson & Schmida 2008)
- Various Blue spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra and E. melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bull-oak open forest and woodland associations on sandstone derived soils (Brigalow Belt Reptiles Workshop 2010; Stephenson & Schmida 2008; TSN 2008)

In other environments, one specimen was found on the edge of dry vine scrub near Tarong Power Station, Queensland, whilst another was found in hard ironstone country (Queensland Regional Ecosystem Land Zone 7) at Lake Broadwater near Dalby, Queensland (DSEWPaC 2012q).

Little is known about the ecological requirements of Dunmall's snake, however, the species has been found sheltering under fallen timber and ground litter (Brigalow Belt Reptiles Workshop 2010; Cogger *et al* 1993) and may use cracks in alluvial clay soils (DERM 2010b; Richardson 2006).

Records indicate the species prefers habitats between 200 to 500 m above sea level (DSEWPaC 2012q).

8.26.2.4 Biology and reproduction

The diet of Dunmall's snake consists of small skinks and geckos. Specific studies have found the gut contents of one specimen containing the remains of the Tree Skink, *Egernia striolata* (Shine 1981).

Little is known about the life cycle or reproduction behaviour of Dunmall's snake (Queensland CRA/RFA Steering Committee 1997). While there is no information on the breeding season or clutch size of the species (Forests Taskforce 1997), it is known that the species lays eggs rather than live young (Threatened Species Network (TSN) 2008).

8.26.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. Suitable woodland habitat dominated by *Acacia* sp. and *Eucalyptus* sp. is present within the development area. However, an abundance of soil cracks wase not recorded and most patches were found to have a high level of disturbance from exotic grass, grazing and edge effects. Microhabitat features such as deep leaf litter were only abundant in the larger contiguous patches of habitat (western ridgeline and Public Reserve). A single historical record (1977) occurs within 50 km of the development area at Presho State Forest to the east.

8.26.4 Anticipated threats and potential impacts from the development

A total of 2.0 ha of breeding and foraging habitat will be directly impacted via vegetation clearing. As habitat is not considered important, these impacts are considered low as per the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles. Other potential indirect impacts relevant to the ornamental snake includes:

- pest incursion
- fauna mortality via entrapment in trenches
- light disturbance.

8.26.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.3, the following species-specific mitigation measure is recommended:

- Minimise the time that excavations remain open. Where excavations do need to remain open overnight, leaving suitable materials to create ‘ladders’ to enable fauna to exit and to provide shelter. Excavations will be checked morning and night by a spotter catcher for entrapped fauna.

Indirect impacts will also be managed in accordance with the EMP.

8.27 Fitzroy river turtle

8.27.1 Status

Vulnerable – listed 16 July 2000

8.27.2 Biology and ecology

8.27.2.1 Characteristics

The Fitzroy river turtle (*Rheodytes leukops*) is a medium to dark brown turtle growing to 25 cm shell length (SL) with scattered darker spots and blotches on the upper shell surface (DSEWPaC 2011aa). It has a pale yellow or cream belly and dull olive-grey exposed fleshy parts. The shell is broadly oval and the neck is covered with large, pointed conical tubercles (Cogger 2000). The back edge of the shell on hatchlings is serrated (Cogger 2000; Latta & Latta 2005; Wilson & Swan 2003). The Fitzroy river turtle has distinctive eyes with black pupils surrounded by a narrow white inner ring (adults) or a metallic silvery-blue iris (hatchlings) (Cogger 2000; Limpus 2007). The Fitzroy river turtle has relatively long forelimbs with five long claws and a large cloacal bursae which has a respiratory function (Cogger 2000; Wilson & Swan 2003).

Plate 28: Fitzroy river turtle (Source: DERM 2007b)

8.27.2.2 Known distribution

The Fitzroy river turtle is only found in the drainage system of the Fitzroy River, Queensland (DSEWPaC 2011aa). It is estimated that this species occurs in a total area of less than 10,000 km^2 (Cogger *et al* 1993, McDonald *et al* 1991). Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek, and Gogango (Cogger *et al* 1993; Covacevich *et al* 1996; Tucker *et al* 2001; Venz 2002).

No population information is available for this species.

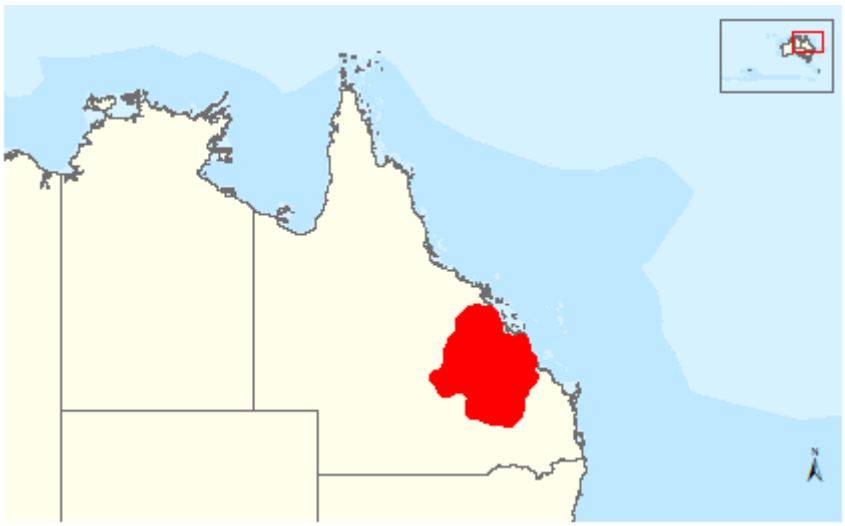

Figure 27: Mapped distribution of Fitzroy river turtle (Source: DSEWPaC 2011aa)

8.27.2.3 Habitat description

The Fitzroy river turtle is found in rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (DSEWPaC 2011aa). Preferred areas have high water clarity, and are often associated with Ribbonweed (*Vallisneria* sp.) beds (Cogger *et al* 1993). Common riparian vegetation associated with the Fitzroy river turtle includes Blue gums (*Eucalyptus tereticornis*), River oaks (*Casuarina cunninghamiana*), Weeping bottlebrushes (*Callistemon viminalis*) and Paperbarks (*Melaleuca linariifolia*) (Tucker *et al* 2001).

Turtles often associate with logs in deeper water, and may sit on the downstream side or under rocks in fast flowing riffles (Cann 1998; Tucker *et al* 2001).

It is thought that the Fitzroy river turtle has an affinity for well-oxygenated riffle zones, moving into deeper pools as the riffle zones cease to flow (Tucker *et al* 2001). However, recent studies have captured several turtles from deep pools (Gordos *et al* 2003a; 2003b, 2004).

8.27.2.4 Biology and reproduction

The Fitzroy river turtle forages on the river bottom (Cann 1998) and is known to consume a variety of foods, including Ribbonweed (*Vallisneria* sp.), freshwater sponge, aquatic insect larvae, algae, small snails, terrestrial insects and terrestrial plant material such as leaves and bark (Cann 1998; Tucker *et al* 2001).

Nesting occurs between September and October (Legler 1985). All located nests have been on river sandbanks 1 to 4 m above water level (Cann 1998; Cogger *et al* 1993). Nests have been found up to 15 m from water on flat sandbanks (Cann 1998).

Annual reproductive potential of females is 46 to 59 eggs laid in three to five clutches (Cann 1998). Eggs can take up to 90 days to hatch (Legler 1985). Eggs are deposited in nesting chambers 170 mm deep, containing between 12 and 20 eggs (Latta & Latta 2005). The eggs are approximately 29 mm long and 21 mm wide (Limpus 2007).

This species can take between 15 to 20 years to reach sexual maturity (Limpus 2007).

8.27.3 Likelihood of occurrence within the Towrie development area

This species is considered unlikely to occur within the development area. No suitable habitat is present within the development area and no ALA records occur within 50 km.

8.27.4 Anticipated threats and potential impacts from the development

No disturbance to the Fitzroy river turtle is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging and breeding behaviour.

8.27.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.3, the following species-specific mitigation measures are recommended:

- Water extraction will be conducted at an alternative location within the development area should a White-throated snapping turtle be identified utilising the habitat.
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.28 Fork-tailed swift

8.28.1 Status

Marine and Migratory (CAMBA/JAMBA/ROKAMBA)

8.28.2 Biology and ecology

8.28.2.1 Characteristics

The Fork-tailed swift (*Apus pacificus*) is a medium-sized Swift with a length of 18 to 21 cm, a wingspan of 40 to 42 cm and weight of around 30 to 40 g. The body is slim, with long scythe-shaped wings that taper to finely pointed tips. It is characterised by a long and deeply forked tail. The species is mainly blackish with a white band across the rump and a white patch on the chin and throat. The sexes are alike, with juveniles also indistinguishable in the field (DOTE 2014ac).

Plate 29: Fork-tailed swift (Source: Francksan n.d.)

8.28.2.2 Known distribution

This species occurs throughout the majority of Australian except for south-eastern Western Australian and western South Australia.

Within Queensland this species is normally found in higher abundance west of the Great Dividing Range, while east of the range records are more scattered. There is limited information on the population size (DOTE 2014ac).

