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Significant Species Management Plan – GFD Project

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Santos GLNG

Table of Contents

Santos GLNG

Santos GLNG

Tables

Figures

Santos GLNG

Plates

Santos GLNG

Santos GLNG

Appendices

Santos GLNG

Abbreviations and Units

Acronym	Description
CAMBA	China-Australia Migratory Bird Agreement
cm	Centimetre
CSG	Coal Seam Gas
E	Endangered
EA	Environmental Authority
EHSMS	Santos Environment, Health, Safety & Management System
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographical Information System
GLNG	Gladstone Liquefied Natural Gas
ha	Hectares
HERBRECS	Queensland Herbarium database
JAMBA	Japan-Australia Migratory Bird Agreement
LNG	Liquefied Natural Gas
LZ	Land Zone
m	Metres
Mi	Migratory
Mm	Millimetres
MNES	Matters of National Significance
MSES	Matters of State 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
SSMP	Significant Species Management Plan
TEC	Threatened Ecological Communities
V	Vulnerable

1.0 Introduction

The Santos GLNG Gas Field Development Project (the GFD Project) is an expansion of the existing approved Santos GLNG Project involving the construction, operation, decommissioning and rehabilitation of additional production wells, and associated supporting infrastructure that will provide additional gas over a project life exceeding 30 years.

The GFD Project will expand the Santos GLNG Project's gas fields from 6,887 km^2 to 9,885 km^2 and develop an additional 6,100 production wells beyond the currently authorised 2,650 production wells; resulting in a maximum of 8,750 wells. The GFD Project will progressively develop wells and associated supporting infrastructure across a number of Santos GLNG petroleum tenements, which include the current existing project area and surrounding tenures located in the Arcadia, Fairview, Roma and Scotia gas fields. These areas combined are referred to as the Santos GLNG Upstream Project Area.

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) are known to, or have the potential to, occur within the Santos GLNG Upstream Project Area. The EPBC Approval (2012/6615) authorises maximum disturbance limits to Matters of National Environmental Significance (MNES) to protect those EPBC listed threatened species, communities and migratory species that may occur within the Santos GLNG Upstream Project Area.

Given the iterative nature of the planning and development for upstream infrastructure, Santos GLNG is conditioned to prepare and implement a Significant Species Management Plan (SSMP) 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 GLNG with the tools to systematically identify significant species and implement management measures during the course of conducting activities in the Santos GLNG Upstream Project Area.

1.1 Purpose and Scope of the SSMP

Santos GLNG must comply with requirements of approval EPBC (2012/6615). Specifically Condition 9 requires that:

'The approval holder must submit a Significant Species Management Plan for the Ministers written approval. The Significant Species Management Plan must include:

a) *Measures that will be taken to avoid, mitigate and manage impacts to EPBC threatened species and EPBC migratory species and their habitat, and EPBC communities during clearance of vegetation, including supervision by a suitably qualified person at all times during clearance of vegetation;*
b) *Measures that will 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;*
c) *Details of how the approved Constraints Protocol has been applied to avoid and minimise impacts to EPBC threatened species and EPBC migratory species and their habitat and EPBC communities during construction, operation and decommissioning of the action;*
d) *A monitoring program to determine the success of mitigation and management measures to ensure adaptive management for the duration of this approval;*
e) *Details of the timeframe for a regular review of the approved Significant Species Management Plan;*

f) *A discussion of relevant conservation advice, recovery plans and threat abatement plans and how measures proposed in the Significant Species Management Plan take into account relevant conservation advice and are consistent with the measures contained in relevant recovery plans and threat abatement plans'.*

This SSMP has been prepared to guide the management of impacts from activities that have been planned (in consideration of ecological constraints) and approved for construction and will have an identified 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 *Environmental Protocol for Constraints Planning and Field Development (0007-650-PLA-0007).*

This SSMP applies to GFD Project activities carried out within the Santos GLNG Upstream Project Area. The Santos GLNG Upstream Project Area consists of Santos GLNG petroleum tenements comprising the Arcadia, Fairview, Roma and Scotia gas fields and as illustrated in Figure 1.

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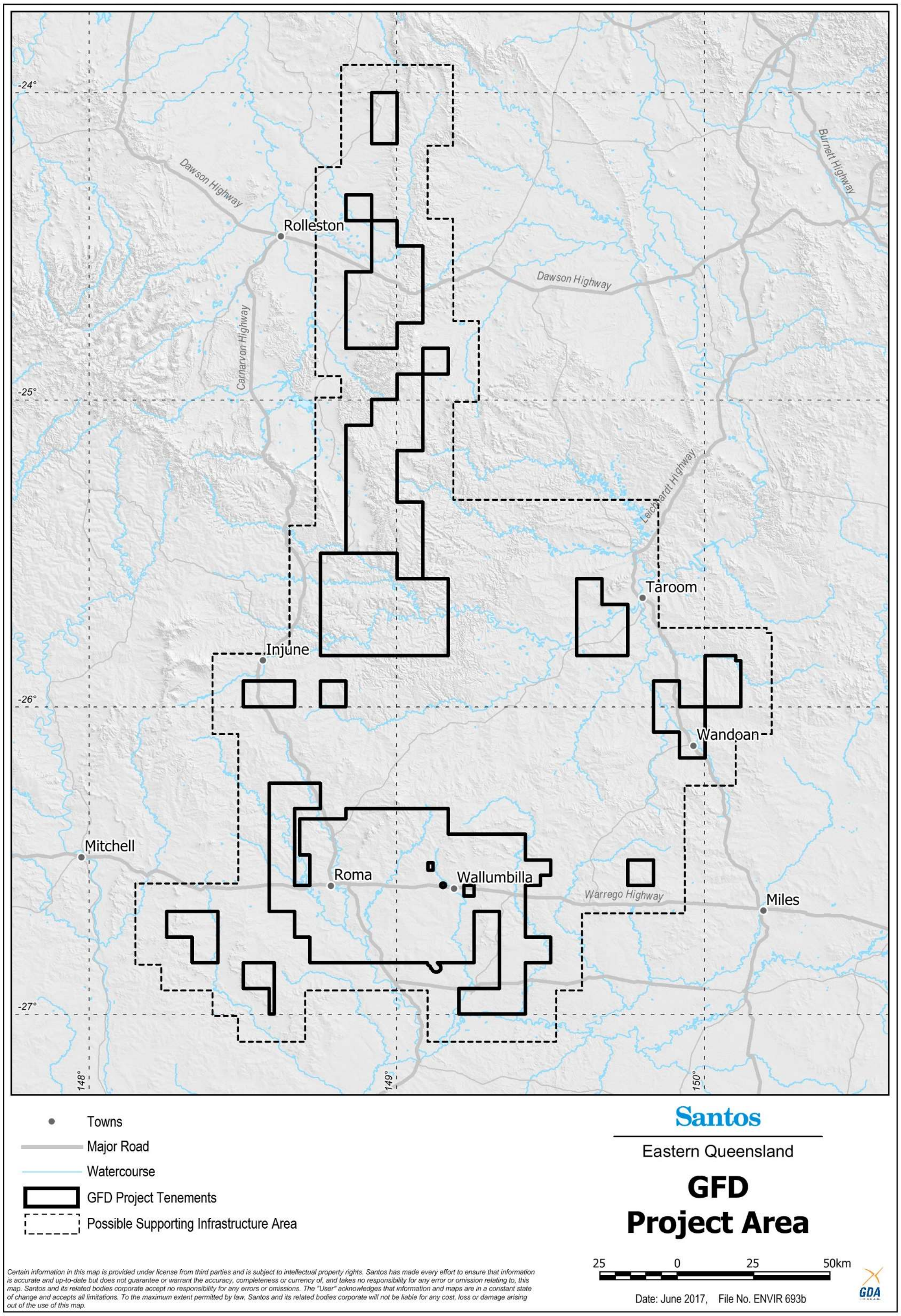

Figure 1: The Santos GLNG Upstream Project Area

2.0 Legal and Other Requirements

2.1 Legal Requirements

Santos GLNG must comply with all relevant Commonwealth and Queensland legislation and approvals. A summary of primary legislation in relation to the management of significant species and TECs relevant to the development of the SSMP 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. The GFD Project will be undertaken in accordance with the conditions of EPBC Approval 2012/6615.
State Development and Public Works Organisation Act 1971 **(SDPWOA)**	Under Section 35 of SDPWOA the Coordinator-General must prepare the Coordinator-General's report for an Environmental Impact Statement. In evaluating the Environmental Impact Statement, the Coordinator-General may state conditions and make recommendations. The Coordinator-General's evaluation report for the GFD Project EIS was released in December 2015.
Environmental Protection Act 1994 **(EP Act)** ***Environmental Protection Regulation 2008*** **(EP Reg)**	The EP Act provides for environmental management practices and environmental safeguards. The EP Act is applicable to the GFD Project in regards to Environmental Authorities (EAs). The conduct of petroleum activities cannot occur without an EA. The EP Act details the process of environmental assessment for the granting of EAs. The EP Act also requires Santos GLNG 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. Permits / management programs may be required for the taking of protected plants and for tampering with animal breeding places for protected flora and fauna species.

The SSMP is also informed by advice contained wthin the standards and guidelines provided in Table 2. Appendix A of this SSMP provides additional detail regarding the consideration and application of relevant conservation advices, recovery plans and threat abatemwent plans for each potentially affected species.

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
Draft Queensland Brigalow Belt Reptile Recovery Plan 2008-2012	Richardson 2008
(Draft) National Recovery Plan for the South-Eastern Long-Eared Bat (*Nyctophilus corbeni*)	Schulz & Lumsden 2010
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
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 Black-Breasted Button-Quail (*Turnix Melanogaster*)	Mathieson & Smith 2009
National Recovery Plan for the *Bertya sp*. (Cobar-Coolabah) (This Recovery Plan Encompasses *Bertya opponens*)	NPWS 2002a
Recovery Plan for the Brigalow (*Acacia harpophylla*) Dominant and Co-Dominant Endangered Ecological Community	Butler 2007b
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
National Recovery Plan for The “Semi-Evergreen Vine Thickets of the Brigalow Belt (North And South) And Nandewar Bioregions” Ecological Community	Mcdonald 2010
The Action Plan for Australian Birds	Garnett *et al* 2010
Republic of Korea- Australia Migratory Bird Agreement (ROKAMBA) (2007)	Government of Australia 2007
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

Santos GLNG

Standards and Guidelines	
Title	**Author**
Recovery Plan for the Community of Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin	Fensham *et al* 2010
The Action Plan for Australian Bats	Environment Australia 1999
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
Threat Abatement Plan for predation by the European red fox	DEWHA 2008
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
Wildlife Conservation Plan for Migratory Shorebirds	DOTE 2006

3.0 Significant Species in the Santos GLNG Upstream Project Area

3.1 Overview

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

Species considered **unlikely to occur** include species that fit one or more of the following criteria:

- Have not been recorded previously in the study area and locality and for which the study area is beyond the current distributional limits; or
- Use specific habitat types or resources that are not present in the study area; or
- Are considered locally extinct.

Species considered **likely to occur** include species that fit one or more of the following criteria:

- Have previously infrequently been recorded in the study area and locality and for which the study area is within current distributional limits; or
- Use habitat types or resources that are present in the study area (including use of seasonal resources); or
- Are not considered to be locally extinct.

Species considered to be **known to occur** include species recorded within the study area during field assessments or included as specimen-backed records in the HERBRECS, Wildlife online, Atlas of Living Australia, Queensland Museum and/or Birds Australia databases.

The following Sections provide an overview of the significant species and TECs and their likelihood of occurrence within the GFD Project Area. These species are subject to the requirements of the SSMP should they or their habitat be proposed to be impacted by Project activities. This SSMP provides detailed profiles for each of the species and TECs discussed in Section 8.0

Should an EPBC threatened species, community or migratory species be identified within the Project area that is not contained in this plan, then Project activities that may impact the newly identified species 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 Department of the Environment's Protected Matters Search Tool as possibly occurring in the Santos GLNG Upstream Project 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 their presence in the gas fields (refer Section 3.1); and
- a general description of the habitat within which each species is expected to occur.

Santos GLNG

Table 3: Significant Flora Species within the Santos GLNG Upstream Project Area

Species	Common Name	Occurrence in GFD Project Area	Status		Species Profile
			EPBC Act	NC Act	
Terrestrial Flora					
Acacia curranii	Curly-bark wattle	Unlikely	V	V	Section 8.1
Acacia grandifolia	-	Likely	V	C	Section 8.2
Aristida annua	-	Likely	V	V	Section 8.3
Arthraxon hispidus	Hairy-joint grass	Likely	V	V	Section 8.4
Bertya opponens	Coolabah bertya	Known to occur	V	-	Section 8.5
Cadellia pentastylis	Ooline	Known to occur	V	V	Section 8.6
Calytrix gurulmundensis		Unlikely	V	V	Section 8.7
Daviesia discolor	-	Likely	V	V	Section 8.8
Dichanthium queenslandicum	King bluegrass	Known to occur	E	V	Section 8.9
Dichanthium setosum	Bluegrass	Likely	V	NT	Section 8.10
Eucalyptus beaniana	Bean's ironbark	Likely	V	V	Section 8.11
Homopholis belsonii	Belson's panic	Likely	V	E	Section 8.12
Homoranthus decumbens	A Shrub	Unlikely	E	V	Section 8.13
Macrozamia platyrhachis	-	Unlikely	E	E	Section 8.14
Phaius australis	Lesser-swamp Orchid	Likely	E	E	Section 8.15
Swainsona murrayana	Slender darling-pea	Unlikely	V	V	Section 8.16
Thesium australe	Austral toadflax	Likely	V	V	Section 8.17
Tylophora linearis	-	Unlikely	E	E	Section 8.18
Westringia parvifolia	-	Unlikely	V	V	Section 8.19
Xerothamnella herbacea	-	Known to occur	E	E	Section 8.20
Aquatic Flora					
Eriocaulon carsonii	Salt pipewort	Known to occur	E	E	Section 8.21

Table notes: EPBC Act = *Environmental Protection and Biodiversity Conservation Act 1999;* NC Act = *Nature Conservation Act 1992*

E = Endangered, V = Vulnerable, NT = Near Threatened, LC = Least Concern

3.3 Significant Fauna

Significant fauna species (including migratory species) identified by the Department of the Environment's Protected Matters Search Tool as possibly occurring in the Santos GLNG Upstream Project Area are presented in Table 4. The conservation status of each species under both the EPBC Act and the NC Act as well as the likelihood of their presence in the gas fields (refer Section 3.1) is also provided.

Fauna habitat descriptions have been developed for the purposes of this SSMP based on previous pre-clearance surveys, available scientific information, and expert advice contained within the Biodiversity

Planning Assessment (BPA) (EPA 2006). More detailed species-specific habitat descriptions are outlined within each species profile contained in Section 8.0 of this SSMP.

Table 4: Significant Fauna and Migratory Bird Species within the Santos GLNG Upstream Project Area

Species	Common Name	Occurrence in GFD Project Area	Status		Species Profile
			EPBC Act	NC Act	
Invertebrates					
Adclarkia dawsonensis	Boggomoss snail, Dawson valley snail	Unlikely	CE	LC	Section 8.22
Aves					
Botaurus poiciloptilus	Australasian bittern	Likely	E	LC	Section 8.23
Erythrotriorchis radiatus	Red goshawk	Likely	V	E	Section 8.24
Geophaps scripta scripta	Squatter pigeon	Known to occur	V	V	Section 8.25
Lathamus discolor	Swift parrot	Unlikely	E	E	Section 8.26
Neochmia ruficauda ruficauda	Star finch	Unlikely	E	E	Section 8.27
Pedionomus torquatus	Plains-wanderer	Unlikely	V	V	Section 8.28
Polytelis swainsonii	Superb parrot	Unlikely	V	LC	Section 8.29
Poephila cincta cincta	Black-throated finch	Unlikely	E	E	Section 0
Rostratula australis	Australian painted snipe	Known to occur	E/M	V	Section 8.31
Turnix melanogaster	Black-breasted button-quail	Likely	V	V	Section 8.32
Reptiles					
Anomalopus mackayi	Five-clawed worm-skink	Unlikely	V	E	Section 8.33
Furina dunmalli	Dunmall's snake	Likely	V	V	Section 8.34
Denisonia maculata	Ornamental snake	Likely	V	V	Section 8.35
Delma torquata	Collared delma	Likely	V	V	Section 8.36
Egernia rugosa	Yakka skink	Known to occur	V	V	Section 8.37
Mammals					
Chalinolobus dwyeri	Large-eared pied bat	Likely	V	V	Section 8.38
Nyctophilus corbeni	South-eastern long-eared bat	Likely	V	V	Section 8.39
Dasyurus hallucatus	Northern quoll	Likely	E	LC	Section 8.40
Onychogalea fraenata	Bridled nail-tail wallaby	Unlikely	E	E	Section 8.41
Petrogale penicillata	Brush-tailed rock-wallaby	Unlikely	V	V	Section 8.42
Pteropus poliocephalus	Grey-headed flying-fox	Unlikely	V	LC	Section 8.43

Santos GLNG

Species	Common Name	Occurrence in GFD Project Area	Status		Species Profile
			EPBC Act	NC Act	
Phascolarctos cinereus	Koala	Known to occur	V	V	Section 8.44
Aquatic Fauna					
Maccullochella peelii	Murray cod	Likely	V	LC	Section 8.45
Rheodytes leukops	Fitzroy river turtle	Likely	V	V	Section 8.46
Migratory Birds					
Ardea alba *(Ardea modesta)*	Great egret	Likely	M	SLC	Section 8.47
Ardea ibis	Cattle egret	Likely	M	SLC	Section 8.48
Apus pacificus	Fork-tailed swift	Known to occur	M	SLC	Section 8.49
Calidris acuminate	Sharp-tailed sandpiper	Likely	M	SLC	Section 8.50
Gallinago hardwickii	Latham's snipe, Japanese snipe	Likely	M	SLC	Section 8.51
Haliaeetus leucogaster	White-bellied sea eagle	Likely	M	SLC	Section 8.52
Hirundapus caudacutus	White-throated needletail	Likely	M	SLC	Section 8.53
Merops ornatus	Rainbow bee-eater	Known to occur	M	SLC	Section 8.54
Monarcha melanopsis	Black-faced monarch	Unlikely	M	SLC	Section 8.55
Monarcha trivirgatus	Spectacled monarch	Unlikely	M	SLC	Section 8.56
Myiagra cyanoleuca	Satin flycatcher	Likely	M	SLC	Section 8.57
Pandion haliaetus	Eastern osprey	Unlikely	M	SLC	Section 8.58
Plegadis falcinellus	Glossy ibis	Known to occur	M	SLC	Section 8.59
Tringa nebularia	Common greenshank	Likely	M	-	Section 8.60
Tringa stagnatilis	Marsh sandpiper	Likely	M	SLC	Section 8.61
Pluvialis fulva	Pacific golden plover	Likely	M	SLC	Section 8.62
Tringa glareola	Wood sandpiper	Likely	M	SLC	Section 8.63
Hydroprogne caspia	Caspian tern	Likely	M	SLC	Section 8.64

Table notes: EPBC Act = *Environmental Protection and Biodiversity Conservation Act 1999;* NC Act = (*Nature Conservation Act 1992*

E = Endangered, V = Vulnerable, NT = Near Threatened, M = Migratory, LC = Least Concern, SLC = Special Least Concern

3.4 Threatened Ecological Communities

The spatial extent of TECs has been estimated using vegetation community data in Santos' GIS. This data utilises the Regional Ecosystems (RE) mapping as a base layer and is updated and refined following desktop interrogation and/or ecological field surveys.

Six EPBC listed TECs are known to occur, or are likely to occur, within the Santos GLNG Upstream Project Area as listed in Table 5. Detailed profiles of these TECs are provided in Sections 8.65 to 8.70 of this SSMP.

Table 5: Threatened Ecological Communities (TEC) within the Santos GLNG Upstream Project Area

Threatened Ecological Community	Likelihood of Occurrence	EPBC Status	Species Profile
Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Not identified but has the potential to occur	Endangered	Section 8.65
Brigalow (*Acacia harpophylla* dominant and sub-dominant)	Known to occur	Endangered	Section 8.66
Semi-evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions	Known to occur	Endangered	Section 8.67
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Known to occur	Endangered	Section 8.68
Weeping Myall Woodlands	Known to occur	Endangered	Section 8.69
Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Known to occur	Endangered	Section 8.70

4.0 Threats to Significant Species and Threatened Ecological Communities

The development of the Santos GLNG Upstream Project Area will see a range of activities occurring concurrently throughout the gas fields. The activities required for the development of the gas fields 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 Project activities is greatest and largely restricted to construction activities, when clearing and earthworks are undertaken. Risks to MNES during all other phases of the project are considered minimal. Potential threats to significant species posed by the development of the Santos GLNG Project are summarised in Table 6.

Table 6: Potential Impacts to Significant Species and Threatened Communities

Potential Impact	Description
Habitat Loss	The clearing of vegetation for the construction of project infrastructure has the potential to result in a direct loss of habitat for significant species. 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 phases 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 GFD Project 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. Much of the Santos GLNG Upstream Project Area is already highly fragmented due to clearing associated with historic grazing practices, however intact stands of contiguous vegetation remain. Project related clearing will predominantly occur during the construction phases 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 man-made and natural mechanisms. Activities conducted throughout the Santos GLNG Upstream Project Area have the potential to inadvertently introduce and spread pest and weed species across the region, primarily through poor weed hygiene practices and the movement of Project vehicles between ‘clean’ and ‘dirty’ regions. There is also potential for increased movement of pest fauna that are already present in the gas fields through habitat modification, and supplementary food sources as a result of generated wastes from Project 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. On its own, some disturbance of fauna movement and behaviour is likely to have minimal impact on populations. However, when combined with the loss of habitat, changes in behaviour may increase the risk of predation and the

Potential Impact	Description
	sustainability of populations. Most Project related 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, TEC 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 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 Project activities may over time also result in vegetation changes, further equating to the loss of habitat. The risk of fire associated with Project 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.

Potential Impact	Description
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.

5.0 Management of Significant Species and TECs

5.1 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 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. Provide Offsets – Where required, Santos GLNG will provide offsets for activities that result in an unavoidable significant residual adverse impact to MNES.

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

5.1.1 Avoid and Minimise

5.1.1.1 Constraints Based Management of Ecological Impacts

Santos GLNG is required to implement an *Environmental Protocol for Constraints Planning and Field Development* (the Protocol). This document outlines the approach Santos GLNG 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 project 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;
- Where required by desktop assessments, detailed environmental 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.

5.1.2 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 habitat and TECs. Mitigation measures specific to significant species and TECs are discussed further in Section 5.2.

5.1.2.1 Rehabilitate

Where a direct or indirect impact has occurred to a significant species or TEC, Santos GLNG will apply rehabilitation measures as appropriate for the impacted species / area, to minimise cumulative impacts throughout the life of the Project. Santos GLNG 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 abandonment. Final rehabilitation is completed in accordance with the conditions of the relevant 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 Project infrastructure for ongoing private use. Rehabilitation objectives will be site-specific, depending on the surrounding land-use and vegetation types. Therefore, rehabilitation plans will be developed at the time an asset is to be decommissioned. Rehabilitation undertaken within or in proximity to MNES will utlise local provenance native species to achieve rehabilitation targets. It should be noted that individual assets across the GFD project will be decommissioned and hence rehabilitated progressively and at different times across the Project lifetime.

5.1.2.2 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.

5.1.3 Offset

Where impacts to MNES are significant, residual and adverse, resulting in a permanent loss of an environmental value, Santos GLNG will provide environmental offsets in accordance with the conditions of EPBC Approval (2012/6615).

5.2 Mitigation and Monitoring

5.2.1 Mitigation

As discussed in Section 5.1.2, this SSMP outlines a series of mitigation measures designed to minimise and/or mitigate potential impacts to significant species and TECs. A focus of these mitigation measures relates to ameliorating known threats to these values as identified in Section 4.0.

Mitigation measures have been grouped into the following categories:

- Flora – Section 5.2.1.1;
- Invertebrates – Section 5.2.1.2;
- Birds – Section 5.2.1.3;
- Reptiles and Amphibians – Section 5.2.1.4;
- Mammals – Section 5.2.1.5;
- Aquatic Fauna – Section 5.2.1.6;
- Migratory Birds – Section 5.2.1.7; and
- TECs – Section 5.2.1.8.

Mitigation measures presented in the following Sections have been further grouped by Project phase:

- 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.

5.2.1.1 Significant Flora Species

Table 7: Mitigation Measures for Significant Flora Species

Activity	Mitigation Measure
Pre-Construction Phase	
Site Preparation	The extent of disturbance within the vicinity of threatened flora will be delineated.
	Any exclusion zones surrounding identified flora species will also be appropriately delineated.
Site Induction and Work Instruction	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 Project locations will occur along designated access tracks only.
Clearing	Clearing must occur only within the approved and demarcated areas.
	All vegetation clearing within identified threatened flora 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].

[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
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.
	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 Project 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.
	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 earthern diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	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.
	With the exception of areas subject to ongoing operational or maintenance requirements or those assets where ownership has been transferred to the landholder, rehabililtation of areas of MNES will commence to achieve the planned final land use and as required by the conditions of the relevant 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 Project 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 GLNG 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 GLNG 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 relevant Environmental Authority except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of Project 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 relevant Environmental Authority except where ownership of the asset has been transferred to the landholder.

5.2.1.2 Significant Invertebrates

Table 8: Mitigation Measures for Significant Invertebrate Species

Activity	Mitigation Measure
Pre-Construction Phase	
Site Preparation	The extent of disturbance in MNES habitat will be delineated.
	Exclusion zones will be established around any identified breeding places and any fauna habitat features to be retained.
	In areas of MNES, 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.
	Any significant habitat features / breeding places to be avoided or moved within the marked extent of disturbance will be identified and delineated.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	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.

Activity	Mitigation Measure
Construction Phase	
Access	Access to and from Project locations will occur along designated access tracks only.
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.
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.
	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 Project area.
	All vehicles must possess an up-to-date Weed Hygiene Declaration.
	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.
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.
	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 earthern diversions in flow path, deploying booms in surface waters or pumping fluids to an alternative storage.
	Contaminated areas will be managed 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 relevant Environmental Authority.

Activity	Mitigation Measure
Operational Phase	
Fire Management	Threat of wildfire caused by Santos GLNG 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 GLNG personnel will be trained in the use of on-site 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 Project 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 Project 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.

5.2.1.3 Significant Threatened Birds

Table 9: 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 extent of disturbance in MNES habitat will be delineated.
	Disturbance in and around wetlands (bird habitat) will be avoided or minimised.
	Efforts will be made to retain mature trees.

Activity	Mitigation Measure
	Exclusion zones will be established around identified active breeding places and any fauna habitat feastures to be retained (eg mature trees, inactive breeding places) and appropriately marked out.
	Active breeding places will be monitored to ensure the breeding site has been vacated prior to the exclusion zone being removed.
	In areas of MNES, 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.
	Any significant habitat features / breeding places to be avoided or moved within the marked extent of disturbance will be identified and delineated.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	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 Project 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.
	Night works within restricted zones will be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities
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.
	Spotter-catchers will monitor all clearing works in MNES habitat. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	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.

Activity	Mitigation Measure
	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.
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 Project 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.
	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 earthern 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 relevant 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 Project 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 GLNG 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 GLNG 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.
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 Project 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 relevant Environmental Authority except where ownership of the asset has been transferred to the landholder.

5.2.1.4 Significant Reptiles

Table 10: 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 extent of disturbance in MNES habitat will be delineated.
	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 active breeding places and any fauna habitat features to be retained (eg mature trees, rocky habitat, log piles).
	Active breeding places will be monitored to ensure the breeding site has been vacated prior to the exclusion zone being removed.
	In areas of MNES, 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.
	Any significant habitat features / breeding places to be avoided or moved within the marked extent of disturbance will be identified and delineated.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	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 Project 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.
	Night works within restricted zones will be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities
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.
	Spotter-catchers will monitor all clearing works in MNES habitat.
	Where microhabitat features are removed they will be utilised in areas adjacent to the clearing activities.

Activity	Mitigation Measure
	Displaced fauna will be relocated to a suitable recipient site provided that the animal did not sustain any injuries. Any injured animals 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.
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 Project 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.
	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 earthern 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.

Activity	Mitigation Measure
	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 relevant Environmental Authority.
Operational Phase	
Fire Management	Threat of wildfire caused by Santos GLNG 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 GLNG 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 Project 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 Project 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.

5.2.1.5 Significant Mammal Species

Table 11: 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 extent of disturbance in MNES habitat will be delineated.
	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 active breeding places and any fauna habitat features to be retained (eg mature trees, rocky outcrops, cave structures, etc).
	Active breeding places will be monitored to ensure the breeding site has been vacated prior to the exclusion zone being removed.
	In areas of MNES, 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 / breeding places to be avoided or moved within the marked extent of disturbance will be identified and delineated.
	Microhabitat will be relocated to adjacent areas of undisturbed vegetation prior to vegetation clearing.
Site Induction and Work Instruction	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 Project 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.
	Night works within restricted zones will be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities
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.

Activity	Mitigation Measure
	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.
	A spotter-catcher will monitor all clearing works in habitat. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	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.
	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.
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.

Santos GLNG

Activity	Mitigation Measure
	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 Project 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.
	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 earthern 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 relevant 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 GLNG 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 GLNG 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 Project 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.
	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 Project infrastructure will be conducted as per relevant internal processes and regulatory requirements.
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 relevant Environmental Authority, except where ownership of the asset has been transferred to the landholder..

5.2.1.6 Aquatic Fauna

Table 12: 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 extent of disturbance in MNES habitat will be delineated.
	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
	Exclusion zones will be established around identified active Fitzroy River Turtle breeding places (nests).
	Active breeding places will be monitored to ensure the breeding site has been vacated prior to the exclusion zone being removed.
	In areas of MNES, 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 / breeding places 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	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.

Activity	Mitigation Measure
Construction Phase	
Access	Access to and from Project locations will occur along designated access tracks only.
	Exclusion zones will be established around Fitzroy River Turtle nests that have become active after construction has commenced.
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.
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.
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 Project 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.
	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 earthern 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.

Activity	Mitigation Measure
	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 relevant 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 Project 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 Project 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 relevant Environmental Authority except where ownership of the asset has been transferred to the landholder.

5.2.1.7 Significant Migratory Birds

Table 13: 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.
	The extent of disturbance in MNES habitat will be delineated.
	Disturbance in and around wetlands (bird habitat) will be avoided or minimised.
	Efforts will be made to retain mature trees will be made.

Activity	Mitigation Measure
	Exclusion zones will be established around identified active breeding places and any fauna habitat features to be retained (eg mature trees).
	Active breeding places will be monitored to ensure the breeding site has been vacated prior to the exclusion zone being removed.
	In areas of MNES, 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.
	Any significant habitat features / breeding places 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	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 Project 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.
	Night works within restricted zones will be avoided. Where they are required to occur, activities will be restricted to critical site specific construction activities.
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.
	• A spotter-catcher will monitor all clearing works in habitat. The status of active nests will be regularly checked in a way that does not risk the nest being abandoned by the breeding pair.
	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;

Activity	Mitigation Measure
	• 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.
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 Project 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.
	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 earthern 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.

Activity	Mitigation Measure
	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 relevant Environmental Authority.
Operational Phase	
Fire Management	Threat of wildfire caused by Santos GLNG 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 GLNG 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 Project 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 Project 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.

5.2.1.8 Threatened Ecological Communities

Table 14: Mitigation Measures for TECs

Activity	Mitigation Measure
Pre-construction Phase	
Site Preparation	The extent of disturbance in TEC will be delineated.
Site Induction and Work Instruction	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 TEC's.
Construction Phase	
Access	Access to and from Project 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 Project 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 TEC's will be stored within contained areas, designed and managed in accordance with relevant regulatory requirements and 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.

Activity	Mitigation Measure
	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 earthern 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.
	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 relevant Environmental Authority.
Operational Phase	
Fire Management	Threat of wildfire caused by Santos GLNG 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 GLNG 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 Project 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.
	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 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 relevant Environmental Authority, except where ownership of the asset has been transferred to the landholder.
Decommissioning Phase	
Decommissioning and Abandonment	Decommissioning and abandonment of Project infrastructure will be conducted as per relevant internal processes and regulatory requirements.

Activity	Mitigation Measure
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 relevant Environmental Authority, except where ownership of the asset has been transferred to the landholder.

5.2.2 Monitoring and Corrective Actions

Table 15 below provides an overview of monitoring requriements and corrective actions to assess the effectiveness of the mitigation measures implemented during all Project phases. Corrective actions will be adapted where they do not resolve identified issues to ensure the ongoing minimisation of impacts to MNES values.

It should be noted that due to the geographical extent of the GFD Project, monitoring activities will be focussed on higher risk activities and higher risk disturbances based on their location within the landscape. 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 an MNES with a constraints basis ranking of 3 as defined in the Environmental Protocol for Constraints Planning and Field Development; 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 Project.

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

- Conduct internal and third party audits to formally assess the level of compliance with both regulatory requirements and with Santos GLNG 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.

Santos GLNG

Table 15: 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 Project vehicles leaving designated accesses.	Daily onsite transit observations Intermittent reiew 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

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
					during site toolbox / induction meetings. 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).

Santos GLNG

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
Pest and Weed Management	No new or increased infestations of declared and significant weed species in MNES as a result of construction activities. Pest animals have no access to supplementary food sources from Santos GLNG activities	Conduct checks on Project 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 construction activities. Inspect camp / waste facilities to ensure putrescible wastes are appropriate covered and contained.	Daily / weekly project vehicle checks during construction. Monthly / quarterly weed infestation checks during programmed site inspections (site dependent).	New weed infestations present in Santos GLNG construction areas caused by Santos GLNG activities. A significant proportion of Project machinery and vehicles do not possess up-to-date Weed Hygiene Declarations. Significant pest population present in Santos GLNG 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. 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.

Santos GLNG

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
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.
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 GLNG activities.	Conduct checks on Project 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 Project operational activities. Monitor the effectiveness of any weed control programs implemented in MNES. Inspect major Project accesses to ensure free of declared and/or significant weeds. Inspect camp / waste facilities to ensure putrescible wastes are appropriate 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 GLNG operational areas in MNES caused by Santos GLNG activities. Project machinery, vehicles and other materials do not possess up-to-date Weed Hygiene Declarations. Significant pest population present in Santos GLNG 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.

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
					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.
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

Activity	Performance Criteria	Monitoring Activity	Monitoring Activity Timing	Trigger Level	Corrective Action
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.

Santos
GLNG

6.0 Recording and Reporting Requirements

Consistent with the Protocol, the following information will be collected and maintained to demonstrate compliance with this SSMP.

6.1.1 Data Collection

Records of flora and fauna individuals sighted in the Santos GLNG Upstream Project 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 Threatened Ecological Communities 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.

6.1.2 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. Similary, 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 Project.

6.1.3 Reporting

Santos GLNG will report on upstream activities as required by Commonwealth Government approvals. Details of any impact or presumed impact to a significant species or TECs 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 Santos GLNG Upstream Project 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 GFD referral is identified within the Santos GLNG Upstream Project Area and is not included in the SSMP;
- Details of specific SPRAT profiles, threat abatement plans and conservation advices change; or
- A written request from the Minister for the SSMP to be reviewed.

Consistent with condition 36 of EPBC Approval (2012/6615) a revised SSMP will be submitted to the Minister for approval when the revision will likely have a new or increased impact on MNES. In all other instances, Santos will notify the Department in writing that the approved plan has been revised and provide a copy of the revised plan to the Department.

8.0 Species and Community Profiles

8.1 *Acacia curranii*

8.1.1 Status

Vulnerable – listed 16 July 2000

8.1.2 Biology and ecology

8.1.2.1 Characteristics

Acacia curranii (Curly-bark wattle) is an erect or spreading multi-stemmed shrub with distinctive red curling (minniritchi) bark. Its habit resembles that of broombush and it grows to a heigh of 3 to 4 m (Pedley 1978; Harden 1991; Cunningham *et al* 1992).

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

8.1.2.2 Known distribution

The species has a disjunct distribution in western New South Wales and south-eastern Queensland, occurring in three areas each separated by several hundred kilometres. In New South Wales it grows in the Lake Cargelligo area and on the Gunderbooka Range near Bourke. In Queensland it occurs in the Gurulmundi area, north of Miles (Pickard 1995). In the Gurulmundi area in the Darling Downs district of Queensland, plants occur in widely scattered thickets of about ten plants. This distribution centre is less than 20 km across (Pickard 1995).

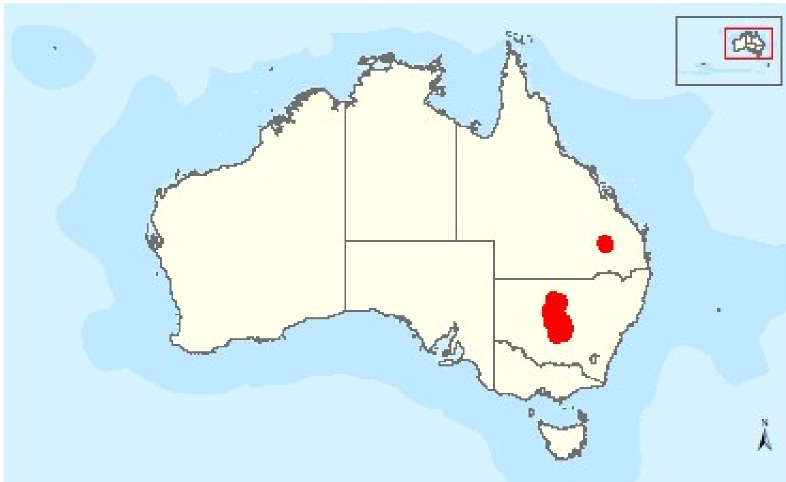

Figure 2: Mapped distribution range of *Acacia curranii* (Source: DOTE 2014c)

8.1.2.3 Known species populations within the Gas fields

Acacia curranii is unlikely to occur within the gas fields. Suitable habitat may be present, however known populations are geographically restricted and therefore arenot expected to occur in the Project area (Boobook 2015).

8.1.2.4 Habitat

Acacia curranii grows most often on rocky outcrops of isolated hills and ranges. Soils are variable between the different centres of distribution (Pickard 1995).

This species forms groves. In New South Wales typical accompanying species are *Acacia doratoxylon*, *Eucalyptus dwyeri* and *Callitris glaucophylla*. In Queensland, the plant occurs in patches in very species-rich heathy scrub (DOTE 2014c).

In Gurulmundi, the species occurs on deeply weathered sandstone forming red sandy soils. The soil is stony with patches of deep sand and little evidence of rock outcrop near the patches. The species occurs in widely scattered thickets in patches of diverse heath scrub with emergent trees (Pickard 1995).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (TSSC 2008m)

8.1.2.5 Biology and reproduction

The flowerheads are ovoid-shaped spikes and are golden in colour and flowers are borne August to September (Orchard & Wilson 2001). Pods ripen in November (Lithgow 1997).

This species may well require fire before the seeds will germinate (Pickard 1995). Preliminary attempts to germinate seeds by seed scarification have been largely unsuccessful, though this may be due to insect damage or poor development rendering seeds unviable (Pickard 1995).

