Australia Pacific LNG Project

Volume 3: Pipeline

Chapter 8: Terrestrial Ecology

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8. Terrestrial ecology

8.1 Introduction

8.1.1 Purpose

Australia Pacific LNG will develop its coal seam gas (CSG) resources within the Walloons gas fields in south central Queensland, to supply its proposed liquefied natural gas (LNG) facility on Curtis Island near Gladstone via a main gas transmission pipeline (the gas pipeline). The gas fields, gas pipeline and LNG facility constitute the Australia Pacific LNG Project (the Project).

This chapter assesses the potential terrestrial ecology impacts associated with the construction, operation and decommissioning of the proposed gas pipeline on these values within a national, state, regional and local context. The chapter also outlines proposed management measures to avoid, or minimise and mitigate such impacts.

The assessment of the potential impacts on terrestrial ecology associated with development of the pipeline has been conducted in accordance with the environmental impact statement (EIS) terms of reference for the Project. More information about the terrestrial ecology assessment is available in Volume 5 Attachment 15, while the aquatic ecology assessment is discussed in Volume 3 Chapter 9.

The development of the gas pipeline has the potential to impact on the local flora and fauna located within the gas pipeline corridor. Australia Pacific LNG will be guided by the Australia Pacific LNG sustainability principles when identifying potential impacts the Project may have on local biodiversity values. Of Australia Pacific LNG's 12 sustainability principles, the relevant principles to terrestrial ecology in the gas fields include:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas.
- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

Under these principles, potential impacts on biodiversity values will be identified during detailed desktop assessment and dedicated field surveys. Where practicable, these impacts will be avoided by altering the alignment and reducing the corridor width in sensitive areas. In instances where impacts cannot be avoided, mitigation of unavoidable impacts will occur through the development of management plans and offsets strategies promoting rehabilitation and ecological sustainability.

Throughout the planning, design, construction and operation of the gas pipeline, ongoing monitoring of identified biodiversity values will be conducted to ensure long term sustainability of the local flora and fauna.

Cumulative impacts which consider the combined effects of the Project and other known CSG developments within the surrounding area are addressed in Volume 3 Chapter 25.

8.1.2 Scope of work

The scope of work for this chapter is to:

- Identify key flora and fauna values of the gas pipeline corridor through desktop and field studies. These values include ecological and vegetation communities, flora and fauna species, fauna habitat types and movement corridors, weeds and animal pest species and other areas of ecological significance
- Identify potential impacts on these ecological features and values that may result from activities associated with the gas pipeline
- Identify appropriate mitigation measures to avoid and minimise potential impacts on these ecological features and values.

8.1.3 Legislative and policy framework

Key legislation and planning objectives relative to the protection and management of terrestrial ecology in the project area are based on national, state and regional/local laws and policies.

- Australian Government
  - *Environment Protection and Biodiversity Conservation Act 1999*
- Queensland Government
  - *Coastal Protection and Management Act 1995*
  - *Environmental Protection Act 1994*
  - *Sustainable Planning Act 2009*
  - *Land Protection (Pest and Stock Route Management) Act 2002*
  - *Nature Conservation Act 1992*
  - *Vegetation Management Act 1999*
  - *Water Act 2000*
- Local and regional context
  - Curtis Coast Regional Coastal Management Plan 2003
  - Calliope Shire Council Planning Scheme 2007
  - Murilla Shire Council Planning Scheme 2006
  - Taroom Shire Council Planning Scheme 2006
  - Banana Shire Council Planning Scheme 2005.

Australian Government

Environment Protection and Biodiversity Planning Act

The *Environment Protection and Biodiversity Planning Act 1999* (EPBC Act) provides for the identification and management of matters of national environmental significance including threatened flora and fauna species, ecological communities, migratory species protected under international

treaties, internationally recognised significant wetlands and critical habitat areas. This Act is further discussed in Volume 1 Chapter 2.