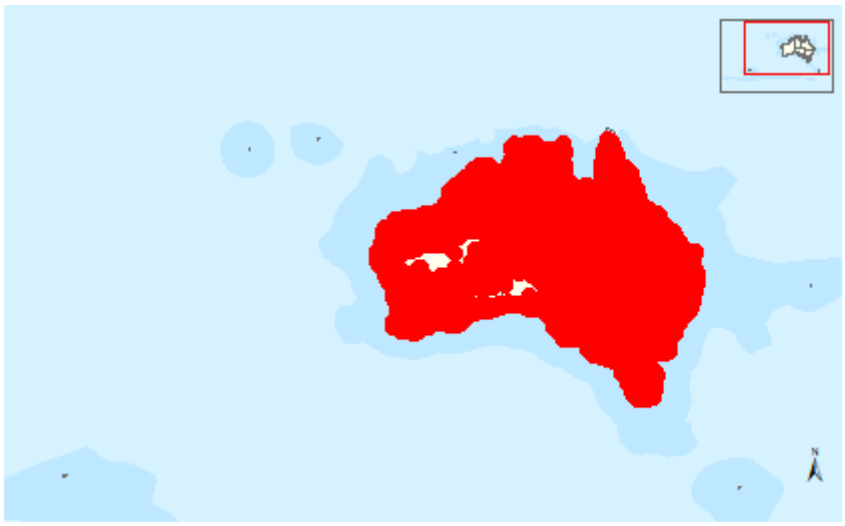

Figure 28: Mapped distribution of the Fork-tailed swift (Source: DOTE 2014ac)

8.28.2.3 Habitat description

This species is usually observed flying over open country (from semi-arid to coastal zones and islands), however occasionally observed flying over forests and cities (Pizzey & Knight 2007).

In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The species sometimes occurs above rainforests, wet sclerophyll forest or open forest or plantations of pines (Higgins 1999).

8.28.2.4 Biology and reproduction

This species flies anywhere between 1 and 300 m above the ground, with the species highly mobile in Australia. The species forages for insects generally in flocks (10 to 1,000) along the edge of low pressure.

The Fork-tailed swift is a non-breeding migrant to Australia usually in the summer (October to April) (DOTE 2014ac, Pizzey & Knight 2007).

8.28.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. The species is predominantly aerial and therefore could be foraging and dispersing above the development area. A single undated ALA record occurs immediately east of the development area, otherwise no records occur within 50 km.

8.28.4 Anticipated threats and potential impacts from the development

Direct impacts will occur to 13.0 ha of foraging only habitat via vegetation clearing. Given this species is predominately aerial and is widespread within Australia, impacts are unlikely to affect the persistence of the species. Potential indirect impacts relevant to the species includes:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.28.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.6 and within the EMP will manage any direct and indirect impacts to this species.

8.29 Glossy ibis

8.29.1 Status

Marine and Migratory (CAMBA/Bonn)

8.29.2 Biology and ecology

8.29.2.1 Characteristics

The Glossy ibis (*Plegadis falcinellus*) is the smallest ibis known in Australia. The neck is reddish-brown and the body is a bronze-brown with a metallic iridescent sheen on the wings. The Glossy ibis has a distinctive long, downwards curved bill that is olive-brown in colour (DOTE 2014b). The facial skin is blue-grey with a white line that extends around the eyes. The eyes, legs and feet are brown (Birds Australia 2010). Sexes are similar in plumage, but the male is larger in size. The average length of a Glossy Ibis is 55 to 65 cm, with a wingspan of 80 to 95 cm, and weight of approximately 500 to 800 grams (Hancock *et al* 1992; Marchant & Higgins 1990).

During the breeding season, plumage colour intensifies to a rich chestnut on the neck, mantle, shoulders and under parts. A purple-green sheen occurs on the head, upperparts, tail and wings. The facial skin turns pale blue with courtship, and fades to dark purple after the courting period (Hancock *et al* 1992).

Juveniles have similar dark plumage to adults. Nestlings have a pink bill which gradually turns olive-brown starting from the tip (Hancock *et al* 1992).

Plate 30: Glossy ibis (Source: Karatay 2007)

8.29.2.2 Known distribution

Within Australia, the Glossy ibis is generally located east of the Kimberley in Western Australia and Eyre Peninsula in South Australia. The species is also known to be patchily distributed in the rest of Western Australia. The species is rare or a vagrant in Tasmania (Beehler *et al* 1986; Coates & Bishop 1997; Marchant & Higgins 1990).

Figure 29: Mapped distribution of the Glossy ibis (Source: BirdLife International 2014c)

8.29.2.3 Habitat description

The Glossy ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. The species is occasionally found in coastal locations such as estuaries, deltas, saltmarshes and coastal lagoons (del Hoyo *et al* 1992; Hancock *et al* 1992; Marchant & Higgins 1990).

Within Australia, the largest contiguous areas of prime habitat is inland and northern floodplains. The Glossy ibis is commonly in largest numbers in drying Top End grass/sedge swamps and Channel Country grass/forb meadows. The species is sometimes recorded in wooded swamps, artificial wetlands (such as irrigated fields), and in mangroves for breeding (Chatto 2000; Marchant & Higgins 1990). The species may retreat to permanent wetlands and/or coastal areas (including tidal wetlands) during drought (Marchant & Higgins 1990).

Glossy ibis roost in trees or shrubs usually near, but sometimes far, from water bodies (Brown *et al* 1982; Marchant & Higgins 1990).

Australian breeding habitat types include wooded and shrubby swamps in the semi-arid and arid regions of the Northern Territory and Queensland. This includes Cooba (*Acacia stenophylla*), Eucalyptus/lignum swamps (*Muehlenbeckia florulenta*) of the Murray-Darling Basin and in Melaleuca/reed swamps at near-coastal breeding colonies in the south. Breeding has once been recorded in mangroves in the Northern Territory (Marchant & Higgins 1990).

8.29.2.4 Biology and reproduction

Glossy ibis feed mainly on aquatic invertebrates/insects such as freshwater snails, mussels, crabs and crayfish. The species will also, however, eat fish, frogs and tadpoles, dryland invertebrates (such as beetles and grasshoppers), lizards, small snakes and nestling birds (del Hoyo *et al* 1992; Gowland 1988; Marchant & Higgins 1990; Vestjens 1977).

Glossy ibis breed from mid spring to the end of summer (DOTE 2014b). Reproduction may extend to September to April if there are persistent food resources at breeding sites. In some areas, breeding is said to coincide with annual rains (del Hoyo *et al* 1992).

Three to six eggs are laid. Both adults care for young who fledge in approximately 25 to 28 days (Hancock *et al* 1992). Chicks will interact with chicks from nearby nests from approximately ten days of age. Once fledged, adults remain feeding young for several weeks (Marchant & Higgins 1990).

The nest is a platform of twigs and vegetation usually positioned less than one metre above water (occasionally up to 7 m) in tall dense stands of emergent vegetation (e.g. reeds or rushes), low trees or bushes (del Hoyo *et al* 1992). The nest is often lined with aquatic vegetation (Birds Australia 2010).

8.29.3 Likelihood of occurrence within the Towrie development area

This species is known to occur within the development area, with approximately six individuals recorded in the constructed wetland. Potential habitat is considered suitable for foraging only due to the development area not occurring within one of the known breeding locations for this species.

8.29.4 Anticipated threats and potential impacts from the development

A total of 1.0 ha of potential foraging and dispersal habitat may be cleared along the edges of farm dams as part of the development. Vegetation clearing and particularly the loss of fringing aquatic vegetation may result in further degradation of potential habitat within the development area. Water extraction activities may occur at some wetland locations during construction, however this is likely to occur during the dry season when the species is likely to have migrated away from the development area. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging and breeding behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.29.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no Glossy ibis are foraging in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a bird be identified utilising the habitat.
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point

will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.30 Oriental cuckoo

8.30.1 Status

Migratory (CAMBA, JAMBA, ROKAMBA)

8.30.2 Biology and ecology

8.30.2.1 Characteristics

The Oriental cuckoo (*Cuculus optatus*) is a medium sized cuckoo 30-32 cm in length with a wingspan of 51-57 cm and weighs 73-156 g. The belly is creamy white with dark bars and the vent is frequently buff with few markings. The eye, eye-ring and legs are yellow (Pizzey & Knight, 1997).

Plate 31: Oriental cuckoo (Source: Tony Ashton)

8.30.2.2 Known distribution

The oriental cuckoo is a regular migrant to Australia, where it spends the non-breeding season (Sept-May) in coastal regions across northern and eastern Australia and offshore islands. In Queensland scattered records occur near south-east and eastern edges of Gulf of Carpentaria. It is widespread on tablelands and eastern slopes of the Great Divide from near Cooktown to the NSW border (DoE, 2015b).

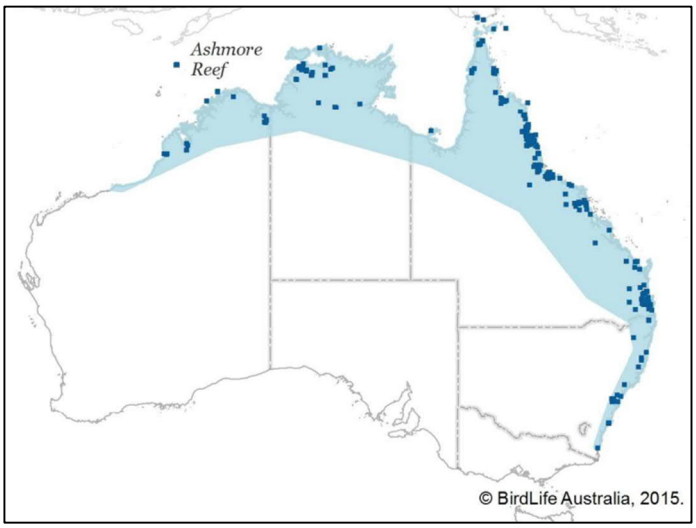

Figure 30: Mapped distribution of Oriental cuckoo (Source: BirdLife Australia)

8.30.2.3 Habitat description

The species uses a range of vegetated habitats such as monsoon rainforest, wet sclerophyll forest, open woodlands and appears often along edges of forests, or ecotones between forest types (DoE, 2015b).