Anecdotes and field observations indicate that populations adjacent to Nombinnie National Park, at Shepherds Hill and at Gurulmundi are regenerating after disturbance and fire (Pickard 1995). In general, populations which have undergone disturbance (eg railway spur at Shepherds Hill and a burnt area on Mylone and Ambone) appear to have many small plants, while undisturbed populations are generally composed entirely of medium to large plants. It is uncertain whether the many small plants that seem to be a result of disturbance are seedlings or root suckers. No recruitment of juveniles was observed at Gundabooka National Park (NSW NPWS 2003).

The three main population regions are considered too isolated for gene flow (Pickard 1995).

8.1.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Acacia currani* habitat from Project activities is 328 hectares. However, direct impacts to this species from gas field development will be limited given the species low likelihood of occurrence in the Project area.

Threats to this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the EPBC offsets policy.

8.1.4 Management practices and methods

Management measures for this species are outlined in Section 5.0 and Appendix A

8.2 *Acacia grandifolia*

8.2.1 Status

Vulnerable – listed 16 July 2000

8.2.2 Biology and ecology

8.2.2.1 Characteristics

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

Plate 2: *Acacia grandifolia* (Source: Fagg n.d)

8.2.2.2 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).

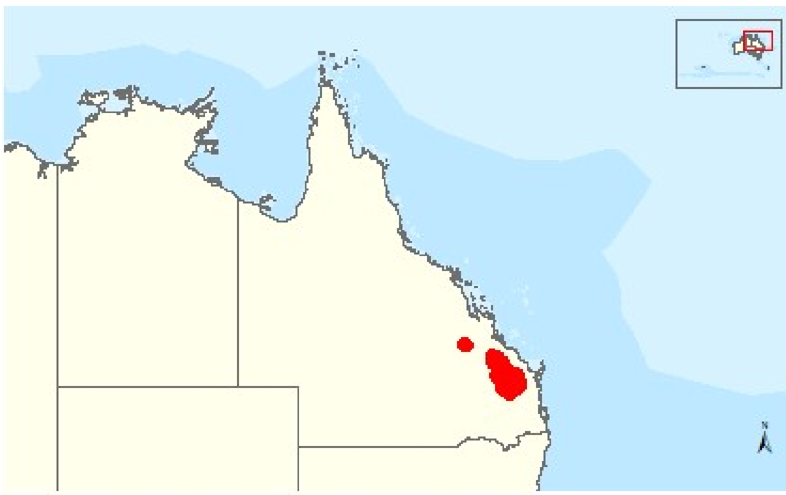

Figure 3: Mapped distribution range of *Acacia grandifolia* (Source: DOTE 2014d)

8.2.2.3 Known species populations within the gas fields

Acacia grandifolia is likely to occur within the gas fields. It is potentially present in areas of suitable habitat and within the following GFD tenements: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.2.2.4 Habitat

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).

8.2.2.5 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 plants flowered profusely, no seed was produced at observed sites over two successive years. This may have been due to climatic conditions or to low genetic diversity. 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).

8.2.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Acacia grandifolia* habitat from Project activities is 859 hectares. Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and EPBC offsets policy.

8.2.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.3 *Aristida annua*

8.3.1 Status

Vulnerable – listed 16 July 2000

8.3.2 Biology and ecology

8.3.2.1 Characteristics

Aristida annua is an annual loosely tufted grass with a flowering stem growing to approximately 50 cm in height. It has smooth 25 to 50 cm long culms (stems) with culm-internodes that are distally glabrous. The species has sparse lateral branches and leaf-blades that have pubescent surfaces, are hairy adaxially and grow between 7 and 15 cm long and 1 to 1.5 mm wide. Panicle is open (10 to 20 cm long and 5 to 12 cm wide), elliptic and effuse. Spikelets are solitary (Simon 1992).

Plate 3: *Aristida annua* (Source: Ausgrass2 n.d)

8.3.2.2 Known distribution

Aristida annua is restricted to grasslands in central Queensland and in Emerald and Springsure districts. The species is very poorly understood and there appears to be no survey data (DOTE 2014e).

There is no information on the population size of *Aristida annua* and the species has not been researched (DOTE 2014e).

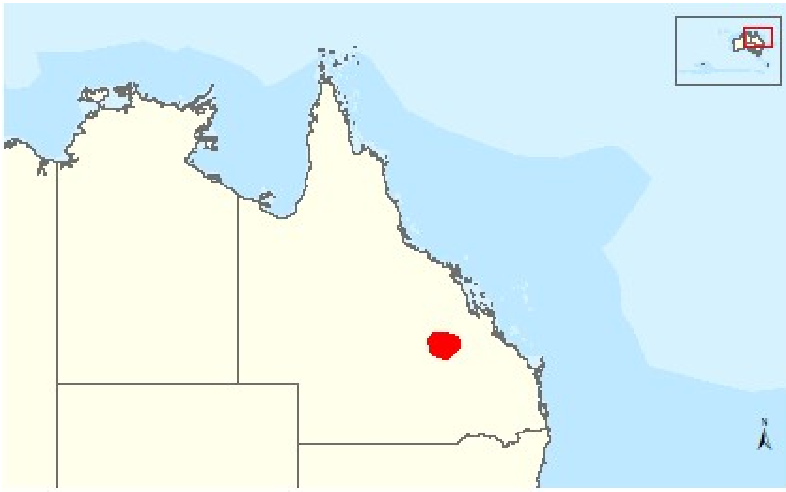

Figure 4: Mapped distribution range of *Aristida annua* (Source: DOTE 2014e)

8.3.2.3 Known species populations within the gas fields

Aristida annua is likely to occur within the gas fields. It is potentially present within the following GFD tenements: ATP526, STP745, ATP804 (Boobook, 2015).

8.3.2.4 Habitat

Aristida annua occurs in eucalypt woodland. It is restricted to black clay soils, basalt soils and possibly disturbed sites (DOTE 2014e). The species occurs in the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community, which is listed as Endangered under the EPBC Act (QLD DERM 2011b).

8.3.2.5 Biology and reproduction

The species flowers between March and June (BRI collection records n.d).

8.3.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Aristida annua* habitat from Project activities is 40 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.3.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.4 *Arthraxon hispidus*

8.4.1 Status

Vulnerable – listed 16 July 2000

8.4.2 Biology and ecology

8.4.2.1 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 4: *Arthraxon hispidus* (Source: Ausgrass2 n.d)

8.4.2.2 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).

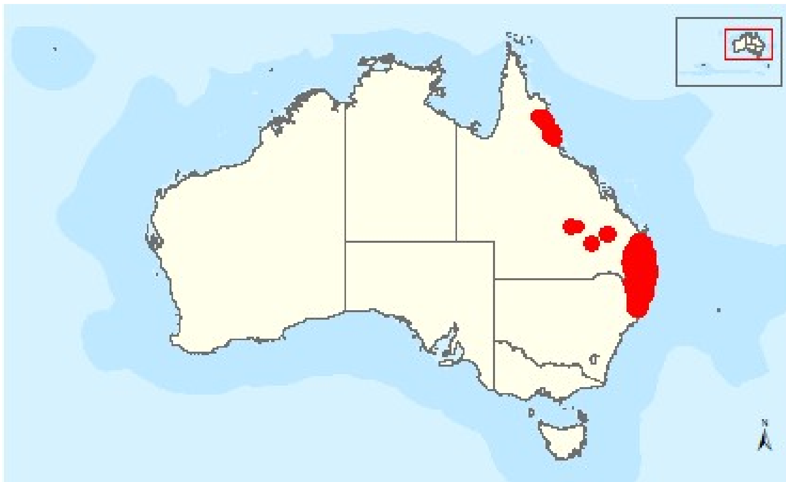

Figure 5: Mapped distribution range of *Arthraxon hispidus* (Source: DOTE 2014f)

8.4.2.3 Known species populations within the gas fields

Arthraxon hispidus is likely to occur within the gas fields and within the following GFD tenements: ATP803, PL90, PL91, PL92, PL99, PL100, PL232 and PL234 (Boobook 2015).

8.4.2.4 Habitat

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).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- 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
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (TSSC 2008n)

8.4.2.5 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).

8.4.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Arthrazon hispidus* habitat from Project activities is 346 hectares. Threats affecting this species are outlined in Section 4.0 and Appendix A Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.4.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.5 *Bertya opponens*

8.5.1 Status

Vulnerable – listed 16 July 2000

8.5.2 Biology and ecology

8.5.2.1 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 5: ***Bertya opponens*** **(Source: Wain 2011)**

8.5.2.2 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).

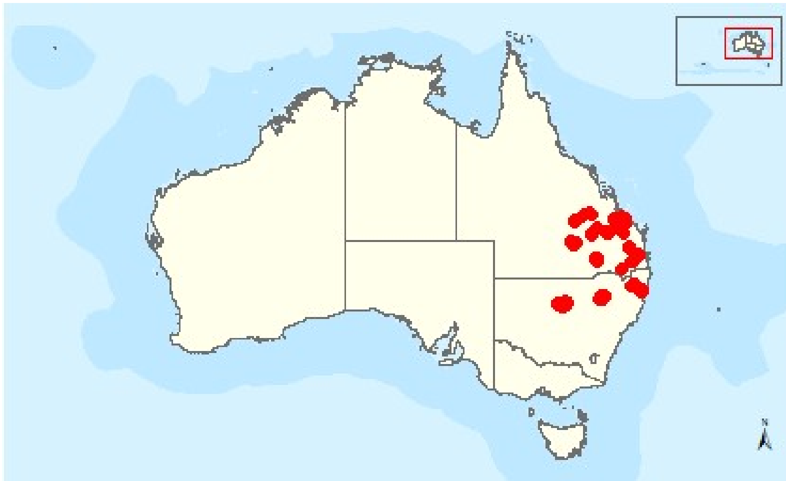

Figure 6: Mapped distribution range of *Bertya opponens* (Source: DSEWPaC 2011b)

8.5.2.3 Known species populations within the gas fields

Bertya opponens is known to occur within the gas fields and is known / predicted to occur within the following GFD tenements: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420, PL421 and PL440.

8.5.2.4 Habitat

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).

8.5.2.5 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).

8.5.3 Anticipated threats and potential impacts from the Project

Maxium disturbance to *Bertya opponens* habitat from Project activities is 478 hectares. Threats affecting this species are outlined in Section 4.0 and Appendix A

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.5.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.6 *Cadellia pentastylis*

8.6.1 Status

Vulnerable – listed 16 July 2000

8.6.2 Biology and ecology

8.6.2.1 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 6: *Cadellia pentastylis* (Source: Stark 2014)

8.6.2.2 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).

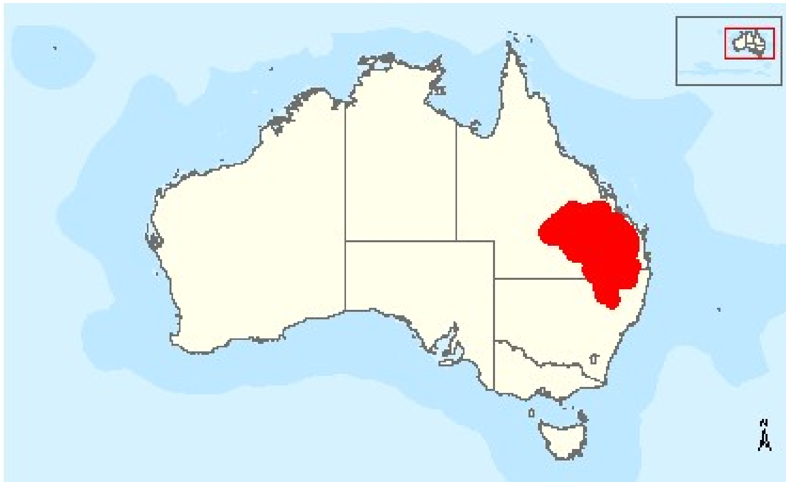

Figure 7: Mapped distribution range of *Cadellia pentastylis* (Source: DSEWPaC 2011c)

8.6.2.3 Known species populations within the gas fields

Cadellia pentastylis is known to occur within the gas fields and is known / predicted to occur within the following GFD tenements: ATP526, ATP655, ATP745, ATP803, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420, PL421 and PL440.

8.6.2.4 Habitat

Ooline 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).

8.6.2.5 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).

8.6.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Cadellia pentasylis* habitat from Project activities is 232 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.6.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.7 *Calytrix gurulmundensis*

8.7.1 Status

Vulnerable – listed 16 July 2000

8.7.2 Biology and ecology

8.7.2.1 Characteristics

Calytrix gurulmundensis is a shrub up to two metres tall, with cream to yellow star-shaped flowers that have also been recorded as white or pinkish-white (ANPS 2008; Craven 1987). The species, like many Calytrix species, has fine hairs (awns) that extend beyond the petals (ANPS 2008) and there can be up to 60 to 70 stamens in each flower. Leaves are linear and 4 to 11 mm long, 0.5 to 1 mm wide and aromatic when crushed (Craven 1987).

Plate 7: *Calytrix gurulmundensis* (Source: Clarke n.d)

8.7.2.2 Known distribution

Restricted to south-eastern Queensland, *Calytrix gurulmundensis* is known from the Gurulmundi, Guluguba and Barakula areas (QDNR 2000), north-west of Toowomba (ANPS 2008).

The extent of occurrence of *Calytrix gurulmundensis* is less than 100 km^2 (Briggs & Leigh 1996).

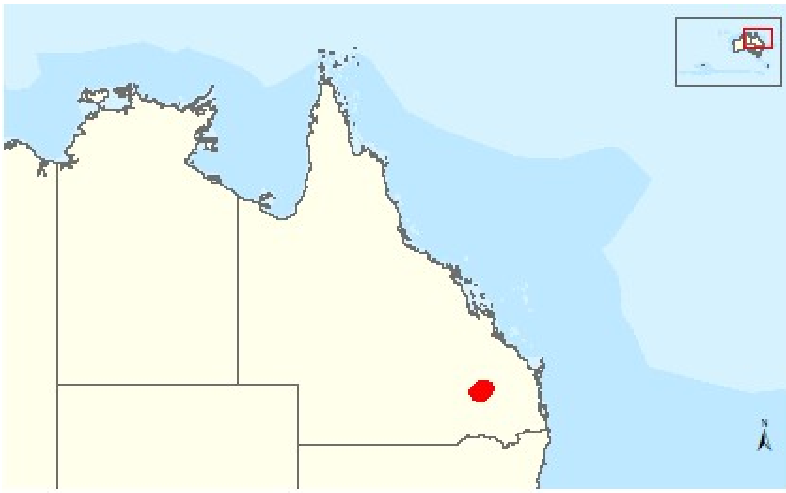

Figure 8: Mapped distribution range of *Calytrix gurulmundensis* (Source: DOTE 2014g)

8.7.2.3 Known species populations within the gas fields

Calytrix gurulmundensis is unlikely to occur within the gas fields . The species is geographically limited to an area outside of the GFD area (refer Section 9.7.2.3) (Boobook 2015).

8.7.2.4 Habitat

The species is recorded as occurring in open shrubland with sparse, stunted *Eucalyptus*, *Casuarina* and *Acacia* spp. and in *Triodia* hummock grassland with scattered shrubs (Craven 1987; QDNR 2000). The habitat at Gurulmundi State Forest is consistent with Queensland Regional Ecosystem Shrubland Community RE11.7.5 (Unidel 2009). At this site, grader activity is suggested to have moved the species along tracks so that its distribution covers an area of several square kilometres. Plants are stated to be denser in sunlit areas than in shade, suggesting the species is tolerant of disturbance but shade sensitive (Unidel 2009).

This species grows on the tops of low, heavily eroded, laterised sandstone ridges on Tertiary formations. The soils are well-drained, usually shallow and either gravelly, sandy clay or sandy in texture (QDNR 2000).

8.7.2.5 Biology and reproduction

Flowers are recorded from June to October (QDNR 2000).

8.7.3 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 115 hectares of *Calytrix gurulmundensis* habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.7.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.8 *Daviesia discolor*

8.8.1 Status

Vulnerable – listed 16 July 2000

8.8.2 Biology and ecology

8.8.2.1 Characteristics

Daviesia discolor, Family Fabaceae, is a multi-stemmed shrub to 2 m tall with hairless, angular branchlets. Phyllodes are spirally arranged, more or less sickle-shaped, tapered to both ends, 4 to 16 cm long, 4 to 11 mm wide, thin and green. Flowers are in inflorescences borne in the angles between the upper phyllodes and branchlets. Inflorescences are 3 to 8 flowered, the axis 2.5 to 10 mm long. Flowers are of a typical "pea" form with a large petal at the back (the standard), two smaller lateral petals (wings) and two inner petals fused together to form the keel. The standard is yellow with dull red markings surrounding an intense yellow spot in the centre. Wings are yellow towards the apex, dull red towards the base. The keel is pale green with a dull red tip. Pods are 7 to 8.5 mm long, 5.5 to 6 mm wide, lead grey or purple. Flowering occurs from August to October (Crisp 1991).

Plate 8: *Daviesia discolor* (Source: Hotchkiss n.d)

8.8.2.2 Known distribution

Daviesia discolor is known from three widely disjunct localities in Queensland, near Blackwater on the Blackdown Tableland, in the Mount Walsh area near Biggenden (Crisp 1991) and north of Mount Playfair within Carnarvon National Park (TSSC 2008o).

The species is conserved within Blackdown Tableland National Park (Briggs & Leigh 1996), Mount Walsh National Park (Halford 1998) and Carnarvon National Park. Surveys in the Mount Walsh area in 1997 indicated that there were two populations, at Mount Walsh National Park and State Forest 1344, with a combined total of about 17,800 plants over an area of 2.5 ha, all being mature individuals to 1.5 m tall (Halford 1998). The Mount Walsh National Park population contained approximately 90% of the total population (Halford 1998). There are no survey data available for the Blackdown Tableland area but herbarium notes indicate that the species was regarded as locally common when collected in the area in 1977, 1990 and 1997 (TSSC 2008o). No data are available on the size of the population in Carnarvon National Park. This species occurs within the Fitzroy and Burnett Mary (Queensland) Natural Resource Management Regions (TSSC 2008o).

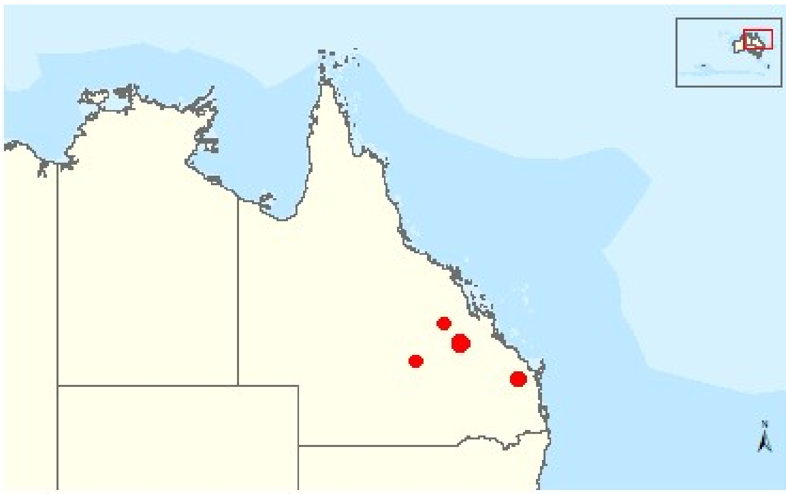

Figure 9: Mapped distribution range of *Daviesia discolor* (Source: DOTE 2014h)

8.8.2.3 Known species populations within the gas fields

Daviesia discolor is likely to occur within the gas fields. It is potentially present in suitable habitat within the following GFD tenements: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.8.2.4 Habitat

On the Blackdown Tableland, *Daviesia discolor* occurs on sandy soil derived from sandstone and on lateritic clay, at altitudes of 600 to 900 m, in open eucalypt forest dominated by species such as Blackdown stringybark (*Eucalyptus sphaerocarpa*) and Black stringybark (*Eucalyptus nigra*) (Crisp 1991). In the Mount Walsh area, *Daviesia discolor* grows in very tall open forests of Bloodwood (*Corymbia trachyphloia*) and White mahogany (*Eucalyptus acmenoides*) on hillcrests and slopes at 500 to 580 m altitude on well-drained, shallow sandy loam to sandy clays (Halford 1998). The population in Carnarvon National Park occurs on brown sandy loam of creek banks, in mixed shrubland with scattered *Triodia* sp. hummocks and *Angophora* sp. trees (TSSC 2008o).

The distribution of this species overlaps with the Brigalow (*Acacia harpophylla* dominant and co-dominant) EPBC Act-listed threatened ecological community (TSSC 2008o).

8.8.2.5 Biology and reproduction

Flowering of *Daviesia discolor* occurs from August to October and seed pods have been recorded in October (Queensland Herbarium 2012).

8.8.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Daviesia discolor* habitat from Project activities is 7 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.8.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.9 *Dichanthium queenslandicum*

8.9.1 Status

Endangered – listed 26 February 2013

8.9.2 Biology and ecology

8.9.2.1 Characteristics

Dichanthium queenslandicum (King bluegrass) is a perennial, tufted, erect grass up to 80 cm tall. Clumes rarely branched, nodes bearded (Stanley & Ross 1989). Leaf sheaths with long spreading tubercular-based hairs; ligules up to 1.5 mm long; leaf blades linear, apex attenuate, with long spreading tubercular-based hairs (Stanley & Ross 1989). Racemes soliatary, rarely paired, up to 10 cm long, rachis and pedicels with long spreading hairs; sessile spikelet 7.5 to 8.5 mm long, lower glume as long as spikelet, glabrous, scabrid on margin, upper glume as long as spikelet, glabrous (Stanley & Ross 1989).

Plate 9: *Dichanthium queenslandicum* (Source: Queensland Herbarium 2002)

8.9.2.2 Distribution

This species is endemic to Queensland where it is usually observed in black clay soils around the Darling Downs, Leichhardt and Port Curtis pastoral districts (Stanley & Ross 1989; Sharp & Simon 2002).

Dichanthium queenslandicum occurs within the South Eastern Queensland, Brigalow Belt South, Brigalow Belt North, Central Mackay Coast, Desert Uplands, Mitchell Grass Downs and Einasleigh Uplands Bioregions; and the South East Queensland, Condamine, Border Rivers Maranoa-Balonne, Burnett Mary, Fitzroy, Burdekin, Mackay Whitsunday, Southern Gulf and Desert Channels Natural Resource Management Regions (TSSC 2008t).

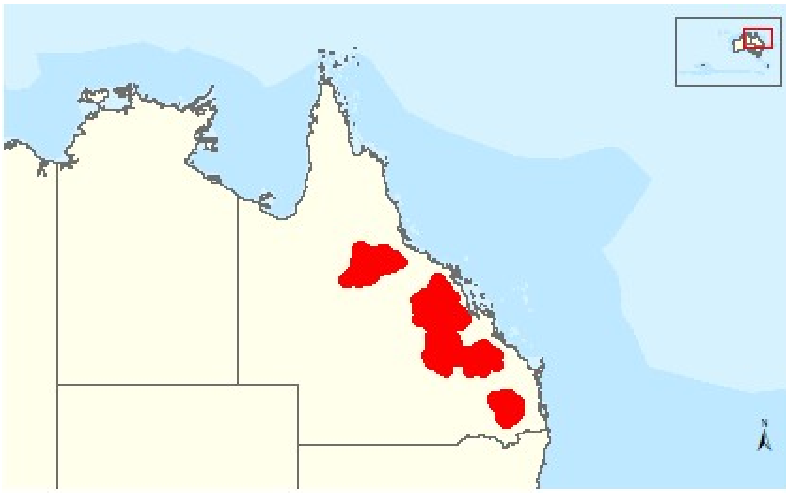

Figure 10: Mapped distribution range of *Dichanthium queenslandicum* (Source: DSEWPaC 2011e)

8.9.2.3 Known species populations within the gas fields

Dichanthium queenslandicum is known to occur within the gas fields and within ATP745 (ALA 2015). It is potentially present in suitable habitat with the following GFD tenements: ATP526 and ATP804 (Boobook 2015).

8.9.2.4 Habitat

Dichanthium queenslandicum occurs on black cracking clay in tussock grasslands mainly in association with other species of blue grasses (*Dichanthium* spp. And *Bothriochloa* spp.) but also with other grasses restricted to this soil type (Fletcher 2001; Simon 1982). *Dichanthium queenslandicum* is mostly confined to natural grassland on the heavy black clay soils (basalt downs, basalt cracking clay, open downs) on undulating plains. Other communities where *Dichanthium queenslandicum* can be found include *Acacia salicina* thickets in grassland and eucalypt woodlands (ie *Corymbia dallachiana*, *Corymbia erythrophloia*, *Eucalyptus orgadophila*) (Fensham 1999; Queensland Herbarium 2012).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Brigalow (Acacia harpophylla dominant and co-dominant)
- Weeping Myall Woodlands
- Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and southern Queensland
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (TSSC 2008t)

8.9.2.5 Biology and reproduction

Sessile spikelet is bisexual, dorsally compressed and straw-coloured to pale mauve. Pedicelled spikelets are male, straw-coloured to pale mauve (Sharp & Simon 2002).

8.9.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Dicanthium queenslandicum* habitat from Project activities is 40 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.9.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.10 *Dichanthium setosum*

8.10.1 Status

Vulnerable – listed 16 July 2000

8.10.2 Biology and ecology

8.10.2.1 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).

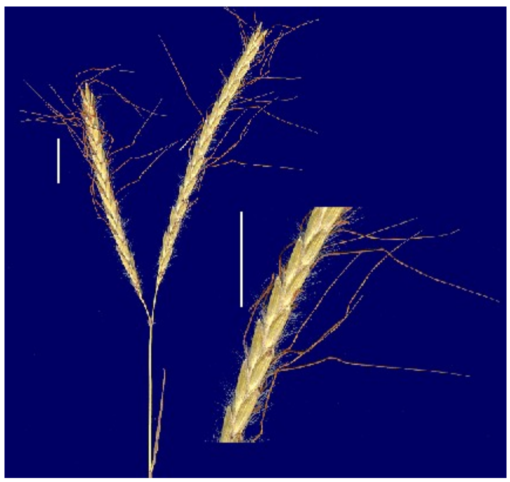

Plate 10: *Dichanthium setosum* (Source: Queensland Herbarium 2002)

8.10.2.2 Distribution

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

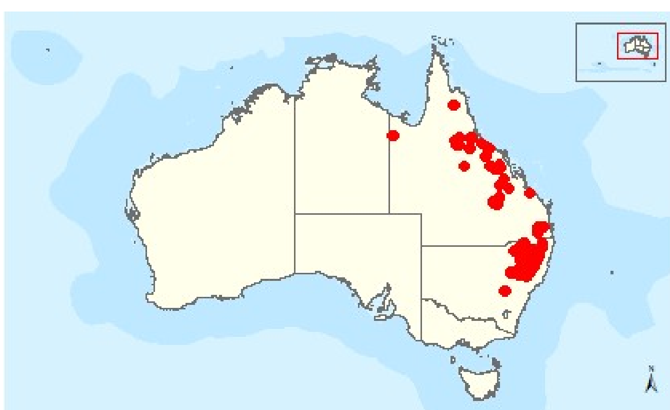

Figure 11: Mapped distribution range of *Dichanthium setosum* (Source: DSEWPaC 2011f)

8.10.2.3 Known species populations within the gas fields

Dichanthium setosum is likely to occur within the gas fields. It is potentially present in suitable habitat within the following GFD tenements: ATP526, ATP745, ATP804, PL234, PL420 and PL421 (Boobook 2015).

8.10.2.4 Habitat

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).

8.10.2.5 Biology and reproduction

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

8.10.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Dicanthium setosum* habitat from Project activities is 4 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.10.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.11 *Eucalyptus beaniana*

8.11.1 Status

Vulnerable – listed 16 July 2000

8.11.2 Biology and ecology

8.11.2.1 Characteristics

Eucalyptus beaniana, Family Myrtaceae, is a medium sized tree 14 to 22 m high. The bark is persistent on the trunk and most branches, being hard, grey to black, and longitudinally furrowed (an ironbark). Branches less than about 4 cm in diameter are smooth and white. The adult leaves are narrowly lance-shaped, 8 to 15 mm wide, somewhat pendulous, the same colour on both sides. The flowers occur in terminal clusters and flower buds are egg-shaped, 6 to 7 mm long and 2 to 3 mm wide, with stalks. The fruit is cup-shaped or funnel-shaped, 5 to 6 mm long, with 4 or 5 cavities, and the valves are at rim level or protruding (Brooker & Kleinig 2004).

Eucalyptus beaniana is closely related to *Eucalyptus taurina*, but differs by the linear juvenile leaves, the fruits with valves scarcely exerted, the narrower adult leaves and greater amount of smooth bark on the branches (TSSC 2008p).

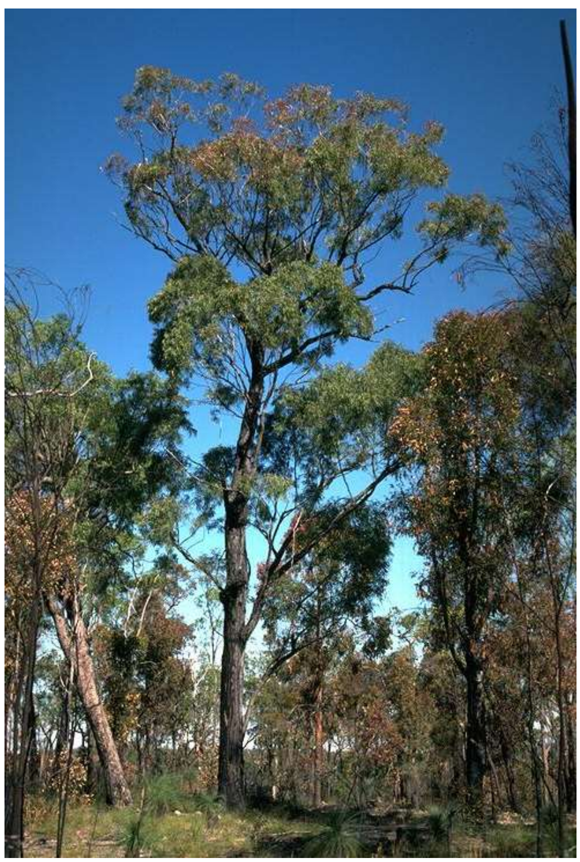

Plate 11: *Eucalyptus beaniana* (Source: Brooker & Kleinig n.d)

8.11.2.2 Known distribution

Eucalyptus beaniana is known only from two locations at Isla Gorge and north-east of Baroondah station, Queensland. The total number of plants is unknown. This species occurs within the Fitzroy (Queensland) Natural Resource Management Region (TSSC 2008p).

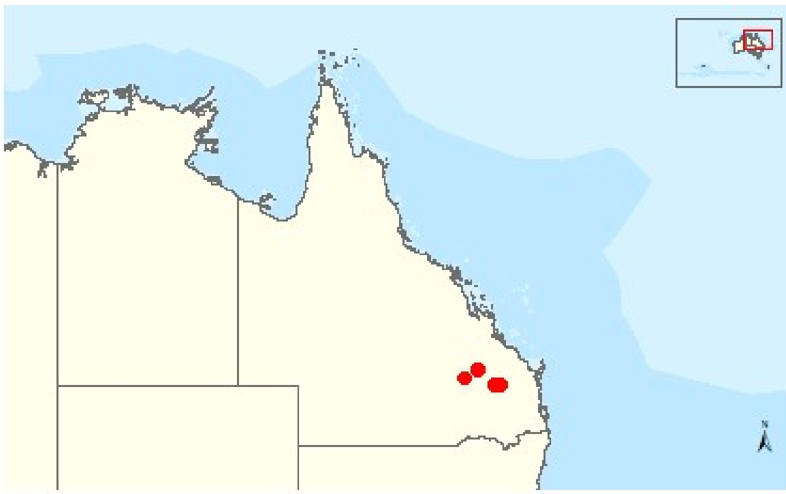

Figure 12: Mapped distribution range of *Eucalyptus beaniana* (Source: DOTE 2014i)

8.11.2.3 Known species populations within the gas fields

Eucalyptus beaniana is likely to occur in the gas fields. It is potentially present in suitable habitat in the following GFD tenements: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.11.2.4 Habitat

Eucalyptus beaniana grows in woodland with numerous other eucalypt species, on quartzose sandstone ridges. Soils are shallow and sandy (Queensland Herbarium 2008c). All populations occur in areas of remnant vegetation and are therefore currently protected from broad-scale clearing (TSSC 2008p).

The distribution of *Eucalyptus beaniana* overlaps with the following EPBC Act-listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (TSSC 2008p)

8.11.2.5 Biology and reproduction

Very little is known about the life history of *Eucalyptus beaniana*. The species flowers in September and fruits have been recorded in April, June and September to November (Queensland Herbarium 2008).

8.11.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Eucalyptus beaniana* habitat from Project activities is 243 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.11.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.12 *Homopholis belsonii*

8.12.1 Status

Vulnerable – listed 16 July 2000

8.12.2 Biology and ecology

8.12.2.1 Characteristics

Homopholis belsonii (Belson's panic) is an erect perennial grass growing up to 40 cm tall (Stanley & Ross 1989). Leaves with ligule up to 1.5 mm long; blade 2 to 4.5 mm wide, glabrous (Stanley & Ross 1989). Inflorescence not fully exserted, common axis 8 to 15 cm long; primary branches 8 to 15 cm long, with hairy axils (TSSC 2008f).

Panicles up to 25 cm long, up to 20 cm broad, with primary and secondary branching; spikelets 4.5 to 6 mm long; lower glume with sparse minute hairs, upper glume minutely hairy (Stanley & Ross 1989).

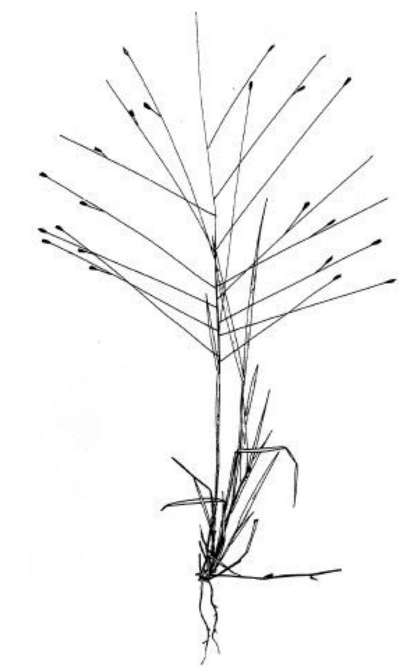

Plate 12: *Homopholis belsonii* (Source: Tropical Grassland Society of Australia Inc 1996)

8.12.2.2 Distribution

In Queensland, this species is known to occur within the southern Brigalow Belt within the Border Rivers Maranoa–Balonne and Condamine (Queensland) Natural Resource Management Regions and has been recorded as far west as the area between Miles and Roma (TSSC 2008f).

Figure 13: Mapped distribution range of *Homopholis belsonii* (Source: DSEWPaC 2011h)

8.12.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. It may potentially be present in suitable habitat in the southern GFD tenements: ATP336, ATP631, ATP868, PL3, PL6, PL8, PL9, PL11, PL176, PL309, PL315, PL317, PL320 and PL322 (Boobook 2015).

8.12.2.4 Habitat

Homopholis belsonii is usually found in dry woodland habitats at elevations ranging from 200 to 520 m altitude including rocky hills supporting White box (*Eucalyptus albens*) and in Wilga (*Geijera parviflora*) woodland; flat to gently undulating alluvial areas supporting Belah (*Casuarina cristata*) forest; soils and plant communities of Poplar box (*Eucalyptus populnea*) woodlands and shadier areas of Brigalow (*Acacia harpophylla*), Yarran (*Acacia melvillei*), and Weeping myall (*Acacia pendula*) communities; in Mountain coolibah (*Eucalyptus orgadophila*) communities; and on roadsides (TSSC 2008f). Within these habitats, the species is associated with fallen timber at the base of trees or shrubs, among branches and leaves of trees hanging to ground level or along the bottom of netting fences (TSSC 2008f).

8.12.2.5 Biology and reproduction

Homopholis belsonii is proposed to have the ability to recolonise cleared or a highly disturbed area as it has been found in regenerating vegetation along roadsides (Menkins 1998).

Flowering occurs February to May (Sharp & Simon 2002) and possibly November to December as fruiting has been recorded in February (Leigh *et al* 1984). The exact viability time for seeds is not known. However, initial trials have indicated that it germinates readily without the need for a dormancy period (Menkins 1998; Trémont & Whalley 1993). Dispersal of seed occurs when the panicle dries after seed formation and breaks off in the wind. The wind causes the panicle to migrate forward in a continuous rolling motion until an obstacle is encountered (Menkins 1998). Menkins (1998) suggests that the seed is then discarded with the further drying of the panicle.

8.12.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Homopholis belsonii* habitat from Project activities is 1937 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.12.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.13 *Homoranthus decumbens*

8.13.1 Status

Endangered – listed 26 February 2013

8.13.2 Biology and ecology

8.13.2.1 Characteristics

Homoranthus decumbens, Family Myrtaceae, is a shrub growing to 15 cm high and 2 m across. Leaves are opposite, lacking a distinct leaf stalk and are whitish-green when growing then change to reddish-brown. Flowers occur singularly in the leaf axils (Craven & Jones 1991).

H. decumbens is similar to *H. melanostictus* which also occurs in the Barakula State Forest. Both have small linear leaves and their yellow flowers are of about the same size. *H. decumbens* differs by the purplish foliage and the procumbent habit (TSSC 2013).

Plate 13: *Homoranthus decumbens* (Source: © plant.nerd 2010)

8.13.2.2 Known distribution

Homoranthus decumbens is endemic to Queensland and is confined to Barakula State Forest (Queensland Herbarium 2009). The extent of occurrence is 3 km^2 and area of occupancy is estimated to be less that 1 km^2 (Queensland Herbarium 2009). The specimen from Blackdown Tableland referred to within ALA 2015 and DotE2015 has been redetermined by DSITI (2015) as *H. brevistylis*.

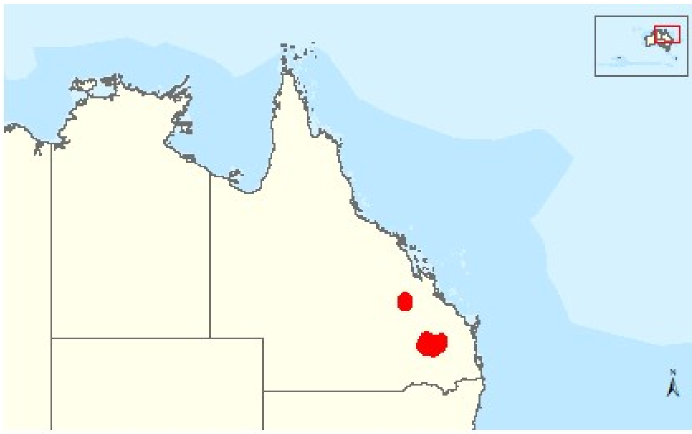

Figure 14: Mapped distribution range of *Homoranthus decumbens* (Source: DOTE 2014j)

8.13.2.3 Known species populations and their relationship within the gas fields

Homoranthus decumbens is unlikely to occur within the gas fields. Its distribution is restricted to Barakula State Forest outside of the GFD tenements (Boobook 2015).

8.13.2.4 Habitat

The species is found in tall shrubland or heath up to 800 m in altitude. It occurs on the edges of sandstone cliffs or in shallow sandy soil containing lateritic pebbles, and is often associated with species such as *Goodenia racemosa*, *Petrophile* spp. (Cone bush), *Xanthorrhoea* spp. (Grasstree) and *Banksia oblongifolia* (Dwarf banksia) (Wang 1995).