Queensland Government

Environmental Protection Act

The *Environmental Protection Act 1994* provides the framework to manage the environment within the principles of ecologically sustainable development. The Act outlines responsibility and the duty of care all persons have to the environment and the scope and content for preparing environmental protection policies.

Sustainable Planning Act

The *Sustainable Planning Act 2009* provides the framework for Queensland's planning and development assessment system. It aims to achieve ecological sustainability by managing the process by which development takes place, managing the effects of development on the environment and continue the coordination and integration of planning at the local, regional and state levels.

Coastal Protection Management Act

The *Coastal Protection and Management Act 1995* provides for the protection, conservation, rehabilitation and management of the coast and all its resources and biological diversity. This Act provides the coordinated and integrated management and administrative framework for ecologically sustainable development in the coastal zone.

Nature Conservation Act

The *Nature Conservation Act 1992* (NC Act) provides a comprehensive strategy for the conservation and management of Queensland's native animals and plants.

Vegetation Management Act

The *Vegetation Management Act 1999* (VMA) regulates the clearing of native vegetation including remnant vegetation, regulated regrowth vegetation, vegetation in declared areas and essential habitat. The objective of the VMA is to prevent land degradation and loss of biodiversity caused by clearing, maintain ecological processes and reduce greenhouse gas emissions.

Land Protection (Pest and Stock Route Management) Act

The *Land Protection (Pest and Stock Route Management) Act 2002* provides for the management of pests on land and the management of the stock route network. This Act identifies state-declared plants (weeds) and animal pests and the management requirements of landholders to control these species.

Water Act

The *Water Act 2000* provides for the sustainable management of water and other resources and the establishment and operation of water authorities.

Local and regional context

Curtis Coast Regional Coastal Management Plan

The *Curtis Coast Regional Coastal Management Plan 2003* provides the framework to manage the Curtis Coast region and guides DERM's decisions regarding coastal development and management.

Local government planning schemes

Planning schemes provide a framework for managing development in a way that advances the purposes of the *Sustainable Planning Act 2009* by identifying assessable and self-assessable development and outcomes sought within the local government areas. These local authority schemes have no powers in relation to the gas pipeline but their conservation intents need to be considered. The gas pipeline alignment transects a number of regional councils, as outlined in Volume 3 Chapter 6.

8.2 Methodology

The terrestrial ecology assessment consisted of two stages – a desktop study followed by a field assessment of the gas pipeline alignment.

In this assessment, kilometre points (KPs) for the Condabri Lateral are given with the prefix 'Con' (e.g. KP Con 28.5), those for the Woleebee Lateral are given with the prefix 'Wol' (e.g. KP Wol 28.5) and those for the main line are given no prefix (e.g. KP 28.5). For the purposes of this assessment, the following terminology applies.

- The *gas pipeline* refers to the main gas transmission pipeline, including the Condabri and Woleebee laterals and the marine crossing at The Narrows
- The *gas pipeline study area* refers to the broad study area, approximately 60km wide as defined by the petroleum survey license
- The *gas pipeline corridor* refers to the 10km wide area that has been used for the desktop assessments
- The *gas pipeline route* refers to the 100m wide area used for ground-truthing studies
- The *gas pipeline alignment* refers to the indicative centre line of the main gas transmission pipeline route, as defined for the purposes of the EIS
- The *gas pipeline right of way* refers to the proposed Australia Pacific LNG gas pipeline construction area, which will be a maximum of 40m wide.