8.30.2.4 Biology and reproduction

Oriental cuckoo forages for invertebrates on loose bark on the trunks and branches of trees, and among the foliage, including in mistletoes. It occasionally forages on the ground but requires shrubs or trees on which it can roost and consume prey. Caterpillars are a favoured food (DoE, 2015b).

The species tends to be solitary but has been recorded in groups of two or more, especially where infestations of caterpillars occur (DoE, 2015b).

The Oriental cuckoo is a brood parasite, mainly choosing to lay its eggs in the nests of Eurasian warblers belonging to the genus Phylloscopus (including the Arctic warbler, Willow warbler and Chiffchaff) (NZ Birds Online, 2020).

8.30.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. The Eucalypt woodland in the western extent of the development area along the ridgeline provides the intact habitat that the species could utilise for foraging and dispersal. No ALA records occur within 50 km of the development area, however two records from 2001 occur within 80 km (one west of Injune and the other to the east in Presho Forest Reserve).

8.30.4 Anticipated threats and potential impacts from the development

A total of 13.0 ha of potential habitat will be directly impacted via vegetation clearing, which may also result in further fragmentation of potential habitat within the development area.

Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.30.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.6 and within the EMP will manage any direct and indirect impacts to this species.

8.31 Yellow wagtail

8.31.1 Status

Migratory, Marine (CAMBA, JAMBA, ROKAMBA)

8.31.2 Biology and ecology

8.31.2.1 Characteristics

The Yellow wagtail (*Motacilla falva*) is a dark-legged wagtail of several different subspecies. The tail is shorter than other species. Most subspecies have uniform grey-green or olive-green backs. In breeding plumage the underparts are bright yellow from breast to vent (Pizzey & Knight 1997).

Plate 32: Yellow wagtail (Source: eBird Australia)

8.31.2.2 Known distribution

The Yellow wagtail is a regular uncommon wet season visitor to Australia. The species is most common along the north Australian coast from Darwin to Broome. In Queensland this species is a regular visitor from Mossman south to Townsville. The species is a vagrant further south and on Heron Island (DoE, 2015b).

Figure 31: Mapped distribution of Yellow wagtail (Souce: ALA)

8.31.2.3 Habitat description

Habitat for the Yellow wagtail is highly variable, but typically includes open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, and sometimes utilise tidal mudflats and edges of mangroves (DoE, 2015b).

8.31.2.4 Biology and reproduction

Yellow wagtail is generally seen singly or in small groups. Larger flocks of up to 50 individuals have been recorded. Mixed flocks with Australasian pipits have been recorded (DoE, 2015b).

The nest is a grass cup lined with hair and placed on or close to the ground in a shallow scrape. Four to six eggs are usually laid. Yellow wagtail feeds on a wide variety of terrestrial and aquatic invertebrates as well as some plant material, particularly seeds (BirdLife International, 2020).

Yellow wagtail breeds from Europe to Siberia and western Alaska, and migrates to Africa, south and south-east Asia, Indonesia and Papua New Guinea (Pizzey & Knight 1997).

8.31.3 Likelihood of occurrence within the Towrie development area

This species is considered unlikely to occur within the development area. No records occur surrounding the development area. Only small numbers of this species visit Australia, and while some very marginal habitat does occur within the development area it is unlikely to be preferential to migrating individuals.

8.31.4 Anticipated threats and potential impacts from the development

No disturbance to the Yellow wagtail is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity

- weed and pest incursion
- mortality from moving vehicles and machinery.

8.31.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.6 and within the EMP will manage any direct and indirect impacts to this species.

8.32 Satin flycatcher

8.32.1 Status

Marine and Migratory (Bonn)

8.32.2 Biology and ecology

8.32.2.1 Characteristics

The Satin flycatcher (*Myiagra cyanoleuca*) ranges in size from 15 to 17 cm. This species is blue-black and white with a small crest. The sexes are dimorphic. Males are glossy blue-black dorsally, with a blue-black chest and white below. Females are duskier blue-black dorsally, with an orange-red chin, throat and breast, and white underparts and pale-edged wing and tail feathers. Young birds are dark brown-grey above, with pale streaks and buff edges to the wing feathers, and a mottled brown-orange throat and chest (Pizzey & Knight 1997).

Plate 33: Satin flycatcher female (left) and male (right) (Source: Birds Australia 2010)

8.32.2.2 Known distribution

The Satin flycatcher occurs along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. It is also found in New Guinea. The Satin flycatcher is not a commonly seen species, especially in the far south of its range, where it is a summer breeding migrant (Birdlife Australia 2012f).

The Satin flycatcher is a migratory species, moving northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring (Pizzey & Knight 1997).

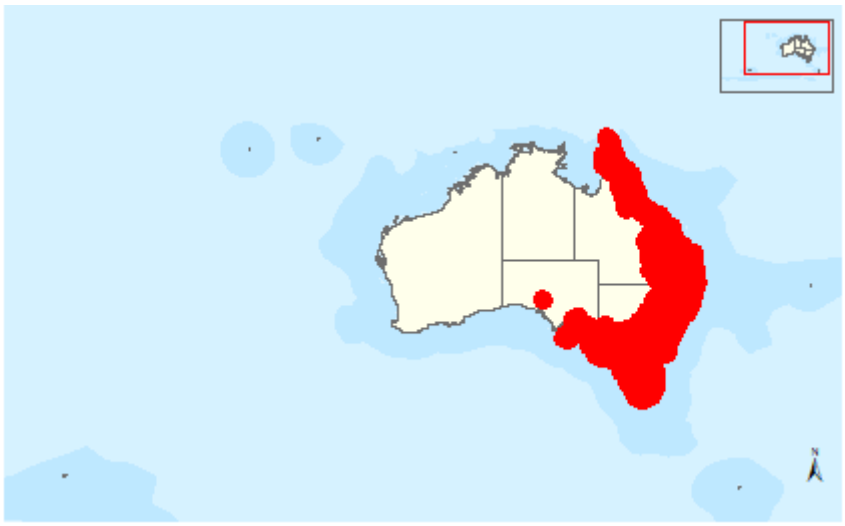

Figure 32: Mapped distribution of Satin flycatcher (Source: DSEWPaC 2011ak)

8.32.2.3 Habitat description

The Satin flycatcher is found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests (Birdlife Australia 2012f).

- This species is known to inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands (cited in DSEWPaC 2011ak) usually above the shrub layer (Pizzey & Knight 1997)
- On migration, this species occurs in coastal forests, woodlands, mangroves and drier woodlands and open forests (Blakers *et al* 1984; Emison *et al* 1987; Officer 1969) as well as trees in open country and gardens (Pizzey & Knight 1997).

8.32.2.4 Biology and reproduction

The Satin flycatcher is a resident in the north of its range, but is a migrant to coastal south-eastern Australia, arriving in August to October and returning northwards in February to April (Pizzey & Knight 1997).

The Satin flycatcher forages for insects among foliage, or catches flying insects on the wing (Pizzey & Knight 1997).

The Satin flycatcher builds a neat cup of bark strips, moss, spiders webs on a horizontal dead branch located 5 to 25 m above the ground under living foliage (Pizzey & Knight 1997). This species has been reported to nest in lose groups with each individual pair spaced between 20 to 50 m apart. Both sexes build the nest, incubate the eggs and feed the young (Pizzey & Knight 1997).

Clutch size ranges from two to three eggs and breeding occurs between October and February (Pizzey & Knight 1997).

8.32.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. The Eucalypt woodland in the western extent of the development area along the ridgeline provides the intact habitat that the species could utilise for foraging and dispersal. Three ALA records occur within 50 km of the development area; two from 2015 located east in Belington Hut State Forest, and a single undated record north at Nuga Nuga National Park.

8.32.4 Anticipated threats and potential impacts from the development

A total of 13.0 ha of potential habitat will be directly impacted via vegetation clearing, which may also result in further fragmentation of potential habitat within the development area. Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.32.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.6 and within the EMP will manage any direct and indirect impacts to this species.

8.33 Rufous fantail

8.33.1 Status

Marine and Migratory (Bonn)

8.33.2 Biology and ecology

8.33.2.1 Characteristics

The Rufous fantail (*Rhipidura rufifrons*) is a medium sized bird that resembles a darting flame with its fiery rufous tail (Pizzey & Knight 1997). Birds range from 14.5-18.5 cm in length with a wingspan of 18-22.5 cm and weight of approximately 10 g. The forehead is reddish-brown across the eyes with a white arc underneath of the eyes. The top of the head, back of the neck and upper back transition from olive to reddish-brown, blending into a blackish-brown fan-shaped tail (DAWE, 2020). The wings are grey-brown and the tail feathers are dark grey, tipped white with red-brown bases. Young birds are similar, but duller, with less distinct markings on the breast (BirdLife Australia, 2020).

Plate 34: Rufous fantail (Source: BirdLife Australia)

8.33.2.2 Known distribution

The Rufous fantail occurs in northern and eastern coastal Australia, being more common in the north. The species winters in from Cape York Peninsula in Queensland to Torres Strait and southern Papua New Guinea. It migrates to south-east Australia during October-April to breed, mostly in or on the coastal side of the Great Dividing Range (DAWE, 2020b).