The distribution of this species is not known to overlap with any EPBC Act-listed threatened ecological community (TSSC 2013).

8.13.2.5 Biology and reproduction

Homoranthus decumbens flowers from September to December. There is no information available on its fruiting period (Wang 1995).

8.13.3 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 1051 hectares of *Homoranthus decumbens* habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this species are outlined in Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.13.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.14 *Macrozamia platyrhachis*

8.14.1 Status

Endangered – listed 16 July 2000

8.14.2 Biology and ecology

8.14.2.1 Characteristics

Macrozamia platyrhachis has mature leaves that number two to eight in the crown, are erect, or reclining with the ends ascending, 45 to 80 cm long. The leaf stalk is 9 to 13 mm wide at the top (at first leaflet). Leaflets are usually 10 to 20 mm wide, mid-green and glossy above, paler green beneath. Male cones are quadrangular in cross section, 10 to 23 cm long, 2.7 to 4.5 cm diameter and straight or slightly curved with age. Female cones are oval-shaped, 12 to 17 cm long, 8 to 9 cm wide and mid-green. Seeds are 22 to 28 mm long, 18 to 25 mm wide and red when ripe (Queensland Herbarium 2007).

Plate 14: *Macrozamia platyrhachis* (Source: Dowling n.d.)

8.14.2.2 Known distribution

Macrozamia platyrhachis has a restricted distribution in the Blackdown Tableland – Planet Downs area of the Dawson Range in central Queensland. There are also historical records from the Ceres Holding south-east of Springsure (1973) and from Spring Creek (1972), but these populations have not yet been relocated. The total area of occupancy is estimated to be less than 400 ha. It is found in at least 12 populations within a latitudinal and longitudinal range of about 40 x 40 km and is both more widespread and more common than previously thought (Whitelock 2002).

The 12 populations of *Macrozamia platyrhachis* have a projected number of individuals between 1,000 and 198,000 individuals. Adult plants may be densely distributed with a large number of individuals in close proximity to one another, or may consist of solitary individuals. All populations are considered to be viable in the long-term (Queensland Herbarium 2007).

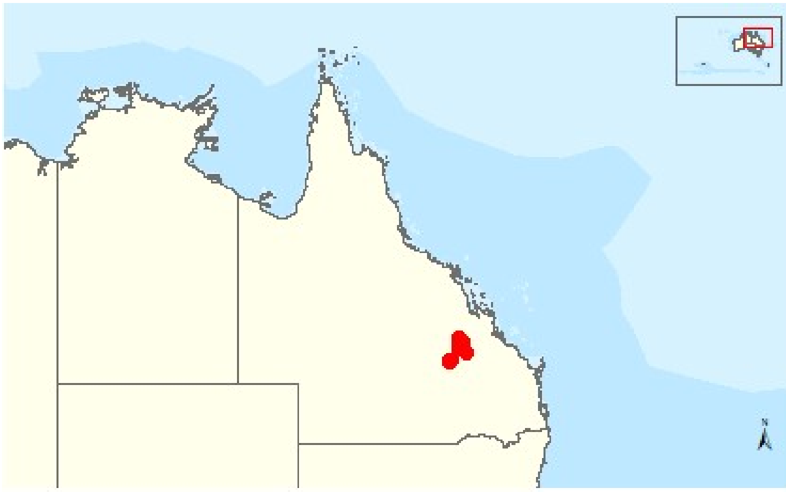

Figure 15: Mapped distribution range of *Macrozamia platyrhachis* (Source: DOTE 2014l)

8.14.2.3 Known species populations within the gas fields

Macrozamia platyrhachis is unlikely to occur within the gas fields. This species is confined to areas outside of the GFD tenements (Boobook 2015).

8.14.2.4 Habitat

Populations of *Macrozamia platyrhachis* are found in eucalypt woodland or open forest. Dominants include *Angophora leiocarpa, Corymbia bunites, Corymbia citriodora subsp. citriodora, Corymbia hendersonii, Corymbia watsoniana, Eucalyptus baileyana, Eucalyptus cloeziana, Eucalyptus crebra, Eucalyptus melanoleuca, Eucalyptus suffulgens, Lophostemon suaveolens and Lysicarpus angustifolius* on deep sandy soils derived from sandstone at altitudes between 300 and 780 m. The mid- and under-stories of the vegetation may be quite dense, but this is variable depending on fire history (Queensland Herbarium 2007).

8.14.2.5 Biology and reproduction

Macrozamia platyrhachis is unusual in being pollinated by *Cycadothrips* thrips in a mutualistic relationship, a trait shared with *Macrozamia fearnsidei* (Queensland Herbarium 2007).

Seed becomes ripe in March to April. As with all Macrozamia species, the fresh seed is not ready to germinate for another 12 months, due to the delayed fertilisation process unique to cycads (Norstog & Nicholls 1997).

Limited dispersal of ripe seeds from cycad species may occur via mammals such as possums, rodents or fruit bats. Although cycad seeds are brightly coloured, they are highly toxic and few vertebrate dispersers of seed or fruit of a similar size to cycad seed now exist in Australia (Queensland Herbarium 2007)

There is limited information on the dispersal or recruitment levels of *Macrozamia platyrhachis* (Queensland Herbarium 2007).

8.14.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Macrozamia platyrhachis* habitat from Project activities is 2496 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.14.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.15 *Phaius australis*

8.15.1 Status

Endangered – listed 16 July 2000

8.15.2 Biology and ecology

8.15.2.1 Characteristics

Phaius australis (Lesser swamp-orchid) is a terrestrial (ground dwelling) orchid and produces the largest flowers of any Australian orchid (QLD EPA & QPWS 2006). The species has four to eight large, pleated leaves and one to two spikes (flower stalks). The leaves of this orchid are long (approximately 70 cm), relatively narrow (3 to 10 cm wide) and are very similar to the other swamp-orchids (Benwell 1994). The flowers grow on the top of stalks that are 70 to 110 cm long and, unlike the other swamp orchids, are red-brown with yellow veins inside the flower (NH NSW 2006). The flowers are perfumed and are 10 to 15 cm across (QLD EPA & QPWS 2006).

Plate 15: *Phaius australis* (Source: Woodard 2010)

8.15.2.2 Known distribution

Phaius australis is endemic to Australia and occurs in southern Queensland and northern NSW. The distribution of *Phaius australis* has been tentatively described as being north from Lake Cathie (near Port Macquarie), but mainly north of the Evans Head area to the Barron River in north-east Queensland, although it is rare in the latter region (only one or two records) and the populations are now thought to be destroyed (Benwell 1994).

Most populations of *Phaius australis* are sporadically distributed between Coffs Harbour and Fraser Island. There is a large discontinuity in this species' range in central-eastern Queensland, between the Fraser Island populations and an isolated population at Byfield National Park. There is a further range disjunction between this latter population and the suspected former population in north-east Queensland (Benwell 1994).

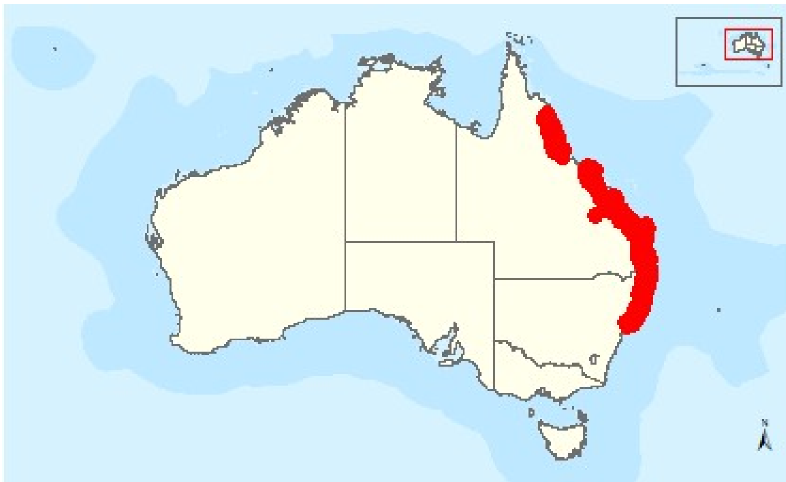

Figure 16: Mapped distribution range of *Phaius australis* (Source: DOTE 2014m)

8.15.2.3 Known species populations within the gas fields

Phaius australis is likely to occur within the gas fields. The species is potentially present in suitable habitat in the upper Dawson catchment and within the following GFD tenements: PL90, PL91, PL92, PL99, PL100, PL232 and PL234.

8.15.2.4 Habitat

Phaius australis is commonly associated with coastal wet heath/sedgeland wetlands (Barry 2005), swampy grassland or swampy forest and often where Broad-leaved paperbark or Swamp mahogany are found (NH NSW 2006; Sparshott & Bostock 1993). Typically, *Phaius australis* is restricted to the swamp-forest margins, where it occurs in swamp sclerophyll forest (Broad-leaved paperbark/Swamp mahogany/Swamp box (*Lophostemon suaveolens*)), swampy rainforest (often with sclerophyll emergents), or fringing open forest. It is often associated with rainforest elements such as Bangalow palm (*Archontophoenix cunninghamiana*) or Cabbage tree palm (*Livistona australis*) (Benwell 1994; Bishop 1996; Weston in Harden 1993).

This orchid species is relatively adaptable in its requirements for light and soil type. Soils range from acidic waterlogged peat, with a pH of 4.2 to peaty-sand, with a pH of 7.0 (Sparshott & Bostock 1993). Soil parent materials include marine aeolian sand, the most common substrate, alluvium, granite, metasediments, hailstone gravel and sandstone. Soil types on sand range from shallow peat to humus/groundwater podzol (Benwell 1994b; Bishop 1996; Harden 1993).

8.15.2.5 Biology and reproduction

Phaius australis flowers in spring (September to November) and can reproduce sexually (by pollination) (Field 2006) and asexually (by dormant buds along the flower spikes). Although vegetative reproduction is thought to occur only infrequently in the wild, it is common in cultivation (Sparshott & Bostock 1993). Most flowers of *Phaius australis* set fruit (Benwell 1994) and like most orchids, thousands of tiny seeds may be produced within each fruit (1992; Sparshott & Bostock 1993).

Information on the pollination biology of this species is limited, but it is thought that members of this genus are pollinated by bees (Benwell 1994). Other members of the genus *Phaius* have a 'rostellum', a structure that acts like a cap and prevents the male and female parts of an individual flower coming into contact, but is removed by the pollinator to enable cross-pollination. *Phaius australis* lacks this cap and it is possible that the abundant fruit set of this species is indicative of self pollination (Benwell 1994).

8.15.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Phaius australis* habitat from Project activities is 481 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.15.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.16 *Swainsona murrayana*

8.16.1 Status

Vulnerable – listed 16 July 2000

8.16.2 Biology and ecology

8.16.2.1 Characteristics

Swainsona murrayana (Slender darling pea) is a slender herb to 25 cm tall. Leaves are 5 to 10 cm long and grow on a slender stem with dense hairs (TSSC 2008h). It has pink or purple flowers and produces leathery elliptical seed pods 20 to 65 mm long (TSSC 2008h).

Plate 16: *Swainsona murrayana* (Source: Knight 2005)

8.16.2.2 Distribution

In Queensland the species is known from near Surat in the Border Rivers Maranoa-Balonne catchment (TSSC 2008h).

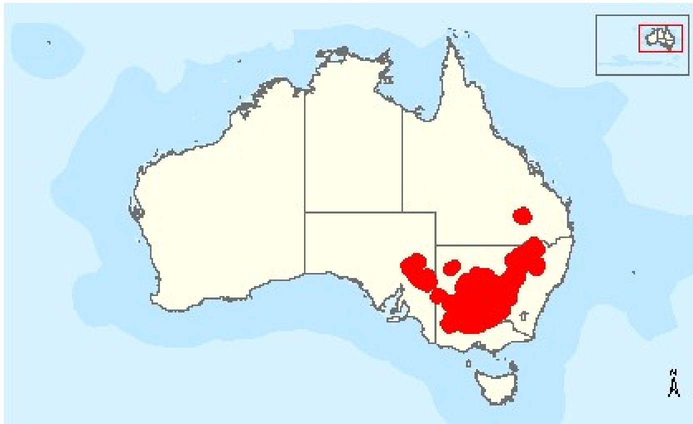

Figure 17: Mapped distribution range of *Swainsona murrayana* (Source: DSEWPaC 2011j)

8.16.2.3 Known species populations within the gas fields

Swainsona murrayana is unlikely to occur in the gas fields. The species is only known in Queensland from one specimen collected outh of Surat and outside of the GFD tenements.

8.16.2.4 Habitat

Swainsona murrayana is found in grassland, herbland, and open Black-box woodland, often in depressions. This species grows in heavy grey or brown clay, loam, or red cracking clays. It is often associated with low Chenopod shrubs (*Maireana* spp.), Wallaby-grass (*Austrodanthonia* spp), and Spear grass (*Austrostipa* spp). The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (TSSC 2008h).

8.16.2.5 Biology and reproduction

Swainsona murrayana has pink or purple flowers, which appear between spring and early summer. It produces leathery elliptical seed pods 20 to 65 mm long (TSSC 2008h).

8.16.3 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 40 hectares of *Swainsona murrayana* habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats to this species are outlined in Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.16.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.17 *Thesium australe*

8.17.1 Status

Vulnerable – listed 16 July 2000

8.17.2 Biology and ecology

8.17.2.1 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 17: *Thesium australe* (Source: Office of Environment and Heritage n.d.)

8.17.2.2 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).

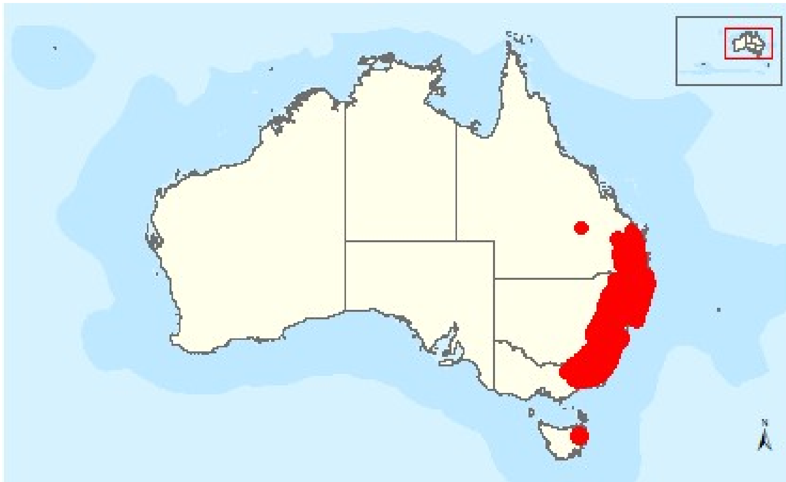

Figure 18: Mapped distribution range of *Thesium australe* (Source: DOTE 2014n)

8.17.2.3 Known species populations and their relationship within the gas fields

Thesium australe is likely to occur within the gas fields. It is potentially present in suitable habitat within the following GFD tenements: ATP526, ATP745, ATP804, PL234, PL420 and PL421.

8.17.2.4 Habitat

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).

8.17.2.5 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).

8.17.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Thesium australe* habitat from Project activities is 1659 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.17.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.18 *Tylophora linearis*

8.18.1 Status

Endangered – listed 16 July 2000

8.18.2 Biology and ecology

8.18.2.1 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 18: *Tylophora linearis* (Source: © Carr n.d.)

8.18.2.2 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).

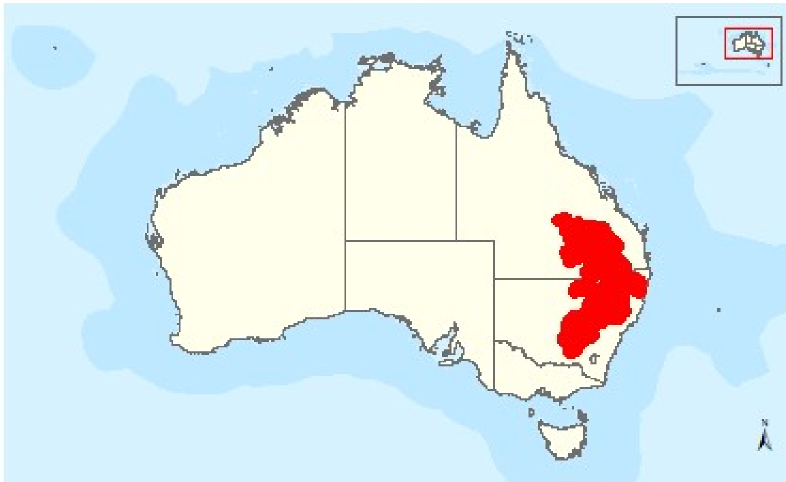

Figure 19: Mapped distribution range of *Tylophora linearis* (Source: DOTE 2014o)

8.18.2.3 Known species populations and their relationship within the gas fields

Tylophora linearis is unlikely to occur within the gas fields. Th species is only known in Queensland from one record near Glenmogan and outside of the GFD tenements (Boobook 2015).

8.18.2.4 Habitat

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).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

8.18.2.5 Biology and reproduction

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

8.18.3 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 975 hectares of *Tylophora linearis* habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this are outlined in Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan the EPBC offsets policy.

8.18.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.19 *Westringia parvifolia*

8.19.1 Status

Vulnerable – listed 16 July 2000

8.19.2 Biology and ecology

8.19.2.1 Characteristics

Westringia parvifolia is a small 'twiggy' shrub that grows to approximately one metre in height, and has tiny oval shaped leaves 1.5 to 3 mm long, with slightly recurved margins. Leaves are arranged along the stem in groups of three forming a ring (whorl) at each node. Flowers are pale purple to white with reddish spots and occur in the upper leaf axils, forming a terminal leafy head of three to seven flowers. Young shoots and flowers are covered with small, white hairs pressed closely to the surface and the branchlets are often hexagonal (Boivin 1949; Galbraith 1977; White & Francis 1921).

8.19.2.2 Known distribution

Westringia parvifolia is known from four collections near Yelarbon, Inglewood and Goondiwindi in south-east Queensland and from near Yetman in northern New South Wales (BRI n.d.; The Royal Botanic Gardens and Domain Trust 2011). The distribution range is approximately 80 km (BRI n.d.; White & Francis 1921).

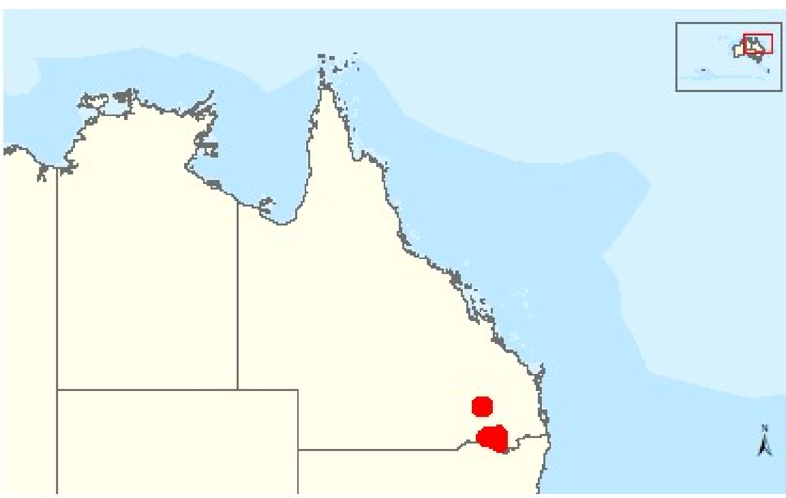

Figure 20: Mapped distribution range of *Westringia parvifolia* (Source: DOTE 2014p)

8.19.2.3 Known species populations within the gas fields

Westringia parvifolia is unlikely to occur within the gas fields. The specis is confined to the souther Darling Downs area of Queensland and outside of the GFD tenements (Boobook 2015).

8.19.2.4 Habitat

Westringia parvifolia grows with Baker's mallee (*Eucalyptus bakeri*) and Green mallee (*Eucalyptus viridis*) and between clumps of Spinifex (*Triodia* sp.) on sandy and stony soils (BRI n.d.; White & Francis 1921).

8.19.2.5 Biology and reproduction

Flowering has been recorded in September and November (BRI n.d.).

8.19.3 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 263 hectares of *Westringia parvifolia* habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this species are outlined in Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.19.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.20 *Xerothamnella herbacea*

8.20.1 Status

Endangered – listed 16 July 2000

8.20.2 Biology and ecology

8.20.2.1 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 19: *Xerothamnella herbacea* (Source: Queensland Herbarium 2007)

8.20.2.2 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).

This distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities (TSSC 2008i):

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- White box-Yellow box-Blakely's red gum Grassy Woodland and Derived Native Grassland

In November 2011, *Xerothamnella herbacea* was identified at the Santos GLNG GTP ROW 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.

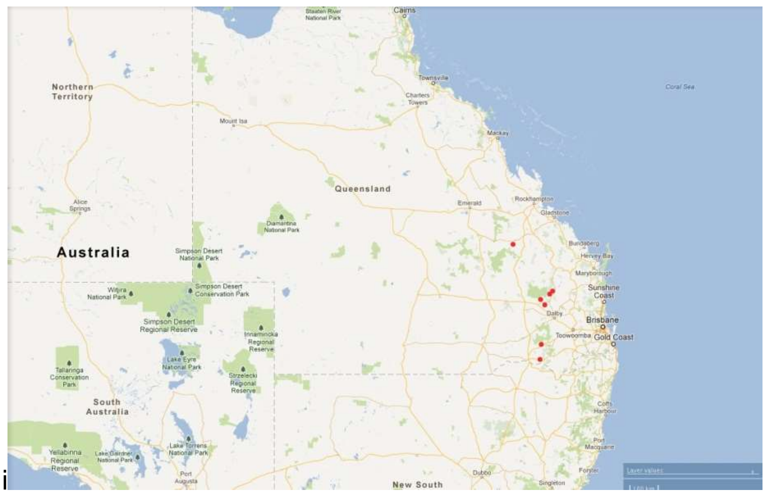

Figure 21: Mapped distribution range of *Xerothamnella herbacea* (Source: Atlas of Living Australia 2012)

<u>8.20.2.3 Known species populations within the gas fields</u>

Xerothamnella herbacea is known to occur within the gas fields, being recorded from the southern end of the Arcadia Valley. The species is potentially present in suitable habitat in the norther GFD tenements: ATP526, AT745, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420, PL421 and PL440.

<u>8.20.2.4 Habitat</u>

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).

8.20.2.5 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).

8.20.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Xerothamnella herbacea* habitat from Project activities is 129 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.20.4 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.21 *Eriocaulon carsonii*

8.21.1 Status

Endangered – listed 16 July 2000

8.21.2 Biology and ecology

8.21.2.1 Characteristics

Eriocaulon carsonii (Salt pipewort) is a hairless, perennial, aquatic herb that has a circular cluster of leaves at its base and clustered flowers (DEHP 2011a). *Eriocaulon carsonii* usually forms mat-like colonies and can vary in appearance. For example, smaller plants (up to 10 cm tall) with hairless flower heads are found in western Queensland, while larger plants (up to 50 cm tall) with hairy flower heads occur in southern, eastern and northern Queensland (DEHP 2014).

Flowers are tiny (3 to 4 mm in diameter) and white in colour. Fruit are a membranous, swollen, three celled capsule (NPWS 2002b).

Plate 20: *Eriocaulon carsonii* (Source: DEHP n.d)

8.21.2.2 Distribution

Eriocaulon carsonii is an aquatic plant only found on permanent, spring-fed wetlands with a groundwater source from the Great Artesian Basin. Populations generally occur on relatively flat landscapes in Queensland, New South Wales and South Australia. In Queensland *Eriocaulon carsonii* is known from 12 spring complexes (group of springs on similar landforms located no more than 6 km apart) (DEHP 2014). With the exception of two populations in the Einasleigh Uplands region of north Queensland, the Great Artesian Basin sustains the wetlands which support this species (DEHP 2014).

Spring wetlands in the Great Artesian Basin have been well surveyed and there is a high level of certainty that no further complexes containing *Eriocaulon carsonii* will be found (DEHP 2014). Two populations are known to have become extinct as a consequence of Great Artesian Basin springs becoming inactive; one of these is in southern Queensland and is in the largest spring of the Eulo region (Wiggera Springs) (Fensham & Fairfax 2003).

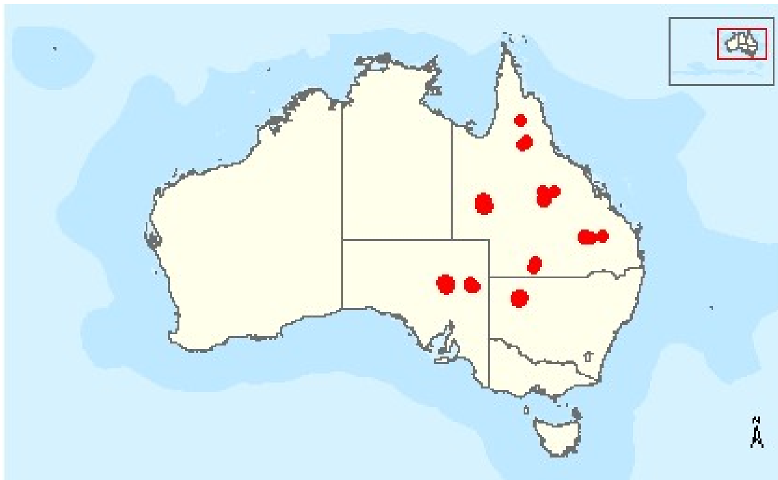

Figure 22: Mapped distribution range of *Eriocaulon carsonii* (Source: DSEWPaC 2011k)

8.21.2.3 Known species populations within the gas fields

Eriocaulon carsonii is known to occur within the gas fields, within the Fairivew area. It is potentially present in the following GFD tenements: PL99.

8.21.2.4 Habitat

Eriocaulon carsonii is entirely restricted to flowing mound springs. Such springs occur on all margins of the Great Artesian Basin (Ponder 1986). The springs lie on faults, which provide direct access for the artesian water to reach the surface. Accumulated evaporite and mud deposits at the springs form mounds from 1 to 10 m high and 2 to greater than 100 m diameter. *Eriocaulon carsonii* is generally associated with vegetated mounds that, over considerable time, have formed organic fen soils. Fen soils are the alkaline equivalent to the acidic peat bog. The species appears to prefer areas of shallow standing water with slow flow (Fatchen & Fatchen 1993). Populations are generally found at the tail of the spring or above the vent of slow flowing springs (NPWS 2002b).

8.21.2.5 Biology and reproduction

Flowers are tiny (3 to 4 mm in diameter) and white in colour, with female flowers forming first, followed by the male flowers. Flowering is known to occur between summer and late autumn. Fruit are a membranous, swollen, three celled capsule (NPWS 2002b).

8.21.3 Anticipated threats and potential impacts from the Project

Maximum disturbance to *Eriocaulon carsonii* habitat from Project activities is 2330 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Policy and the EPBC offsets policy.

8.21.4 Management measures and methods

Management measures for this species are outlined in Section 5.0.

8.22 Boggomoss snail

8.22.1 Status

Critically Endangered – listed 2 June 2003

8.22.2 Biology and ecology

8.22.2.1 Characteristics

The helicoid shell of the Boggomoss snail (*Adclarkia dawsonensis*) is light brown, becoming greenish-yellow towards the apex, with a white lip. It is thin and semi-transparent, with an average diameter of about 2.3 cm, and is made up of five 1/8 to five 5/8 whorls. The shell is 1.5 cm high with a slightly elevated spire and a very small central depression. The animal itself is light brown to white, with the amount of grey around the neck, on the sides of the foot and above the tail differing between specimens. Black blotches on the lung roof are visible through the shell (DSEWPaC 2011l). The species may potentially be confused with several other species of camaenid land snails.

Plate 21: Boggomoss snail (*Adclarkia dawsonensis*) (Source: White 2006)

8.22.2.2 Known distribution

The Boggomoss snail is found in the greater Taroom area of south-eastern Queensland. It occurs in the Dawson Valley, north-east of Taroom, on the Dawson River. There are two main subpopulations of the snail. One subpopulation is found in boggomoss (artesian spring) habitat on private property on the Dawson River near Taroom. The other population occurs on a camping and water reserve between Tarooma and Theodore, at the Isla-Delusion crossing of the Dawson River (DSEWPaC 2011l). Several small populations have also been discovered in the greater Taroom area in recent years.

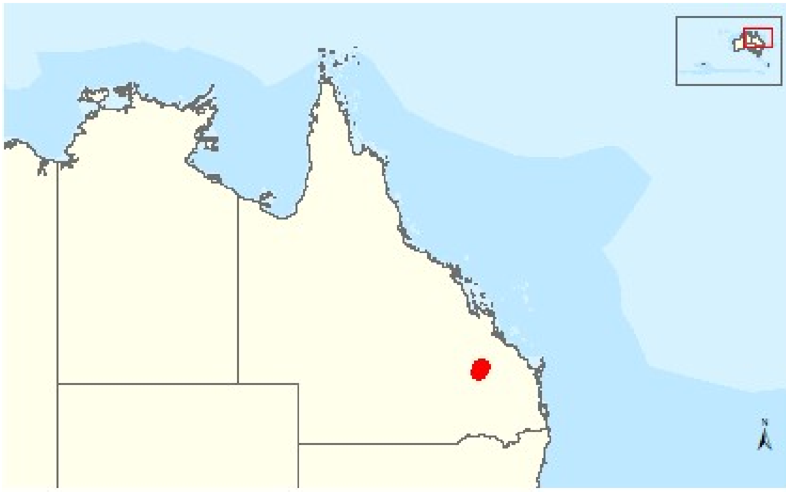

Figure 23: Mapped distribution range of Boggomoss snail (Source: DSEWPaC 2011l)

<u>8.22.2.3 Known species populations within the gas fields</u>

This species is unlikely to occur within the gas fields. Potentially suitable habitat is present in ATP803, however this area is outside of the known distrubtion of the species (Boobook 2015).

<u>8.22.2.4 Biology and reproduction</u>

It is assumed that, like many other snails, the Boggomoss snail feeds on decaying plant matter, bacteria and fungi (Clarke & Spier-Ashcroft 2003).

The life history of the Boggomoss snail is unknown. Stanisic (2008) suggests that the species may have a similar lifespan (10 to 20 years) to that of other land snails in arid northern Australia. The Boggomoss snail is known to aestivate (hibernate) in very dry periods. It is a free sealer, hibernating in the litter or soil under logs and sealing the opening of the shell with a calcified mucous covering (Stanisic 2008).

8.22.3 Habitat

Based on knowledge of the species' current distribution in the Taroom area, the Boggomoss snail prefers grassy eucalypt woodlands on alluvial flats along drainage lines. This species typically occurs on Gilgai black soils within Eucalypt and Brigalow communities.

Essential microhabitat for the Boggomoss snail includes intact drainage lines where populations are known or highly likely to occur. This species is dependent upon an intact overstorey, which retains sufficient moisture for the snails to survive. This species is also expected to occur in non-remnant areas adjoining watercourses where there are suitable microhabitat features including fallen logs, leaf litter and other cover (Stanisic 2008). Essential microhabitat requirements for the Boggomoss snail are a well-developed leaf litter layer for food, shelter (eg logs, fallen bark) and breeding sites, and a good coverage of vegetation to support the leaf litter environment and maintain a moist microclimate (Stanisic 2008).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is found in moister riparian (riverside) and boggomoss habitats on alluvial flats (DSEWPaC 2011l). As such, areas mapped as 'riverine', 'lacustrine' and pulstrine' Wetland Regional Ecosystems as well as 'riverine', lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping

(Version 3.0) are considered habitat for this species in ATP803 and where they possess the following microhabitat features:

- Dense leaf litter (> 50%)
- Hollow logs
- Coarse woody debris (non-hollow logs and large pieces of bark)

8.22.4 Anticipated threats and potential impacts from the Project

Direct impacts to this species from gas field development will be limited, given the gas fields are outside the species known distribution. Suitable habitat is present within the Project area and therefore some disturbance to habitat may be necessary for project activiites.

Area of disturbance to Boggomoss snail habitat will be recorded.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where an unavoidable disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.22.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.23 Australasian bittern

8.23.1 Status

Endangered – listed 3 March 2011

8.23.2 Biology and ecology

8.23.2.1 Characteristics

The Australasian bittern (*Botaurus poiciloptilus*) is a large, stocky, thick-necked heron-like bird with camouflage-like plumage growing to a length of 66 to 76 cm, with a wingspan of 1,050 to 1,180 cm. The male weighs 1,400 g and the female weighs 900 g (Marchant & Higgins 1990). The upperparts are brown and dark brown to black, mottled buff in complex patterns that aid the bird's concealment in swamp vegetation; the underparts are streaked and scalloped brown and buff. The bird has a prominent black-brown stripe running down the side of the neck, the eyebrow is pale, and the chin and upper throat are white. The bill is straight and pointed, straw yellow to buff in colour, with a dark grey culmen (dorsal ridge of the bill); the legs and feet are pale green to olive; and the iris orange-brown or yellow (Marchant & Higgins 1990; Pizzey & Knight 1997; DOTE 2014r). Dark and pale variants of the plumage have been observed in adults, but the variations are not understood. The sexes appear similar, but females are smaller (Marchant & Higgins 1990). Juveniles are generally paler than adults (Marchant & Higgins 1990; Pizzey & Knight 1997), with heavier buff flecking on the back; adults and juveniles are probably not separable in the field (Marchant & Higgins 1990).

Plate 22: Australasian bittern (*Botaurus poiciloptilus*) (Source: Turner 2008)

8.23.2.2 Known distribution

The Australasian bittern occurs from south-east Queensland to south-east South Australia, Tasmania and in the southwest of Western Australia (Marchant & Higgins 1990).

In Queensland, the bittern occurs in the far south-east; it has been reported north to Baralaba and west to Wyandra, although in most years it is probably confined to a few coastal swamps (Marchant & Higgins

1990; DOTE 2014r). Today, it is rarely recorded in Queensland, and possibly survives only in protected areas such as the Cooloola and Fraser regions (DOTE 2014r).

The extent of occurrence is stable at an estimated 1,000,000 km^2 (DOTE 2014r). The estimate is considered to be of high reliability.

The estimated area of occupancy is 1,200 km^2 but is considered to be of low reliability (Garnett & Crowley 2000). Documented data shows that the area of occupancy is decreasing (Garnett & Crowley 2000).

The Australian population of the Australasian bittern is estimated at 2,500 breeding birds. This estimate is considered to be of low reliability (Garnett & Crowley 2000).

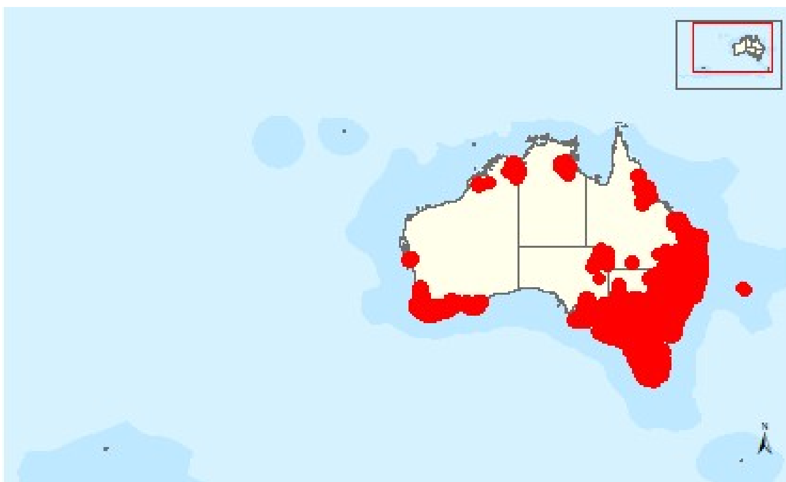

Figure 24: Mapped distribution range of Australasian bittern (Source: DOTE 2014r)

8.23.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. It is usually associated with densely vegetation wetlands and most likely to be present on major watercourses wehre suitable wetlands are present within the GFD area. Suitable habitat may be present in the following GFD tenements: ATP631, ATP708, ATP803, ATP868, PL3, PL6, PL8, PL9, PL91, PL92, PL99, PL100, PL232, PL315 and PL322.

8.23.2.4 Biology and reproduction

The Australasian bittern feeds mostly on animals taken from or around pools and waterways. It forages in still shallow water up to 0.3 m in depth, often at the water's edge, or from platforms or mats of flattened vegetation over deeper water (Heather & Robertson 2000; Marchant & Higgins 1990).

In Australia, the bittern has been recorded feeding on freshwater crayfish, fish (including goldfish), weevils, snakes, leaves and fruit (Marchant & Higgins 1990), and frogs and tadpoles are also likely to be eaten (DOTE 2014r).

Little information is available on the breeding biology of the Australasian bittern. It breeds in single solitary pairs, but sometimes several nests may be placed quite close together. In Australia, breeding is said to occur from October to February (Marchant & Higgins 1990).

The nest is a well-constructed saucer of flat pieces of reeds or rushes that are laid across one another; it measures about 35 to 40 cm across and 20 to 22 cm thick, and may be sheltered above by stems of the surrounding vegetation. The eggs are oval, smooth and glossy, and pure olive in colour; they measure 49.0 to 53.8 mm (Marchant & Higgins 1990). Clutch-size is usually four or five, but can range from three to six (Marchant & Higgins 1990; Serventy & Whittell 1976).

8.23.3 Habitat

The Australasian bittern occurs mainly in densely vegetated freshwater wetlands and, rarely, in estuaries or tidal wetlands (Marchant & Higgins 1990).

In Australia, this species occurs in terrestrial wetlands and, rarely, estuarine habitats, mainly in the temperate southeast and southwest. It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (eg *Phragmites*, *Cyperus*, *Eleocharis*, *Juncus*, *Typha*, *Baumea*, *Bolboschoenus*) or Cutting grass (*Gahnia*) growing over muddy or peaty substrate (Marchant & Higgins 1990).

Knowledge of the breeding ecology of the Australasian bittern is poor. Available data indicate that the bittern breeds in relatively deep, densely vegetated freshwater swamps and pools, building its nests in deep cover over shallow water (Marchant & Higgins 1990). In rushland, it may avoid breeding in the densest areas (Marchant & Higgins 1990); alternatively, this may simply reflect the accessibility of the few nests that have been found (DOTE 2014r). If population density is high, it may resort to open wetlands for nesting, eg in stunted Acacia swamps (Marchant & Higgins 1990).

The bittern appears to be capable of moving between habitats as suitability changes. It can occur in high densities in temporary or infrequently filled wetlands during exceptionally wet years, and will also use ephemeral wetlands when irrupting from drying floods (Garnett 1992).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is most often associated with freshwater terrestrial wetlands (DOTE 2014r). As such, areas mapped as ‘riverine’, ‘lacustrine’ and pulstrine’ Wetland Regional Ecosystems as well as ‘lacustrine’ and ‘pulstrine’ waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered habitat for this species along with some anthropogenic permanent water sources (such as large farm dams)

8.23.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Australasian Bittern habitat from Project activities is 168 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.23.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.24 Red goshawk

8.24.1 Status

Vulnerable – listed 16 July 2000

8.24.2 Biology and ecology

8.24.2.1 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 23: Red goshawk (Source: Baker-Gabb 2008)

8.24.2.2 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).