8.2.1 Desktop review

A review of current literature and government agency databases was undertaken for the gas pipeline study area to identify the key flora and fauna values known or likely to occur within or adjacent to the study area. Data sources reviewed included:

- The Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) protected matters search tool
- The Queensland Herbarium flora collection records (HERBRECS)
- The Queensland Museum fauna collection records

- The Birds Australia database
- The Queensland Department of Environment and Resource Management (DERM) Wildlife Online database
- The DERM regional ecosystem (RE) and regrowth vegetation mapping and current satellite imagery
- The Directory of Important Wetlands database
- The DERM essential habitat and environmentally sensitive area mapping
- The DERM biodiversity planning assessment and associated expert panel reports
- Non-statutory conservation agreements and action plans
- Regional and local plans and planning schemes
- Previous studies of the gas pipeline study area.

8.2.2 Field studies

Whereas the desktop assessment investigated values within the gas pipeline corridor, field studies focused on a 100m wide corridor (the gas pipeline route) centred on the gas pipeline alignment, but also assessed surrounding areas where relevant (such as to identify options for avoiding certain ecological constraints along the gas pipeline route).

8.2.3 Flora assessment

A flora field survey was undertaken by WorleyParsons' botanists during two separate periods from 26 September to 6 October 2009 and 15 to 30 October 2009 and included:

- Investigation of the presence/absence or likely presence/absence of endangered, vulnerable or rare (EVR) flora species and communities identified from the desktop assessment
- Investigation of the presence of regionally significant vegetation communities
- Ground-truthing of 149 sites, mostly within RE types mapped along the gas pipeline alignment
- Opportunistic significant species surveys during the field assessment.

Of the 149 field sites surveyed, 46 sites were assessed to the Tertiary level and 103 sites were assessed to the Quaternary level in accordance with the methodology outlined by the Queensland Herbarium (Neldner et al. 2005). Ground-truthing surveys were undertaken in accordance with the Queensland Herbarium methodology and data collected are compatible with the Queensland Herbarium's CORVEG database. Survey sites were distributed so as to sample environmental variability along the alignment. Locations of flora field survey sites are illustrated in Volume 5 Attachment 15.

8.2.4 Fauna assessment

The fauna field assessment was conducted over several periods in 2009:

- 14 to 17 April (Curtis Island, four days as part of LNG facility site surveys)
- 7 to 8 September (Callide Infrastructure Corridor, two days)
- 24 September to 6 October (11 days)

- 7 to 9 October 2009 (Curtis Island, three days as part of LNG facility site surveys)
- 16 to 29 October (13 days).

The field assessment focused on habitat assessments of selected sites (refer to Volume 5 Attachment 15). Representative habitats along the alignment were chosen for inspection, based on the following parameters to increase the likelihood of fauna observation:

- Occurrence of forested patches and other fauna habitats (e.g. riparian habitats and wildlife corridors) determined from the results of the desktop study
- Preferred habitat for EVR and regionally significant fauna identified from database searches, predicted from RE mapping combined with satellite imagery interpretation.

A total of 174 sites were visited and assessed along the gas pipeline alignment, including six sites along the Curtis Island section of the gas pipeline route conducted as part of the LNG facility site fauna assessment. Detailed fauna habitat assessments were conducted at 63 sites and general habitat observations recorded at a further 111 sites. Habitat assessments quantified a range of habitat features, whereas general habitat observations comprised a less detailed overview of habitat features and quality. A total of 26 days (plus seven days on Curtis Island, as part of the LNG facility site surveys) were spent assessing fauna habitat and recording fauna during the field study.

Habitat assessments were supplemented by opportunistic searches for fauna and fauna signs at each site. Survey techniques employed included:

- Visual and audio (such as bird and frog calls) identification
- Dedicated searches under rocks, logs, bark and leaf litter for reptiles
- Dedicated searches of likely faunal hotspots such as riparian vegetation, sources of water (e.g. dams, creeks) and rocky areas
- Dedicated searches for animal signs (such as scats and tracks)
- Opportunistic and incidental observations
- Anabat electronic recording of bat calls, with one of these units used and set to record all night from approximately dusk until dawn[1].