Figure 33: Mapped distribution of Rufous fantail (Source: BirdLife International)

8.33.2.3 Habitat description

In east and south-east Australia, the Rufous fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (Eucalyptus microcorys), Mountain Grey Gum (E. cypellocarpa), Narrow-leaved Peppermint (E. radiata), Mountain Ash (E. regnans), Alpine Ash (E. delegatensis), Blackbutt (E. pilularis) or Red Mahogany (E. resinifera); usually with a dense shrubby understorey. They also occur in subtropical and temperate rainforests, including temperate Lilly pilly (Acmena smithi) rainforest, and occasionally occur in secondary regrowth, following disturbance in forests or rainforests. In north and north-east Australia, they often occur in tropical rainforest and monsoon rainforests, including semi-evergreen mesophyll vine forests, semi-deciduous vine thickets or thickets of Paperbarks (Melaleuca spp.) (DAWE, 2020b).

8.33.2.4 Biology and reproduction

The Rufous fantail mostly forages in the low to middle strata of forests, sometimes in or below the canopy or on the ground. They are insectivorous feeding on a variety of spiders, beetles, flies, bugs, wasps, bees, ants, butterflies and moths (DAWE, 2020b).

The Rufous fantail is usually seen singly or in pairs, but occasionally in small groups. Life-span is not well known but one adult banded in the Brindabella Ranges in the Australian Capital Territory, was re-caught at the same site over nine years later. Evidence from banding studies indicate that birds return to the same location each season (DAWE, 2020b).

Rufous fantail breeds from September to February, with most eggs laid during November-December. Two to four eggs are laid in a small cup-shaped nest made from grass, roots, fine strips of bark, plant-fibre, decayed wood, moss and spider web. The nest is placed in a tree, shrub or vine between 0.34-6.0 m above the ground. The incubation period is 15-17 days (DAWE, 2020).

8.33.3 Likelihood of occurrence within the Towrie development area

The Rufous fantail is considered likely to occur within the development area. Areas of intact SEVT (remnant and high value regrowth) provide the dense habitat that the species requires for nesting, and the woodland and regrowth habitat in the development area provide the dense shrubby understorey that may be utilised by this species while on passage. Four ALA records occur within 50 km of the development area; a single record located east in Expedition National Park from 2017, and three records

north at Nuga Nuga National Park (2012, 2018 and undated). This species was also recorded in 2017 by Boobook on a property approximately 10 km to the north east.

8.33.4 Anticipated threats and potential impacts from the development

A total of 13.0 ha of potential foraging habitat will be directly impacted via vegetation clearing, which may also result in further fragmentation of potential habitat within the development area. Potential indirect impacts on this species include:

- increased noise and light levels affecting foraging behaviour or resulting in complete avoidance and displacement from habitats
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.33.5 Management practices and methods

The mitigation measures outlined in Section 4.2.1.6 and within the EMP will manage any direct and indirect impacts to this species.

8.34 Common sandpiper

8.34.1 Status

Marine, Migratory (Bonn, CAMBA, JAMBA, ROKAMBA)

8.34.2 Biology and ecology

8.34.2.1 Characteristics

The Common sandpiper (*Actitis hypoleucos*) is a small shorebird with short legs, a long, straight, blunt bill, and a long tail that extends well beyond the wing tips. Individual birds are 19-21 cm in length with a wingspan of 32-35 cm. It is grey-brown above and white below. There is an indistinct white supercilium (eyebrow) and white eye-ring. The bill is dark grey with yellow at the base and the legs vary from greyish-olive to a yellowish-brown (Geering et al., 2007; BirdLife Australia, 2020).

Plate 35: Common sandpiper (Source: National Geographic)

8.34.2.2 Known distribution

In Australia Common sandpiper is found along all coastlines and in many areas inland. The species is widespread in small numbers. The Australian population is concentrated in northern and western Australia (DAWE, 2020).

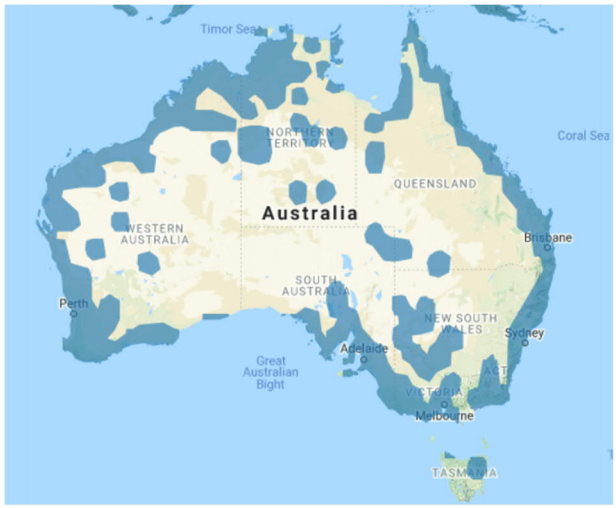

Figure 34: Mapped distribution of Common sandpiper (Souce: BirdLife International)

8.34.2.3 Habitat description

The Common sandpiper is known to occur in a range of wetland environments, both coastal and inland. The species is most abundant in mangrove inlets but is found on narrow muddy margins or rocky shores. It has also been recorded in estuaries and deltas of streams, on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties (DAWE, 2020; Geering et al., 2007).

8.34.2.4 Biology and reproduction

Common sandpiper is typically carnivorous, feeding on molluscs such as bivalves, crustaceans such as amphipods and crabs and a variety of insects including crickets, antlions, rove beetles and kelp flies (DAWE, 2020).

The species is usually solitary or occurs in very small flocks. It is often observed flying from one site to another in search of food. It is busy when feeding, sometimes dashing after prey or continuously pecking small items from the surface, climbing nimbly over mangrove roots and other obstacles (Geering et al., 2007).

Common sandpiper breeds in the vicinity of water in a variety of habitats in parts of Europe and Asia, and occasionally Africa. Incubation takes approximately 21–22 days, and chicks fledge in 26–28 days. The population that migrates to Australia breeds in the Russian far east. The Australian population during the non-breeding period is estimated to be approximately 3000 (Geering et al. 2007).

8.34.3 Likelihood of occurrence within the Towrie development area

The Common sandpiper is considered unlikely to occur within the development area. This species is primarily coastal, and the development area is approximately 250 km inland. No suitable habitat occurs within the development area and no nearby records occur.

8.34.4 Anticipated threats and potential impacts from the development

No disturbance to the Common sandpiper is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.34.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no migratory birds are roosting in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a migratory wetland bird be identified utilising the habitat.
- Construction works that will occur in the direct vicinity of the constructed wetland should only be conducted outside of the migratory bird period (August to May)
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.35 Sharp-tailed sandpiper

8.35.1 Status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

8.35.2 Biology and ecology

8.35.2.1 Characteristics

The Sharp-tailed sandpiper (*Calidris acuminata*) is a small to medium wader. The bird has a length of 17 to 22 cm, a wingspan of 36 to 43 cm and a weight of 65 g. It is a portly sandpiper with a flat back, pot belly and somewhat drawn-out rear end. It has a small flat head on a short neck with a short and slightly decurved bill. The species has medium length legs. At rest, the primaries are level with or slightly short of the tip of the tail. The primary projection is short in adults and moderately long in juveniles. The sexes are similar and there is marked seasonal variation (Higgins & Davies 1996).

Plate 36: Sharp-tailed sandpiper (Source: Alnus 2007)

8.35.2.2 Known distribution

The Sharp-tailed sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (Cramp 1985; Higgins & Davies 1996).

In Queensland, they are recorded in most regions, being widespread along much of the coast and very sparsely scattered inland, particularly in central and south-western regions (Higgins & Davies 1996).

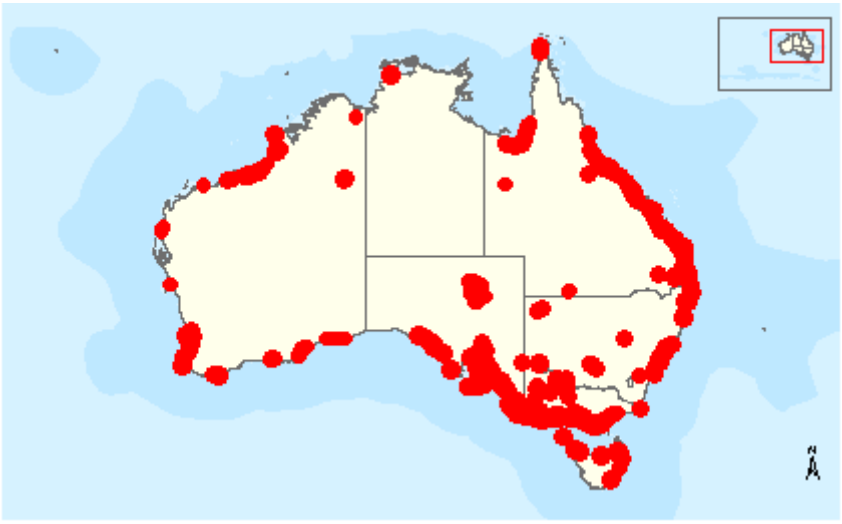

Figure 35: Mapped distribution of Sharp-tailed sandpiper (Source: DOTE 2014ab)

8.35.2.3 Habitat description

In Australasia, the Sharp-tailed sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season. They may be attracted to mats of algae and water weed either floating or washed up around terrestrial wetlands, and coastal areas with much beachcast seaweed. Sometimes they occur on rocky shores and rarely on exposed reefs (Higgins & Davies 1996).

8.35.2.4 Biology and reproduction

The Sharp-tailed sandpiper forages on seeds, worms, molluscs, crustaceans and insects (Higgins & Davies 1996). It has also been recorded to eat *Paspalum* spp.; Clover (*Trifolium* spp.); *Medicago* sp., Lucerne (*Medicago sativa*); *Ruppia* spp.; Goosefoot (*Chenopodium* spp.) and Knotweed (*Polygonum* spp.) plant seeds (Higgins & Davies 1996) and arachnids and dead fish (Barker & Vestjens 1989; Higgins & Davies 1996). They also ingest grit, sand and charcoal.