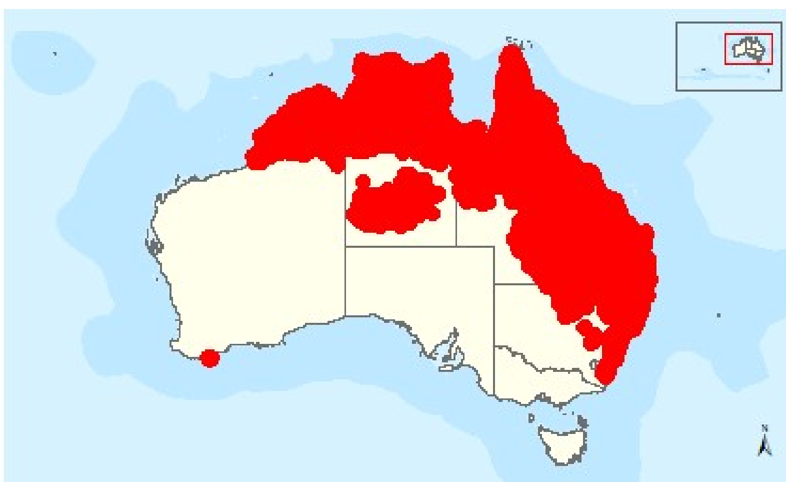

Figure 25: Mapped distribution range of Red goshawk (Source: DSEWPaC 2011m)

8.24.2.3 Known species populations within the gas fields

The Red goshawk is likely to occur within the gas fields. The GFD tenements tha coupld upport the species include those featureing forested uplands of the Fitzroy and Dawson River catchments: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.24.2.4 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).

8.24.3 Habitat

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).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of any regional ecosystem except natural grassland regional ecosystems that contain any of the following microhabitat features:
  - Tall trees present (> 18m)
  - Rivers with large deep pools and abundant rock or woody habitat features
  - Myrtaceae dominated canopy

8.24.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Red Goshawk habitat from Project activities is 2425 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where an unavoidable disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.24.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.25 Squatter pigeon – southern subspecies

8.25.1 Status

Vulnerable - listed 16 July 2000

8.25.2 Biology and ecology

8.25.2.1 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 24: Squatter pigeon (southern) (Source: Dreis 2010)

8.25.2.2 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).

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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).

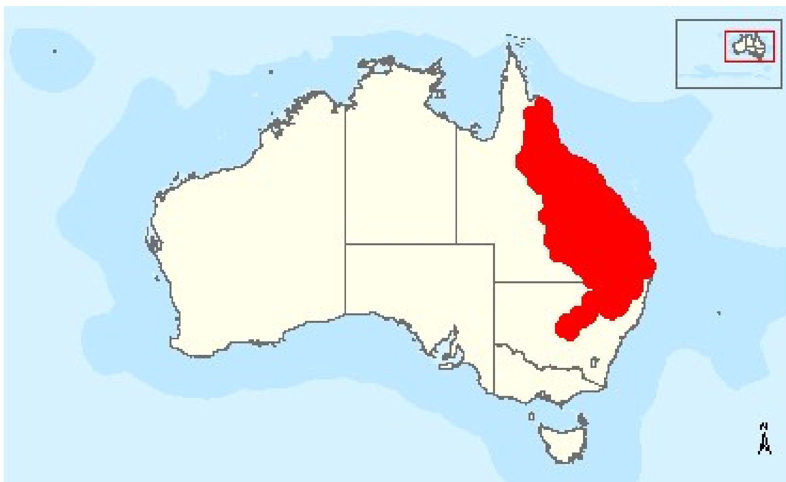

Figure 26: Mapped distribution range of Squatter pigeon (southern) (Source: DSEWPaC 2011n)

8.25.2.3 Known species populations within the gas fields

Squatter pigeons (southern) are known to occur within the gas fields. Although the GFD project area is within the known historical range of the species, the Squatter Pigeon has undergone a contraction in range which includes southern and eastern tenements. It is not considered to currently occur south of a line closely approximating the location of the Roma-Taroom road. Suitable habitat is potentially present within the following GFD tenements: ATP526, ATP655, ATP745, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420, PL421 and PL440.

8.25.2.4 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).

8.25.3 Habitat

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 relaible water sources during the dry season or during droughts (Squatter Pigeon Workshop 2011).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of all regional ecosystems except those that are SEVT within 3km of a significant water source.

8.25.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Squatter Pigeon habitat from Project activities is 4032 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.25.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.26 Swift parrot

8.26.1 Status

Marine and Endangered – listed 16 July 2000

8.26.2 Biology and ecology

8.26.2.1 Characteristics

The Swift parrot (*Lathamus discolor*) is mostly bright green in colour, with dark-blue patches on the crown, a prominent red face, and the chin and throat are narrowly bordered with yellow. It is approximately 25 cm in length, the wingspan is 32 to 36 cm and it weighs about 65g. It is a slim, medium-sized parrot with angular pointed wings and a slender tail giving it the characteristic streamlined flight-silhouette (Higgins 1999).

This species is sometimes confused with lorikeets, most likely when seen flying overhead. In this situation the Swift Parrot is then best distinguished by calls, all of which are quite different from the harsh screeching or buzzing calls of lorikeets, and also by its slimmer build and distinctly longer finely pointed tail. No lorikeet has the combination of red underwing-coverts and undertail-coverts seen in the adult male Swift Parrot (Higgins 1999).

The Swift parrot can be distinguished from the Musk lorikeet (*Glossopsitta concinna*) by its red (compared with green) underwing-coverts. It can be distinguished from the Scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*) by the uniformly yellow-green breast and belly, less red on underwing-coverts and (when present) shorter creamy underwing-bar and red undertail-coverts (scaly-breasted always has scaly, yellow markings over underbody, long pink-orange underwing-bar extending farther out onto primaries, and green undertail-coverts) (Higgins 1999).

Plate 25: Swift parrot (*Lathamus discolor*) (Source: Harrison 2010)

8.26.2.2 Known distribution

This species breeds in Tasmania during spring and summer, dispersing widely across south-eastern Australia during winter. The principal wintering grounds are the inland slopes of the Great Dividing Range and along the eastern coastal plains (Kennedy & Overs 2001; Kennedy & Tzaros 2005; Saunders 2002).

Recent records from southern Queensland have come from the Gold Coast, Noosa, Toowoomba, Warwick and Lockyer Valley areas and the species is rarely recorded outside these regions (Swift Parrot Recovery Team 2001).

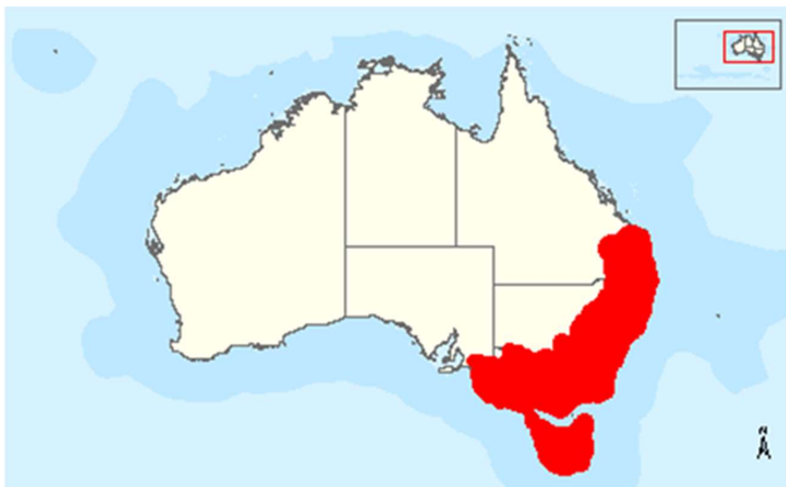

Figure 27: Mapped distribution range of Swift parrot (Source: DOTE 2014s)

8.26.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. The species is migratory and is now rarely recorded beyond the south-eastern corner of Queensland. There are no published records of the species being within the GFD tenements (Boobook 2015).

8.26.2.4 Biology and reproduction

The Swift parrot feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. It is a mostly arboreal forager, foraging mainly in eucalypts, but occasionally coming to the ground to feed on seeds, fallen flowers, fruit and lerp, and to drink (Higgins 1999; Mallick *et al* 2004; Swift Parrot Recovery Team 2001).

During the non-breeding season this species feeds extensively on nectar and lerp and other items from eucalypt foliage. Swamp mahogany (*Eucalyptus robusta*), Spotted gum (*Corymbia maculata*), Coastal grey box (*Eucalyptus moluccana*) and Red bloodwood (*Corymbia gummifera*) are important nectar sources in coastal parts of the non-breeding range. Forest red gum (*Eucalyptus tereticornis*) and Yellow box (*Eucalyptus melliodora*) are used in northern New South Wales and south-eastern Queensland (Saunders & Heinsohn 2008; Swift Parrot Recovery Team 2001). Over large parts of their box-ironbark winter range, they also consume both developed and undeveloped racemes of Golden wattle (*Acacia pycnantha*) (Cheers & Cheers 2005; Kennedy & Tzaros 2005; Mac Nally & Horrocks 2000).

The species does not breed on mainland Australia (Swift Parrot Recovery Team 2001).

8.26.3 Habitat

The Swift parrot inhabits dry sclerophyll eucalypt forests and woodlands. It occasionally occurs in wet sclerophyll forests (Higgins 1999; Swift Parrot Recovery Team 2001). Saunders and Heinsohn (2008) observed that the Swift Parrot predominantly forages within habitats that have been so significantly cleared that they are classified as endangered ecological communities.

The Swift parrot migrates from its Tasmanian breeding grounds to overwinter in the box-ironbark forests and woodlands of Victoria, New South Wales and southern Queensland (DOTE 2014s).

In northern New South Wales and south-eastern Queensland, Narrow-leaved red ironbark (*Eucalyptus crebra*), Forest red gum forests and Yellow box forest are commonly utilised (Kennedy & Tzaros 2005; Swift Parrot Recovery Team 2001). While on the western slopes Mugga ironbark (*Eucalyptus sideroxylon*) and Grey box (*Eucalyptus microcarpa*) woodlands are used (Saunders & Heinsohn 2008).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is most often associated with Narrow-leaved red ironbark (*Eucalyptus crebra*), Forest red gum forests and Yellow box forest in south-eastern Queensland (Kennedy & Tzaros 2005; Swift Parrot Recovery Team 2001)
- Species is associated with Mugga ironbark (*Eucalyptus sideroxylon*) and Grey box (*Eucalyptus microcarpa*) woodlands on the western slopes (Saunders & Heinsohn 2008)

8.26.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 1987 hectares of Swift Parrot habitat. However, direct impacts to this species from gas field development will be negligible, as the gas fields are outside the species known geographical distribution.

Threats affecting this species are outlined in Appendix A.

8.26.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.27 Star finch

8.27.1 Status

Endangered – listed 16 July 2000

8.27.2 Biology and ecology

8.27.2.1 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 26: Star finch (*Neochmia ruficauda ruficauda*) (Source: Harrison n.d)

8.27.2.2 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).

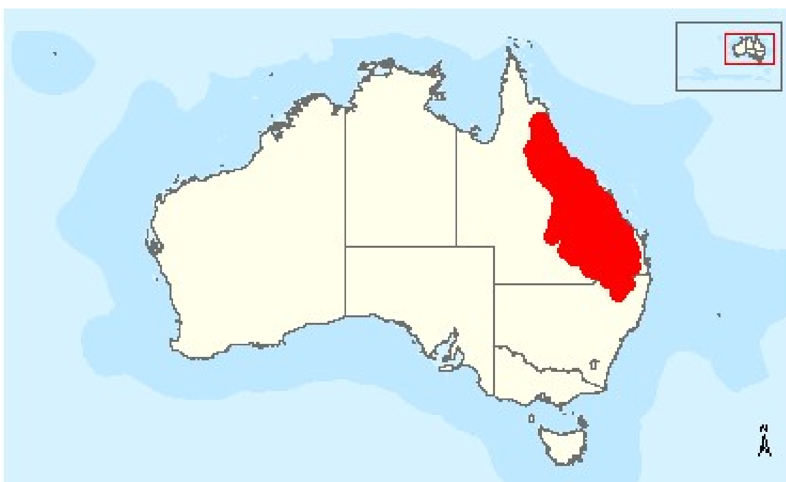

Figure 28: Mapped distribution range of Star finch (Source: DOTE 2014t)

8.27.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. The range of this species has contracted markedly and it may now be extinct. It is considered no longer extant in the GFD tenements (Boobook 2015).

8.27.2.4 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).

8.27.3 Habitat

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

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water (DOTE 2014t). As such, ‘non-remnant’ areas within 1 km of areas mapped as ‘riverine’, ‘lacustrine’ and pulstrine’ Wetland Regional Ecosystems as well as ‘riverine’, lacustrine’ and ‘pulstrine’ waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered habitat for this species
- Area that the species utilised are dominated by trees that are typically associated with permanent water or areas that are regularly inundated; the most common associated dominant vegetation species are *Eucalyptus coolabah, Eucalyptus tereticornis, Corymbia tessellaris, Melaleuca leucadendra, Eucalyptus camaldulensis* and *Casuarina cunninghamii* (Holmes 1996)

8.27.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 3244 hectares of Star Finch habitat. However, direct impacts to this species from gas field development will be negligible. The species is no longer considered extant within the gas fields.

Threats affecting this species are outlined in Appendix A.

8.27.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.28 Plains-wanderer

8.28.1 Status

Endangered – listed 16 July 2000

8.28.2 Biology and ecology

8.28.2.1 Characteristics

The Plains-wanderer (*Pedionomus torquatus*) is a small, quail-like bird that, when fully grown, measures 15 to 19 cm in length, has a wing-span of 28 to 36 cm, and has a mass of 40 to 80 g in males and 55 to 95 g in females (Marchant & Higgins 1993).

In adult plumage, the sexes differ in appearance. The males are light brown or buff above, with white streaks and blackish scallops and vermiculations, and spots and streaks on the head and neck. They are mostly buff to orange-buff below, with blackish crescents, spots and streaks, but have a white and unmarked belly. They have a cream-coloured iris, a cream to pale yellow bill that has a dusky to dark-brown culmen (ie dorsal surface), and cream to pale yellow legs and feet (Marchant & Higgins 1993). The females have a broad black collar around the neck, with white streaks and spots, and a broad rufous patch on the upper breast. The females are also more brightly coloured than the males, and tend to be more yellow on the bill, iris, legs and feet, especially during the breeding season when the bill and legs can become orange-yellow (Marchant & Higgins 1993).

Juveniles are similar in appearance to adult males, but can be distinguished by the dark-brown spots on the breast, flanks and undertail coverts (in the adults, this area is marked with blackish crescents). They cannot be distinguished from the adult males after their post-juvenile moult is completed (Marchant & Higgins 1993).

Plate 27: Plains-wanderer (*Pedionomus torquatus*) (Source: Bishop n.d)

8.28.2.2 Known distribution

The Plains-wanderer occurs at scattered sites in Queensland, New South Wales, Victoria and South Australia. The primary 'stronghold' of the species is the Riverina region of south-western NSW (Baker-Gabb *et al* 1990; Bennett 1983).

In Queensland, more than 80% of records have been made in the channel country in the far west of the state (Baker-Gabb 2002; Bennett 1983). These records are concentrated in the northern reaches of Astrebla Downs National Park (which was formerly part of Davenport Downs Station), the southern reaches of Diamantina Lakes National Park, and on Sandringham Station (Baker-Gabb 2002). There have been scattered records of the species in native grasslands extending east and south-west from this region (Baker-Gabb 1990; Bennett 1983) and it is possible that these areas may harbour some important sites that have not yet been discovered (Baker-Gabb 2002).

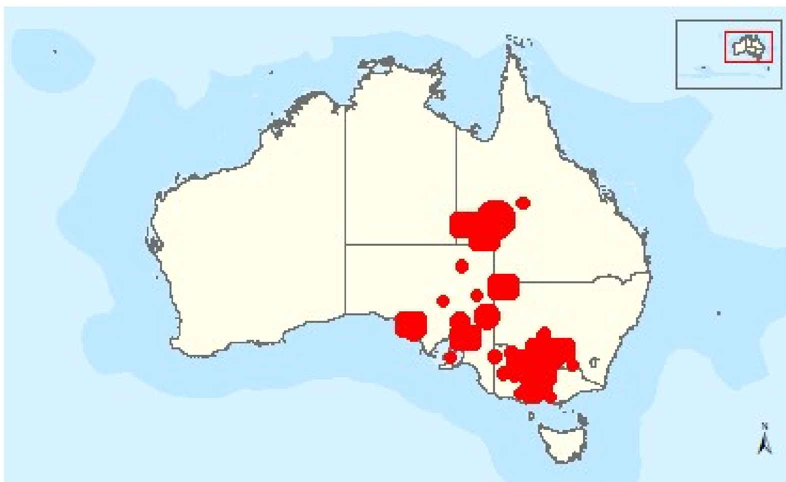

Figure 29: Mapped distribution range of Plains-wanderer (Source: DOTE 2014u)

8.28.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. Any record of this species in eastern Queensland may not be reliable and at best would represent vagrants. Suitable habitat is not present within the GFD tenements (Boobook 2015).

8.28.2.4 Biology and reproduction

The Plains-wanderer feeds on a mixture of seeds, invertebrates and leaves. Seeds are taken from grasses (including species of *Austrotipa*, *Sporobilis*, *Panicum*, *Austrodanthonia*, *Vulpia* and *Eragrostis*), chenopods (including species of *Atriplex*, *Maireana*, *Chenopodium* and *Sclerolaena*) and other plants (such as species of *Asperula*, *Galium*, *Spergularia*, *Carthamus* and *Euphorbia*). The invertebrate food consists of insects (including beetles, ants, bugs, caterpillars and locusts) and spiders (Baker-Gabb 1988; Bennett 1983).

The Plains-wanderer is capable of breeding in its first year and it breeds in solitary pairs (Baker-Gabb *et al* 1990; Crome & Rushton 1975; Ridley 1986).

Breeding has been recorded in most months of the year. The nest is a hollow or 'scrape' that is scratched into the ground and lined with grass. In some instances nearby grasses may be pulled over the nest to form a concealing cone or tent. The nests are placed amongst native grasses and herbs, or sometimes amongst crops (DOTE 2014u).

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Clutch-size is usually four, but can range from two to five (Bennett 1983). The male does most of the incubation during the 23 day incubation period (Baker-Gabb *et al* 1990; Bennett 1983; Ridley 1986). The young are attended by the male (Baker-Gabb *et al* 1990), and perhaps sometimes by the female (Marchant & Higgins 1993), and become independent at about two months of age (DOTE 2014u).

8.28.3 Habitat

The Plains-wanderer inhabits sparse, treeless, lowland native grasslands with approximately 50% bare ground, most vegetation less than 5 cm in height, with some widely-spaced plants up to 30 cm high (DOTE 2014u; Garnett *et al* 2011; Harrington *et al* 1988).

These sparse native grasslands usually occur on hard, red-brown clay soils that do not support dense pasture growth under any conditions. The (approximately) 50% cover typically consist of 40% grasses and herbs, and 10% organic litter. The majority of the vegetation is less than 5 cm tall, but larger plants, mostly up to 30 cm tall and generally spaced 10 to 20 cm apart, are important because they provide shelter from predators. The grasslands can support a variety of ephemeral and perennial species of grasses and herbs. However, the composition of plant species in grasslands occupied by the Plains-wanderer is very similar to that found in dense native grasslands that are not occupied by the Plains-wanderer, which suggests that the structure of the grassland is more important than the species composition in determining its suitability for the Plains-wanderer (Baker-Gabb 2002; Harrington *et al* 1988; Llewellyn 1975, DOTE 2014u).

The Plains-wanderer occasionally occurs in other types of habitat: it has been recorded in the stubble, and amongst low crops, of cereal grasses (Bennett 1983; Llewellyn 1975; Souter 1938; Sutton 1927) and in chenopod shrublands (Harrington *et al* 1988).

The Plains-wanderer is known to actively avoid areas of dense grass or other vegetation (Radford *et al* 2013).

The Plains-wanderer is not known to associate with any other listed threatened species of fauna. However, it does often occur in areas that support threatened species of grassland plants, such as the Red darling-pea (*Swainsona plagiotropus*) and Slender darling-pea (*Swainsona murrayana*), both of which are listed as Vulnerable under the EPBC Act 1999 (DOTE 2014u).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs mainly in sparse, treeless, lowland native grasslands with approximately 50% bare ground, most vegetation less than 5 cm in height, with some widely-spaced plants up to 30 cm high
- This species occasionally occurs in the stubble, and amongst low crops, of cereal grasses and in chenopod shrublands (DOTE 2014u)

8.28.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 278 hectares of Plains Wanderer habitat. However, direct impacts to this species from gas field development will be negligible. Suitable habitat is not considered present in the project area.

Threats affecting this species are outlined in Appendix A.

8.28.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.29 Superb parrot

8.29.1 Status

Vulnerable – listed 16 July 2000

8.29.2 Biology and ecology

8.29.2.1 Characteristics

The Superb parrot (*Polytelis swainsonii*) is a medium-sized (length: 40 cm; weight: 130 to 160 g) parrot with bright green plumage and a long tail. The males and females are dimorphic. Males are generally bright green, though slightly paler and yellowish below, with a blueish wash on the crown and nape, a bright-yellow face and bright red band across the throat, slightly darker green tail, and a blue leading edge to the upperwing. The bill is brownish red, the eyes red; and the legs and feet are grey. Females are paler than males, being generally dull green with a blueish-green wash to the face, grading to greyish green on the upper throat, a pale pinkish patch on the lower throat, and a dull yellow-green underbody with pink-red thighs. The bill is brownish red, the eyes crimson and the legs and feet grey. Juveniles are generally similar to adult females except without any blueish wash to the face or pink wash to the throat (Higgins 1999).

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Plate 28: Superb parrot (*Polytelis swainsonii*) (Source: Palmer 2012)

8.29.2.2 Known distribution

The Superb parrot occurs only in south-eastern Australia. The Superb Parrot is found in New South Wales and northern Victoria, where it occurs on the inland slopes of the Great Divide and on adjacent plains, especially along the major river-systems; vagrants have also been recorded in southern Queensland (DOTE 2014v).

The extent of occurrence of the Superb parrot is estimated, with high reliability, to be 81,000 km² (Garnett & Crowley 2000).

The area of occupancy of the Superb parrot is estimated at 1,000 km². However, this estimate is considered to be of low reliability (Garnett & Crowley 2000).

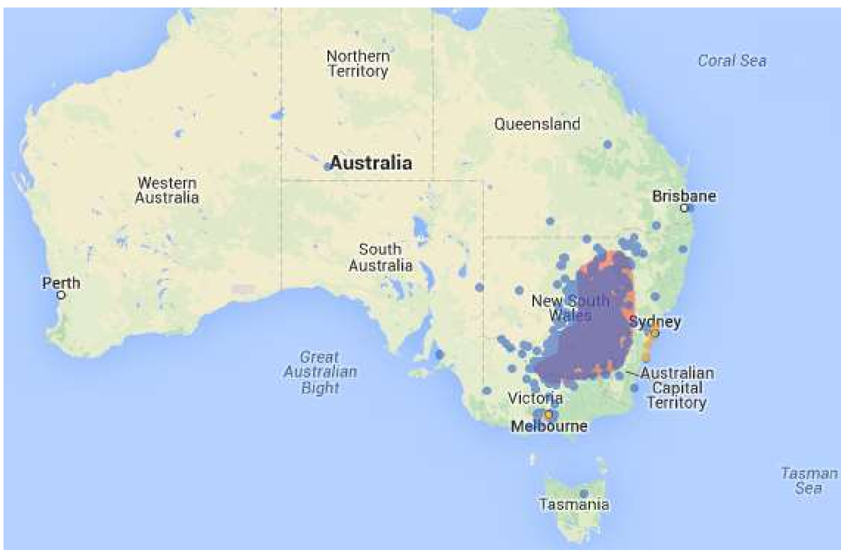

Figure 30: Mapped distribution range of the Supurb parrot (Source: Atlas of Living Australia 2014)

8.29.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. It very rarely visits Queensland during winter. There are no published records within the GFD tenements (Boobook 2015).

8.29.2.4 Biology and reproduction

The Superb parrot forages on many different species of plants, most of which occur in woodlands dominated by gum and box eucalypts, and, in some areas, in woodlands dominated by Boree, native pine (*Callitris*) or box-native pine associations (Higgins 1999; Webster 1988). When foraging on the ground, Superb parrots often eat the seeds of plants such as the native Ringed wallaby-grass (*Danthonia caespitosa*), barley-grasses (*Critesion*), as well as cereal crops including wheat, oats and canola (*Brassica napus*); and spilt grain (Christie 2004; Webster 1988; Webster & Ahern 1992). They also eat the seed-pods of many understorey species of wattles such as Gold-dust wattle (*Acacia acinacea*), Silver wattle (*Acacia dealbata*) and Deane's wattle (*Acacia deanei*) and cultivated Cootamundra wattle (*Acacia baileyana*) (Christie 2004; Webster 1988, 1991). When foraging in the forest canopy, Superb parrots eat the flowers and fruits of eucalypts, especially in spring and summer

(Christie 2004; Frith & Calaby 1953; Webster 1988), the berries of mistletoe, such as Box mistletoe (*Amyema miquelii*) and Grey mistletoe (*Amyema quandang*) (Webster 1998), and, in winter, lerps from the foliage of eucalypts (Webster 1998).

There is no information on the age of sexual maturity of wild Superb parrots, but captive birds usually first breed successfully when two to three years old (DOTE 2014v).

The Superb parrot breeds between September and January. Between four and six white eggs are laid on a bed of decayed wood in a hollow branch or a hole in the trunk of a large tree, usually a eucalypt, especially in River red gums and Blakely's red gum, but also other species including Yellow box, Grey box, Apple box, White box, Inland red box and Red box (DOTE 2014v). Nest sites are always within 10 km of areas of suitable foraging habitat (Webster 1988). Nest trees are usually near a watercourse, and may be living and healthy, or dead trees (Webster 1988, 1998). Incubation of the eggs is by the female only. In captivity, the incubation period lasts 22 days (West 1957).

8.29.3 Habitat

The Superb parrot mainly inhabits forests and woodlands dominated by eucalypts, especially River red gums (*Eucalyptus camaldulensis*) and box eucalypts such as Yellow box (*Eucalyptus melliodora*) or Grey box (*Eucalyptus microcarpa*). The species also seasonally occurs in box-pine (*Callitris*) and Boree (*Acacia pendula*) woodlands (Webster 1998).

The Superb parrot uses a number of habitats for different activities. Superb parrots breed in either River red gum forests and woodlands or box woodlands (Webster 1998).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- This species occurs in forests and woodlands dominated by eucalypts, especially River red gums (*Eucalyptus camaldulensis*) and box eucalypts such as Yellow box (*Eucalyptus melliodora*) or Grey box (*Eucalyptus microcarpa*) (Webster 1998)
- This species also seasonally occurs in box-pine (*Callitris*) and Boree (*Acacia pendula*) woodlands (Webster 1998)

8.29.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 2136 hectares of Superb Parrot habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this species are outlined in Appendix A.

8.29.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.30 Black-throated finch

8.30.1 Status

Endangered – listed 14 February 2005

8.30.2 Biology and ecology

8.30.2.1 Characteristics

At the species level, the Black-throated finch (southern) (*Poephila cincta cincta*) is a sleek but thickset grass-finch, which measures approximately 12 cm in length, and weighs approximately 15 g (DOTE 2014w). It has a grey head and neck, with a short black loral stripe, and a conspicuous, large black 'bib' over the chin, throat and upper breast. The bill is short, thick, conical and coloured black. The eye is a dark reddish-brown. The breast, back, and most of the belly, is brown. The wings are a darker shade of brown, and when folded have a narrow white stripe along the leading edge. The rump and the tail, which is short and rather rounded or square-tipped, are both black. The lower underbody is white, but with a black patch on the rear flanks. The legs and feet are a bright pinkish-red. Juveniles appear very similar to adults, but with duller colouring (Higgins *et al* 2006).

The subspecies can be distinguished primarily by the colouring of the upper-tail coverts; these are white in the southern subspecies, black in the northern subspecies, and of intermediate colour in hybrid birds (Ford 1986; Higgins *et al* 2006; Keast 1958; Zann 1976). The brown plumage of the body is also said to be richer in the southern subspecies than in the northern subspecies (BTF Recovery Team 2004; Schodde & Mason 1999).

Plate 29: Black-throated finch (*Poephila cincta cincta*) (Source: Williamson 2009)

8.30.2.2 Known distribution

The Black-throated finch (southern) occurs in the Townsville region, where it is considered to be locally common at a few sites around Townsville and Charters Towers (BTF Recovery Team 2004; Garnett & Crowley 2000); and at scattered sites in central-eastern Queensland (BTF Recovery Team 2004).

The Black-throated finch (southern) historically occurred from far south-eastern Queensland, near the Queensland-New South Wales border, through eastern Queensland north to the divide between the Burdekin and Lynd Rivers (Blakers *et al* 1984; Schodde & Mason 1999). The subspecies is now extinct at most sites south of Burdekin River, and is confined to a very few remaining 'pockets' of suitable habitat (DOTE 2014w).

There have been very few records of the subspecies south of 23° S since the late 1970s, and there have been almost no records from this region since 1995 (Barrett *et al* 2003; Blakers *et al* 1984; BTF Recovery Team 2004). Black-throated finches (southern) were recorded from the Severn River, near Ballandean in southern Queensland, in the early 1980s and mid-1990s (BTF Recovery Team 2004) and there is a single record from Stanthorp, near Brisbane in 2002 (BTF recovery Team 2008).

No reliable estimates of the size of the Black-throated finch (southern) population are available. The population has been estimated at 20,000 breeding birds (based on area of occupancy and available data on densities of populations), but this estimate is considered to be of low reliability (Garnett & Crowley 2000).

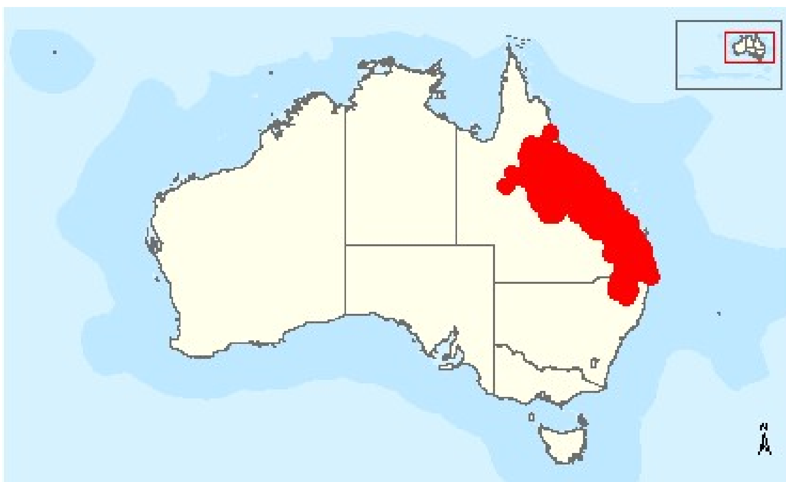

Figure 31: Mapped distribution range of the Black-throated finch (Source: DOTE 2014w)

8.30.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. The range of this species has contracted markedly northward and is no longer considered extant in the GFD tenements (Boobook 2015).

8.30.2.4 Biology and reproduction

Black-throated finches (southern) feed on the seeds of grasses (such as *Urochloa mosambicensis*, *Digitaria ciliaris*, *Melinis repens*, *Chloris inflata*) and herbaceous plants (Mitchell 1996; NRA 2005).

At the species level, Black-throated finches feed mainly on the half-ripe seeds of grasses (for example, *Dactyloctenium*, *Digitaria*, *Eremochloa*, *Paspalidium*, *Setaria*), and less often on the seeds of other plants (for example *Stylosanthes*). They also eat insects (for example termites) and their larvae, especially during the wet (breeding) season (BTF Recovery Team 2004; DOTE 2014w).

Breeding can occur throughout the year under optimal conditions and varies throughout its range (Mitchell 1996; Higgins *et al* 2006; NRA 2007). In the Townsville area, breeding typically occurs during the wet season, usually between February and May (Mitchell 1996; Higgins *et al* 2006; NRA 2007). In other parts of their range, eggs are laid mainly from August to December, but clutches have also been recorded in March, April and July (DOTE 2014w). Five or six white eggs are usually laid, however, clutch-size is reported to range from three to nine (Campbell 1974; Mitchell 1996; North 1901-14).

Both sexes of the subspecies participate in the construction of the nest, the incubation of the clutch, and in the feeding and brooding of the young (NRA 2005; Zann 1976).

Black-throated finches (southern) breed in colonies, mainly in non-remnant native vegetation associated with solodic soils and alluvial plains (NRA 2005), with the dispersion of nests within colonies varying. A single tree may contain up to three nesting pairs or, alternatively, individual nests may be separated by distances of up to 50 m (NRA 2005).

The nests are often built in a hollow branch of a tree, or in a fork of a tree, shrub or sapling. However, it is not uncommon for nests to be placed in other sites, such as in tall grass, amongst mistletoe, beneath active raptor nests, or in an old nest of a Babbler (*Pomatostomus* spp.) or Diamond firetail (*Stagonopleura guttata*) (Baldwin 1976; Campbell 1974; North 1901-14; NRA 2005; Roberts 1955). Nest sites tend to be located in close proximity to water.

The nests are oval in shape and have a spout-like entrance (an arrangement also described as 'bottle-shaped'). They are usually composed of grass (Campbell 1974; North 1901-14). In addition to their breeding nests, Black-throated finches (southern) also build non-breeding nests that are used for roosting during the non-breeding and (sometimes) breeding periods (NRA 2005).

8.30.3 Habitat

The Black-throated finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands or other habitats (for example freshwater wetlands), often along or near watercourses, or in the vicinity of water (Baldwin 1976; Britton & Britton 2000; BTF Recovery Team 2004; Ley & Cook 2001; NRA 2005; Wieneke 1989). Almost all recent records of the finch from south of the tropics have been in riparian habitat (Baldwin 1976; BTF Recovery Team 2004; Ley & Cook 2001). The subspecies is thought to require a mosaic of different habitats in which it can find seed during the wet season (Mitchell 1996).

Some of the more common species of eucalypts in woodlands and forests frequented by the subspecies include Narrow-leaved ironbark (*Eucalyptus crebra*), River red gum (*Eucalyptus camaldulensis*), Silver-leaved ironbark (*Eucalyptus melanophloia*), Reid river box (*Eucalyptus brownii*), Yellow jacket (*Eucalyptus similis*) and Forest red gum (*Eucalyptus tereticornis*). The subspecies occasionally occurs in *Melaleuca* woodlands, or in grasslands comprised of genera such as *Astrebla*, *Dichanthium* or *Panicum* (BTF Recovery Team 2004).

In south-eastern Queensland, it was formerly recorded in open forest on ridges, on grassy hillsides, and on 'mountain flats' (Lord 1956). Recent studies conducted further north (near Townsville) have recorded the Black-throated finch (southern) in both modified and relatively intact vegetation communities (Mitchell 1996; NRA 2005).

The Black-throated finch (southern) has occasionally been recorded in other habitats, including in freshwater wetlands (BTF Recovery Plan 2004), in cultivation surrounded by woodland (Hall 1974) and in a heavily grazed paddock (Ley & Cook 2001). It is likely that permanent sources of water (and the habitat surrounding these) provide refuge for Black-throated finches (southern) during the dry season, especially during drought years (NRA 2007).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The Black-throated finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands (DOTE 2014w)
- It is usually found within a few kilometres of fresh water (Curtis *et al* 2012). As such, areas mapped as ‘riverine’ ‘lacustrine’ and pulstrine’ Wetland Regional Ecosystems are considered habitat for this species

8.30.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 2745 hectares of Black-throated finch habitat. However, direct impacts to this species from gas field development will be negligible – the species is no longer considered extant in the gas fields.

Threats affecting this species are outlined in Appendix A.

8.30.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.31 Australian painted snipe

8.31.1 Status

Endangered – listed 15 May 2013

Marine and Migratory (CAMBA)

8.31.2 Biology and ecology

8.31.2.1 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 30: Australian painted snipe (Source: Aviceda 2002a)

8.31.2.2 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).

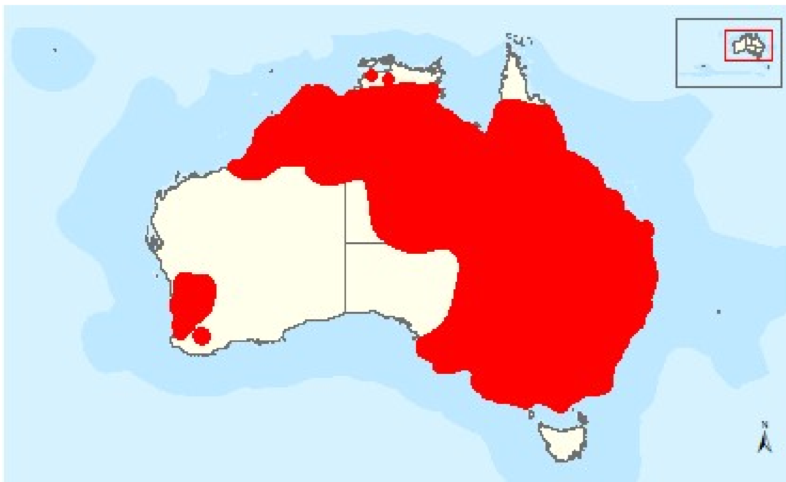

Figure 32: Mapped distribution range of Australian painted snipe (Source: DSEWPaC 2011o)

8.31.2.3 Known species populations within the gas fields

This species is known to occur within the gas fields, and has been recorded within the Roma gas fields. The following list of GFD tenements may possess suitable habitat to support the species atleast periodically: ATP336R, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.31.2.4 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).

8.31.3 Habitat

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).

The Australian painted snipe is not known to associate with any other species or subspecies of fauna or flora that is listed as threatened under the EPBC Act (DSEWPaC 2011o).

The following general habitat assumption has been made based on current scientific knowledge of this species:

- Habitat is comprised of woodlands / open forest associated with riparian zones and floodplains that contain the following microhabitat features:
  - Rivers with large deep pools and abundant rock or woody habitat features;
  - Rivers with large deep pools interconnected by riffles; or
  - Swamps, gilgai and other ephemeral wetlands.

8.31.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Australian Painted Snipe habitat from Project activities is 168 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.31.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.32 Black-breasted button-quail

8.32.1 Status

Vulnerable – listed 16 July 2000

8.32.2 Biology and ecology

8.32.2.1 Characteristics

The Black-breasted button-quail is a large, plump, pale-eyed button-quail. It is similar in size to the Painted button-quail. The male Black-breasted button-quails are about 18 cm long, with a wingspan of 32 to 35 cm, and weighing 65 g. The females are larger, weighing approximately 100 g. The sexes differ in plumage. No seasonal variation in plumage occurs in this species. Males have finely patterned backs and wings with brown, black, grey and white mottling. The face and throat are whitish and the breast is black with numerous white half-moon markings (DSEWPaC 2011p). The female is similar to the male in regards to colouration and patterning, except for the presence of a black face and throat, a larger dark area over the upper and lower breast and heavier white half-moon markings on the upper and lower breast. The bill is grey and the legs are pale yellow. Juveniles resemble males in colouration, but are duller (Marchant & Higgins 1993).

Black-breasted button-quail are commonly seen in pairs or occasionally in small groups. Being territorial, females are occasionally seen singly (Hughes & Hughes 1991; Marchant & Higgins 1993).