Anabat call recording for microbats was conducted at five sites:

- KP Con 11.5 (Dogwood Creek)
- KP Con 36.7 (Bottle Tree Creek)
- KP 103.4 (Fairyland)
- KP 257.8 (Callide Timber Reserve, Callide Range)
- KP 263.6 (Collards Creek, Callide Range).

8.2.5 Conservation significance

Terrestrial flora and fauna species, vegetation and ecological communities and non-native species of significance were defined as:

[1] Analysis and identification of bat calls was carried out by Greg Ford.

- Threatened ecological communities are those listed under the EPBC Act as critically endangered, endangered or vulnerable
- REs are those listed under the VMA as endangered, of concern or least concern
- 'At threshold' REs refer to those REs listed under the Regional Vegetation Management Code for the relevant bioregions
- Regulated regrowth vegetation refers to high value regrowth as described under the VMA
- EVR species are those listed under the EPBC Act and/or NC Act as critically endangered, endangered, vulnerable, rare or near threatened
- Fauna species not listed as EVR under the EPBC Act and/or NC Act but identified as high or critical priority by the Back on Track framework (DERM 2008) have been included as EVR fauna in this assessment. Flora species listed under the Back on Track framework have also been recognised
- Regionally significant flora species are those not considered EVR but listed under a non-statutory conservation agreement, action plan or regional plan
- Regionally significant fauna are defined as those taxa identified by EPA (2002) as non-EVR priority taxa for the Brigalow Belt South Bioregion or the South-east Queensland Bioregion (for the Curtis Island section of the alignment). Also included in regionally significant fauna are those taxa that have not been listed as EVR fauna under the EPBC Act or NC Act, but have been listed in the relevant action plan as vulnerable, rare, near threatened, insufficiently known or data deficient
- Species of other conservation significance are those not considered endangered, vulnerable and rare (EVR) or regionally significant but are listed under Commonwealth or Queensland legislation including marine plants protected under the Queensland *Fisheries Act 1994* and migratory protected species listed under the EPBC Act. Species identified as having cultural, economic or recreational significance are also considered under this category
- Significant weed species are those listed under the national weeds strategy or declared by the state.

All other native flora and fauna species have been designated as common.

8.2.6 Assumptions and limitations

In the preparation of this flora and fauna assessment, the following assumptions and limitations have been made:

- The assessment is based on DERM RE mapping (Version 6.0) and Regulated Regrowth Vegetation mapping (Version 2.0) and the RE description database (Version 6.0 November 2009)
- The existing Queensland Herbarium (QH) RE mapping has been used on the basis that it is correct except in those locations where site-specific surveys identified inaccuracies at the local scale. It was not possible to ground-truth all mapped remnant vegetation along the gas pipeline alignment due to time and access constraints
- Existing QH RE mapping and noted inaccuracies with this mapping have been used to determine proposed clearing requirements for the gas pipeline route and existing mapping was used to estimate the total area of each RE type occurring within the gas pipeline corridor. Fauna

habitat mapping has been derived from the same sources and is subject to similar assumptions and limitations

- All clearing calculations have been based on a maximum right of way width of 40m
- It is recognised that information gained from database searches and included in the desktop components of this assessment has caveats attached to it regarding its robustness or completeness. Queensland Herbarium HERBRECS data are based on specimens actually recorded as present in the given locations. The absence of any specimen records for a particular species from an area does not imply the species does not occur in that area. Data from the DEWHA EPBC Protected Matters Search are based on a combination of actual records combined with modelled distributions of species according to the ecological characteristics of those species
- As detailed targeted field surveys were not undertaken, the precautionary approach was adopted throughout this assessment. As such, any species that could potentially occur within the study area (as identified through ecological databases together with habitat assessments and the knowledge of the botanists and fauna ecologists) has been assumed to occur in the study area.