This species does not breed in Australia (DOTE 2014ab).

8.35.3 Likelihood of occurrence within the Towrie development area

The Sharp-tailed sandpiper is considered unlikely to occur within the development area. This species is primarily coastal, and the development area is approximately 250 km inland. No suitable habitat occurs within the development area and no nearby records occur.

8.35.4 Anticipated threats and potential impacts from the development

No disturbance to the Sharp-tailed sandpiper is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.35.5 Management Practices and Methods

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no migratory birds are roosting in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a migratory wetland bird be identified utilising the habitat.
- Construction works that will occur in the direct vicinity of the constructed wetland should only be conducted outside of the migratory bird period (August to May)
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.36 Pectoral sandpiper

8.36.1 Status

Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

8.36.2 Biology and ecology

8.36.2.1 Characteristics

The Pectoral sandpiper (*Calidris melanotos*) is a small to medium-sized shorebird with a longish neck, short legs and medium-length bill that is slightly decurved at the tip. At rest the flight feathers are level with, just short of, or slightly longer than the tip of the tail. The species has a length of 19-24 cm with a wingspan of 37-45 cm and a weight of 85 g for males and 60 g for females (Geering et al., 2007; DAWE, 2020).

The species is usually solitary but can be found in small flocks of 2-5 birds (Geering et al., 2007).

Plate 37: Pectoral sandpiper (Source: Steve Attwood)

8.36.2.2 Known distribution

Pectoral sandpiper is a regular, uncommon summer migrant to Australia. In Queensland, most records for the pectoral sandpiper occur around Cairns. Scattered records also occur east of the Great Divide between Townsville and Yeppoon, in the south-east of the state as well as a few inland records at Mount Isa, Longreach and Oakley (DAWE, 2020).

Figure 36: Mapped distribution of Pectoral sandpiper (Source: ALA)

8.36.2.3 Habitat description

This species is usually found in coastal or near coastal habitat but very occasionally found further inland. It prefers shallow fresh waters, often with low grass or other herbage such as samphire. It also occurs in swamp margins, flooded pastures, sewage ponds, and occasionally tidal areas and saltmarshes (Pizzey & Knight 1997).

8.36.2.4 Biology and reproduction

The Pectoral sandpiper is omnivorous, consuming algae, seeds, crustaceans, arachnids and insects. While feeding, they move slowly, probing with rapid strokes. Food is found by sight or by probing. They walk slowly on grass fringing water (Higgins & Davies 1996).

Pectoral sandpiper breeds on dry fringes of well-vegetated wetlands in the high arctic tundra of North America and eastern Siberia. Most birds migrate to South America, but some travel to Japan, Pacific Islands, Papua New Guinea, Australia and New Zealand (Geering et al., 2007; Pizzey & Knight, 1997).

8.36.3 Likelihood of occurrence within the Towrie development area

The Pectoral sandpiper is considered unlikely to occur within the development area. This species is primarily coastal, and the development area is approximately 250 km inland. No suitable habitat occurs within the development area and no nearby records occur.

8.36.4 Anticipated threats and potential impacts from the development

No disturbance to the Pectoral sandpiper is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals

- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.36.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no migratory birds are roosting in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a migratory wetland bird be identified utilising the habitat.
- Construction works that will occur in the direct vicinity of the constructed wetland should only be conducted outside of the migratory bird period (August to May)
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.37 Latham's snipe

8.37.1 Status

Marine and Migratory (CAMBA/JAMBA/ROCKAMBA/Bonn)

8.37.2 Biology and ecology

8.37.2.1 Characteristics

Latham's snipe (*Gallinago hardwickii*) is a medium sized wader, and the largest snipe in Australia, with a length of 29 to 33 cm, a wingspan of 50 to 54 cm and a mass of 150 to 230 g. It has a long straight bill, rather short broad pointed wings, a long tail and short legs (Higgins & Davies 1996). The cryptic plumage is intricately marked with barring and chevrons of buff, black and various shades of brown, with blackish-brown stripes across the crown and cream streaks down the back. The belly and parts of the head are white, and the tail is rufous with a white tip. The eyes are large and blackish-brown in colour (Higgins & Davies 1996; Pizzey & Knight 1997). The colour of the bill varies from pale-brown to olive, becoming blackish at the distal third and olive-yellow at the base. The legs and feet are olive-grey to olive in colour. The sexes are similar in appearance, and there is no seasonal variation in the plumage. Juveniles in fresh plumage differ only slightly from adults, but can be distinguished by slight differences in the patterning on the upper wing. Adults and juveniles are indistinguishable after early November (Higgins & Davies 1996).

Plate 38: Latham's snipe (Source: Birds in Backyards 2010)

8.37.2.2 Known distribution

Latham's snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia (ie it travels through northern Australia to reach non-breeding areas located further south) (Higgins & Davies 1996). The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia (including the Adelaide plains and Mount Lofty Ranges, and the Eyre Peninsula). The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales (Barrett et al 2003; Blakers et al 1984; Frith et al 1977).

The extent of occurrence is estimated to be 3,000,000 km2 and the area of occupancy 3,000 km2 (Garnett & Crowley 2000).

The distribution of Latham's snipe is naturally fragmented (although, because of the mobility of the species, this is unlikely to have any effect on survival) (DSEWPaC 2011ad).

The size of the Latham's snipe population that visits Australia is estimated at 25,000 to 100,000 birds (Wetlands International 2002).

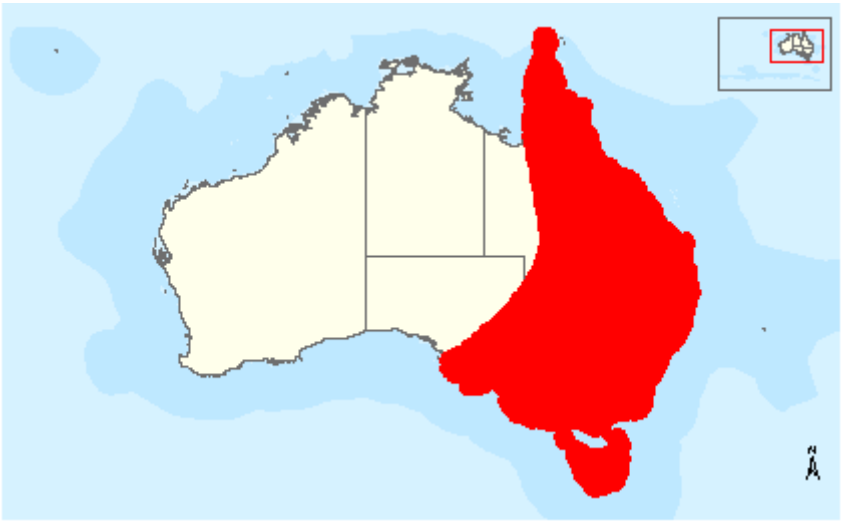

Figure 37: Mapped distribution of Latham's snipe (Source: DSEWPaC 2011ad)

8.37.2.3 Habitat description

Latham's snipe occurs in temperate and tropical regions of Australia (Driscoll 1993). Its altitudinal range extends from sea-level (ie the coast) to approximately 2,000 m above sea-level (Chapman 1969; Driscoll 1993).

In Australia, Latham's snipe occurs in a wide variety of permanent and ephemeral wetlands (Naarding 1981). It usually occurs in open, freshwater wetlands that have some form of shelter (usually low and dense vegetation) nearby (Frith et al 1977; Naarding 1983; DSEWPaC 2011ad). It generally occupies flooded meadows, seasonal or semi-permanent swamps, or open waters (Frith et al 1977; Naarding 1983), but various other freshwater habitats can be used including bogs, waterholes, billabongs, lagoons, lakes, creeks or river margins, river pools and floodplains (Frith et al 1977; Naarding 1981 & 1983). The structure and composition of the vegetation that occurs around these wetlands is not important in determining the suitability of habitat (Naarding 1983). As such, snipe may be found in a variety of vegetation types or communities including tussock grasslands with rushes, reeds and sedges, coastal and alpine heathlands, lignum or tea-tree scrub, button-grass plains, alpine herbfields and open forest (Chapman 1969; Frith 1970; Frith et al 1977; Naarding 1983; Wall 1990).

Latham's snipe sometimes occurs in habitats that have saline or brackish water, such as saltmarsh, mangrove creeks, around bays and beaches, and at tidal rivers (Frith et al 1977; Naarding 1983; Patterson 1991). These habitats are most commonly used when the birds are on migration (Frith et al 1977). They are regularly recorded in or around modified or artificial habitats including pasture, ploughed paddocks, irrigation channels and drainage ditches, rice fields, orchards, saltworks, and sewage and dairy farms (Fielding 1979; Frith et al 1977; Lane & Jessop 1985; Naarding 1982 & 1983). They can also occur in various sites close to humans or human activity (eg near roads, railways, airfields, commercial or industrial complexes) (Frith et al 1977; Naarding 1983).

The foraging habitats of Latham's snipe are characterised by areas of mud (either exposed or beneath a very shallow covering of water) and some form of cover (eg low, dense vegetation) (Frith et al 1977; Todd 2000). The snipe roosts on the ground near (or sometimes in) foraging areas, usually in sites that provide some degree of shelter, eg beside or under clumps of vegetation, among dense tea-tree, in forests, in drainage ditches or plough marks, among boulders, or in shallow water if cover is unavailable (Frith et al 1977; Naarding 1982 & 1983).