Plate 31: Black-breasted button-quail (Source: Hogan 1996)

8.32.2.2 Known distribution

The Black-breasted button-quail is endemic to eastern Australia. It is restricted to coastal and near-coastal regions of south-eastern Queensland and north-eastern New South Wales. The main populations occur within south-east Queensland (DSEWPaC 2011p).

Present-day known distribution in Queensland extends from near Byfield in the north, south to the New South Wales border and westwards to Palm Grove National Park and Barakula State Forest (Marchant & Higgins 1993, DSEWPaC 2011p). The most significant populations appear to be in the Yarraman-Nanango, Jimna-Conondale and Great Sandy regions (Bennett 1985; Hamley *et al* 1997; DSEWPaC 2011p).

The extent of occurrence is estimated to be approximately 5,200 km², but this estimate is only of medium reliability (Garnett & Crowley 2000). Total area of occupancy is estimated to be approximately 750 km², but this estimate is of low reliability (Garnett & Crowley 2000).

Populations have become severely fragmented since European settlement, mostly due to clearance of forests and bushland for agriculture (Hamley *et al* 1997). There are approximately 25 sub-populations of this species and most of these are probably isolated in fragments (Garnett & Crowley 2000). A survey in south-eastern Queensland indicated that there were 14 discrete areas where this species occurs, and there is also some fragmentation within these areas (Hamley *et al* 1997; Garnett & Crowley 2000).

The total population is estimated at 5,000 breeding birds. However, this estimate is of low reliability (Garnett & Crowley 2000).

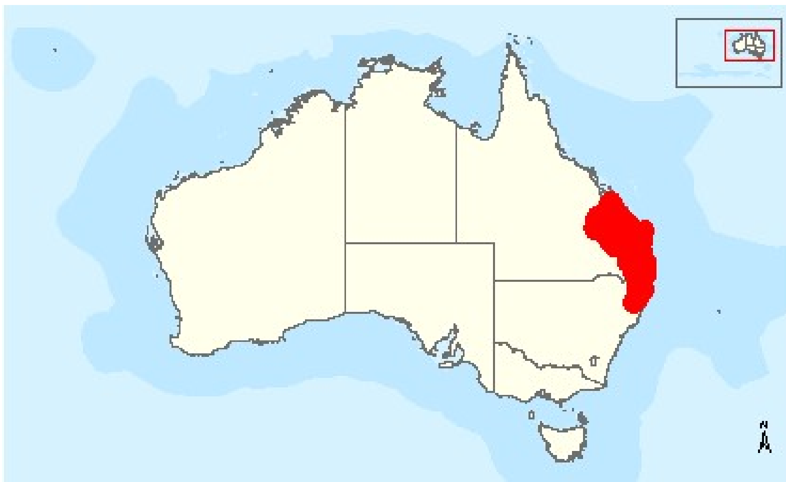

Figure 33: Mapped distribution range of Black-breasted button-quail (Source: DSEWPaC 2011p)

8.32.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. The species occurs in SEVT and associated Brigalow communities in the Brigalow Belt South Bioregion where it is at its western range limits. Despite there being no records within the gas fields, it is possible populations are present. GFD tenements possessing potentially suitable habitat are ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.32.2.4 Biology and reproduction

The diet is mostly invertebrates, taken from litter on the forest floor (Hughes & Hughes 1991; Lees & Smith 1998; Marchant & Higgins 1993; McConnell & Hobson 1995), but seeds are also possibly taken (Smyth 1997).

There is no information concerning sexual maturity or life-span of birds in the wild (DSEWPaC 2011p).

The breeding season generally occurs from September to April/May (DSEWPaC 2011p). At one site in south-eastern Queensland, juveniles were observed in all except one month, suggesting that breeding can occur throughout the year at certain localities (Hughes & Hughes 1991; Smyth & Young 1996). The onset and finish of the breeding season may be affected by climatic factors such as minimum daily temperature and rainfall, eg a reduction in the amount of food available, caused by dropping temperatures, probably causes the breeding season to end (Smyth & Young 1996; DSEWPaC 2011p). However, the relationship between rainfall and breeding season is not clear (Smyth & Young 1996).

Between three and five eggs are laid, with a mean clutch-size of 3.88 (Smyth & Young 1996). Nests consist of a scrape in the ground, lined with leaves, grass or moss. Nests are well-concealed and placed in the buttress root of a tree or sapling, the base of a fern or under a low bush or grass tussock (Marchant & Higgins 1993; Smyth & Young 1996).

Nests are often in areas where the common understorey plants include species such as Bracken (*Pteridium esculentum*), Rasp fern (*Doodia aspera*) and Lantana (*Lantana camara*) (Smyth & Young 1996).

The incubation period in the wild is 18 to 21 days (Smyth & Young 1996). Only the male incubates (Marchant & Higgins 1993; Smyth & Young 1996). During the breeding season, females are territorial toward other females, but not males. Males possibly hold small temporary territories for courtship and mating, these being within a female's larger territory. The female apparently mates with several males in succession (Smyth & Young 1996). Mating takes place within the female's own territory and, on occasions, within the adjacent territories of other females (DSEWPaC 2011p). The female can lay two clutches 8 to 10 days apart (Smyth & Young 1996).

8.32.3 Habitat

The Black-breasted button-quail is restricted to rainforests and forests, mostly in areas with 770 to 1,200 mm rainfall per annum (Bennett 1985; Hughes & Hughes 1991; Marchant & Higgins 1993). They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest (Bennett 1985; Hughes & Hughes 1991; Marchant & Higgins 1993; Milledge & McKinley 1998; Smyth *et al* 2001). They may also be found in low, dense acacia thickets and, in littoral area, in vegetation behind sand dunes (Smith & Mathieson 2004).

Many areas of optimum habitat are located on highly fertile soils. It is believed that the highly fertile soils promote rapid leaf growth on plants (DSEWPaC 2012p). During dry periods, much of the foliage then drops to the ground thus maintaining the deep leaf litter layer which is crucial to the foraging requirements of the species (Smith & Mathieson 2004).

Many reports are from dry forest described as Bottle tree scrub, comprising Brigalow (*Acacia harpophylla*), Belah (*Casuarina cristata*) and Bottle tree (*Brachychiton rupestris*), with or without emergent Hoop pine (*Araucaria cunninghamii*), with a shrub understorey and thick litter layer (Bennett 1985). Much of this vegetation type, especially in the Fitzroy and Dawson valleys has been grossly depleted (Hamley *et al* 1997).

In Googa State Forest, south-eastern Queensland, birds are most commonly associated with remnant microphyll vine forest with no lantana in the understorey, but lantana is often used for diurnal foraging and nocturnal roosting. This species has been recorded as far as 60 m into mature Hoop Pine plantations. A mosaic of Lantana and emergent vine forest species appears to be important for cover (Smith *et al* 1998).

In littoral areas, the species associates with vegetation behind dunes, namely vine scrubs and thickets, acacia thickets and areas densely covered in shrubs, particularly Midgen Berry (*Austromyrtus dulcis*) and Lantana (Smith & Mathieson 2004). In the Great Sandy region of southeast Queensland, Black-breasted button-quail occur in Brush box (*Lophostemon confertus*), Pink bloodwood (*Corymbia intermedia*) and Forest red gum (*Eucalyptus tereticornis*) forest, with an understorey of Black she-oak (*Allocasuarina littoralis*), Acacias, Lantana and berry-bearing shrubs (Bennett 1985).

In south-eastern Queensland, they are recorded on rare occasions in open eucalypt forest (Smyth *et al* 2001). An extensive dense leaf-litter layer is required for foraging (Hughes & Hughes 1991) and possibly also roosting (McConnell & Hobson 1995). Fallen logs and a dense, heterogeneously distributed shrub layers are also considered to be important habitat characteristics for shelter and breeding (Smith *et al* 1998; Smyth & Young 1996).

The species has also recorded from vine forest remnants between Hoop Pine plantations and agricultural land (Smith *et al* 1998) and occasionally in areas of pasture grass adjacent to habitat areas (Hughes & Hughes 1991).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Preferred habitat of this species consists of drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest (DSEWPaC 2011p; EPA 2006) (except for that located in the Grafton Range) and that contain the following microhabitat features:
    - Dense leaf litter (>50%);
    - Thick shrub layer (>30% shrub cover).

8.32.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Black-breasted button-quail habitat from Project activities is 233 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.32.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.33 Five-clawed worm-skink

8.33.1 Status

Vulnerable – listed 16 July 2000

8.33.2 Biology and ecology

8.33.2.1 Characteristics

The Five-clawed worm-skink (*Anomalopus mackayi*) is a medium sized species of the Scincidae family. It is a burrowing skink which is characterised by three fingers and two toes and grows up to 27 cm long. It has smooth scales with an overall greyish-brown upper body with longitudinal rows of dark spots. The ventral surface is yellow-green with dark flecking. In the southern region of its range the Five-clawed worm-skink is unpatterned, while in the north of its range, it has longitudinal rows of dark spots over the dorsal and lateral surfaces (Cogger 2000; Queensland EPA 2007).

Plate 32: Five-clawed worm-skink (*Anomalopus mackayi*) (Source: Dolley n.d)

8.33.2.2 Known distribution

The known distribution of the Five-clawed worm-skink is patchy in north-eastern New South Wales and south-eastern Queensland (Brigalow Belt Reptiles Workshop 2010; NSW DECCW 2005; Sadlier & Pressey 1994).

In south-eastern Queensland, the species' known distribution is on the upper Condamine River Floodplain from Warwick in the south to the Jimbour region in the north and bordered by the western edge of the granite belt (DOTE 2014x).

Specimens have been recorded at (Greer & Cogger 1985; Shea *et al* 1987):

- Allora
- Bongeen
- Cecil Plains
- Oakey

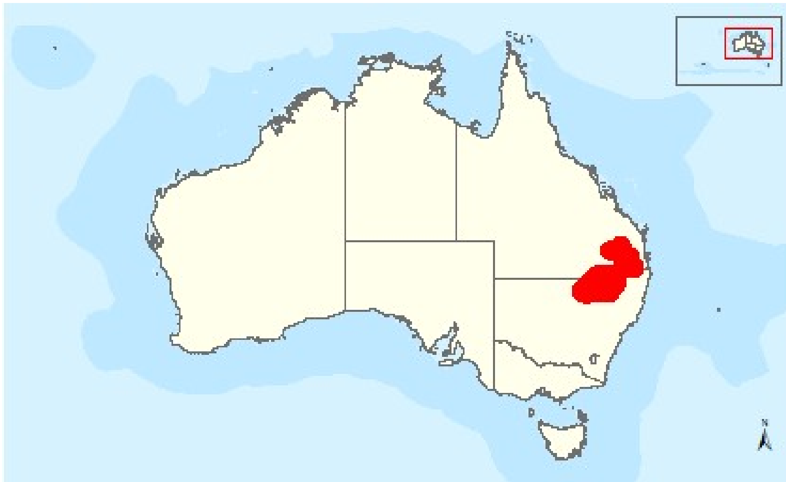

Figure 34: Mapped distribution range of the Five-clawed worm-skink (Source: DOTE 2014x)

8.33.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. This species distribution is confined to the eastern Darling Downs and does not occur within GFD tenements (Boobook 2015).

8.33.2.4 Biology and reproduction

No information is available about the species' feeding behaviour in the wild; however, it is believed to feed on arthropods, such as white ants. Captive specimens have been recorded eating mealworms (Brigalow Belt Reptiles Workshop 2010; NSW DECCW 2005).

Very little is known about the species' biology. Average clutch size or mortality rates for newborns are unknown. One specimen was observed laying three eggs in spring (NSW DECCW 2005).

8.33.3 Habitat

The Five-clawed worm-skink is known to occur in both remnant and non-remnant woodlands and grasslands. In areas modified by agriculture and other human activities, the species has been found sheltering under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales (Brigalow Belt Reptiles Workshop 2010; Richardson 2006).

On the Darling Downs, the species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell grass dominated grasslands or mixed grasslands dominated by other grass species, but still categorised RE 11.3.21 (Brigalow Belt Reptiles Workshop 2010). In south-east Queensland, the species may occur in River red gum–Queensland blue gum–Coolibah–Bimble/Poplar box grassy woodland/open forests (Brigalow Belt Reptiles Workshop 2010).

Whilst a single specimen was found under a railway sleeper on sandy soil north of Oakey (Cogger *et al* 1993), the species is not likely to be found in soils in which deep cracks do not form, such as hard-setting brown clays or sandy soils types (Spark 2010).

The Five-clawed Worm-skink occurs in the following threatened ecological communities (Brigalow Belt Reptiles Workshop 2010):

- Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and Southern Queensland ecological community

- Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community
- Weeping Myall Woodlands ecological community
- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell grass dominated grasslands or mixed grasslands dominated by other grass species and in River red gum–Queensland blue gum–Coolibah–Bimble/Poplar box grassy woodland/open forests (Brigalow Belt Reptiles Workshop 2010)
- The species occurs in non-remnant areas under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales (Brigalow Belt Reptiles Workshop 2010)

8.33.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 40 hectares of Five-clawed worm skink habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this species are outlined in Appendix A.

8.33.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.34 Dunmall's snake

8.34.1 Status

Vulnerable – listed 16 July 2000

8.34.2 Biology and ecology

8.34.2.1 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 33: Dunmall's snake (Source: Wilson 2009)

8.34.2.2 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).

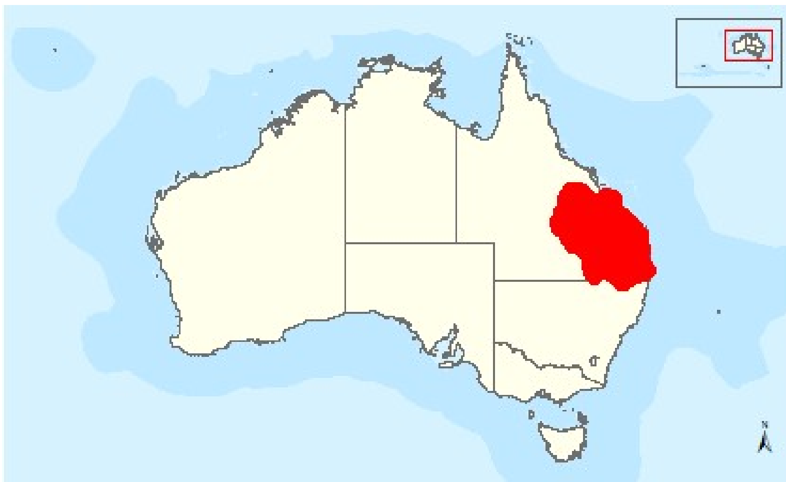

Figure 35: Mapped distribution range of Dunmall's snake (Source: DSEWPaC 2011q)

8.34.2.3 Known species populations within the gas fields

Dunmall's snake is likely to occur within the gas fields. GFD tenements with potentially suitable habitat include: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.34.2.4 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).

8.34.3 Habitat

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).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of all regional ecosystems except natural grassland regional ecosystems that contain any of the following microhabitat features:
  - Dense leaf litter (>50%)
  - Rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes
  - Loose/exfoliating bark
  - Cracking clay soils
  - Hollow logs
  - Coarse woody debris (non-hollow logs and large pieces of bark)
  - Sink holes/tunnel erosion
  - Termite mounds
  - Burrow complexes

8.34.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Dunmall’s Snake habitat from Project activities is 2512 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.34.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.35 Ornamental snake

8.35.1 Status

Vulnerable – listed 16 July 2000

8.35.2 Biology and ecology

8.35.2.1 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 fore body, is very finely peppered with dark brown or black markings. Lips distinctly barred. Scales are smooth and are 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 34: Ornamental snake (Source: Wilson 2008)

8.35.2.2 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).

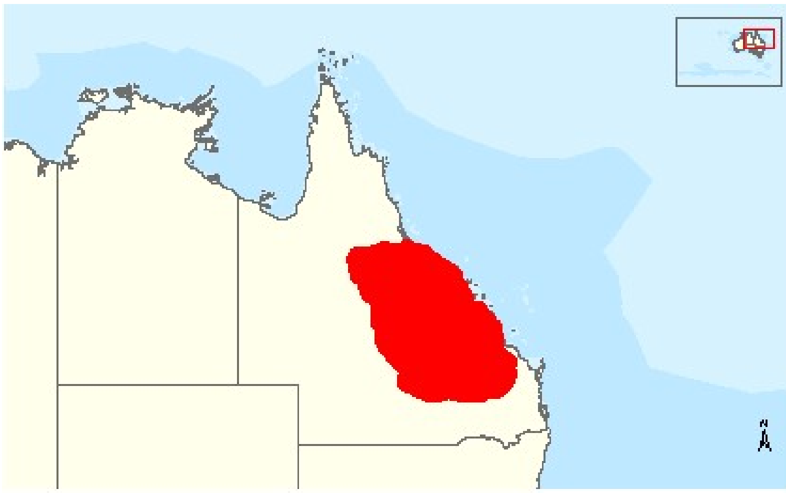

Figure 36: Mapped distribution range of Ornamental snake (Source: DSEWPaC 2011r)

8.35.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. Potentially suitable habitat is present in lowlands associated with the Dawon and Fitzroy catchments within the following GFD tenements: ATP526, ATP745, ATP803, ATP804, ATP868, PL176, PL234, PL236, PL420 and PL421.

8.35.2.4 Biology and reproduction

This species is nocturnal and feeds almost elusively 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 frog 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).

8.35.3 Habitat

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 project footprint 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).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of any regional ecosystem that contains any of the following microhabitat features:
  - Dense leaf litter (> 50%)
  - Loose/exfoliating bark
  - Cracking clay soils
  - Swamps, gilgai and other ephemeral wetlands
  - Coarse woody debris (non-hollow logs and large pieces of bark)

Plate 35: Photo of habitat example (Source: Aurecon 2013)

8.35.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Ornamental Snake habitat from Project activities is 279 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.35.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.36 Collared delma

8.36.1 Status

Vulnerable – listed 16 July 2000

8.36.2 Biology and ecology

8.36.2.1 Characteristics

The Collared delma (*Delma torquata*) 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 36: Collared delma (Source: Peck 2006)

8.36.2.2 Known distribution

Despite difficulties in estimating the Collared 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 or records come from the western suburbs of Brisbane (DSEWPaC 2011s).

Due to specific habitat requirements of Collared 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).

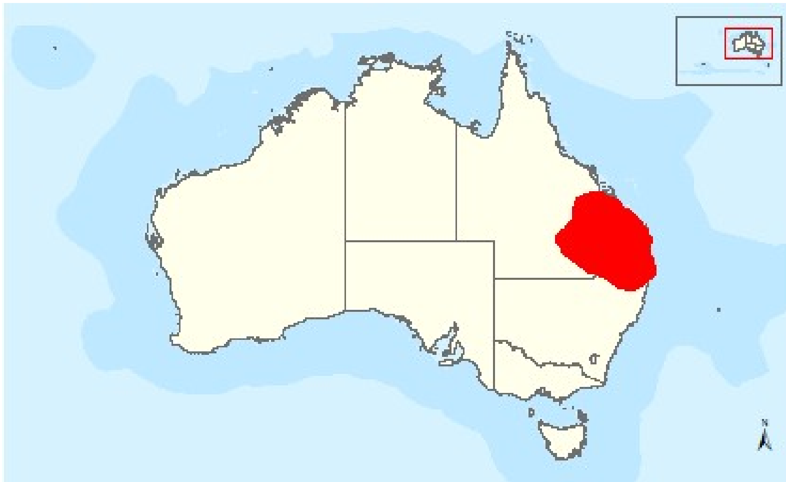

Figure 37: Mapped distribution range of Collared delma (Source: DSEWPaC 2011s)

8.36.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields.Potential suitable habitat may be present within the following GFD tenements: ATP336R, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.36.2.4 Biology and reproduction

The Collared 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 Collared delma produces two small white, elongated eggs in December. These then hatch in February to March (Peck & Hobson 2007).

8.36.3 Habitat

The Collared 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 Collared 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 Collared 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 the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of any regional ecosystem except natural grassland regional ecosystems that contain any of the following microhabitat features:
  - Dense leaf litter (> 50%)

- Rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes
- Loose/exfoliating bark
- Cracking clay soils
- Hollow logs
- Coarse woody debris (non-hollow logs and large pieces of bark)
- Sink holes / tunnel erosion.

8.36.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Collared Delma habitat from Project activities is 2703 hectares. Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.36.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.37 Yakka skink

8.37.1 Status

EPBC Act – Vulnerable

8.37.2 Biology and ecology

8.37.2.1 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 37: Yakka skink (Source: DSEWPaC 2011t)

8.37.2.2 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).

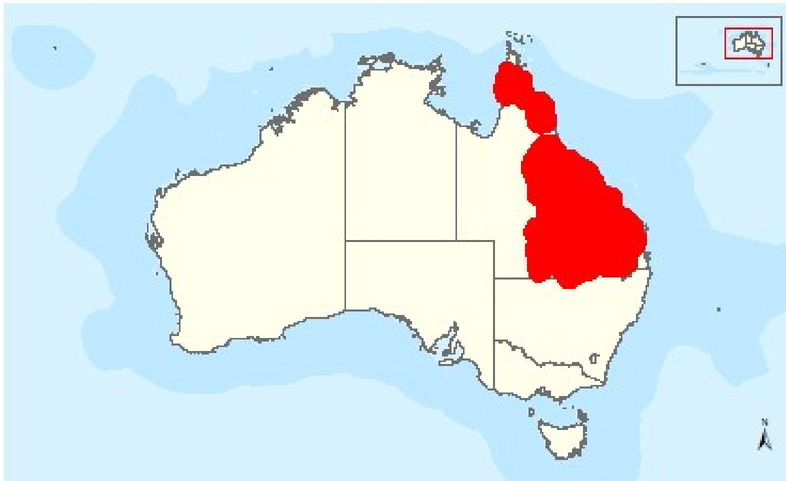

Figure 38: Mapped distribution range of Yakka skink (Source: DSEWPaC 2011t)

8.37.2.3 Known species populations within the gas fields

This species is known to occur within the gas fields. The GFD tenements with the potential to include suitable habitat include: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745.

8.37.2.4 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).

8.37.3 Habitat

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 also in habitats which also support the Brigalow scaly-foot (DSEWPaC 2011t).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of any vegetation community that contains the following microhabitat features:
  - Rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes
  - Loose/exfoliating bark
  - Cracking clay soils
  - Hollow logs
  - Coarse woody debris (non-hollow logs and large pieces of bark)
  - Sink holes/tunnel erosion
  - Termite mounds
  - Burrow complexes

8.37.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Yakka Skink habitat from Project activities is 4144 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.37.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.38 Large-eared pied bat

8.38.1 Status

Vulnerable – listed 4 April 2001

8.38.2 Biology and ecology

8.38.2.1 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 38: Large-eared pied bat (Source: Pennay 2006)

8.38.2.2 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).

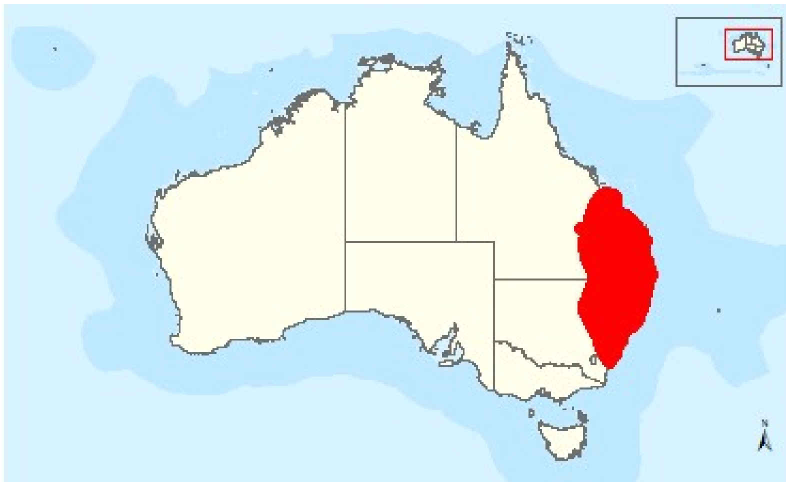

Figure 39: Mapped distribution range of Large-eared pied bat (Source: DSEWPaC 2011v)

8.38.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. The species is likely to be present in uplands with appropriate goology (usually sandstone) providing essential habitat in the form of caves, crevices, holes etc. GFD tenements with the potential for suitable habitat include: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.38.2.4 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).

8.38.3 Habitat

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).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of all regional ecosystem vegetation communities except natural grassland regional ecosystems that contain any of the following microhabitat features:
  - Rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes
  - Deeply dissected sandstone rock faces, cliffs line and caves
  - Deeply dissected sandstone rock faces, cliffs line and caves within 5km

8.38.4 Anticipated threats and potenitial impacts from the Project

Maximum disturbance to Large Eared Pied Bat habitat from Project activities is 1950 hectares. Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.38.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.39 South-eastern long-eared bat

8.39.1 Status

Vulnerable – listed 4 April 2001

8.39.2 Biology and ecology

8.39.2.1 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 39: South-eastern long-eared bat (Source: Murphy 2005)

8.39.2.2 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 Project footprint are from the Rundle Range, north of Gladstone and Expedition National Park on Melancholy Creek (DERM 2012; Atlas of Living Australia 2012).

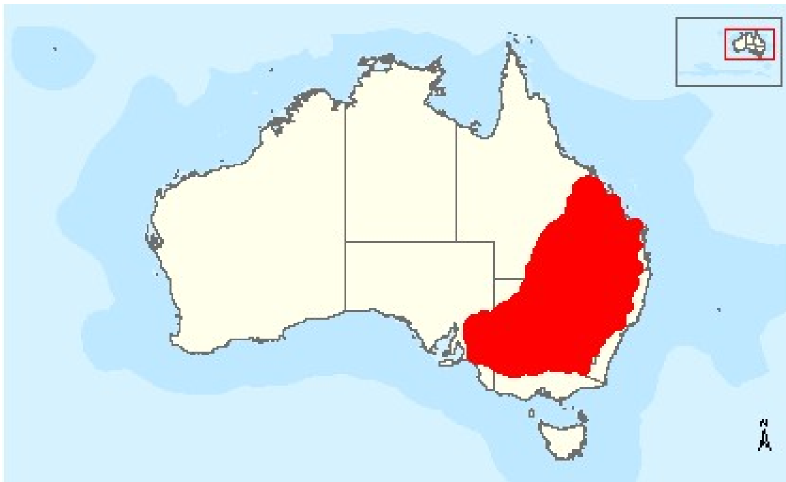

Figure 40: Mapped distribution range of South-eastern long-eared bat (Source: DSEWPaC 2011w)

8.39.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. GFD tenements comprising potential suitable habitat include: ATP336R, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.39.2.4 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).

8.39.3 Habitat

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).

'Essential habitat' is generally associated with large tracts of vegetation (100s to 1,000s of ha), including open forest with open to dense u/storey (but also found in SEVT and brigalow/ belah); mixed *Eucalyptus*/ *Corymbia*/ *Angophora* +/- cypress/ bull-oak (pers comm. Greg Ford). 'General habitat' seems to be associated mainly with large tracts of relatively undisturbed woodland and forest, particularly on landzones 5, 7 and 10 (and landzone 3 within these), although it does venture into landzone 4 and 9 (pers comm. Greg Ford).

The species is known to fly large distances (>7 km in a night) from roosts to foraging areas. There is limited information on species habitat in Queensland, with data based on capture records only (Curtis *et al* 2012).

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).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of all regional ecosystem vegetation communities except natural grassland regional ecosystems that contain any of the following microhabitat features:
  - Loose/exfoliating bark
  - Hollow-bearing trees within 1km

8.39.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to South-eastern Long-eared bat habitat from Project activities is 4202 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.39.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.40 Northern quoll

8.40.1 Status

Endangered – listed 12 April 2005

8.40.2 Biology and ecology

8.40.2.1 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 tails 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 40: Northern quoll (Source: Ward 2010)

8.40.2.2 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).

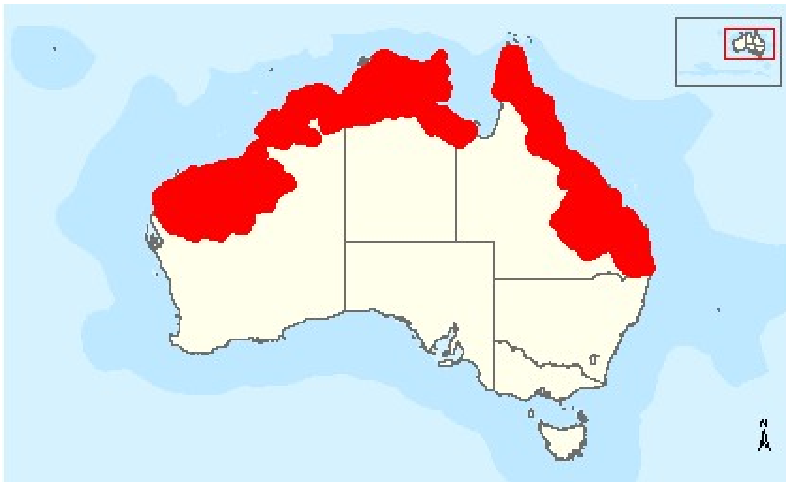

Figure 41: Mapped distribution range of Northern quoll (Source: DSEWPaC 2011x)

8.40.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. GFD tenements with potential suitable habitat are restricted to those that comprise rugged and remote areas with forested uplands, high relief and/or contain abundant rocky outcrops and include ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.40.2.4 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.

8.40.3 Habitat

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).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, (DSEWPaC 2011x)
- Research indicates that the species is more likely to be present in high relief areas that have shallower soils, greater cover of vegetation, boulders, less fire impact and were closer to permanent water (Woinarski *et al* 2008)
- It can also be assumed that the Northern quoll habitat would not extend into the surrounding un-wooded grasslands based on its habitat requirements such as cover from predators, height relief areas with a greater cover of boulders, rocky outcrops and less fire impact (Woinarski *et al* 2008; DSEWPaC 2011x; Curtis *et al* 2012)
- Habitat is comprised of all regional ecosystems except natural grassland regional ecosystems that contain any of the following microhabitat features:
    - Rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes
    - Deeply dissected sandstone rock faces, cliffs line and caves
    - Deeply dissected sandstone rock faces, cliffs line and caves within 5km
    - Hollow logs

8.40.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Northern Quoll habitat from Project activities is 4855 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.40.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.41 Bridled nail-tail wallaby

8.41.1 Status

Endangered – listed 16 July 2000

8.41.2 Biology and ecology

8.41.2.1 Characteristics

The Bridled nail-tail wallaby (*Onychogalea fraenata*) is a highly solitary, medium-sized macropod; up to 1 m tall and weighing up to 8 kg (males). The species has distinctive markings of a white 'bridle' line running from the centre of the neck, along the shoulder to behind the forearm on each side of the body. A black stripe runs the length of the body, and white cheek stripes are present on both sides of the head. A horny 'nail' occurs at the tip of the tail, is between 3 to 6 mm and is partly concealed by hair (Lundie-Jenkins 2001).

The species has a high level of sexual dimorphism and males may be up to twice as large as females (Sigg & Goldizen 2006).

Plate 41: Bridled nail-tail wallaby (*Onychogalea fraenata*) (Source: Reardon n.d)

8.41.2.2 Known distribution

The Bridled nail-tail wallaby is confined to Taunton National Park (Scientific) (an area of 11,000 ha) near the town of Dingo with some sightings within 10 km of the park (Davidson 1991; Lundie-Jenkins 2001). Population genetics and radio-tracking studies have shown that the populations at different localities within Taunton National Park (Scientific) are not isolated, but connected through frequent juvenile dispersal (Fisher 1999). One reintroduced population is confined to a smaller section of Idalia National Park in Western Queensland (Pople *et al* 2001), and another exists at Avocet Nature Refuge near Emerald, in Central Queensland (Lundie-Jenkins & Lowry 2005). Another population has been re-introduced at Scotia Sanctuary (64,000 ha), 150 km south of Broken Hill (Finlayson *et al* 2008).

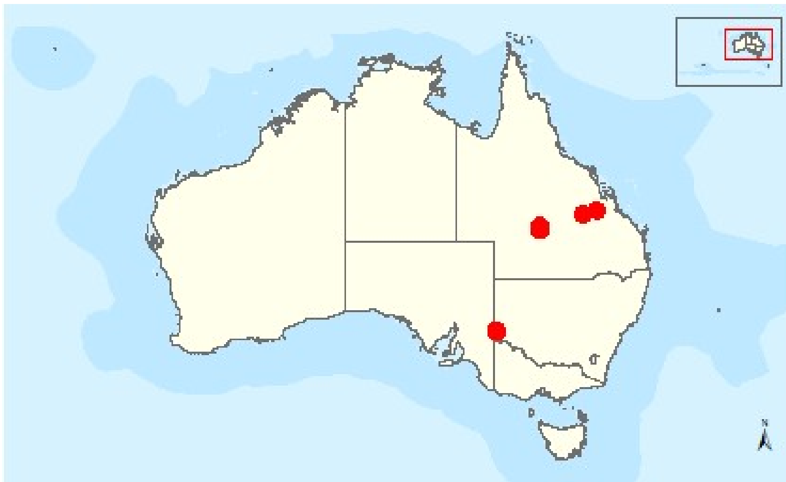

Figure 42: Mapped distribution range of the Bridled nail-tail wallaby (Source: DOTE 2014y)

8.41.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. There are no extant populations of this species within the GFD tenements (Boobook 2015).

8.41.2.4 Biology and reproduction

A study at Taunton National Park (Scientific) found the diet of the Bridled nail-tail wallaby to be diverse, including herbaceous species (forbs), grasses and shrubs. Proportions of these different plant groups varied with season and availability. Bridled nail-tail wallabies prefer other foods to grass species in all seasons, particularly during the dry winter. At this time forbs (mostly chenopods) became the major dietary component, and feeding selectivity was high for the relatively rare food items such as sedges. There was strong selection for sedges during spring, when food resources were at their lowest abundance. They showed a preference for food items of relatively high nutritional value (leaf and reproductive parts such as seedheads) and selection against items of relatively high fibre content (grass stem and sheath). They also appeared to prefer younger stages of growth (which have less fibre) (Evans & Jarman 1999).

Bridled nail-tail wallabies breed all year round. Females conceive while they have a joey in the pouch, and the timing of development is such that the next young is born the day after the previous one leaves the pouch permanently (Fisher & Goldizen 2001; Johnson 1997).

Bridled nail-tail wallabies require areas of low, dense ground cover that is close to pasture to breed successfully. After young leave the pouch permanently at around 17 weeks old, juvenile Bridled nail-tail wallabies do not follow their mothers as larger kangaroos do. Rather, they spend the day concealed in dense cover, generally at the edge of a feeding area that is more than 200 m away from their mothers' daytime shelter (DOTE 2014x).

8.41.3 Habitat

The Bridled nail-tail wallaby occurs in woodland, particularly in Brigalow (*Acacia harpophylla*) scrub, preferring areas with the most fertile soil (Lundie-Jenkins 2001). During the day (when they are resting), Bridled nail-tail wallabies prefer habitat that consists of young Brigalow regrowth or contains fallen logs (Evans 1996). They shelter beneath shrubs, in large grass tussocks and inside hollow logs. Adults prefer logs where available (Fisher & Goldizen 2001) but also used grass shelters as the biomass of grass increases after a drought, enabling them to shelter closer to feeding areas. They generally choose shelter sites with the densest cover of foliage and stems at Bridled nail-tail wallaby height (25 to 50 cm), and this type of shelter is concentrated at the edges of wooded areas such as Brigalow regrowth (Fisher 2000). At night (when they are feeding), they prefer the ecotone habitat containing both pasture and young Brigalow regrowth (Evans 1996). When feeding in open pasture, they prefer to stay close to the edge of shelter habitat (Evans 1996).

On the north-western section of Taunton National Park (Scientific), the Bridled nail-tail wallaby is found in all four of the major vegetation types; open grassy eucalypt woodland dominated by Poplar box (*Eucalyptus populnea*), dense *Acacia* forest dominated by Brigalow, transitional vegetation intermediate between the woodland and forest and in areas of very dense Brigalow regrowth (Tierney 1985). At Idalia National Park, reintroduced Bridled nail-tail wallabies use open woodland as well as Brigalow regrowth, and also use Wilga bushes (*Geijera parviflora*) as shelter habitat (Pople *et al* 2001).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- The species occurs in open grassy eucalypt woodland dominated by Poplar box (*Eucalyptus populnea*), dense *Acacia* forest dominated by Brigalow, transitional vegetation intermediate between the woodland and forest and in areas of very dense Brigalow regrowth (Tierney 1985)
- The species prefers the ecotone habitat containing both pasture and young Brigalow regrowth when feeding (Evans 1996)

8.41.4 Anticipated threats and potential impacts from the Project

Direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species known distribution.

Threats affecting this species are outlined in Appendix A.

8.41.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.42 Brush-tailed rock-wallaby

8.42.1 Status

Vulnerable – listed 16 July 2000

8.42.2 Biology and ecology

8.42.2.1 Characteristics

The Brush-tailed rock-wallaby (*Petrogale penicillata*) is brown above, tending to be rufous on the rump and grey on the shoulders. The chest and belly is paler and in some individuals there is a white blaze on the chest. There is a white to buff cheek stripe and a black dorsal stripe from the forehead to the back of the head. The exterior of the ears is black, and inside the ears is buff. There is a black auxiliary patch often extending as a dark stripe to the margin of the hind-legs. There is a pale grey side-stripe sometimes present. The feet and paws are dark brown to black. The tail darkens distally with a prominent brush. The pelage is long and thick, particularly about the rump, flanks and base of the tail. Individuals from the north of the species range tend to be lighter and have a less prominent tail brush (Eldridge & Close 1998).

Males grow to 529 to 586 mm and females to 510 to 570 mm in head and body length. The tail length of the male is 510 to 700 mm and 500 to 630 mm for females. Males reach a weight of 5.5 to 10.9 kg and females a weight of 4.9 to 8.2 kg (Eldridge & Close 1998).

Plate 42: Brush-tailed rock-wallaby (*Petrogale penicillata*) (Source: Fergus 2004)

8.42.2.2 Known distribution

It is estimated that the total population size is between 15,000 and 30,000 individuals (DOTE 2014z). Gaining a more precise estimate of numbers is difficult due to inaccessibility of the species habitat, particularly to the north of its range where numbers are known to be greater (DEC 2005b). Seventeen percent of the total population occurs in south-eastern Queensland, 82% in New South Wales (including ACT), and fewer than 1% in Victoria. Up to 80% of the total population occurs in northern New South Wales alone (DEC 2005b).

The Brush-tailed rock-wallaby was once widespread and abundant in south-eastern Australia. It was formerly found along the Great Dividing Range from Nanango in south-east Queensland through to east Gippsland in Victoria (Connolly 1995; Eldridge & Close 1992; Short & Milkovits 1990). However, there has been a reduction in the species range and numbers with the decline being greatest in Victoria and southern New South Wales (DEC 2005b). Despite this range contraction, the Brush-tailed rock-wallaby is still the most widespread Petrogale in eastern Australia (Eldridge & Close 1992). The species is known from 962 nationally-recorded sites; 876 of these sites are in New South Wales (DEC 2005b).

Populations of the Brush-tailed rock-wallaby occur, or did occur, throughout the Great Dividing Range from the border with New South Wales to Nanango, 100 km northwest of Brisbane (where it forms a hybrid zone with *Petrogale herberti*) (Eldridge & Close 1992). Although there are no recent surveys published from Queensland, this species is considered to be declining and vulnerable (Clancy & Close 1997). It appears that the population in Lamington National Park is now extinct (Maxwell *et al* 1996).