Access constraints meant that some sections of the alignment could not be assessed during the field study. Key sections that were assessed in the desk top study but not the field study include:

- The mainland section of the alignment within the Gladstone State Development Area from the Bruce Highway (KP 325.2) to Friend Point (KP 354.5)
- The Calliope Range (KP 281.5-282.1) at the western end of the Callide Common Infrastructure Corridor
- KP 114 (Ross Creek) to KP 144 (Horse Creek), east of Cracow.

The field assessment was carried out during late September and October 2009, with some preliminary assessment on the Curtis Island section of the route conducted during April 2009. Little or no rainfall occurred during the majority of the field assessment and almost all of the creeks were dry at the time of the assessment, with the remainder having only small, isolated waterholes. As such, the conditions were not suited for the surveying of some fauna (such as amphibians) and flora. A precautionary approach has been adopted to account for this variability.

Marine-restricted fauna species, such as whales, dolphins, dugong, marine turtles and sea snakes, have been excluded from this terrestrial ecology assessment and are specifically addressed in Volume 3 Chapter 12.

This assessment focuses on the preferred gas pipeline alignment as described in the project description (Volume 3 Chapter 3), with limited assessment of some proposed sites for temporary accommodation facilities and laydown areas.

8.3 Existing environment

8.3.1 Bioregional context

The gas pipeline alignment travels across the South East Queensland (SEQ), Brigalow Belt South (BBS) and Brigalow Belt North (BBN) bioregions. However, the majority (97.4%) of the alignment is located within the Brigalow Belt South (BBS) bioregion. Across the three bioregions, the alignment intersects nine different subregions. The subregions transected by the gas pipeline alignment and the

corresponding areas of the right of way within each subregion are described in Table 8.1. The location of the gas pipeline alignment is shown in Figure 8.1.

Table 8.1 Subregions the gas pipeline alignment transects

Subregion	Bioregion*	Location (KPs)	Length (km)
Burnett - Curtis Hills and Ranges	SEQ	356 - 359.8	3.8
Taroom Downs	BBS	Wol 20.6 - Wol 29.2, Wol 33.7 - Wol 37, Con 42.8 - Con 44, 0 - 0.9, 5.1 - 7.3, 10.4 - 26.6, 28.9 - 29.3, 30.7 - 35.8	38.2
Callide Creek Downs	BBS	223.9 - 251.9	28.1
Barakula	BBS	Wol 18.8 - Wol 20.4, Wol 29.2 - Wol 33.7, Con 0 - Con 42.8, 0.9 - 5.1, 7.3 - 10.4, 26.6 - 28.9, 29.3 - 30.7, 35.8 - 89.6	113.0
Southern Downs	BBS	Wol 0 - Wol 18.8, Wol 20.4 - Wol 20.6	19.1
Banana - Auburn Ranges	BBS	93.3 - 97.4, 97.9 - 98.5, 99.9 - 101.5, 103.8 - 223.9	126.4
Carnarvon Ranges	BBS	89.6 - 93.3, 97.4 - 97.9, 98.5 - 99.9, 101.5 - 103.8	8.3
Mount Morgan Ranges	BBS	251.9 - 346.8	95.3
Marlborough Plains	BBN	346.8 - 354.4	7.6

*BBS = Brigalow Belt South, BBN = Brigalow Belt North and SEQ = South East Queensland

The climate of the Brigalow Belt South is subhumid to semi-arid. Vegetation in the bioregion is dominated by eucalypt woodlands and open forests, cypress pine (*Callitris glaucophylla*), grasslands (*Dichanthium* spp.), Brigalow-Belah forests (*Acacia harpophylla*, *Casuarina cristata*) and semi-evergreen vine thicket.

The condition and trend of the subregions located on the extensive plains is poor and declining, while areas in ranges tend to be in reasonable condition and relatively stable (Australian Natural Resource Atlas (ANRA) 2009).