Latham's snipe could potentially occur in Bluegrass (Dichanthium) dominant grasslands of the Brigalow Belt Bioregions (North and South) if this community is subject to flooding (DSEWPaC 2011ad).

8.37.2.4 Biology and reproduction

Latham's snipe is an omnivorous species that feeds on seeds and other plant material (mainly from species in families such as Cyperaceae, Poaceae, Juncaceae, Polygonaceae, Ranunculaceae and Fabaceae), and on invertebrates including insects (mainly flies and beetles), earthworms and spiders and occasionally molluscs, isopods and centipedes (Frith *et al* 1977; Todd 2000).

Latham's snipe does not breed in Australia; instead it breeds in Japan and eastern Russia (DSEWPaC 2011ad).

8.37.3 Likelihood of occurrence within the Towrie development area

This species is considered to have the potential to occur within the development area. A constructed wetland as well as some of the larger farm dams contain fringing aquatic habitat that could provide sufficient coverage for the species whilst foraging and dispersing. Two ALA records occur within 50 km of the development area; one located south near Doonkuna State Forest (2003) and the other further west with a high spatial uncertainty (1979).

8.37.4 Anticipated threats and potential impacts from the development

A total of 1.0 ha of potential foraging and dispersal habitat may be cleared along the edges of farm dams as part of the development. Vegetation clearing and particularly the loss of fringing aquatic vegetation may result in further degradation of potential habitat within the development area. Water extraction activities may also occur at some wetland locations during construction. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats
- increased risk of contamination associated with activities such as refuelling or storage of chemicals
- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off
- removal of water from existing constructed wetlands and farm dams leading to changes in hydrology / habitat extent and water quality. Increased activity at these locations resulting in avoidance and potentially altered foraging and breeding behaviour
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity
- increased pest levels, notably those which may prey upon this species.

8.37.5 Management practices and methods

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no Latham's snipe are foraging in proximity that may be disturbed by the activity.
- Water extraction will be conducted at an alternative location within the development area should a bird be identified utilising the habitat.
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels. Per waterbody, a single access point will be utilised for water extraction to minimise areas of disturbance and allow potentially occurring individuals to avoid the same area during construction.

Indirect impacts will also be managed in accordance with the EMP.

8.38 Eastern osprey

8.38.1 Status

Migratory, Marine (Bonn)

8.38.2 Biology and ecology

8.38.2.1 Characteristics

Osprey (*Pandion haliaetus*) is a large hawk with long, angular wings and heavy feet; long forearm bones and tapered wings like a large seabird. Adult birds are brown with a white head and underparts. A dark streak runs through the eye and down the side of the neck, with a mottled brown breast-band (prominent in females and faint in males). The nape is crested, chest bulging and belly concave, and the wing tips reach beyond the tail tip. The bird is 50-66 cm length (tail less than half) with a wingspan of 149-168 cm, and an average weight of 1013 g for males and 1235g for females (Debus, 2019).

Plate 39: Eastern osprey (Source: BirdLife Australia Raptor Group)

8.38.2.2 Known distribution

The breeding range of the osprey extends around the northern coast of Australia (including many offshore islands) from Albany in Western Australia to Lake Macquarie in New South Wales; with a second isolated breeding population on the coast of South Australia, extending from Head of Bight east to Cape Spencer and Kangaroo Island. Outside of these ranges Ospreys are considered non-breeding visitors (DAWE, 2020c).

Figure 38: Mapped distribution of Eastern osprey (Source: ALA)

8.38.2.3 Habitat description

Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in north-western Australia. They require extensive areas of open fresh, brackish or saline water for foraging (DAWE, 2020).

8.38.2.4 Biology and reproduction

Ospreys feed predominantly on fish, occasionally taking crustaceans, reptiles, small mammals and birds. Hunting birds dive headlong into water with feet thrown forwards, submerging with the wings raised (Debus, 2019).

Ospreys lay eggs during March to July in northern Australia and May to October in southern Australia. The nests consists of a large bowl or pile of sticks and driftwood up to 2 m across and 2 m deep. The clutch size ranges from two to four eggs. Incubation takes 35-38 days and the nestling period is 71-76 days (Debus, 2019).

8.38.3 Likelihood of occurrence within the Towrie development area

This species is considered unlikely to occur within the development area. No records occur within the area surrounding the development area. This species is typically found along the Queensland coastline and the development area is greater than 250 km from the coast. The development area also does not contain extensive fresh, brackish or saline water to support sufficient foraging resources for the species.

8.38.4 Anticipated threats and potential impacts from the development

No disturbance to the Osprey is anticipated from development activities due to the lack of suitable habitat. However, should a transitory individual be identified within the development area, impacts from construction activities will be managed with the fauna spotter catcher. Potential indirect impacts on this species include:

- soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats

- temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off, which may affect prey availability
- periodic burst of elevated noise levels may startle and disorientate individuals within proximity.

8.38.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.6, the following species-specific mitigation measures are recommended:

- Prior to construction works commencing, the spotter catcher will ensure no Latham's snipe are foraging in proximity that may be disturbed by the activity.
- Water extraction activities will be strictly controlled and monitored in liaison with the landholder to ensure no waterbodies are reduced to unusually low levels.

Indirect impacts will also be managed in accordance with the EMP.

8.39 Brigalow (*Acacia harpophylla* dominant and co-dominant)

8.39.1 Status

Endangered – listed 4 April 2001

Plate 40: Brigalow TEC (Source: Ponce Reyes et al., 2016)

8.39.2 Biology and ecology

8.39.2.1 Habitat

The Brigalow TEC is characterised by either the dominance or codominance of *Acacia harpophylla* (Brigalow) as a canopy or sub-canopy species. Other canopy species that may be associated with this TEC include *Casuarina cristata* (Belah), other *Acacia* species and/or Eucalypt species. Occasionally these other species may be more common than *Acacia harpophylla* within the broad matrix of brigalow woodlands vegetation. The Brigalow TEC has a considerable range of vegetation structure and composition united by a suite of species that tend to occur on acidic and salty clay soils (Isbell, 1962; Johnson, 1964; Bui and Henderson, 2003). However not all vegetation in which *Acacia harpophylla* is dominant or co-dominant is part of the listed ecological community. Structurally, the community may exist in a variety of forms from low open woodlands to open forests with dominant tree layers ranging between 9 m in height (in low rainfall regions) through to 25 m in height (in higher rainfall areas) (DAWE 2020d).

Table 16 lists REs in the Brigalow Belt Bioregion that are considered analogous with Brigalow TEC.

Table 16: REs analogous with Brigalow TEC in the Brigalow Belt Bioregion

RE	Description
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains
11.4.3	*Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains
11.4.7	Open forest of *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* on Cainozoic clay plains

RE	Description
11.4.8	*Eucalyptus cambageana* open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
11.4.9	*Acacia harpophylla* shrubby open forest with Terminalia oblongata on Cainozoic clay plains
11.4.10	*Eucalyptus populnea* or *E. pilligaensis*, *Acacia harpophylla*, *Casuarina cristata* open forest on margins of Cainozoic clay plains
11.5.16	*Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces
11.9.1	*Acacia harpophylla*, *Eucalyptus cambageana* open forest on Cainozoic fine grained sedimentary rocks
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on Cainozoic fine grained sedimentary rocks
11.9.6	*Acacia melvillei* ± *A. harpophylla* open forest on Cainozoic fine grained sedimentary rocks
11.11.14	*Acacia harpophylla* open forest on deformed and metamorphosed sediments and interbedded volcanics
11.12.21	*Acacia harpophylla* open forest on igneous rocks; colluvial lower slopes

8.39.2.2 Known distribution

The Brigalow TEC extends from south of Charters Towers in Queensland, in a broad swathe east of Blackall, Charleville and Cunnamulla and south to northern New South Wales near Narrabri and Bourke (DAWE 2020d).

In Queensland, it occurs predominantly within the Brigalow Belt North, Brigalow Belt South, Darling Riverine Plains and Southeast Queensland bioregions. It also occurs to a lesser extent in the Mitchell Grass Downs, Mulga Lands and Einasleigh Uplands bioregions. The original extent of the Brigalow TEC in Queensland was estimated to be more than 7.3 million hectares. By 2003 about eight percent remained. Core areas of remnants are located in the Northern Bowen Basin, Belyando Downs, Issac-Comet Downs and Claude River Downs subregions of the Brigalow Belt North bioregion and in the Southern Downs and Moonie River-Commoron Creek Floodout subregions of the Brigalow Belt South Bioregion (cited in DAWE 2020d).

Figure 39: Mapped distribution of Brigalow TEC (Source: DAWE)

8.39.3 Likelihood of occurrence within the Towrie development area

This TEC is known to occur within the development area. A total of 253.65 ha of Brigalow TEC is modelled within the development area based on the field survey and LiDAR assessment findings.

8.39.4 Anticipated threats and potential impacts from the development

A maximum of 2.0 ha of Brigalow TEC will be directly impacted via vegetation clearing for the development. Given that some components of the development are linear, clearing may fragment existing patches and reduce their size below TEC status threshold. Other potential indirect impacts relevant to the Brigalow TEC includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.39.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.7, the following specific mitigation measures are recommended:

- Clearing works will not intersect or dissect a patch of Brigalow TEC in a way that reduces the patch size below 0.5 ha
- The Brigalow TEC should be identified and the extent mapped during pre-clearance surveys. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species within the patch.

Indirect impacts will also be managed in accordance with the EMP.