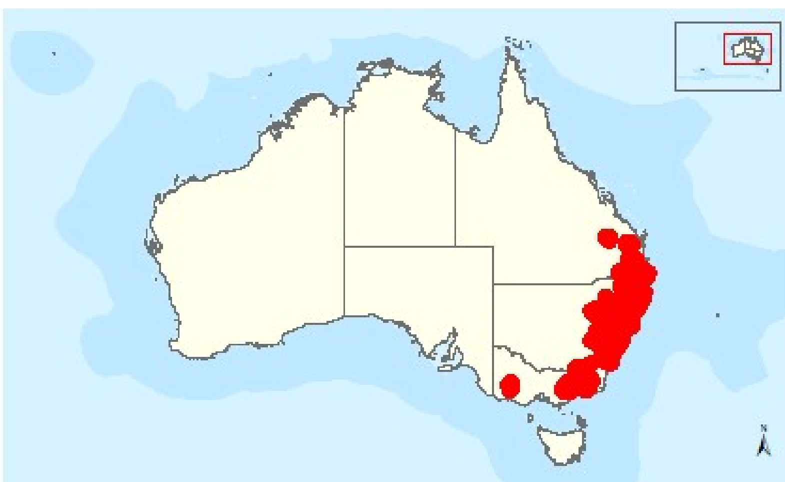

Figure 43: Mapped distribution range of the Bridled nail-tail wallaby (Source: DOTE 2014z)

8.42.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. The distribution of this species does not extend to the GFD tenements (Boobook 2015).

8.42.2.4 Biology and reproduction

The diet of the Brush-tailed rock-wallaby is primarily grasses (35 to 50%), forbs (25 to 40%) and "browse" (shrubs, trees and climbers) (12 to 30%) with ferns and sedges of very minor importance (Short 1989). It is also reported to eat *Themeda triandra* (Kangaroo grass) more than other grass species (Jarman & Phillips 1989). Rock-wallabies forage mostly at night (NPWS 2003).

Sexual maturation of females occurs at 18 months and males at 20 to 24 months (Lee & Ward 1989; DEC 2005b).

Brush-tailed rock-wallabies are polygamous and a dominant male will be found with up to four females. They appear to live in family groups of two to five adults and usually one or two juveniles and sub-adult individuals (Joblin 1983; Short 1980), but are also known to occur in male-female pairs (DEC 2005b).

A rocky habitat with an abundant supply of ledges, caves and potential pathways, plus a northerly aspect were found to be important for rock-wallabies to breed (Short 1982).

Females give birth to a single pouch young at a time, after a gestation period of approximately 30 days (Close 1993). The young remain in the pouch for six months. After it first emerges from the pouch, the joey spends a further seven to 20 days in and out of the pouch. The mother leaves the dependent young in small caves during the day between feeds. Weaning is believed to occur 86 days after leaving the pouch, when the joey is nine months old (Lee & Ward 1989).

8.42.3 Habitat

This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (Murray *et al* 2008; Short 1982). It also utilises tree limbs (Maxwell *et al* 1996, Sharman & Maynes 1983). While it appears that most Brush-tailed rock-wallaby colonies are on north-facing slopes and cliff lines (Short 1982), colonies have been found on south-facing cliffs in Kangaroo Valley (Kutzner & Dodd 1996; Wong 1997), in the Macleay River Gorge (Bayne 1994), in the Warrumbungles and at Mt Kaputar (NPWS 2003), although usually in lower densities (DOTE 2014z).

Rocky outcrops appear crucial to current habitat selection by rock-wallabies, however, vegetation structure and composition is also considered to be an important factor (Bugg 1995; Lim & Giles 1987; Pearson 1992). In many parts of their range, including at the Warrumbungles, rock-wallabies are closely associated with dense arboreal cover, especially fig trees (NPWS 2003). The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation (Wong 1993 & 1997). A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (Murray *et al* 2008).

Brush-tailed rock-wallabies typically shelter during the day in rock crevices, caves and overhangs, yet often bask in exposed sunny spots (Sharman & Maynes 1983). Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways (Joblin 1983) and these are often defended vigorously (Bayne 1994).

Brush-tailed rock-wallabies select foraging locations that tend to be more open and with more short green grasses and forbs than other locations nearby. Foraging Brush-tailed rock-wallabies do not favour areas that are concealed by tussocks or near to the cliffs (Carter & Goldizen 2003).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (Murray *et al* 2008; Short 1982)
- Most Brush-tailed rock-wallaby colonies are on north-facing slopes and cliff lines and when present populations on south-facing slopes contain fewer individuals (Short 1982)

8.42.4 Anticipated threats and potential impacts from the Project

Santos GLNG is authorised to disturb up to 166 hectares of Brush-tailed rock wallaby habitat. However, direct impacts to this species from gas field development will be negligible, given the gas fields are outside the species geographical distribution.

Threats affecting this species are outlined in Appendix A.

8.42.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.43 Grey-headed flying-fox

8.43.1 Status

Vulnerable – listed 6 December 2001

8.43.2 Biology and ecology

8.43.2.1 Characteristics

The Grey-headed flying-fox (*Pteropus poliocephalus*) is one of the largest bats in the world with a weight of 600 to 1,000 g and a head-body length of 230 to 289 mm (Eby & Lunney 2002; Tidemann 1998). It is the only Australian flying-fox that has a collar of orange/brown fully encircling its neck (Hall 1987). Thick leg fur extends to the ankle, in contrast to other Pteropus species in which it only reaches the knee (Hall 1987; Tidemann 1998). As its name implies, the head is covered by light grey fur (Hall 1987). The belly fur is grey, often with flecks of white and ginger. The fur on the back shows two morphs which could be related to age, moult or sub-population (Hall & Richards 2000). One morph has dark grey fur and the other has a pronounced silver or frosted appearance (Hall 1987). Winter fur is darker than summer fur with a pronounced moult occurring in June (Hall 1987).

Plate 43: Grey-headed flying fox (*Pteropus poliocephalus*) (Source: Welbergen 2009)

8.43.2.2 Known distribution

The Grey-headed flying-fox is Australia's only endemic flying-fox and occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (Tidemann 1998). However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years. At a local scale, the species is generally present intermittently and irregularly (Eby & Lunney 2002). At a regional scale, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration (Eby & Lunney 2002). Whilst Brisbane, Newcastle, Sydney and Melbourne are occupied continuously (Pallin 2000; Hall 2002; van der Ree *et al* 2006), elsewhere, during spring, Grey-headed flying-foxes are uncommon south of Nowra and widespread in other areas of their range. The species is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregrates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of New South Wales (associated with flowering Spotted gum (*Corymbia maculata*)) and on the north-west slopes (generally associated with flowering White box (*Eucalyptus albens*) or Mugga ionbark (*Eucalyptus sideroxylon*)) (NSW DECCW 2010).

The species sometimes ranges into South Australia (Hall & Richards 2000) and occasional individuals have been observed on Bass Strait islands (Tidemann 1998) and mainland Tasmania (Kempton 2010). It is infrequently found west of the Great Dividing Range (Tidemann 1998).

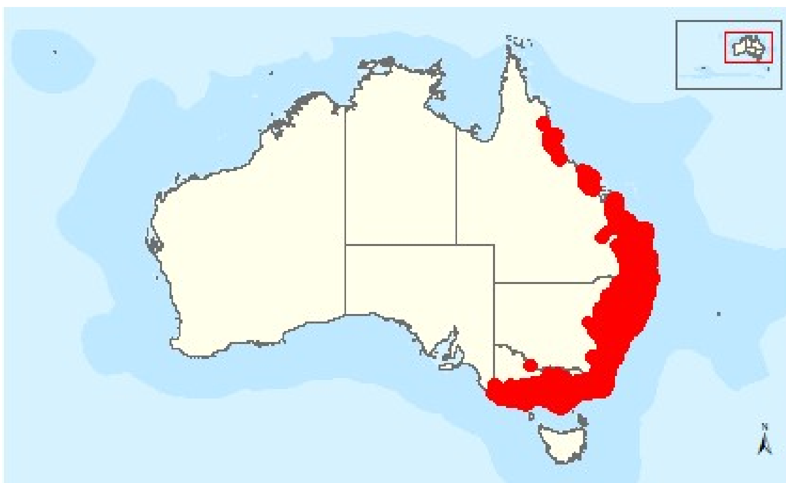

Figure 44: Mapped distribution range of the Grey-headed flying-fox (Source: DOTE 2014aa)

8.43.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. The presence of this species within the GFD tenements is likely to include rare vagrant individuals only (within ATP803, ATP868 & PL176) – the species is not resident in the area (Boobook 2015).

8.43.2.4 Biology and reproduction

The Grey-headed flying-fox has a diverse native diet, which it supplements with introduced plants (Eby 1995, 1998; Hall & Richards 2000; Parry-Jones & Augee 1991). Nectar and pollen from the flowers of eucalypts (genera *Eucalyptus*, *Corymbia* and *Angophora*), melaleucas and banksias are the primary food for the species (Duncan *et al* 1999). Most eucalypts have regular seasonal flowering schedules but do not flower every year, and there are a few areas within the range of the Grey-headed flying-fox where nectar is available continuously (House 1997; Law *et al* 2000; Wilson & Bennett 1999).

Generally, females do not reach full sexual maturity until three years of age (Martin 2000).

Mating occurs in early autumn, after which time the larger camps begin to break up, reforming in late spring/early summer, as food resources become more abundant (Hall & Richards 2000). Males and females segregate in October when females usually give birth. Following six months of gestation, females bear a single young each year. Lactation usually begins in October and continues for three to four months or sometimes longer (Nelson 1965).

For a period of four to five weeks after giving birth, the mother carries her single young with her to feeding sites. Young are carried on the ventral surface of their foraging mothers (Tidemann 1998). Once the young are completely furred, they are left in maternal camps and continue to be nursed until they are independent after around 12 weeks (Hall & Richards 2000).

8.43.3 Habitat

The Grey-headed flying-fox requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits (Eby 1998).

The Grey-headed flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located near water, such as lakes, rivers or the coast (van der Ree *et al* 2005). Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation (Nelson 1965; Ratcliffe 1931), but colonies also use highly modified vegetation in urban and suburban areas (Birt *et al* 1998; Tidemann & Vardon 1997; van der Ree *et al* 2005). The species can maintain fidelity to roost sites for extended periods (Lunney & Moon 1997), although new sites have been colonised (Tidemann & Vardon 1997).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- This species utilises rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands, commercial fruit crops and introduced tree species in urban areas (Eby 1998)
- The primary food source is blossom from *Eucalyptus* and related genera (Eby 1998)
- The species utilises rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation typically located near water, such as lakes, rivers or the coast for roosting (Nelson 1965; Ratcliffe 1931)

8.43.4 Anticipated threats and potential impacts from the Project

Direct impacts to this species from gas field development will be limited. This species is not resident in the gas fields area.

Threats affecting this species are outlined in Appendix A..

8.43.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.44 Koala

8.44.1 Status

Vulnerable - listed 2 May 2012

8.44.2 Biology and ecology

8.44.2.1 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 44: Koala (Source: Monkhouse 2005)

8.44.2.2 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).

Santos GLNG

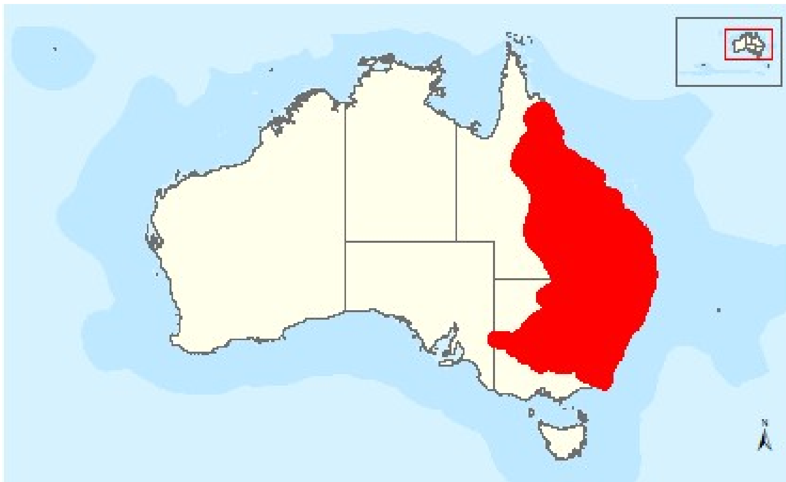

Figure 45: Mapped distribution range of Koala (Source: DOTE 2014a)

8.44.2.3 Known species populations within the gas fields

This species is known to occur within the gas fields. GFD tenements comprsing suitable habitat include: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440, and PL745 (Boobook 2015).

8.44.2.4 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).

8.44.3 Habitat

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 occuring 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).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Habitat is comprised of all regional ecosystems that are either woodlands/Open forest on non-alluvial plains and uplands or woodlands/Open forest on non-alluvial plains and uplands dominated by Myrtaceae species (particularly species of the genus Eucalyptus and Corymbia).

8.44.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Koala habitat from Project activities is 3303 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.44.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.45 Murray cod

8.45.1 Status

Vulnerable – listed 3 July 2003

8.45.2 Biology and ecology

8.45.2.1 Characteristics

The Murray cod (*Maccullochella peelii*) is the largest freshwater fish found in Australia, growing up to 1.8 m in length and weighing over 100 kg, although most commonly weighing 10 kg. It possesses a broad, depressed head with a rounded snout and a concave forehead profile. It has a large mouth and jaws that are approximately equal in length. The caudal fin is rounded and 65 to 81 scales are present in the lateral line. It is olive-green with small brown spots, rounded pectoral fins, creamy white undersides and sometimes with red on fin edges (DSEWPaC 2011y).

This species is a long-lived predator that is highly territorial and will aggressively attack any fish entering its area. The species rate of growth varies probably due to temperature, habitat and food availability; however, it does not vary between sexes. Murray cod older than five years gain 1 to 1.5 kg per year in rivers and 2 to 2.5 kg per year in warm impoundments (DSEWPaC 2011y).

Plate 45: Murray cod (Source: Schmida 2003)

8.45.2.2 Known distribution

The Murray cod is found extensively throughout the Murray-Darling Basin in the south-eastern region of Australia. Both hatchery-bred and wild caught fish have been translocated outside the natural range. The species has been introduced in the Cooper Creek system in Queensland and South Australia. In Queensland it has also been introduced to the Burnett and Fitzroy River systems (DSEWPaC 2011y).

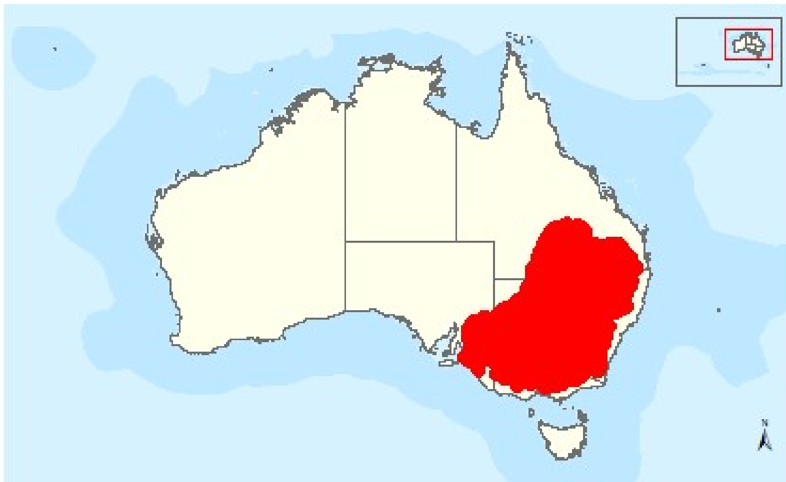

Figure 46: Mapped distribution range of Murray cod (Source: DSEWPaC 2011y)

8.45.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. Naturally occurring populations are confined to permanent water in riverine environments in the Condamine, Maranoa-Balonne, Weir and Moonie River catchments. Suitable habitat may be present in the GFD tenement ATP336.

8.45.2.4 Biology and reproduction

The Murray cod is the top predator of Australia's inland rivers. Cod are carnivorous and, at times, voracious feeders (McDowall 1996). The diet changes with age, with the typical adult diet consisting of spiny crayfish, yabbies and shrimps (National Murray Cod Recovery Team 2009). It also feeds on the following fish:

- Common carp (introduced)
- Goldfish and Redfin perch (introduced)
- Bony herring
- Catfish
- Golden perch
- Western carp gudgeon
- other Cod species

Other species found in the diet include ducks, cormorants, grebes, tortoises, water dragons, snakes, mice, frogs and mussels. Upon hatching, larvae are 5 to 8 mm long and within 8 to 10 days are able to feed on zooplankton. After reaching a length of 15 to 20 mm, they begin to feed on aquatic insects (Kearney & Kildea 2001; Native Fish 2004).

The Murray cod reaches sexual maturity at 4 to 5 years of age and at 2 to 3 kg in weight. The species has relatively low fertility compared to many other freshwater fish (Native Fish 2004). A female weighing around 3 kg can produce approximately 10,000 eggs whereas a female around 23 kg produces up to 90,000 eggs (Kearney & Kildea 2001).

The species migrates upstream prior to spawning in late spring and early summer when the water reaches a temperatue of between 16 to 21°C. This change in temperature provides the stimulus for spawning (Kearney & Kildea 2001). Murray cod form pairs prior to breeding. A spawning site is selected, usually a sunken red gum log in lowland rivers, or a submerged rock in upland streams, although Murray cod have been recorded excavating and laying eggs in depressions in clay banks as well. The female is believed to clean the breeding site with her tail before laying her large adhesive eggs as a large mat on the spawning surface. The male then squirts his milt over the eggs fertilising them (Native Fish 2004). Hatching usually occurs 5 to 7 days after fertilisation, and a batch of eggs takes 3 to 4 days to hatch (Kearney & Kildea 2001). The larvae then drift downriver, prior to the fry settling out in suitable protected habitat (TSSC 2003c).

8.45.3 Habitat

The Murray cod has the ability to live in a diverse range of habitats, including clear rocky streams to slow flowing, turbid rivers and billabongs. The Murray cod is considered a main channel specialist as it is frequently found in the main river channel and larger tributaries. It is found in floodplain channels when they contain water; although this usage appears limited. Juveniles are most commonly found in the main river channel until about one year of age, after which they branch out (National Murray Cod Recovery Team 2010).

The Murray cod is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures (National Murray Cod Recovery Team 2010).

Essential microhabitat for the Murray cod includes intact waterway habitat with complex structural cover (large rocks, snags, overhanging vegetation), main channel or high flow areas that are known or highly likely to support natural populations of this species.

The following habitat assumption has been made based on current scientific knowledge of this species:

- Murray cod habitat is comprised of deep pools and abundant rock or woody habitat features occurring within the Balonne River.

8.45.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Murray Cod habitat from Project activities is 73 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.45.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.46 Fitzroy river turtle

8.46.1 Status

Vulnerable – listed 16 July 2000

8.46.2 Biology and ecology

8.46.2.1 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 46: Fitzroy river turtle (Source: DERM 2007b)

8.46.2.2 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.

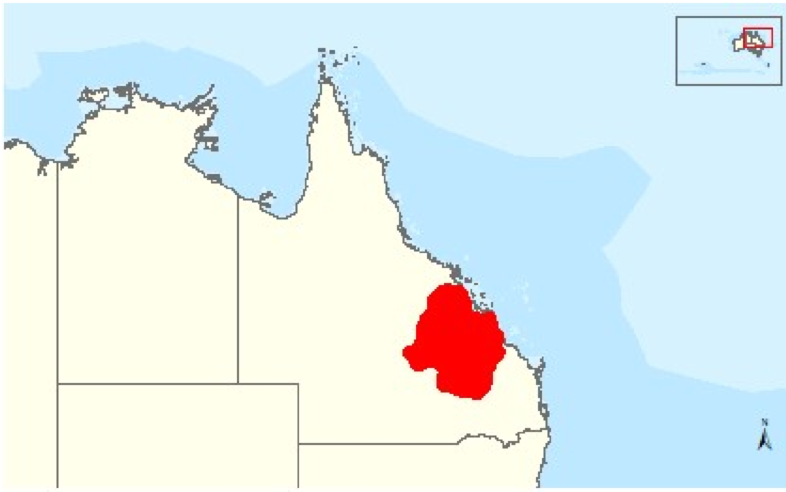

Figure 47: Mapped distribution range of Fitzroy river turtle (Source: DSEWPaC 2011aa)

8.46.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. This species is confined to the Fitzroy and Dawson River catchments, where it requires permanent water in riverine environments. It is potentially present within the following GFD tenements: ATP803 and PL232.

8.46.2.4 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).

8.46.3 Habitat

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).

The following habitat assumption has been made based on current scientific knowledge of this species:

- The Fitzroy river turtle is found in rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (DSEWPaC 2011aa) associated with the Dawson River.

8.46.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Fitzroy River Turtle habitat from Project activities is 73 hectares.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the species, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.46.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.47 Great egret

8.47.1 Status

Marine and Migratory (CAMBA/JAMBA)

8.47.2 Biology and ecology

8.47.2.1 Characteristics

The Great egret (*Ardea alba* (syn. *Ardea modesta*)) is a moderately large bird (83 to 103 cm in length, 700 to 1,200 g in weight) with white plumage, a black or yellow bill and long reddish and black legs. During the breeding season the colour of the bare parts change (DSEWPaC 2011ab).

Plate 47: Great egret (Source: Folini 2006)

8.47.2.2 Known distribution

The species is a widespread throughout southern and eastern Asia and Australasia. The species occur throughout the majority of Australia. There are no published estimates of the extent of occurrence of this species in Australia, however the area of occupancy is estimated at 408,400 km² (DSEWPaC 2011ab).

It is estimated that there are between 25,000 and 100,000 individuals within Australia. The most important populations, based on the capacity for recruitment and abundance, are the breeding populations that occur at the Top End, in the Channel Country and in the Darling Riverine Plains and Riverina regions. It should be noted that minor breeding sites are scatted across this species range, including the central Queensland Coast (DSEWPaC 2011ab). However, no known breeding sites have been documented within the Port Curtis area.

Figure 48: Mapped distribution range of Great egret (Source: DSEWPaC 2011ab)

8.47.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. GFD tenements that may comprise suitable habitat and support the species atleast periodically are ATP336R, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.47.2.4 Biology and reproduction

This species is dispersive and, in parts of its range, migratory and is often observed as a solitarily individual, or in small groups when feeding. They roost in large flocks that may consist of hundreds of birds (DSEWPaC 2011ab).

The species exhibits a diverse array of complex foraging behaviours, including foraging by wading through shallow to moderately deep water, by standing in water and capturing prey that wanders nearby, or by walking over shore or dry ground. Prey is taken from water and vegetation but not from sediments. Prey species include fish, insects, crustaceans, molluscs, frogs, lizards, snakes and small birds and mammals (DSEWPaC 2011ab).

The breeding season is variable and depends to some extent on rainfall, but generally extends from November to April. The Great egret usually nests in colonies and builds its nest as a platform of sticks in treetops over water in swampy woodlands and mangrove communities (DSEWPaC 2011ab; Pizzey & Knight 2007). These colonies can be mono-specific or more commonly mixed with other wader/waterbird species. Two to six, but usually three to five eggs are laid, with both parents incubating the eggs (23 to 29 days). Fledglings depart the nest or colony between 55 to 88 days of age (DSEWPaC 2011ab).

8.47.3 Habitat

This species is a local migrant throughout Australia and inhabits shallow points of rivers, estuaries, mudflats, freshwater wetlands, irrigated pastures, dams and sewerage ponds (Pizzey & Knight 2007).

The following general habitat assumption has been made based on current scientific knowledge of this species:

- Species is often associated with freshwater and/or saline wetlands (DSEWPaC 2011ab). As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' Wetland REs as well as ' 'riverine', lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species along with permanent anthropogenic water sources such as farm dams

8.47.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to the Great Egret from Project activities is 168 hectares of habitat.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.47.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.48 Cattle egret

8.48.1 Status

Marine and Migratory (CAMBA/JAMBA)

8.48.2 Biology and ecology

8.48.2.1 Characteristics

The Cattle egret (*Ardea ibis*) is about 70 cm in length, while the wingspan and weight vary between sexes; males have a wingspan of 91 cm and weight of 390 g, while the females have a wingspan of 88 cm and weight of 340 g (DSEWPaC 2011ac).

The species is small, stocky and mostly white with a short neck and stout yellow-red bill. During breeding and courtship the species has a heavy jowl, orange-buff crown, neck, breast and mantle. There is a marked seasonal variation in plumages during the breeding and non-breeding seasons. The juveniles are indistinguishable from non-breeding adults until the end of their first year when they may develop coloration during the breeding season (DSEWPaC 2011ac).

Plate 48 Cattle egret (Source: Garg 2008a; Vaidyanathan 2007)

8.48.2.2 Known distribution

In Australia the species is a partial migrant. Two major distributions have been located: from north-east Western Australia to the Top End of the Northern Territory and around south-east Australia. The south-east distribution occurs from Bundaberg, inland to Roma, Thargominda, and then down through Inverell, Walgett, Nyngan, Cobar, Ivanhoe, Balranald to Swan Hill, and then west to Pinnaroo and Port Augusta (DSEWPaC 2011ac).

It is estimated that there are over 100,000 individuals inhabiting Australia, New Zealand.

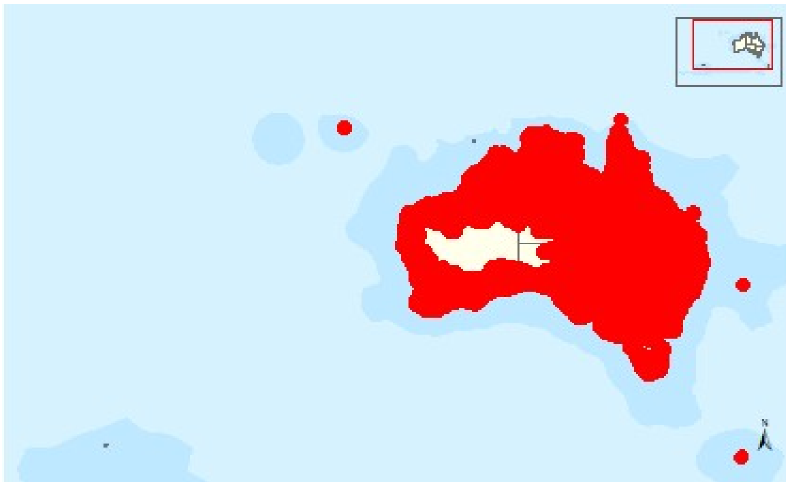

Figure 49: Mapped distribution range of Cattle egret (Source: DSEWPaC 2011ac)

8.48.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. Although a scarce visitor to south central Queensland, the following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.48.2.4 Biology and reproduction

The Cattle egret derives its name from its habit of associating with cattle (eg eating ticks and flies off the backs of livestock). The species also preys on other insects, frogs, lizards, snakes and small mammals (DSEWPaC 2011ac). Foraging normally occurs away from water on low lying grasslands, improved pastures and croplands (DSEWPaC 2011ac).

Breeding in the eastern colonies usually occurs in a well-defined period from October to January, occasionally extending by a month either side. Breeding generally occurs close to the coast from Bundaberg south (DSEWPaC 2011ac). The Cattle egret usually nests in colonies and builds its nest as a small, untidy platform of sticks in foliage in swampy woodlands (Pizzey & Knight 2007). Nests are sited usually in middle to upper branches (DSEWPaC 2011ac).

8.48.3 Habitat

This species is a local migrant throughout Australia and inhabits paddocks, pastures, croplands, garbage tips, wetlands, mudflats and drainage areas and is frequently associated with cattle (Pizzey & Knight 2007).

The species breeds in colonies in wooded swamps such as mangrove forests (eg the lower Adelaide River, Northern Territory), *Melaleuca* swamps (eg Shortland, NSW) and the eucalypt/lignum swamps of the Murray-Darling Basin. They may breed in artificial situations or close to urban areas; generally the nesting trees are inundated except where breeding on small islands (DSEWPaC 2011ac).

The following general habitat assumptions have been made based on current scientific knowledge of this species:

- Species is often associated with freshwater wetlands. As such, areas mapped as ‘riverine’, ‘lacustrine’ and ‘palustrine’ Wetland REs as well as ‘riverine’, ‘lacustrine’ and ‘palustrine’ waterbodies on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species along with permanent anthropogenic water sources such as farm dams
- The species has been identified as utilising low-lying grasslands, improved pasture and cropland as foraging habitat (DSEWPaC 2011ac). As a result of this, areas mapped as ‘non-remnant’ contained within 3 km of a wetland are considered habitat for this species

8.48.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to the Cattle Egret from Project activities is 8162 hectares of habitat.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.48.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.49 Fork-tailed swift

8.49.1 Status

Marine and Migratory (CAMBA/JAMBA/ROKAMBA)

8.49.2 Biology and ecology

8.49.2.1 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 weighs 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 49: Fork-tailed swift (Source: Francksan n.d.)

8.49.2.2 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 50: Mapped distribution range of the Fork-tailed swift (Source: DOTE 2014ac)

8.49.2.3 Known species populations and their relationship within the gas fields

This species is known to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.49.2.4 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).

Table 16: Migration period to Australia (Pizzey & Knight 2007)

Australian Migrants	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Apus pacificus (Fork-tailed swift)												

8.49.3 Habitat

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 sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines (Higgins 1999).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is aerial and hunts and courts in flight. Is reported to roost on cliffs and large trees, but also known to sleep whilst in flight (Pizzey & Knight 1997)
- This species does not breed in Australia. Breeding occurs in Siberia and the Himalayas (Pizzey & Knight 1997)

8.49.4 Anticipated threats and potential impacts from the Project

Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important Fork-tailed Swift habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.49.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.50 Sharp-tailed sandpiper

8.50.1 EPBC Act legal status

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

8.50.2 Biology and ecology

8.50.2.1 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 50: Sharp-tailed sandpiper (Source: Alnus 2007)

8.50.2.2 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 are very sparsely scattered inland, particularly in central and south-western regions (Higgins & Davies 1996).

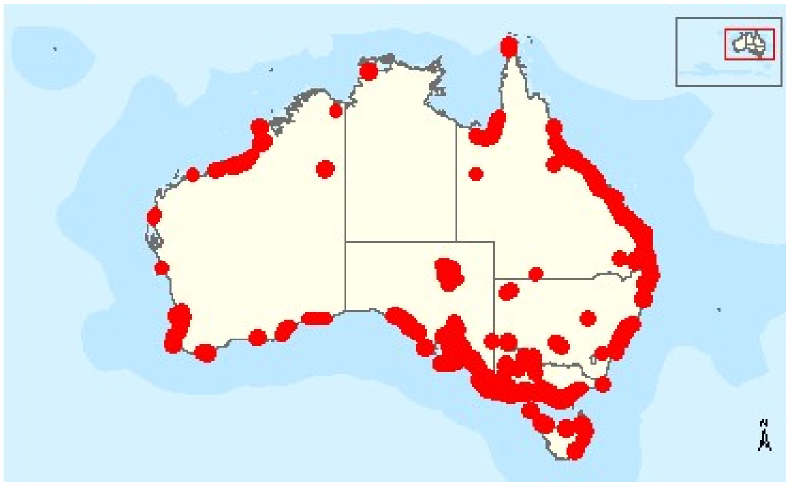

Figure 51: Distribution range of the Sharp-tailed sandpiper (Source: DOTE 2014ab)

8.50.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.50.2.4 Biology and reproduction

The Sharp-tailed sandpiper forages on seeds, worms, molluscs, crustaceans and insects (Higgins & Davies 1996).

The Sharp-tailed sandpiper is 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).

The Sharp-tailed sandpiper has been recorded eating various insects, including the larvae, and molluscs and crustaceans. They also ingest grit, sand and charcoal. They are also reported to eat arachnids and dead fish (Barker & Vestjens 1989; Higgins & Davies 1996).

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

8.50.3 Habitat

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).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species is associated with shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation (Higgins & Davies 1996)
- Species is also associated with non-remnant areas such as saltworks, sewage farms, dams and flooded paddocks (Higgins & Davies 1996)

8.50.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Marine wader habitat (including the Sharp-tailed Sandpiper) from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined Section 4.0 and Appendix A.

8.50.5 Management Practices and Methods

Management measures for this species are outlined in Section 5.0.

8.51 Latham's snipe

8.51.1 Status

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

8.51.2 Biology and ecology

8.51.2.1 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 upperwing. Adults and juveniles are indistinguishable after early November (Higgins & Davies 1996).

Plate 51: Latham's snipe (Source: Birds in Backyards 2010)

8.51.2.2 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 at 3,000,000 km^2 and the area of occupancy is estimated at 3,000 km^2 (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).

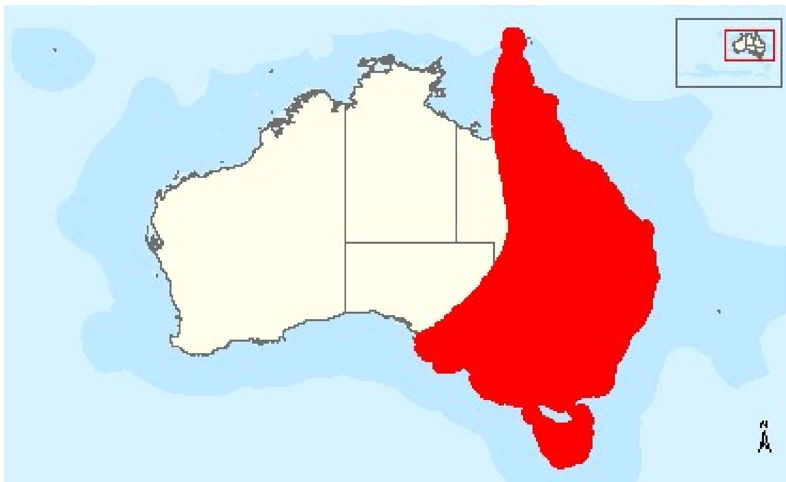

Figure 52: Mapped distribution range of Latham's snipe (Source: DSEWPaC 2011ad)

8.51.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.51.2.4 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).

8.51.3 Habitat

In Australia, Latham's snipe occurs in permanent and ephemeral wetlands up to 2,000 m above sea-level (Chapman 1969; Naarding 1981). They usually inhabit open, freshwater wetlands with low, dense vegetation (eg swamps, flooded grasslands or heathlands, around bogs and other water bodies) (Frith et al 1977; Naarding 1983; DSEWPaC 2011ad). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (Frith et al 1977; Naarding 1983).

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). They usually occur in open, freshwater wetlands that have some form of shelter (usually low and dense vegetation) nearby (Frith et al 1977; Naarding 1983; DSEWPaC 2011ad). They generally occupy 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, creek 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 occur 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, ricefields, 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 roost on the ground near (or sometimes in) their 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).

The following general habitat assumptions have been made based on current scientific knowledge of Latham's snipe:

- Species are associated with freshwater, brackish and marine riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of tidal or stream order 3 or greater waterways within 5 km of the HAT
- Species are often associated with freshwater and/or saline wetlands (DSEWPaC 2011ad). As such, areas mapped as but not limited to estuarine', 'riverine', 'lacustrine' and pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species

8.51.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Latham's Snipe habitat from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.51.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.52 White-bellied sea-eagle

8.52.1 Status

Marine and Migratory (CAMBA)

8.52.2 Biology and ecology

8.52.2.1 Characteristics

The White-bellied sea-eagle (*Haliaeetus leucogaster*) is a large raptor that has long, broad wings and a short, wedge-shaped tail. The species measures 75 to 85 cm in length, and has a wingspan of 180 to 220 cm (DSEWPaC 2011ae).

The plumage of adult birds is predominantly white and grey. The head, breast and belly, and the feathering on the legs, are white, while the back and upper surfaces of the wings are grey, with black tips. The undersides of the wings are greyish-black around the distal edges, with a smaller area of white along the leading edge. The tail is grey at the base, and has a white tip.

Juveniles differ from the adults in appearance, with juveniles having predominantly dark brown plumage on the upper parts, except for the creamy colouring on the head, and creamy markings over the rest of the upper parts. The underside of the body is a similar colour to the upper parts, but becomes paler with wear. The underside of the wing is patterned with a mixture of orange-buff, white, dark brown and dark grey. There is a gradual transition (several moults over several years) from the brown and cream plumage of juvenile birds to the white and grey plumage of the adults (DSEWPaC 2011ae).

Plate 52: White-bellied sea-eagle (Source: Issadeen 2009)

8.52.2.2 Known distribution

The species is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. The species also occurs inland along some of the larger waterways, especially in eastern Australia. Analysis indicates that distribution may shift in response to climatic conditions, with an apparent decreased occupancy of inland sites (and increased occupancy of coastal sites) during drought conditions (DSEWPaC 2011ae).

The total population size of is estimated at more than 500 pairs (DSEWPaC 2011ae). No specific information is available on the number of subpopulations. Some populations are geographically isolated, for example, the Tasmanian population; however such populations are not genetically isolated. No specific populations have been identified as being critical to the long-term survival and recovery of the species (DSEWPaC 2011ae). There is limited published data available on the population dynamics of the central Queensland populations.

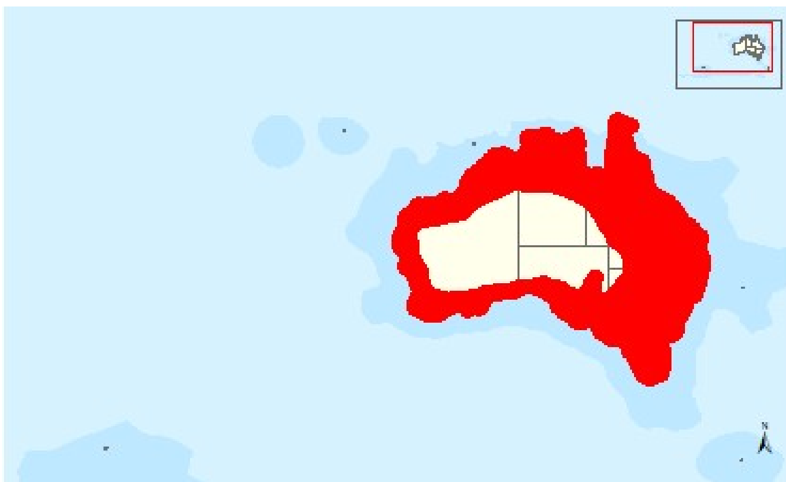

Figure 53: Mapped distribution range of White-bellied sea-eagle (Source: DSEWPaC 2011ae)

8.52.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. Preferred habitat is restricuted to the permanent waters of the Dawson and Ballonne Rivers and the following GFD tenements: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.52.2.4 Biology and reproduction

The White-bellied sea-eagle is described as a breeding resident throughout much of its distribution. The species home range, which is generally close to bodies water can be up to 100 km^2 (DSEWPaC 2011ae).

The White-bellied sea-eagle is generally seen singularly or in pairs, though it may occasionally congregate around sites where food is abundant. The White-bellied sea-eagle hunts its prey from a perch or whilst in flight, including fish, birds, reptiles, mammals and crustaceans. This species also feeds on carrion and offal feeds (DSEWPaC 2011ae).

The species first breeds at approximately six years old, with a high mortality rate in newly-independent young birds. If juveniles survive to breeding age they may live for up to 30 years (DSEWPaC 2011ae).