8.40 Coolibah – Black box woodlands of the Darling Riverine Plains and the Brigalow Belt south bioregions

8.40.1 Status

Endangered – listed 1 March 2011

Plate 41: Coolibah-Black box woodland TEC community (Source: NSW Catchment Management Authority)

8.40.2 Biology and ecology

8.40.2.1 Habitat

The Coolibah – Black Box Woodlands represents occurrences of one type of eucalypt woodland where *Eucalyptus coolabah subsp. coolabah* and/or *Eucalyptus largiflorens* are the dominant canopy species and where the understorey tends to be grassy. The Coolibah – Black Box Woodlands are found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees (NSW Scientific Committee, 2009). The landscape is flat to low relief where small changes in slope and height can influence the species composition. Parts of the ecological community associated with drainage depressions, or areas of lower floodplain remain inundated for longer periods than parts of the ecological community associated with higher floodplain areas of the distribution.

Within Queensland, five REs have been identified as being analogous to the Coolibah – Black Box Woodlands TEC (DAWE 2020e). Table 17 lists these REs and provides a brief description of each RE type.

Table 17: REs analogous with Coolibah – Black Box Woodlands TEC

RE	Description
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains
11.3.15	*Eucalyptus coolabah*, *Acacia stenophylla*, *Muehlenbeckia florulenta* fringing woodland on alluvial plains
11.3.16	*Eucalyptus largiflorens +/- Acacia cambagei +/- A. harpophylla* woodland to low open woodland on alluvial plains

RE	Description
11.3.28	*Casuarina cristata* +/- *Eucalyptus coolabah* open woodland on alluvial plains
11.3.37	*Eucalyptus coolabah* fringing woodland on alluvial plains

8.40.2.1 Known distribution

The Coolibah – Black Box Woodlands are a floodplain ecological community situated within the upper reaches of the Murray-Darling Basin and southern part of the Fitzroy River system and is limited to the Darling Riverine Plains and Brigalow Belt South bioregions, situated in northern NSW and southern Queensland. The southern limit of the ecological community is the southern boundary of the Darling Riverine Plains bioregion in NSW. This equates with the southern distributional limit for Coolibah. The northern limit is the northern boundary of the Brigalow Belt South bioregion in Queensland (DAWE 2020e).

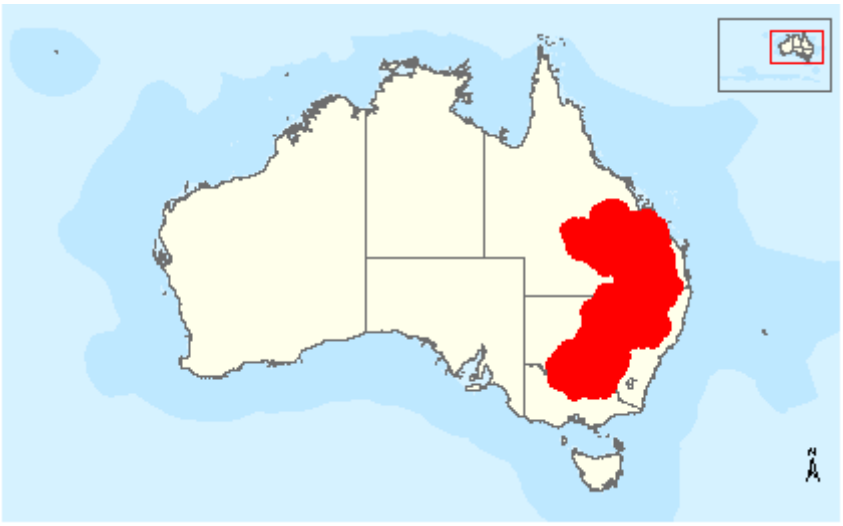

Figure 40: Mapped distribution of Coolibah – Black Box Woodlands TEC (Source: DAWE)

8.40.3 Likelihood of occurrence within the Towrie development area

This TEC is considered unlikely to occur within the development area based on results of the field surveys during which *Eucalyptus coolabah* or any of the listed analogous REs were not recorded.

8.40.4 Anticipated threats and potential impacts of the development

No known areas of the Coolibah – Black Box Woodlands TEC are expected to be impacted by the development. Survey works conducted prior to construction will confirm any areas and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed Coolibah – Black Box Woodlands TEC. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.40.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.7, the following specific mitigation measures are recommended:

- The Coolibah – Black Box Woodlands TEC should be identified and the extent mapped during pre-clearance surveys. Confirmation of TEC avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species within the patch.

Indirect impacts will also be managed in accordance with the EMP.

8.41 Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions

8.41.1 Status

Endangered – listed 4 April 2001

Plate 42: Semi-evergreen vine thicket TEC (Source: NSW Government Local Land Services)

8.41.2 Biology and ecology

8.41.2.1 Characteristics

The Semi-evergreen Vine Thicket (SEVT) TEC is also known as softwood scrub or bottle tree scrub. This TEC is characterised by a floristically diverse and heterogeneous assemblage of species, especially in the canopy and shrub layers (DAWE 2020f).

Typically, one patch of SEVT may contain over 40 vascular plant species, although the number of tree species is highly variable, ranging from 1 to 19 species (DAWE 2020f). Emergent species are composed of a range of evergreen, semi-evergreen and deciduous species, including *Brachychiton rupestris* (Narrow-leaved bottle tree) which is generally present within all SEVT areas. Other species that may be locally present as emergent include *Acacia harpophylla* (Brigalow), *Brachychiton australis* (Broad-leaved bottle tree) and *Casuarina cristata* (Belah), or less often *Acacia fasciculifera*, *Archidendropsis thozetiana* (Grey Boxwood), *Cadellia pentastylis* (Ooline), *Euroschinus falcata*, *Flindersia australis* (Crow's ash) and *Ventilago viminalis* (Vine tree) (DAWE 2020f).

A wide range of species are generally present within the canopy stratum and generally include *Backhousia angustifolia*, *Backhousia kingii*, *Croton insularis*, *Denhamia oleaster*, *Ehretia membranifolia*, *Geijera parviflora*, *Macropteranthes leichhardtii*, *Notelaea microcarpa* and *Pouteria cotinifolia* (DAWE 2020f).

A dense shrub understorey may be present. However where the canopy is very dense, shrubs may be absent as a result of competitive exclusion. Species common in the shrub layer include *Acalypha eremorum*, *Alectryon diversifolius*, *Everistia vacciniifolia*, *Carissa ovata*, *Croton phebalioides*, *Exocarpos latifolius*, *Geijera parviflora*, *Pittosporum spinescens* and *Triflorensia ixoroides* (DAWE 2020f).

Within Queensland, 10 REs have been identified as being analogous to the SEVT TEC (DAWE 2020f). Table 16 lists these REs and provides a brief description of each RE type.

Table 18: REs analogous with SEVT TEC

RE	Description
11.2.3	Microphyll vine forest ("beach scrub") on sandy beach ridges
11.3.11	Semi-evergreen vine thicket on alluvial plains
11.4.1	Semi-evergreen vine thicket ± *Casuarina cristata* on Cainozoic clay plains
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains/remnant surfaces
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks
11.8.6	*Macropteranthes leichhardtii* thicket on Cainozoic igneous rocks
11.8.13	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks
11.9.4	Semi-evergreen vine thicket on Cainozoic fine-grained sedimentary rocks
11.9.8	*Macropteranthes leichhardtii* thicket on Cainozoic fine-grained sedimentary rocks
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding

8.41.2.2 Known distribution

The SEVT TEC extends from Townsville in Queensland south into northern New South Wales (NSW). It is primarily located within the Brigalow Belt Bioregion (ie Bioregion 11).

In Queensland the remnant SEVT areas are scattered from coastal dunes and river deltas in the vicinity of Townsville and Ayr, through to the northern and central parts of the Brigalow Belt Bioregion and south into its south-eastern parts between Jandowae and Killarney on the Queensland/New South Wales border (Queensland Herbarium 2002a). In NSW, remnants usually occur as isolated patches scattered in other shrubby vegetation (Curran 2003) and are located on the North West Slopes east of Moree and north from the Liverpool Plains, with major occurrences in the vicinity of Gunnedah, Bingara and Narrabri (Benson et al 1996, Williams 1999, Curran 2003, Keith 2004).

The SEVT TEC occurs in the Brigalow Belt North, Brigalow Belt South and Nandewar bioregions (Threatened Species Scientific Committee 2001). In Queensland, more than 50% of remnants occur in the Arcadia, Buckland Basalts, Claude River Downs, Dawson River Downs, Northern Bowen Basin and Southern Downs sub regions (McDonald 2007).

Figure 41: Mapped distribution of SEVT TEC (Source: DAWE)

8.41.3 Likelihood of occurrence within the Towrie development area

This TEC is known to occur within the development area. A total of 534.49 ha of SEVT TEC is modelled within the development area based on the field survey and LiDAR assessment findings, including areas within Middle Hill and the western ridgeline.

8.41.4 Anticipated threats and potential impacts from the development

No direct impacts (vegetation clearing) will be permissible in all areas of confirmed SEVT TEC. Other potential indirect impacts relevant to the SEVT TEC includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.41.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.7, the following specific mitigation measures are recommended:

- The SEVT TEC should be identified and the extent mapped during pre-clearance surveys. Confirmation of TEC avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species within the patch.

Indirect impacts will also be managed in accordance with the EMP.

8.42 Poplar Box Grassy Woodland on Alluvial Plains

8.42.1 Status

Endangered – Listed 4 July 2019

Plate 43: Poplar Box Grassy Woodland on Alluvial Plains TEC community (Photo credit: Rosemary Purdie in Department of Environment and Energy (no date))

8.42.2 Biology and ecology

8.42.2.1 Characteristics

The Poplar Box Grassy Woodland on Alluvial Plains ecological community (Poplar Box TEC) occurs as an open woodland to woodland with an understorey mostly of grasses and other herbs. It may include a low density of shrubs, however patches of the ecological community generally lack a substantial mid layer (tall shrub). While Poplar box (*Eucalyptus populnea*) must dominate the canopy, other tree species may also occur in this layer including: *Acacia harpophylla* (brigalow), *Callitris glaucophylla* (White Cypress Pine), *Casuarina cristata* (belah), *Eucalyptus coolabah* (Coolibah), *E. largiflorens* (Black Box), *E. melanophloia* (Silver-leaved Ironbark) and *Melaleuca bracteata*. Canopy height is up to 20 m.

A number of factors including topography, hydrology, fire regimes, soil fertility and disturbance influence the structure and vegetation composition of this community. Within Santos' GLNG gas fields, the community is restricted to sparse or scattered stands along floodplains or minor depressions. It generally occurs in areas with a flat or undulating topography, shallow depressions or gilgais on raised alluvial plains. This community is mainly associated with clay, clay-loam, loam, sandy loam, typically duplex soils or sodosols.

Table 19 lists REs in the Brigalow Belt Bioregion that are considered analogous with Poplar Box TEC.

Table 19: REs analogous with Poplar Box TEC

RE	Description
11.3.2	*Eucalyptus populnea* woodland on alluvial plains

RE	Description
11.3.17	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains
11.4.7	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on Cainozoic clay plains
11.4.12	*Eucalyptus populnea* woodland on Cainozoic clay plains

8.42.2.2 Known distribution

The Poplar Box TEC occurs west of the Great Dividing Range, typically at less than 300 m above sea level (ASL) and between latitudes 20°S to 34°S, associated with ancient and recent alluvial plains. It occurs within the Brigalow Belt North, Brigalow Belt South, Southeast Queensland, Cobar Peneplain, Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions (DEWHA 2009). Figure 40 shows the indicative range of Poplar Box TEC.

The extent of Poplar Box TEC across its entire range is thought to have declined by at least 75% (DEWHA 2009).

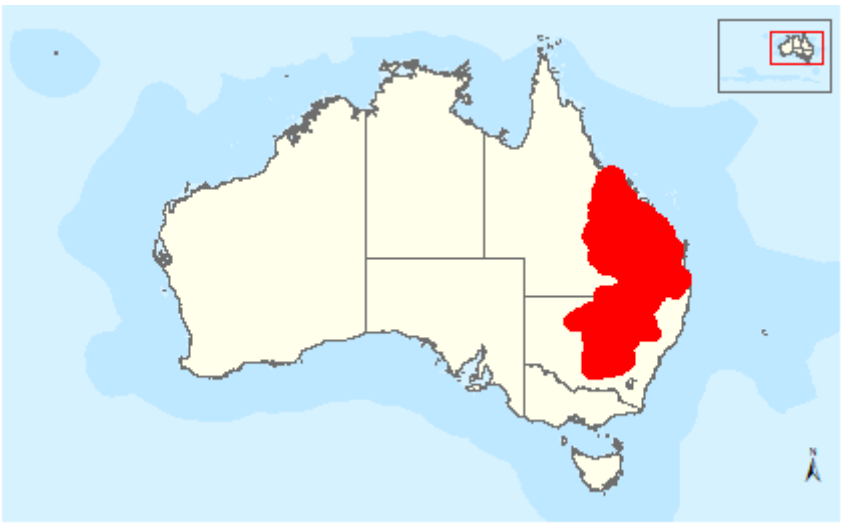

Figure 42: Mapped distribution of Poplar Box TEC (Source: DAWE)

8.42.3 Likelihood of occurrence within the Towrie development area

This TEC is known to occur within the development area. A total of 39.41 ha of Poplar Box TEC is modelled within the development area based on the field survey and LiDAR assessment findings.

8.42.4 Anticipated threats and potential impacts of the development

A maximum of 0.5 ha of Poplar Box TEC will be directly impacted via vegetation clearing for the development. Given that some components of the development are linear, clearing may fragment existing patches and reduce their size below TEC status threshold. Other potential indirect impacts relevant to the TEC includes:

- further weed and pest incursion
- increased edge effects

- elevated dust.

8.42.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.7, the following specific mitigation measures are recommended:

- Clearing works will not intersect or dissect a patch of Poplar Box TEC in a way that reduces the patch size below 1 ha
- The Poplar Box TEC should be identified and the extent mapped during pre-clearance surveys. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species within the patch.

Indirect impacts will also be managed in accordance with the EMP.

8.43 Weeping Myall Woodlands

8.43.1 Status

Endangered – listed 7 January 2009

Plate 44: Weeping Myall Woodlands TEC community (Source: NSW Catchment Management Authority)

8.43.2 Biology and ecology

8.43.2.1 Characteristics

Weeping Myall Woodlands occur in a range of forms, including woodlands and open-woodlands, or as a shrubby or grassy woodland. While Weeping myall (*Acacia pendula*) must be the dominant overstorey species, other tree species may also occur in the canopy layer. This community often includes Western rosewood (*Alectryon oleifolius* subs. *Elongates*), Poplar box (*Eucalyptus populnea*), and Black box (*Eucalyptus largiflorens*). Grey mistletoe (*Amyema quandang*) regularly occurs within Weeping myall communities.

The structure of this community varies throughout its range. Within Santos' GLNG and GFD gas fields, the community is restricted to sparse or scattered stands along floodplains or minor depressions. It generally occurs in areas with a flat topography, shallow depressions or gilgais on raised alluvial plains. Generally these areas are not associated with active drainage channels. This community is associated with black, bow, red-brown or grey clay and clay-loam soils.

Within Queensland, two REs have been identified as being analogous to the Weeping myall TEC (DAWE 2020g). Table 18 lists these REs and provides a brief description of each RE type.

Table 20: REs analogous with Weeping Myall Woodland TEC

RE	Description
11.3.2	*Eucalyptus populnea* woodland on alluvial plains
11.3.28	*Casuarina cristata* +/- *Eucalyptus coolabah* open woodland on alluvial plains

8.43.2.2 Known distribution

In Queensland, Weeping myall woodlands occur on the inland alluvial plains west of the Great Dividing Range in Queensland, within the Brigalow Belt South and Nandewar bioregions (DEWHA 2009). Figure 39 shows the indicative range of Weeping Myall Woodlands TEC.

The extent of Weeping myall woodlands in Queensland is thought to have declined by approximately 75% (DEWHA 2009).

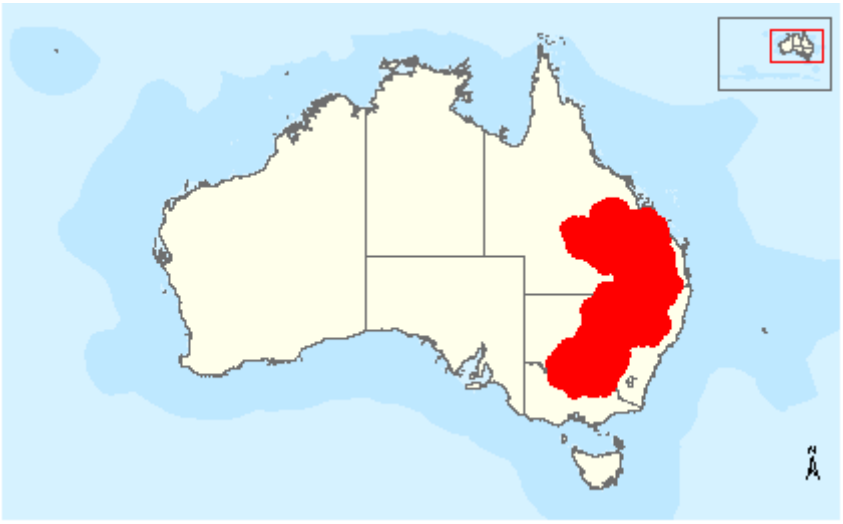

Figure 43: Mapped distribution of Weeping Myall Woodlands TEC (Source: DAWE)

8.43.3 Likelihood of occurrence within the Towrie development area

This TEC is considered unlikely to occur within the development area. Although RE 11.3.2 was confirmed during the field surveys, no areas were considered potential weeping myall woodlands TEC due to the lack of *Acacia pendula*. This species was not recorded during the field survey within the development area or in adjacent areas such as roadsides. A review of ALA for this species reveals that no records occur within 50 km of the development area.

8.43.4 Anticipated threats and potential impacts of the development

No known areas of the Weeping myall woodlands TEC are expected to be impacted by the development. Survey works conducted prior to construction will confirm any areas and associated habitat within the development area. No direct impacts (vegetation clearing) will be permissible in any confirmed Weeping myall woodlands TEC. Should vegetation clearing occur in areas directly adjacent, potential indirect impacts relevant to the species includes:

- further weed and pest incursion
- increased edge effects
- elevated dust.

8.43.5 Specific management requirements

In addition to the mitigation measures outlined in Section 4.2.1.7, the following specific mitigation measures are recommended:

- The Weeping myall woodlands TEC should be identified and the extent mapped during pre-clearance surveys. Confirmation of TEC avoidance should be completed during final scouting. The siting of infrastructure should avoid areas of known occurrence as a priority.
- Clearing works should maintain a sufficient vegetation buffer where possible around identified locations to maintain suitable micro-climatic conditions.
- Rehabilitation works will utilise appropriate native species to reduce the potential proliferation of harmful species within the patch.

Indirect impacts will also be managed in accordance with the EMP.

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