Breeding has been recorded from only a relatively small area of the total distribution, with patchy distribution along the coastline, and especially the eastern coast. However, the species could potentially breed throughout much of its range (DSEWPaC 2011ae).

The start of nesting season is when the species is most vulnerable, with a risk that a breeding pair could desert the nest. This species is a breeding resident throughout much of its range, with breeding adult birds generally sedentary and monogamous (DSEWPaC 2011ae). In Northern Australia, the breeding period for this species is between May and August. The nest of the White-bellied sea-eagle is quite large and often found in tall trees near water, remote coastal cliffs or on the ground on islands, bushes, mangroves, rocky outcrops, caves, crevices, on the ground and on artificial structures (Pizzey & Knight 2007; DSEWPaC 2011ae).

Table 17: Breeding period (Orange indicates breeding period) (Pizzey & Knight 2003)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Clutches for this species usually consist of two eggs, with the eggs incubated for approximately six weeks. The nestlings remain in the nest for 65 to 70 days or more, while the fledged young may be fed by the adults for up to three months after leaving the nest. Fledglings are driven out of their parents breeding territory approximately four months after fledging (DSEWPaC 2011ae).

8.52.3 Habitat

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 2011ae).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Species is associated with freshwater and/or saline wetlands (DSEWPaC 2011ae). As such, areas mapped as ‘marine’, estuarine’ and lacustrine’ Wetland Regional Ecosystems as well as ’ lacustrine’ waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered to contain the required habitat attributes for this species

8.52.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to White-bellied Sea Eagle habitat from Project activities is 2687 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.52.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.53 White-throated needletail

8.53.1 Status

Marine and Migratory (CAMBA/JAMBA/ROKAMBA)

8.53.2 Biology and ecology

8.53.2.1 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 53: White-throated needletail (Source: Bridger 2010)

8.53.2.2 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).

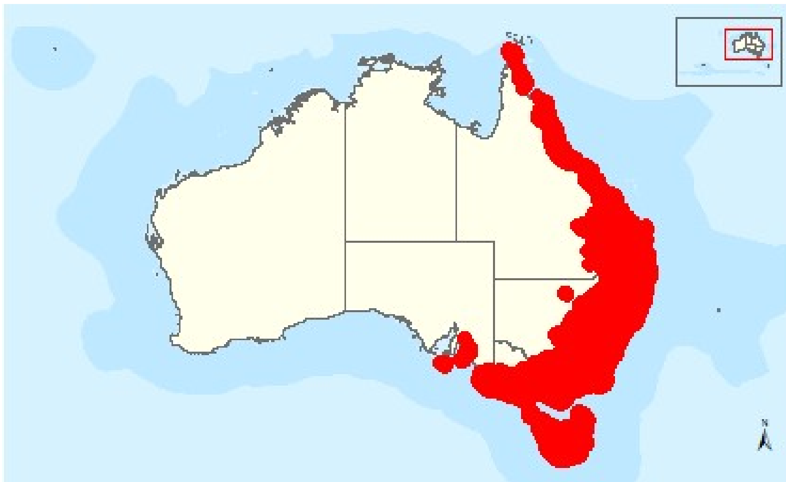

Figure 54: Mapped distribution range of White-throated needletail (Source: DSEWPaC 2011ah)

8.53.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233 PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.53.2.4 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).

8.53.3 Habitat

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.

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Although the White-throated needletail is almost exclusively aerial, it is probably recorded most often above wooded areas, including open forest and rainforest, heathland and may also fly between trees or in clearings, below the canopy (DSEWPaC 2011ah)

8.53.4 Anticipated threats and potential impacts from the Project

Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important White-throated Needletail habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.53.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.54 Rainbow bee-eater

8.54.1 Status

Marine and Migratory (JAMBA)

8.54.2 Biology and ecology

8.54.2.1 Characteristics

The Rainbow bee-eater (*Merops ornatus*) is the only species of bee-eater in Australia. The males measure 25 cm in length and the females 22 cm, including the central tail-streamers, which project 2 to 6 cm beyond the rest of the tail in the male and 1 to 2 cm in the female. The wingspan is 34 cm in the male and 31 cm in the female (DSEWPaC 2011g).

Rainbow bee-eaters have a long, slender and decurved black bill, a red iris, dark grey skin around the eye and blackish legs and feet. The adults have green or blue-green colouring on the forehead and chestnut on the back of the head. There is a bold black stripe across the eye that is bordered below by a narrower blue stripe and bright yellow colouring on the chin and cheeks that changes to chestnut around the throat and that is bordered by a conspicuous, crescent-shaped black patch on the front of the neck. The upper part of the back is bright green, merging to light blue on the lower part of the back to the base of the tail. There is bright green and light blue colouring on the upper surface of the wings, with chestnut colouring on the secondary feathers and dark brown primary feathers, light green colouring on the breast that becomes paler on the belly and that changes to light or pale blue from the lower belly to the base of the tail (DSEWPaC 2011g).

The tail is black with blue edging on the upper surface and two long, wire-like central feathers (termed streamers) that project beyond the tip of the tail. There is some slight seasonal variation in the appearance of the plumage (DSEWPaC 2011g).

Plate 54: Rainbow bee-eater (Source: Aviceda 2007)

8.54.2.2 Known distribution

It is not known if the total population of the Rainbow bee-eater is divided into a series of discrete sub-populations. Analyses have indicated that there has been little or no change in the total population size of the Rainbow bee-eater, but that there have been shifts in local abundances and, possibly, in local distributions. The mobility of the species suggests that it is unlikely that any local or regional population would be genetically isolated from the remainder of the Australian population (DSEWPaC 2011ag).

The Rainbow bee-eater can be found throughout much of mainland Australia and near-shore islands. The occurrence and occupancy of the species within Australia have not been estimated (DSEWPaC 2011ag).

Figure 55: Mapped distribution range of Rainbow bee-eater (Source: DSEWPaC 2011ag)

8.54.2.3 Known species populations within the gas fields

This species is known to occur in the gas fields. The following GFD tenements may comprise suitable habitat: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL233, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.54.2.4 Biology and reproduction

The movement patterns of the Rainbow bee-eater are complex, and are not fully understood. Populations that breed in southern Australia are migratory (ie after breeding, they move north and remain there for the winter). However, populations that breed in northern Australia are considered to be resident, and in many northern localities the Rainbow bee-eater is present throughout the year (DSEWPaC 2011ag).

The Rainbow bee-eater is primarily insectivorous usually foraging from open perches. The species may also feed on the ground, preying on worms and tadpoles (DSEWPaC 2011ag).

The Rainbow bee-eater is capable of living for up to 24 years; however there is no information on the ages of sexual maturity. The breeding season extends from August to January. Nests are located in a chamber at the end of a burrow or tunnel in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel or cliff faces (DSEWPaC 2011ag).

The species breeds in socially monogamous pairs that are sometimes assisted by a varying number of auxiliary birds or 'helpers'. The female lays a clutch of two to eight, but normally four or five, eggs which are incubated by both sexes. Incubation is for a period of 22 to 31 days. The young remain in their burrows for a period of 23 to 36 days and will continue to be fed by the adults for another two to four weeks after their first departure from the nest (DSEWPaC 2011ag).

Table 18: Breeding periods (Orange indicates breeding period) (Pizzey & Knight 2003)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

8.54.3 Habitat

This species inhabits open woodlands with sandy/loamy soils, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforest communities. On migration, the Rainbow bee-eater may also fly over the top of non-preferred habitats such as rainforest or treeless plains (DSEWPaC 2011ag; Pizzey & Knight 1997).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- Occurs mainly in open forests and woodlands, shrub lands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (DSEWPaC 2011ag). These areas are considered to constitute habitat for this species
- It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water (DSEWPaC 2011ag). It is assumed that areas that are located within but not necessarily limited to 3 km of a stream-order 3 or greater watercourse (as indicated on DEHP's mapping) provide potential habitat for this species

8.54.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Rainbow Bee-eater habitat from Project activities is 15738 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.54.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.55 Black-faced monarch

8.55.1 Status

Marine and Migratory (Bonn)

8.55.2 Biology and ecology

8.55.2.1 Characteristics

The Black-faced monarch (*Monarcha melanopsis*) ranges in size from 16 to 19 cm and has a distinctive black face that does not extend across the eyes. The dorsal parts, wings and upper breast are grey and with a rufous coloured belly. The blue-grey bill is hooked at the tip and eye is dark in colour. Young birds are similar but lack the black face, have a black bill and tend to have a brownish body and wings. The Black-faced monarch is one of the monarch flycatchers, a forest and woodland-dwelling group of small insect-eating birds, and is strictly arboreal (Pizzey & Knight 1997).

Plate 55: Black-faced monarch (Source: Armbrust 1998)

8.55.2.2 Known distribution

The Black-faced monarch occurs along the east coast of Australia. This species is located primarily on the eastern side of the Great Dividing Range, between Cape York Peninsular (Queensland) to Glendale National Park in eastern Victoria. This species is more abundant within the northern portion of its range (Pizzey & Knight 1997).

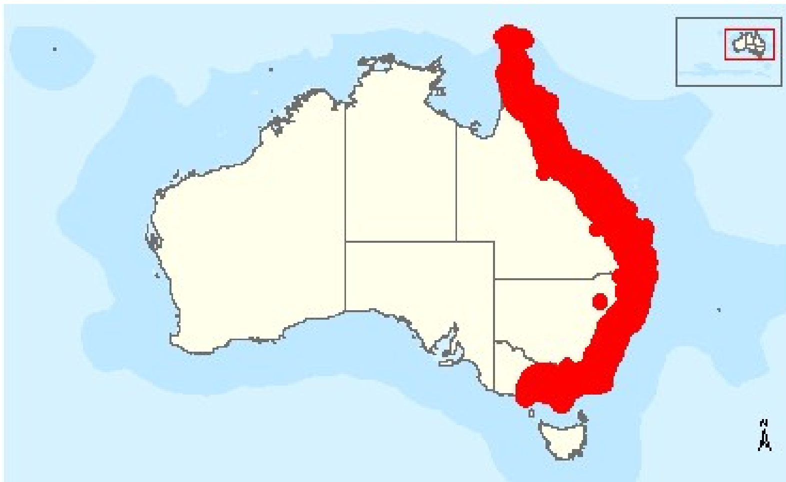

Figure 56: Mapped distribution range of Black-faced monarch (Source: DSEWPaC 2011ai)

8.55.2.3 Known species populations within the gas fields

This species is unlikely to occur within the gas fields. GFD tenements are outside the species range (Boobook 2015).

8.55.2.4 Biology and reproduction

The Black-faced monarch is a resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter (Pizzey & Knight 1997).

The Black-faced monarch forages for insects among foliage, or catches flying insects on the wing (Pizzey & Knight 1997).

The Black-faced monarch builds a deep cup nest of Casuarina needles, bark, roots, moss and spider web in the fork of a tree, about 3 to 6 m above the ground. Only the female builds the nest, but both sexes incubate the eggs and feed the young. Clutch size ranges from two to three and reproduction occurs between October and January (Pizzey & Knight 1997).

8.55.3 Habitat

The Black-faced monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest (DSEWPaC 2011ai).

The species also occurs in selectively logged and 20 to 30 years old regrowth rainforest (Laurance *et al* 1996). It is also sometimes found in nearby open eucalypt forests (mainly wet sclerophyll forests), especially in gullies with a dense, shrubby understorey as well as in dry sclerophyll forests and woodlands, often with a patchy understorey. The species especially occurs in 'marginal' habitats during winter or during passage (migration) (DSEWPaC 2011ai).

Other areas in which the Black-faced monarch may be found include gullies in mountain areas or coastal foothills (DSEWPaC 2011ai), softwood scrub dominated by Brigalow (*Acacia harpophylla*) (Leach 1995), coastal scrub dominated by Coast banksia (*Banksia integrifolia*) and Southern mahogany (*Eucalyptus* *botryiodes*) (Smith 1984), occasionally among mangroves (Draffan *et al* 1983; Storr 1984c; Diamond & Bishop 1994) and sometimes in suburban parks and gardens (Taylor & COG 1992).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is known to inhabit rainforests, eucalypt-dominated woodlands and forests and coastal scrubs in addition to damp gullies in rainforests and eucalypt forests (Pizzey & Knight 1997)

8.55.4 Anticipated threats and potential impacts from the Project

Direct impacts to this species from gas field development are considered negligible as the species distribution occurs outside of the GFD tenements.

Threats affecting this species are outlined in Appendix A.

8.55.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.56 Spectacled monarch

8.56.1 Status

Marine and Migratory (Bonn)

8.56.2 Biology and ecology

8.56.2.1 Characteristics

The Spectacled monarch (*Monarcha trivirgatus*) ranges in size from 14 to 16 cm. This species is blue-grey above, with a black face mask that extends across both eyes. The breast is rufous in colour and the underparts are white. The tail is black with white outer tips. Immature birds lack the black face and have a grey throat. The north Queensland subspecies *albiventris* has a rufous upper breast sharply defined from more extensive white underparts (Pizzey & Knight 1997).

Plate 56: Spectacled monarch (Source: Armbrust 1998)

8.56.2.2 Known distribution

The Spectacled monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. It is also found in Papua New Guinea, the Moluccas and Timor (Blakers *et al* 1984; Pizzey & Knight 1997).

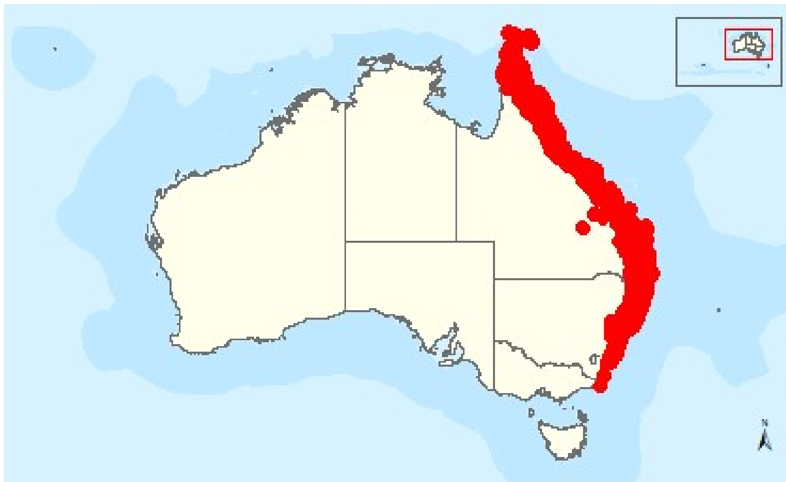

Figure 57: Mapped distribution range of Spectacled monarch (Source: DSEWPaC 2011aj)

8.56.2.3 Known species populations within the gas fields

This species is unlikely to occur within the gas fields. The GFD tenements are outside the species range (Boobook 2015).

8.56.2.4 Biology and reproduction

The Spectacled monarch is a resident in the north of its range (ie from Rockhampton in QLD northward), but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter (Pizzey & Knight 1997).

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

The Spectacled monarch builds a small cup nest of fine bark, plant fibres, moss and spider web in a tree fork or in hanging vines 1 to 6 m above the ground, often near water. Only the female builds the nest, but both sexes incubate the eggs and feed the young. Clutch size consists of two eggs. Reproduction occurs between October and February (Pizzey & Knight 1997).

8.56.3 Habitat

The Spectacled monarch inhabit both dense low vegetation and habitats with fairly open understoreys (Bravery 1970; Huggett 2000) and prefers understorey of mountain and lowland rainforests, thickly wooded gullies and waterside vegetation; mostly well below the canopy (Pizzey & Knight 1997).

The spectacled monarch forages at most levels in the forest, though most often at low or middle levels, within 6 m of the ground (Crome 1978; Hughes & Hughes 1980).

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is known to inhabit both dense low vegetation and habitats with fairly open understoreys, mountain and lowland rainforest understorey, thickly wooded gullies and waterside vegetation (Pizzey & Knight 1997)

8.56.4 Anticipated threats and potential impacts

Direct impacts to this species from gas field development are considered negligible as the species distribution does not extend to the GFD tenements.

Threats affecting this species are outlined in Appendix A.

8.56.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.57 Satin flycatcher

8.57.1 Status

Marine and Migratory (Bonn)

8.57.2 Biology and ecology

8.57.2.1 Characteristics

The Satin flycatcher (*Myiagra cyanoleuca*) ranges in size from 15 to 17 cm. This species is blue-black and white bird 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 57: Satin flycatcher female (left) and male (right) (Source: Birds Australia 2010)

8.57.2.2 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).

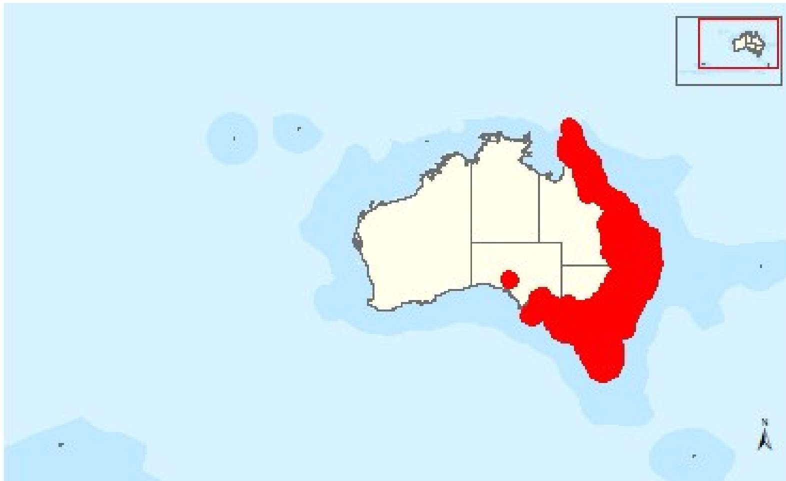

Figure 58: Mapped distribution range of Satin flycatcher (Source: DSEWPaC 2011ak)

8.57.2.3 Known species populations within the gas fields

This species is likely to occur within the gas fields. GFD tenements supporting larger tracts of native vegetation in the northern parts of the project area may present suitable habitat for this species. Relevant GFD tenements include: ATP526, ATP804, PL90, PL91, PL92, PL99, PL100, PL232, PL233, PL234, PL235, PL236, PL420 and PL440 (Boobook 2015).

8.57.2.4 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).

8.57.3 Habitat

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 occur 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)

The following habitat assumptions have been made based on current scientific knowledge of this species:

- This species is known to inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands near wetlands or watercourses (Pizzey & Knight 1997)

8.57.4 Anticipated threats and potential impacts

Threats affecting this species from gas field development are outlined in Section 4.0.

8.57.5 Unavoidable impact from the Project

Where disturbances to this species cannot be avoided, the Santos management hierarchy outlined in the Protocol (Avoidance, Minimise, Mitigate, Remediation and Rehabilitation) will be applied. Unavoidable clearing will be within the disturbance limits stipulated under the EPBC Approval and in accordance with the Protocol.

8.57.6 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.58 Eastern osprey

8.58.1 EPBC Act legal status

Marine and Migratory (Bonn)

8.58.2 Biology and ecology

8.58.2.1 Characteristics

The Eastern osprey (*Pandion cristatus*) is a medium-sized raptor (length 50 to 65 cm, wingspan 145 to 170 cm, weight 1.0 to 1.1 kg in adult males and 1.2 to 1.9 kg in adult females) (DOTE 2014ad). Adults are mainly dark-brown to blackish-brown above and white below with a white head and neck, streaked blackish-brown, a dark-brown to blackish-brown crest, a black stripe across the eye and ear, a band of reddish-brown, brown or dark-brown streaking across the breast (sparse or absent in males), a white and pale greyish-brown underwing with black carpal patches and black trim, a white to pale greyish-brown undertail, yellow irides, a black bill and white to pale grey legs and feet (Johnstone & Storr 1998; Marchant & Higgins 1993). The sexes are similar in appearance but can be distinguished when together by differences in size and plumage (females are typically larger than males and usually have darker and more distinct streaking on the breast). Juveniles are similar in appearance to adults, but can be distinguished by multiple differences in plumage and their darker, yellow-orange irides (Marchant & Higgins 1993).

Plate 58: Eastern osprey (Source: Psylexic 2007)

8.58.2.2 Known distribution

The total range (breeding plus non-breeding) around the northern coast is more widespread, extending from Esperance in Western Australia to NSW, where records become scarcer towards the south, and into Victoria and Tasmania, where the species is a rare vagrant (Barrett *et al* 2003; Blakers *et al* 1984; Johnstone & Storr 1998; Marchant & Higgins 1993; Morris *et al* 1981). The distribution of the species around the northern coast (south-western Western Australia to south-eastern NSW) appears continuous except for a possible gap at Eighty Mile Beach (Barrett *et al* 2003; Blakers *et al* 1984).

There are no published estimates of the extent of occurrence of the Eastern osprey within Australia (DOTE 2014ad) although the area of occupancy for this species in Australia is estimated at 117,400 km^2 (DOTE 2014ad).

The Eastern osprey is considered to be moderately common in Australia (Olsen 1998). The species is most abundant in northern Australia, where high population densities occur in remote areas (Garnett 1992; Johnstone & Storr 1998).

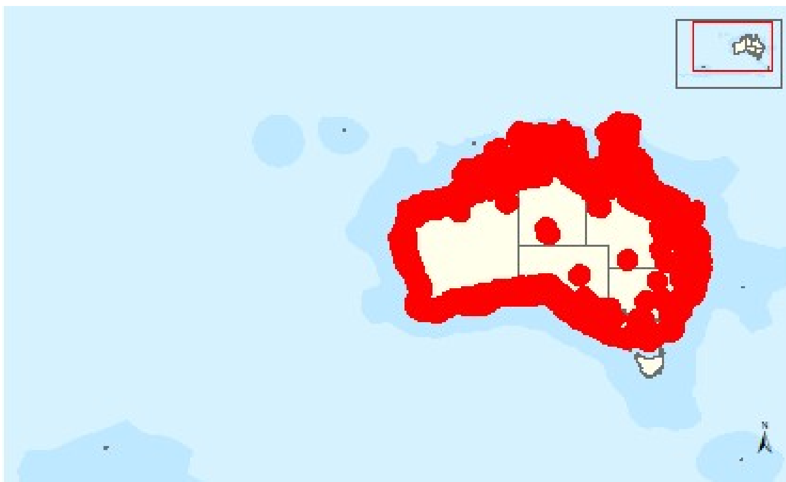

Figure 8.1 Distribution range of the Eastern osprey (Source: DOTE 2014ad)

8.58.2.3 Known species populations and their relationship within the gas fields

This species is unlikely to occur within the gas fields. Resident populations of this species are unlikely, with any individuals likely to be vagrants (Boobook 2015).

8.58.2.4 Biology and reproduction

In Australia, Eastern ospreys mainly feed on fish, especially mullet where available, and rarely take molluscs, crustaceans, insects, reptiles, birds and mammals (DOTE 2014ad).

Eastern ospreys typically breed in monogamous pairs (Marchant & Higgins 1993; Olsen 1995). The Eastern osprey breeds from April to February in Australia (DOTE 2014ad).

Eastern osprey nests vary in size and shape but they are generally large and are mostly composed of sticks (Bischoff 2001; Clancy 2006; Johnstone & Storr 1998; Kennard & Kennard 2006; Marchant & Higgins 1993; Rose 2000). They are constructed in a variety of natural and artificial sites including in dead or partly dead trees or bushes, on cliffs, rocks, rock stacks or islets, on the ground on rocky headlands, coral cays, deserted beaches, sandhills or saltmarshes and on artificial nest platforms, pylons, jetties, lighthouses, navigation towers, cranes, exposed shipwrecks and offshore drilling rigs (Bischoff 2001; Clancy 2006; Dennis 2007a; Dennis & Baxter 2006; Johnstone & Storr 1998; Marchant & Higgins 1993; Olsen 1995; Rose 2000). Nest sites may be used over many years by one or more pairs (DOTE 2014ad).

Females lay clutches of one to four (but typically two or three) eggs (Hollands 2003; Johnstone & Storr 1998; Marchant & Higgins 1993; Olsen 1995). The eggs are white to buff with brownish (and sometimes also underlying purple or grey) spots and blotches (Hollands 2003; Johnstone & Storr 1998; North 1912). They are incubated by both sexes, but mainly by the female, for a period of 33 to 38 days (Clancy 2006; Hollands 2003; Johnstone & Storr 1998; Kennard & Kennard 2006; Rose 2000).

The nestlings are brooded by the female and by the male when the female is absent from the nest. To begin with they are mainly fed by the female on food delivered by the male, but later both parents gather and supply food (Hollands 2003; Kennard & Kennard 2006; Marchant & Higgins 1993; Rose 2000). The young fledge approximately seven to eleven weeks after hatching (Dennis 2007b; Holsworth 1965; Kennard & Kennard 2006; Maciejewski 1993; Rose 2000) but continue to return to the nest for some time thereafter to be fed. The period of post-fledging dependence probably ranges from about one to two months in duration (Dennis 2007b; Hollands 2003; Kennard & Kennard 2006; Marchant & Higgins 1993; Rose 2000). Pairs usually rear one brood but are capable of rearing two broods per season (Clancy 2006; Marchant & Higgins 1993). Pairs tend not to breed each year; breeding attempts may be separated by periods of up to three years (Dennis 2007a).

8.58.3 Habitat

Eastern ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia (Johnstone & Storr 1998; Marchant & Higgins 1993; Olsen 1995). They require extensive areas of open fresh, brackish or saline water for foraging (Marchant & Higgins 1993). They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes (DOTE 2014ad). They exhibit a preference for coastal cliffs and elevated islands in some parts of their range (Boekel 1976; Domm 1977), but may also occur on low sandy, muddy or rocky shores and over coral cays (Marchant & Higgins 1993). They may occur over atypical habitats such as heath, woodland or forest when travelling to and from foraging sites (DOTE 2014ad).

Eastern ospreys occur sympatrically and sometimes interact with White-bellied sea-eagles (Barrett et al 2003; Clancy 2006; Dennis & Baxter 2006; Kennard & Kennard 2006), which is also listed as Marine and Migratory under the EPBC Act.

The following general assumptions have been made based on current scientific knowledge of this species:

- Species inhabits coasts, estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks (Pizzey & Knight 1997)
- The species also ventures far inland and ascends larger rivers, large permanent waterbodies (such as larger farm dams) (Pizzey & Knight 1997)

8.58.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Eastern Osprey habitat from Project activities is 2687 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.58.5 Specific management requirements

Management measures for this species are outlined in Section 5.0.

8.59 Glossy ibis

8.59.1 EPBC Act legal status

Marine and Migratory (CAMBA/Bonn)

8.59.2 Biology and ecology

8.59.2.1 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).

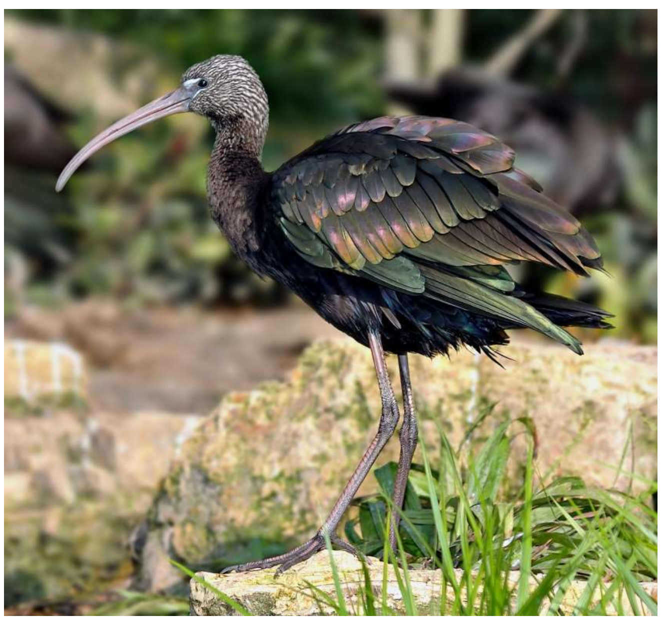

Plate 59: Glossy ibis (Source: Karatay 2007)

8.59.2.2 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 59: Distribution range of the Glossy ibis (Source: BirdLife International 2014c)

8.59.2.3 Known species populations within the gas fields

This species is known to occur in the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.59.2.4 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).

8.59.3 Habitat

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).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species is often associated with freshwater wetlands. As such, areas mapped as 'riverine', 'lacustrine' and 'pulstrine' wetland REs as well as 'riverine', lacustrine' and 'pulstrine' waterbodies on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered suitable habitat for this species

8.59.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Glossy Ibis habitat from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.59.5 Specific management requirements

Management measures for this species are outlined in Section 5.0.

8.60 Common greenshank

8.60.1 EPBC Act legal status

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

8.60.2 Biology and ecology

8.60.2.1 Characteristics

The Common greenshank (*Tringa nebularia*) is a heavily built, elegant wader, 30 to 35 cm in length, with a wingspan of 55 to 65 cm and weight up to 190 g for both males and females. The bill is long and slightly upturned and the legs are long and yellowish-green. In flight, all plumages show uniformly dark upperwing and constrasting white rump extending in a white wedge up the back, whitish tail and tips of toes projecting slightly beyond the tip of the tail. The sexes are alike (Higgins & Davies 1996).

The head and neck are white with heavy black streaking, the interwing coverts are mostly brownish-grey with white fringes. The underbody is white with fine black streaks on chin and throat and there are bold black chevrons on breast and flank. The underwing is white with faint brownish barring on covers and the bill is bluish grey or greenish grey, legs and feet are pale greyish-green (Higgins & Davies 1996).

The juveniles are like non-breeding adults but head and neck are slightly darker with heavier, darker streaking. Bare parts are similar to the adult, but juvenile legs and feet are occasionally bright pale-yellow, dull yellow or dull slate-grey (Higgins & Davies 1996).

Plate 60: Common Greenshank (Source: Aviceda 2009)

8.60.2.2 Known distribution

The Common greenshank does not breed in Australia, however, the species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia (Higgins & Davies 1996).

In Queensland, the species is widespread in the Gulf country and eastern Gulf of Carpentaria. It has been recorded in most coastal regions, possibly with a gap between north Cape York Peninsula and

Cooktown. Inland, there have been a few records south of a line from near Dalby to Mt Guide, and sparsely scattered records elsewhere (Higgins & Davies 1996).

The global population is estimated to be 440,000 to 1,500,000 (BirdLife International 2009). The East Asian-Australasian Flyway population of the Common greenshank is thought to be approximately 60,000, of which 18,000 to 19,000 spend the non-breeding season in Australia (Bamford et al 2008; Clemens et al 2008).

Figure 60: Distribution range of the Common greenshank (Source: Atlas of Living Australia 2014)

8.60.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.60.2.4 Biology and reproduction

The Common greenshank is carnivorous. In Australia is has been recorded eating molluscs, crustaceans, insects, and occasionally fish and frogs. Elsewhere, it has also been recorded eating annelids, lizards, and rodents (Higgins & Davies 1996).

The Common greenshank does not breed in Australia (DOTE 2014ae).

8.60.3 Habitat

The Common greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes, and dead or live trees. It was once recorded with Black-winged stilts (*Himantopus himantopus*) in pasture, but are generally not found in dry grassland (Higgins & Davies 1996).

The species is known to forage at edges of wetlands, in soft mud on mudflats, in channels, or in shallows around the edges of water often among pneumatophores of mangroves or other sparse, emergent or fringing vegetation, such as sedges or saltmarsh. It will occasionally feed on exposed seagrass beds (Higgins & Davies 1996).

The Common greenshank roosts and loafs round wetlands, in shallow pools and puddles, or slightly elevated on rocks, sandbanks or small muddy islets. Occasionally the species will perch and roost on stakes (Higgins & Davies 1996).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ae). As such, areas mapped as but not limited to ‘riverine’, ‘lacustrine’ and pulstrine’ Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species
- All areas identified as shorebird habitat by ‘Shorebird 2020’ are considered ‘essential habitat’ for these species

8.60.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Marine wader habitat (including the Common Greenshank) from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.60.5 Specific management requirements

Management measures for this species are outlined in Section 5.0.

8.61 Marsh sandpiper

8.61.1 EPBC Act legal status

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

8.61.2 Biology and ecology

8.61.2.1 Characteristics

The Marsh sandpiper (*Tringa stagnatilis*) is a medium sized member of the Tringinae family. It has a length of 22 to 26 cm, a wingspan of 40 to 45 cm and a weight of 70 g. In all plumages the species shows a contrasting outerwing, a very pale whitish tail and a bold white wedge up the back (Higgins & Davies 1996).

Plate 61: Marsh sandpiper (Source: Psylexic 2007)

8.61.2.2 Known distribution

The Marsh sandpiper is found on coastal and inland wetlands throughout Australia. The species is widespread in coastal Queensland, but few records exist north of Cooktown (DOTE 2014af).

In Queensland, the south-east Gulf of Carpentaria is an internationally important site, while sites of national importance in Queensland include Buffalo Lake area in Normanton, Lake Namulla in Cunnamulla and Alva Beach in Ayr (Watkins 1993).

The Marsh sandpiper has an estimated East Asian-Australasian Flyway population of 100,000 to 1,000,000. The global population is estimated at 186,000 to 1,242,000 (Bamford et al 2008).

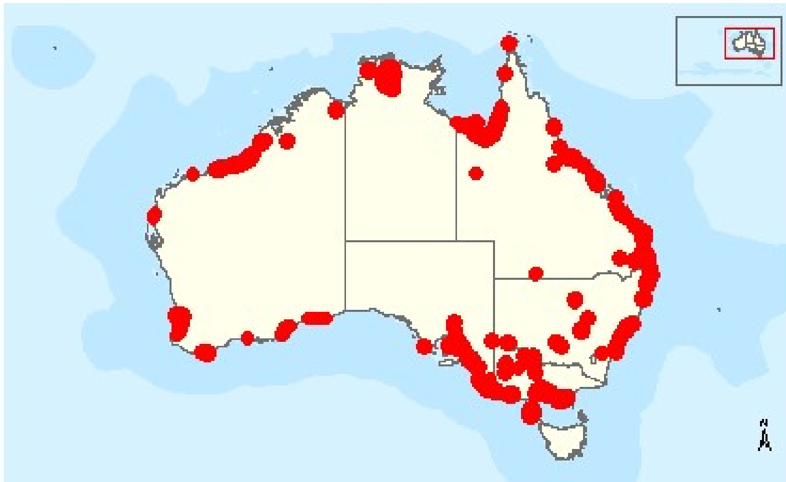

Figure 61: Distribution range of the Marsh sandpiper (Source: DOTE 2014af)

8.61.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.61.2.4 Biology and reproduction

The Marsh sandpiper is carnivorous and has been recorded eating insects, molluscs and (internationally) crustaceans. Plant material has been found in stomachs but this may have been ingested incidentally (Higgins & Davies 1996).

The Marsh sandpiper does not breed in Australia (DOTE 2014af).

8.61.3 Habitat

The Marsh sandpiper lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains and intertidal mudflats and also regularly at sewage farms and saltworks (DOTE 2014af). They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes (Pizzey & Knight 1997). They are found infrequently around mangroves (Higgins & Davies 1996).

The Marsh sandpiper usually forages in shallow water at the edge of wetlands. They probe wet mud of mudflats or feed among marshy vegetation (Higgins & Davies 1996).

The Marsh sandpiper has been recorded roosting or loafing on tidal mudflats, near low saltmarsh, and around inland swamps (Higgins & Davies 1996).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways

- Species are often associated with freshwater wetlands (DOTE 2014ae). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species
- All areas identified as shorebird habitat by 'Shorebird 2020' are considered 'essential habitat' for these species

8.61.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Marine wader habitat (including the Marsh Sandpiper) from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.61.5 Management Practices and Methods

Management measures for this species are outlined in Section 5.0.

8.62 Pacific golden plover

8.62.1 EPBC Act legal status

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

8.62.2 Biology and ecology

8.62.2.1 Characteristics

The Pacific golden plover (*Pluvialis fulva*) is a medium-sized (length 23 to 26 cm, weight 120 to 175 g) plover with long legs and an upright stance. Sexes are generally inseparable, but juveniles are separable from adults in the field (DOTE 2014ag).

In breeding plumage, adults have bold golden spots on the crown and hindneck; a white forehead, which extends as a broad supercilium that curves behind the ear coverts to the sides of the neck; and the rest of the face is black. The upperparts are blackish, boldly spotted with gold, with the tail dark brown with golden-buff bars. The underparts are black, with a broad white stripe (which continues from the sides of the neck) extending down along the sides of the breast to the flanks, where they are spotted black. The underwings are uniform brownish-grey. The bill is black, the eyes are dark brown, and the legs and feet are greyish black (Marchant & Higgins 1993).

In non-breeding plumage, the crown is dark brown with golden streaks; the nape and hindneck are similar, though slightly paler; the forehead, lores, supercilium, chin, throat and sides of the head are all golden or creamy buff. The upperparts are dark brown, heavily marked with bright golden scaly-shaped spots, while the secondary coverts are spotted white, which contrasts with the golden spots of the mantle and scapulars. The foreneck and breast are golden-buff, with grey-brown streaks, and the belly, flanks and undertail are all white with a buff tinge, and the flanks have fine grey-brown streaks. The underwings appear uniform brownish-grey (Marchant & Higgins 1993).

Juvenile birds are similar to non-breeding birds, but the patterning is neater, bolder and more even, with more golden-buff tones to the face and underparts, distinct streaking on the foreneck and barring or marbling on the breast and flanks (Marchant & Higgins 1993).

Plate 62: Pacific golden plover (Source: Harrison 2013)

8.62.2.2 Known distribution

Within Australia, the Pacific golden plover is widespread in coastal regions, though there are also a number of inland records (in all states), sometimes far inland and usually along major river systems, especially the Murray and Darling Rivers and their tributaries. Most Pacific golden plovers occur along the east coast, and are especially widespread along the Queensland and NSW coastlines (DOTE 2014ag).

There are no published estimates of the extent of occurrence of the Pacific golden plover in Australia. The estimated global extent of occurrence is 100,000 to 1,000,000 km^2 (Birdlife International 2007). The area of occupancy of the Pacific golden plover in Australia has been estimated at 46,700 km^2 (DOTE 2014ag).

The distribution of the Pacific golden plover is not fragmented, either in its breeding grounds or in its non-breeding areas (DOTE 2014ag).

The world population of Pacific golden plover has been estimated at about 209,500 (Wiersma 1996) or 170,000 to 220,000 (Birdlife International 2007).

Figure 62: Distribution range of the Pacific golden plover (Source: DOTE 2014ag)

8.62.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.62.2.4 Biology and reproduction

During the non-breeding season, Pacific golden plovers mainly eat molluscs, polychaete worms, insects and insect larvae, spiders and crustaceans (Domm & Recher 1973; Evans 1975; Frith & Calaby 1974; Vestjens 1977c). They are also said to very occasionally eat seeds, leaves, lizards, birds eggs and small fish (Marchant & Higgins 1993).

The species does not breed in Australia (Marchant & Higgins 1993; Wiersma 1996).

8.62.3 Habitat

In non-breeding grounds in Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Pacific golden plovers usually occur on beaches, mudflats and sandflats (sometimes in vegetation such as mangroves, low saltmarsh such as Sarcocornia or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. The species is also sometimes recorded on islands, sand and coral cays and exposed reefs and rocks. They are less often recorded in terrestrial habitats, usually wetlands such as fresh, brackish or saline lakes, billabongs, pools, swamps and wet claypans, especially those with muddy margins and often with submerged vegetation or short emergent grass. Other terrestrial habitats inhabited include short (or, occasionally, long) grass in paddocks, crops or airstrips, sewage ponds, sports feilds or ploughed or recently burnt areas, and they are very occasionally recorded well away from water (Marchant & Higgins 1993; Pizzey & Knight 1997).

This species usually forages on sandy or muddy shores (including mudflats and sandflats) or margins of sheltered areas such as estuaries and lagoons, though it also feeds on rocky shores, islands or reefs. In addition, Pacific golden plovers occasionally forage among vegetation, such as saltmarsh, mangroves or in pasture or crops (Bransbury 1985; Evans 1975; Ewart 1973; Pegler 1983; Smith 1966; Thomas 1968).

They usually roost near foraging areas, on sandy beaches and spits or rocky points, islets or exposed reefs, occasionally among or beneath vegetation including mangroves or low saltmarsh, or among beachcast seaweed. They sometimes also roost on levee banks and islands in evaporation ponds in saltworks (Bransbury 1985; Ewart 1973; Smith 1966; Thomas 1968; Patterson 1982; Pegler 1983; Prendergast *et al* 1985).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ag). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species

8.62.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Marine wader habitat (including the Pacific Golden Plover) from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.62.5 Management Practices and Methods

Management measures for this species are outlined in Section 5.0.

8.63 Wood sandpiper

8.63.1 EPBC Act legal status

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

8.63.2 Biology and ecology

8.63.2.1 Characteristics

The Wood sandpiper (*Tringa glareola*) is a small thin wader and member of the Tringinae family. The species has a length of 19 to 23 cm, a wingspan of 56 to 57 cm and a weight of 55 g. The species has a short straight bill and long legs. It is similiar in size to the Sharp-tailed sandpiper (*Calidris acuminate*), however has a longer neck and slimmer build, slightly longer, straighter bill and longer legs. The species is a dark grey-brown or plain brown above and spotted pailer and white below with a greyish wash on the breast. It has dark streaking on the foreneck and breasts as well as some barring on the fore-flanks. In all plumages the species shows a white supercilium, extending well behind the eye with greenish or yellow legs (Higgins & Davies 1996).

Plate 63: Wood sandpiper (Source: Harrison 2011)

8.63.2.2 Known distribution

The Wood sandpiper has its largest numbers recorded in north-west Australia, with all areas of national importance located in Western-Australia (Watkins 1993).

In Queensland there are sparsely scattered records, generally south of 17° S, but also around Cairns (DOTE 2014ah).

An estimated 100,000 to 1,000,000 Wood sandpipers occupy the East Asian-Australasian Flyway (Bamford *et al* 2008).

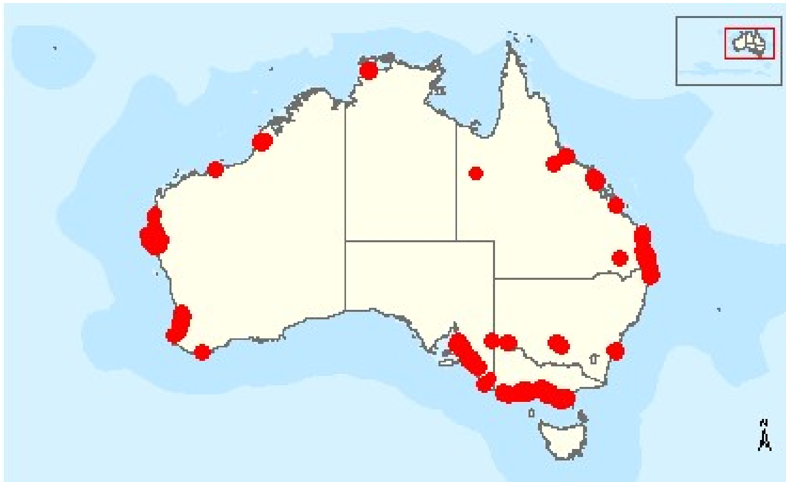

Figure 63: Distribution range of the Wood sandpiper (Source: DOTE 2014ah)

8.63.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. The following GFD tenements may comprise suitable habitat that can support the species atleast periodically: ATP336, ATP526, ATP631, ATP655, ATP665, ATP708, ATP803, ATP804, ATP868, PL3, PL6, PL8, PL9, PL11, PL90, PL91, PL92, PL93, PL99, PL100, PL176, PL232, PL234, PL235, PL236, PL309, PL310, PL314, PL315, PL317, PL320, PL322, PL420, PL421, PL440 and PL745 (Boobook 2015).

8.63.2.4 Biology and reproduction

The Wood sandpiper is carnivorous, eating mainly insects and molluscs in Australia (Higgins & Davies 1996). Elsewhere the species also eats seeds, algae, worms, crustaceans, arachnids, fish and frogs (Cramp & Simmonds 1983).

The Wood sandpiper does not breed in Australia (DOTE 2014ah).

8.63.3 Habitat

The Wood sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially *Melaleuca* and River red gums (*Eucalyptus camaldulensis*) and often with fallen timber. They also frequent inundated grasslands, short herbage or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops. They are also found at some small wetlands only when they are drying. They are rarely found using brackish wetlands, or dry stunted saltmarsh. Typically they do not use coastal flats, but are occasionally recorded in stony wetlands. This species uses artificial wetlands, including open sewage ponds, reservoirs, large farm dams, and bore drains (Higgins & Davies 1996).

The Wood sandpiper forages on moist or dry mud at the edges of wetlands, either along shores, among open scattered aquatic vegetation, or in clear shallow water (Higgins & Davies 1996).

The species has been recorded loafing on a low, grassy hillock in a flooded meadow. It has also been recorded perched low in trees and on fences (Higgins & Davies 1996).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with freshwater and brackish riparian vegetation fringing waterways (Pizzey & Knight 1997) and are associated with the riparian vegetation (20 m either side) of stream order 3 or greater waterways
- Species are often associated with freshwater wetlands (DOTE 2014ah). As such, areas mapped as but not limited to 'riverine', 'lacustrine' and pulstrine' Wetland Regional Ecosystems on the Queensland Wetland Mapping wetlands on the Queensland Wetland Mapping (Version 3.0) are considered potential habitat for these species

8.63.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Marine wader habitat (including the Wood Sandpiper) from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.63.5 Management Practices and Methods

Management measures for this species are outlined in Section 5.0.

8.64 Caspian tern

8.64.1 EPBC Act legal status

Marine and Migratory (CAMBA/JAMBA)

8.64.2 Biology and ecology

8.64.2.1 Characteristics

The largest tern in Australia, the Caspian tern (*Hydroprogne caspia*) has long, slender backswept wings and a slightly forked tail. The heavy bill is red with a dusky tip. The sexes are similar, with a body length between 53 and 60 cm long, and an average weight of 680 g (Higgins & Davies 1996).

The Caspian tern has a white body, with a black and white streaked crown from bill to nape and a short shaggy crest. The mantle and upperwings are grey and the flight feathers are darker. The eye is dark brown and legs are black (Higgins & Davis 1996). When breeding, the crown is black. Immature birds are similar to non-breeding adults. Younger birds are mottled grey and brown (Birds Australia 2010b).

Plate 64: Caspian tern (Source: Mdf 2007)

8.64.2.2 Known distribution

Within Australia, the Caspian tern has a widespread occurrence and can be found in both coastal and inland habitat (Higgins & Davies 1996).

In Queensland, the Caspian tern is widespread in coastal regions from the southern Gulf of Carpentaria to the Torres Strait, and along the eastern coast. The species has been recorded in the western districts, especially the Lake Eyre Drainage Basin, north-west to the Gulf Country north of Mt Isa and Cloncurry, there are also scattered records for central Queensland (Higgins & Davies 1996).

Breeding occurs on the Wellesley Islands in the south-east Gulf of Carpentaria, islands off the far north coast from Bird Island south to Three Isles and from islands around Shoalwater Bay including Pelican Rock south to Fairfax Island. Inland breeding records occur at Lake Bindegolly and Lake Moondarra (Chatto 2001; Higgins & Davies 1996).

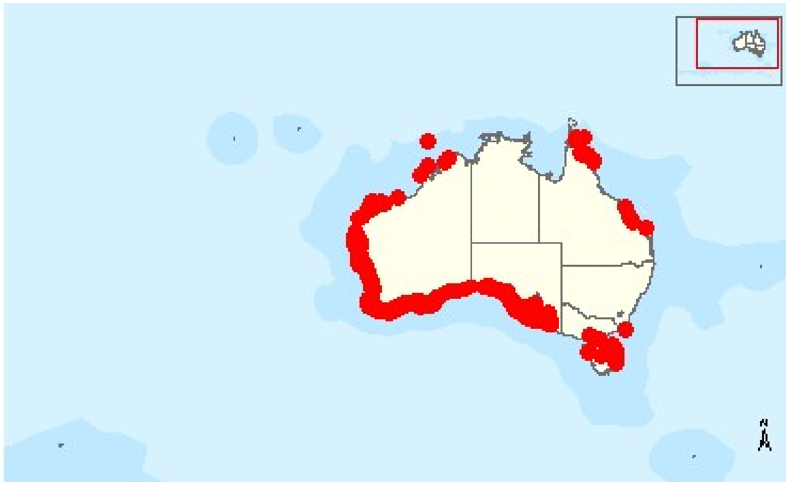

Figure 64: Distribution range of the Caspian tern (Source: DOTE 2014ai)

8.64.2.3 Known species populations and their relationship within the gas fields

This species is likely to occur within the gas fields. Suitable habitat is largely absent within the GFD area however the species may visit larger farm dams with following GFD tenements: ATP803, PL234, PL420 and PL421 (Boobook 2015).

8.64.2.4 Biology and reproduction

The Caspian tern's diet consists predominantly of fish (5 to 25 cm in length) as well as the eggs and young of other birds, carrion, aquatic invertebrates (eg crayfish), flying insects and earthworms (Birdlife International 2010c).

The age of first breeding is four years old, or occasionally three years old (Barlow 1991). Caspian terns return to their natal areas to breed (Birds Australia 2010). The species breeds between September and December in the southern Hemisphere, though timing varies in different areas (Higgins & Davies 1996).

The nest is a deep scrape on the ground, usually unlined, but occasionally sparsely ringed with debris or scraps of local vegetation such as saltbush or Pigface (*Carpobrotus rossii*). Both sexes share nest-building, incubation and care of the young (Higgins & Davies 1996). Laying is asynchronous within colonies, with eggs and young at all stages being present in a colony at the one time (Higgins & Davies 1996). Colonies of Caspian terns can be large, dense and monospecific, or single pairs or small groups (two to three pairs) in large colonies of other bird species (Birdlife International 2010c; Chatto 2001; Fuller *et al* 1994).

The clutch size is one to three eggs, usually two, incubation takes 22 days and chicks fledge in approximately 35 days (Birds Australia 2010b).

8.64.3 Habitat

The Caspian tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks. In offshore areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs (Higgins & Davies 1996).

Large numbers may shelter along the coast, behind coastal sand-dunes or coastal lakes during rough weather, and have been recorded inland after storms (Higgins & Davies 1996).

The Caspian tern usually forages in open wetlands, including lakes and rivers. They often prefer sheltered shallow water near the margins, but can also be found in open coastal waters. In coastal inlets they may prefer to forage in tidal channels, or over submerged mudbanks (Higgins & Davies 1996).

The Caspian tern breeds on variable types of sites including low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks. Nests may be in the open, or among low or sparse vegetation, including herbfield, tussocks, samphire or other prostrate sand-binding plants. They sometimes nest near bushes or other shelter such as large sticks, driftwood and piles of beachcast seagrass. Generally roosting occurs on bare exposed sand or shell spits, banks or shores of coasts, lakes, estuaries, coastal lagoons and inlets. Occasionally they nest among beachcast debris above the high-water mark or at artificial sites, including islands in reservoirs, or on dredge-spoil (Higgins & Davies 1996).

The following general assumptions have been made based on current scientific knowledge of this species:

- Species are associated with coastal and offshore waters, bays, inlets, saline or brackish lakes, saltfields, sewage ponds near the coast (Pizzey & Knight 1997)
- Species inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches (DOTE 2014ai)

8.64.4 Anticipated threats and potential impacts from the Project

Maximum disturbance to Marine wader habitat (including the Caspian Tern) from Project activities is 168 hectares. However, Project activities will not substantially modify, degrade, destroy, destroy or isolate an area of important habitat and will not seriously disrupt the lifecycle of an ecologically significant proportion of a population.

Threats affecting this species are outlined in Section 4.0 and Appendix A.

8.64.5 Management Practices and Methods

Management measures for this species are outlined in Section 5.0.

8.65 Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin

8.65.1 Status

Endangered – listed 7 January 2009

Plate 65: Natural grasslands community (Source: DSEWPaC 2012a)

8.65.2 Ecology

8.65.2.1 Characteristics

The Natural Grasslands are typically composed of perennial native grasses on soils that are fine textured (often cracking clays) derived from either basalt or fine-grained sedimentary rocks, on flat or gently undulating rises. These grasslands occur in areas with relatively high summer rainfall. The tree canopy is usually absent however where trees persist, the projective crown cover is less than 10%. Tree species that may be present as scattered individuals include *Corymbia erythrophloia* (Gum-topped bloodwood), *Eucalyptus coolabah* (Coolibah), *Eucalyptus crebra* (Narrow-leaved ironbark), *Eucalyptus melanophloia* (Silver-leaved ironbark), *Eucalyptus orgadophila* (Mountain coolibah), *Eucalyptus populnea* (Poplar box) and *Melaleuca bracteata* (Black tea-tree).

The ground layer is typically dominated by perennial native grasses and contains at least three of the following indicator species: *Aristida latifolia* (Feather-top wiregrass), *Aristida leptopoda* (White speargrass), *Astrebla elymoides* (Hoop mitchell grass), *Astrebla lappacea* (Curly mitchell grass), *Astrebla squarrosa* (Bull mitchell grass), *Bothriochloa erianthoides* (Satin-top grass), *Dichanthium queenslandicum* (King bluegrass), *Dichanthium sericeum* (Queensland bluegrass), *Eriochloa crebra* (Cup grass), *Panicum decompositum* (Native millet), *Panicum queenslandicum* (Yabila grass), *Paspalidium globoideum* (Shot grass) and/or *Thellungia advena* (Coolibah grass). In a poor season (hot summer or drought), the only visible evidence of natural grassland may be scattered tussocks that are difficult to identify. Identification and assessment of the community should therefore be made during a good season. If it can be demonstrated beyond reasonable doubt, that the grassland was derived from cleared woodland, then it is not considered a part of this TEC (DSEWPaC 2011an).

Within Queensland, eight REs have been identified as being analogous to the Natural Grasslands TEC (DSEWPaC 2011an). Table 1.1 lists these REs and provides a brief description of each RE type. Figure 1 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 19: REs analogous with Natural Grasslands TECs in Queensland

RE	RE Description
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils
11.4.4	Dichanthium spp., Astrebla spp. grassland on Cainozoic clay plains
11.4.11	*Dichanthium sericeum, Astrebla spp. and patchy Acacia harpophylla, Eucalyptus coolabah on Cainozoic clay plains*
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks
11.9.3	*Dichanthium* spp., *Astrebla* spp. Grassland on fine-grained sedimentary rocks
11.9.3a	*Dichanthium* spp., *Astrebla* spp. Grassland on fine-grained sedimentary rocks
11.9.12	*Dichanthium sericeum grassland with clumps of Acacia harpophylla on fine-grained sedimentary rocks*
11.11.17	*Dichanthium sericeum grassland on old sedimentary rocks with varying degrees of metamorphism and folding*

8.65.2.2 Known distribution

This ecological community is endemic to Queensland. It occurs where the Fitzroy River Basin and the Brigalow Belt North coincide, extending from Collinsville in the north to Carnarvon National Park in the south, bounded to the south by the Expedition, Carnarvon, Great Dividing, Drummond and Narrien ranges; and to the north by the Clark, Denham, Connors and Broadsound ranges (DSEWPaC 2011an). It occurs within IBRA subregions 6, 9, 10, 11, 12 and 13 of the Brigalow Belt North and subregions 1 and 9 of the Brigalow Belt South subregions.

8.65.2.3 Biology and reproduction

Climatic factors can cause large and seasonal fluctuations in species dominance and cover in grassland communities (Wilson *et al* 2002). For example in Bluegrass communities, the extent of seedling recruitment of Mitchell grasses and Queensland bluegrass is affected by previous climatic conditions (Austin & Williams 1988). Curly mitchell grass requires a high rainfall event in spring (at least 100 mm) followed by a similar rainfall in autumn and suitable rain the following winter to establish large numbers of seedlings. Queensland bluegrass germinates and establishes in dense populations under warm-season rainfall and will out-compete Curly mitchell grass seedlings and attain dominance in the grasslands during favourable seasonal conditions. Because of these differing requirements, in some years plants of the shorter-lived Queensland bluegrass may be almost or totally absent from Bluegrass communities and the vegetation dominated by Mitchell grasses. Winter rainfall also results in the germination of a large suite of 'cool-season' forb species whereas summer rains favour annual grass species such as *Iseilema membranaceum* (Small flinders grass) (Austin & Williams 1988).

8.65.3 Known TEC populations and their relationship with the gas fields

Grasslands are known to occur within the gas fields. Their potential presence is more likely in the northern GFD tenements (Fairview and Arcadia).

8.65.4 Anticipated threats and potential impacts as a result of the Project

Maximum disturbance to this TEC from Project activities is 288 hectares.

Threats affecting this TEC are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the community, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.65.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

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

8.66.1 Status

Endangered – listed 4 April 2001

Plate 66: Brigalow TEC community (Source: DEHP 2013)

8.66.2 Ecology

8.66.2.1 Characteristics

The Brigalow 'threatened ecological community' (TEC) is characterised by either the dominance or co-dominance 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. 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) (DSEWPaC 2011ao).

The Brigalow TEC is commonly associated with heavy clay soils (ie deep gilgaied clays, sedentary clays, alluvial clays, miscellaneous deep clays and loamy), are relatively fertile and tend to have a high salt content. In Queensland, the soils are primarily cracking clays, but texture contrast soils are common where *Eucalyptus* species are co-dominant. 85% of listed Brigalow community remnants in Queensland occur on flat to gently undulating Cainozoic clay plains not associated with current alluvium, and on gently undulating landscapes. About 10% of remnants are associated with river and creek flats and the remainder are found on old loamy and sandy plains, basalt plains and hills or hills lowlands on metamorphic or granitic rocks. Cracking clay soils, which are characteristic of Brigalow TEC soils, provide shelter for various mammals and reptiles. Woody debris and other litter on the ground also provides important habitat for some faunal species, especially reptiles (cited in DSEWPaC 2011ao).

Within Queensland, 16 REs have been identified as being analogous to the Brigalow TEC (DSEWPaC 2011ao). Table 2.1 lists these REs and provides a brief description of each RE type. Figure 2 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 20: REs analogous with Brigalow TECs in Queensland from DSEWPaC (2011ao)

RE	Description
6.4.2	*Casuarina cristata* +/ *Acacia harpophylla* open forest on clay plains
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
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
12.8.23	*Acacia harpophylla* open forest on Cainozoic igneous rocks
12.9-10.6	*Acacia harpophylla* open forest on sedimentary rocks
12.12.26	*Acacia harpophylla* open forest on Mesozoic to Proterozoic igneous rocks

8.66.2.2 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 (DSEWPaC 2011ao). Figure 2 outlines an indicative distribution of Brigalow TEC in Queensland.

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 ecological community 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 DSEWPaC 2011ao).

8.66.2.3 Biology and reproduction

Acacia harpophylla and *Casuarina cristata* are generally the dominant species within most of the REs analogous to the Brigalow TEC. Therefore, the overall biology of the Brigalow TEC reflects patterns of seasonal growth and flowering as determined by these species. Brigalow flowers between April and

October with the production of viable seed requiring cross-pollination between trees. Seeds normally mature in late spring, early summer and generally remain viable for less than a year. In Queensland germination and establishment require good rainfall following seed set. Where Brigalow has been initially cleared without further treatment, it will sucker from the root systems of the original plants, with this regrowth growing faster than Brigalow seedlings (cited in DSEWPaC 2011ao). These areas of Brigalow regrowth have the ability to provide suitable offsets for the clearing of Brigalow TECs where these areas do not currently fulfil the definition of the Brigalow TEC.

8.66.3 Known TEC populations and their relationship with the gas fields

Brigalow is known to occur within the gas fields. It has the potential to occur within all GFD project tenements.

The identified Brigalow is variable in condition from small low quality patches with considerable weed invasion to very large good quality patches with little evidence of disturbance. 'Endangered' HVR vegetation has potential to be included within this community.

8.66.4 Anticipated threats and potential impacts as a result of the Project

Maximum disturbance to Brigalow TEc from Project activities is 179 hectares.

Threats affecting this TEC are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the community, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.66.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.67 Semi-evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions

8.67.1 Status

Endangered – listed 4 April 2001

Plate 67: SEVT TEC community (Source: EPA 2007)

8.67.2 Ecology

8.67.2.1 Characteristics

The Central Semi-evergreen Vine Thicket (SEVT) 'threatened ecological community' (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 (DSEWPaC 2011ap). 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 (DSEWPaC 2011ap).

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 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) (DSEWPaC 2011ap).

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* (DSEWPaC 2011ap).

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* (DSEWPaC 2011ap).

Within Queensland, 10 REs have been identified as being analogous to the SEVT TEC (DSEWPaC 2011ap). Table 3.1 lists these REs and provides a brief description of each RE type. Figure 3 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 21: REs analogous with SEVT TECs in Queensland from DSEWPaC (2011ap)

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

8.67.2.2 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). Figure 3 outlines an indicative distribution of Brigalow TEC in Queensland based on current DEHP certified RE mapping.

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).

8.67.2.3 Biology and reproduction

The SEVT TEC usually occurs as discrete patch within other vegetation types, including *Acacia harpophylla* forest. These TECs occupy the drier portion of the natural range of closed canopy vegetation communities, and the gradient from humid to sub-humid environments is reflected in the reduction of both canopy height and structural and floristic complexity. In rocky locations the canopy tends to be lower and more open. Adaptations to drier environments include smaller, thicker leaves, swollen roots and stems, and an optional deciduous habit.

SEVT TECs are generally fire sensitive and often rely on *Acacia harpophylla*, and other vegetation, to serve as a buffer to prevent the incursion of fires into the SEVT community.

SEVT ecosystems rely on a variety of dispersal modes for regeneration and recruitment.

The seeds of many canopy emergent species are dispersed by wind, while some seeds of the lower canopy and ground layer species are dispersed by frugivores (fruit-eating animals). SEVT ecosystems are known to be important habitat for numerous bird species and they provide a refuge for wildlife in times of fire and climate change (EPA 2007).

8.67.3 Known TEC populations and their relationship with the gas fields

SEVT is known to occur within the gas fields, particularly in the northern GFD tenements (Fairview and Arcadia) where it is associated with areas of topographical relief.

The identified SEVT is variable in condition from small low quality patches with considerable weed invasion to very large good quality patches with little evidence of disturbance

It should be noted that RE mapping is not sufficiently robust to capture all the area of this community (ie RE mapping is based on a minimum area of 2 ha, community characteristics) and that this community may occur in areas mapped as regrowth and non-remnant under DERM's mapping.

8.67.4 Anticipated threats and potential impacts as a result of the Project

Maximum disturbance to SEVT from Project activities is 190 hectares.

Threats affecting this TEC are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the community, an offset will be applied in accordance with the Offset Management Pland and the EPBC offsets policy.

8.67.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.68 The Community of Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin

8.68.1 Status

Endangered – listed 4 April 2001

Plate 68: Native Species Dependent on Natural Discharge of Groundwater from the Great Artesian Basin TEC community (Source: EPA 2005)

8.68.2 Ecology

8.68.2.1 Characteristics

The Great Artesian Basin (GAB) is a hydrogeological basin that underlies an area of about 1.7 million square kilometres, primarily beneath arid and semi-arid regions of Queensland, New South Wales, South Australia and the Northern Territory (Cox & Barron 1998). The groundwater comes to the surface at points within Great Artesian Basin discharge areas which are the natural surface discharge points of aquifers. The discharge points and their associated wetland areas are variously called springs, artesian springs, mound springs, mud springs, boggomoss springs (springs with raised mounds of organic matter), spring pools and groundwater seeps (TSSC 2001). The size of discharge spring wetlands in Queensland range from 100 cm^2 to 3 ha, with most spring wetlands less than 0.05 ha in area (Fensham & Fairfax 2003).

The native species that comprise the ecological community are assemblages of plant and animal taxa associated with and dependent on the springs and wetland areas located at points where the Great Artesian Basin groundwater is discharged naturally. The species include plants and animals that are endemic to one or more springs/wetlands and species that occur more widely in the Great Artesian Basin (TSSC 2001) or beyond it. Springs in South Australia and New South Wales appear to be floristically similar, but distinct from those in Queensland. Species in common include *Cyperus laevigatus*, *Phragmites australis* and *Eriocaulon carsonii*. Species apparently restricted to Great Artesian Basin discharge spring wetlands in Queensland include *Eragrostis fenshamii* (previously known as *Eragrostis* sp., *Myriophyllum artesium*, *Pennisetum alopecuroides*, *Schoenus falcatus* and *Sporobolus pamelae* (Fensham *et al* 2004).

Within Queensland, six REs have been identified as being analogous to the SEVT TEC (DSEWPaC 2011aq). Table 4.1 lists these REs and provides a brief description of each RE type. Figure 4 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 22: REs analogous with SEVT TECs in Queensland from DSEWPaC (2011aq)

RE	Description
2.3.39	Springs on recent alluvium
4.3.22	Springs on recent alluvia and fine-grained sedimentary rock
5.3.23	Springs on recent alluvia and fine-grained sedimentary rocks
6.3.23	Springs on recent alluvia, ancient alluvia and fine-grained sedimentary rock
10.3.31	Artesian springs emerging on alluvial plains
11.3.22	Springs associated with recent alluvia, but also including those on fine-grained sedimentary rocks, basalt, ancient alluvia and metamorphic rocks

8.68.2.2 Known distribution

The Great Artesian Basin underlies an area approximately 1.7 million square kilometres primarily beneath arid and semi-arid regions of Queensland, New South Wales, South Australia and the Northern Territory (Cox & Barron 1998).

The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin TEC is associated with 12 spring supergroups located in discharge areas on the northern, western and southern margins of the Great Artesian Basin in Queensland, New South Wales and South Australia (Fensham *et al* 2010).

8.68.2.3 Biology and reproduction

Spring wetlands may form vegetated swamps or vegetation may be absent if there is no water seepage (Fensham *et al* 2010). The vegetated area can vary with spring flow, water salinity level, stock grazing and trampling, sediment deposition or removal (by flood or wind), minor diversion of spring tails, surface and near-surface water subsidies in a wet period, and the establishment of root or rhizome caps on small vents (DSEWPaC 2011aq).

Vegetation patterns, including micro-patterning, vegetation height and species present, may be related partly to variations in substrate, water chemistry, water depth and water flow rate. Water chemistry can determine whether some species are present or not (DSEWPaC 2011aq).

Springs are highly dynamic biological systems on a time-scale in the order of years to decades. Floristic composition and diversity vary with the physical location of springs, the number of springs in a spring-group or spring-complex, water salinity, the presence/absence of grazing by domestic stock, flooding following major rainfall events, and short-term and long-term changes in spring water flow (DSEWPaC 2011aq)).

8.68.3 Known TEC populations and their relationship with the gas fields

This community is known to occur in the gas fields. It is present within the Fairview GFD tenements.

8.68.4 Anticipated threats and potential impacts as a result of the Project

Disturbance to this community is not authorised.

Threats affecting this TEC are outlined in Section 4.0 and Appendix A.

8.68.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.69 Weeping Myall Woodlands

8.69.1 Status

Endangered – listed 7 January 2009

Plate 69: Weeping Myall Woodlands TEC community (Source: NSW Catchment Management Authority 2013)

8.69.2 Ecology

8.69.2.1 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 the 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, six REs have been identified as being analogous to the Weeping myall TEC (DSEWPaC 2011ar). Table 5.1 lists these REs and provides a brief description of each RE type. Figure 5 is a map showing the distribution of these REs using DEHP's RE mapping.

Table 23: REs analogous with Weeping myall woodland TECs in Queensland from DSEWPaC (2011ar)

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

8.69.2.2 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),

The extent of Weeping myall woodlands in Queensland is thought to have declined by approximately 75% (DEWHA 2009).

8.69.2.3 Biology and reproduction

Weeping myall woodlands can vary in structure throughout its range. In higher rainfall areas it typically forms an open woodland. As rainfall decreases the ecological community becomes increasingly restricted, tending to sparse or scattered stands of woodland occurring in discrete bands fringing better-watered country. It can also occur as relatively narrow strips on the margins of floodplain woodland or on minor depressions or run-on areas adjacent to sandhills (White *et al* 2002).

Weeping myall flowers from March to May but the intensity and timing is variable between years (Santos 2007)

8.69.3 Known TEC populations and their relationship with the gas fields

Only scattered individuals or small clumps of *Acacia pendula* have been found in the GFD Project area. However, this community may still occur as a component of RE 11.3.2 in all project tenements.

8.69.4 Anticipated threats and potential impacts as a result of the Project

Maximum disturbance to Weeping Myall Woodlands from Project activities is 517 hectares.

Threats affecting this TEC are outlined in Section 4.0 and Appendix A.

Where disturbance results in a significant residual adverse impact to the community, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.69.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

8.70 Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions

8.70.1 Status

Endangered – listed 1 March 2011

Plate 70: Coolibah – Black Box Woodlands TEC community (Source: Ausecology 2012)

8.70.2 Ecology

8.70.2.1 Characteristics

The Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (Coolibah – Black box) 'threatened ecological community' (TEC) is characterised by occurrences of one type of semi-arid to humid subtropical woodland where *Eucalyptus coolabah* subsp. *coolabah* (Coolibah) and/or *Eucalyptus largiflorens* (Black box) are the dominant canopy species and where the understorey tends to be grassy. The ecological community is associated with the floodplains and drainage areas of the Darling Riverine Plains and the Brigalow Belt South bioregions (Threatened Species Scientific Committee (TSSC) 2011c).

The Coolibah – Black box TECs are found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees (NSW Scientific Committee 2009). The TEC occurs on a landscape of flat to low relief where small changes in slope and height can influence the species composition. Parts of the TEC associated with drainage depressions and gilgai, or areas of lower floodplain, remain inundated for longer periods than parts of the TEC associated with higher floodplain areas of the distribution (TSSC 2011c).

The structure of the TEC may vary from tall woodland in riparian zones to very open woodland with a sparse mid layer of shrubs and saplings and a grassy ground layer (TSSC 2011c).

Typically the TEC forms mosaics with grasslands, shrublands and wetlands (NSW Scientific Committee 2009). The structure and composition varies depending on topography and flooding or disturbance history. Some species vary in abundance in an east-west direction across the range of the community, although the overall floristic character of the community is maintained across its range (NSW Scientific Committee & Mackenzie 2008).

The TEC naturally exists in a range of states, reflected by differences in vegetation structure partly in response to natural influences such as flooding history and seed bank availability, but also due to disturbances through human activities. States in which Coolibah – Black box woodlands exist include (TSSC 2011c):

- Structurally intact old growth with mature trees and native ground layer (very rare mature woodland)
- Structurally intact mature stands (thinned stands where trees may have been naturally thinned or ringbarked and coppiced approximately 50 to 100 years ago)
- Dense regrowth, with or without mature trees, with intact native groundcover (typically after flood events)
- Tree canopy removed but native groundcover intact (derived native grassland)
- Isolated paddock trees with relictual groundcover (degraded grassland)
- Native trees and ground cover removed or almost so (cropland, improved pasture)

Canopy species are composed of *Eucalyptus coolabah* subsp. *coolabah* (Coolibah) which must be present and is typically a dominant or subdominant tree species. Where Coolibah is not the dominant tree species present on its own, then Coolibah together with *E. largiflorens* (Black box) make up the dominant tree species in the canopy (TSSC 2011c).

Other tree species may occur in the tree canopy but are not dominant in the ecological community, except as small localised stands within patches of the ecological community. These include *Acacia salicina* (Cooba), *Acacia stenophylla* (River cooba), *Casuarina cristata* (Belah), *Eremophila bignoniiflora* (Eurah), *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus populnea* (Poplar box) (TSSC 2011c).

Medium to tall shrubs are typically sparse to absent in many areas of this TEC. Where a mid-layer is present it may include one or more of the following species: *Alectryon oleifolius* subsp. *elongatus* (Western rosewood), *Alstonia constricta* (Bitterbark), *Chenopodium nitrariaceum* (Nitre goosefoot), *Eremophila mitchellii* (Budda), *Geijera parviflora* (Wilga), *Muehlenbeckia florulenta* (Lignum) and *Rhagodia spinescens* (Spiny saltbush) (Benson *et al* 2006, Benson 2008, NSW Scientific Committee 2009). *Exocarpos aphyllus* (Leafless ballart) may be a common component of the shrub layer in localised areas of NSW and southern Queensland. *Acacia cambagei* (Gidgee) and Lignum may be common shrubs on lower floodplain areas such as stream channels and in depressions (TSSC 2011c).

On higher floodplain areas and over much of the community Western rosewood, *Apophyllum anomalum* (Warrior bush) and *Capparis mitchellii* (Wild orange) commonly tend to form a sparse mid layer (TSSC 2011c).

The ground layer is dominated by native graminoids, other herbs, chenopods and other small shrubs. The native species present may include the graminoids: *Astrebla lappacea* (Curly mitchell grass), *Cyperus victoriensis* (Yelka), *Dactyloctenium radulans* (Button grass), *Dichanthium sericeum* (Queensland bluegrass), *Eleocharis* spp. (Spike-rushes), *Eragrostis setifolia* (Neverfail), *Panicum decompositum* (Native millet), *Paspalidium distans* and *Paspalidium jubiflorum* (Warrego summer grass); and the herbs: *Daucus glochidiatus* (Native Carrot), *Marsilea drummondii* (Common nardoo), *Plantago cunninghamii* (Sagoweed), *Portulaca oleracea* (Pigweed), *Pycnosorus globosus* (Drumsticks), *Tetragonia tetragonioides* (New Zealand spinach) and *Tribulus* spp. (Caltrop). Chenopods include *Atriplex* spp., *Einadia nutans* subsp. *nutans* (Climbing Saltbush) and *Sclerolaena* spp. (TSSC 2011c).

Within Queensland, five REs have been identified as forming part of or aligning with the Coolibah – Black box TEC. Table 3.1 lists these REs and provides a brief description of these RE types. Figure 6 is a map showing the distribution of this RE using DEHP's RE mapping.

Table 24: REs analogous with Coolibah – Black box woodlands TEC in Queensland (TSSC 2011c)

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* +/- *Acacia harpophylla* woodland to low open woodland on alluvial plains
11.3.28	*Eucalyptus coolabah* +/- *Casuarina cristata* open woodland on alluvial plains
11.3.37	*Eucalyptus coolabah* fringing woodland on alluvial plains

There may be some variants recognised within these REs that are not part of the TEC. For instance RE 11.3.15a *Muehlenbeckia florulenta* low shrubland +/- scattered *Eucalyptus coolabah* trees is excluded because the vegetation mainly comprises a lignum shrubland without Coolibah (TSSC 2011c).

Elements of the Coolibah – Black box TEC may extend into other REs, such as parts of RE 11.3.27 Freshwater Wetlands, where the wetlands are associated with fringing woodland, sometimes with Coolibah (TSSC 2011c).

8.70.2.2 Known distribution

The Coolibah – Black box TEC is 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 (IBRA V6.1), situated in northern NSW and southern Queensland (TSSC 2011c).

The southern limit of the TEC is the southern boundary of the Darling Riverine Plains bioregion in NSW. The northern limit is the northern boundary of the Brigalow Belt South bioregion in Queensland (TSSC 2011c).

The TEC is likely to occur in the Catchment Management Authorities / Natural Resource Management Regions of Border Rivers Maranoa-Balonne, Condamine, Desert Channels, Fitzroy and South-West Queensland in Queensland (TSSC 2011c).

The TEC is likely to occur in the Local Government Areas (LGAs) of Balonne, Banana, Barcaldine, Blackall, Tambo, Central Highlands, Goondiwindi, Maranoa, Murweh, Rockhampton and Western Downs in Queensland (TSSC 2011c).

It is primarily located within the Brigalow Belt Bioregion (ie Bioregion 11). Figure 5 outlines an indicative distribution of Coolibah – Black box TEC in Queensland based on current DEHP certified RE mapping.

8.70.2.3 Biology and reproduction

The Coolibah – Black box TEC has developed in response to the wetting and drying cycles predominantly due to flood wetting rather than local rainfall (Cullen *et al* 2003).

Some species persist in the seed bank and only germinate, grow and reproduce in response to flooding (Capon & Brock 2006), whereas other long-lived species, including Coolibah and Black box, require specific inundation patterns for germination and establishment of seedlings (Roberts & Marston 2000).

Flooding for Coolibah associated with floodways is highly variable, brief and most likely in summer or autumn. Coolibah tolerates long dry interflood conditions as well as periodic flooding. Coolibah is intolerant of long-term water-logged soils or flooding. Broad scale regeneration follows certain flood events. Coolibah may be adapted to regenerate after late summer flooding, as germination rates are high in high temperatures (Roberts & Marston 2000, Nairn *et al* 2009).

Black box, which grows higher on the floodplain, has adaptations and characteristics that favour growth and survival under dry conditions, such as very low transpiration rates, small canopy leaf area and pendulous leaf habit that reduce water demand. Tree death of Black box can result from long periods without flooding, as a result of lack of water and accumulation of salt, in addition to extended periods of flooding/inundation (12 to 18 months) (Roberts & Marston 2000, Nairn *et al* 2009).

Groundcover will fluctuate greatly depending on seasonal conditions. Many species in the semi-arid environment are more rainfall dependant (eg year-long green perennials such as *Austrodanthonia* spp.) than having any regular seasonality of growth and flowering. Changes in season or rainfall can also change the relative dominance of ground layer species (Benson *et al* 2006, Benson 2008).

Flooding can stimulate the dense regeneration of Coolibah, Black box and other species from the soil seed bank. Many dense stands of Coolibah – Black box woodlands can be linked with specific flood events (Maher 1995). As the dense regeneration matures, the seedlings undergo self-thinning leading to a progressively more open tree canopy over time, which may be over a 100 year timeframe (Maher 1995).

Fires are rare in Coolibah – Black box woodlands. Little is known about historical fire regimes in the ecological community, however, an appropriate fire regime may be decades between burns (Benson *et al* 2006, Benson 2008). It is thought that more regular, low intensity fires may have contributed to a sparser ecological community to what is mostly evident today, as fires would have prevented establishment of some seedlings (Maher 1995, DEHP 2012d).

8.70.3 Known TEC populations and their relationship with the gas fields

This community is known to occur within the gas fields. Coolibah – Black box woodlands are prevalent as large good quality patches in ATP803 associated with the Dawson River. This TEC may also be present in smaller patches in ATP708, PL9, PL10 and ATP631.

8.70.4 Anticipated threats and potential impacts as a result of the Project

Maximum disturbance to Coolibah-Black Box Woodlands from Project activities is 124 hectares.

Threats affecting this TEC are outlined in Section 4.0 and Appendix A.

Where the disturbance results in a significant residual adverse impact to the community, an offset will be applied in accordance with the Offset Management Plan and the EPBC offsets policy.

8.70.5 Management practices and methods

Management measures for this species are outlined in Section 5.0.

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