The Brigalow Belt North and South bioregions have been identified as one of Australia's 15 National Biodiversity Hotspots, due to the presence of important habitat for a range of rare and threatened species and communities (DEWHA 2009). The identified biodiversity hotspots comprise areas with a high diversity of locally endemic species and that contain particularly high levels of biodiversity under threat (DEWHA 2009).

LNG facility Location
GLADSTONE
CALLIOPE
Dawson Hwy
Fitzroy
Dev Rd
Callide Timber Reserve
Kroombit Tops National Park
Biloela
Moura
Dawson Hwy
Theodore
Main gas pipeline
Monto
Isla Gorge National Park
Fitzroy
Dev Rd
Hwy
Precipice National Park
Leichhardt
Eidsvold - Theodore Rd
Borania State Forest
Rockybar State Forest
Taroom
Mundubbera
Wandoan
Barakula State Forest
Woleebee Lateral
Condabri Lateral
Roma - Taroom Rd
Gurulmundi State Forest
ROMA
Warrego Highway
Miles
Chinchilla
350
300
250
200
150
100
50
0

149.00 149.50 150.00 150.50 151.00
-24.00 -24.50 -25.00 -25.50 -26.00 -26.50

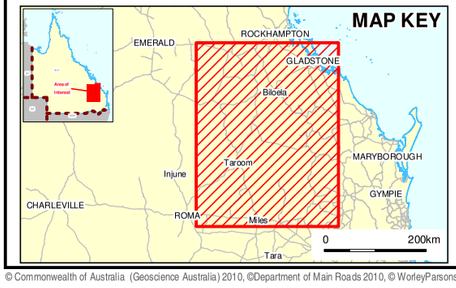
LEGEND

- Major towns
- Pipeline kilometre point
- Road
- Railway
- Major watercourses
- Gas pipeline route
- LNG facility location

Protected Areas

- Conservation park
- Forest reserve
- National park recovery
- National park
- National park scientific
- Resources reserve
- State forest
- Timber reserve

MAP KEY



Source Information

Cadastre and Easements
Department of Natural Resources and Water, Queensland 2009

Protected Areas (Queensland_estates)
Environmental Protection Agency 2009

Gas Pipeline Route
Provided by Origin Energy 03/11/2009

0 25 50km

SCALE - 1 : 1,000,000 (at A3)
Latitude / Longitude
Geocentric Datum of Australia 1994

N

AUSTRALIA PACIFIC LNG PROJECT

Volume 3 Chapter 8
Figure 8.1 Proposed Alignment

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8.3.2 Environmentally sensitive areas

Environmentally sensitive areas (ESAs) have been identified and mapped by DERM including: national parks, nature refuges, state forests and forest reserves. The alignment has been selected to avoid areas of high ecological value wherever practicable, including national parks and conservation parks.

The gas pipeline alignment will transect the Callide Timber Reserve between KPs 254 – 258.2 and the Targinie State Forest between KPs 347.4 – 347.8. No other national or conservation park, state forest or timber reserve, nature refuge or Ramsar-listed wetland of international significance is located within the alignment. Environmentally sensitive areas located within 5km of the alignment are listed in Table 8.2.

Table 8.2 Environmentally sensitive areas within 5km of gas pipeline alignment

Environmentally sensitive areas	Distance from alignment (m)	Location (KP) at closest point
Stones Country Resource Reserve	1,050	Wol 2.9
Gurulmundi State Forest	75	Wol 7
Cherwondah State Forest	1,730	Wol 19.4
Binkey State Forest	1,090	Wol 23.8
Quandong State Forest	300	9.7
Cooaga State Forest	60	30
Barakula State Forest	520	33.9
Mundell State Forest	2,050	50
Rockybar State Forest	200	97.9
Borania State Forest	950	108.4
Camboon State Forest	1,080	131.3
Belmont State Forest	2,120	210.8
Callide Timber Reserve	transected	254 - 258.2
Calliope Range State Forest	290	281.6
Scrubby Mountain State Forest	3,480	345.7
Targinie State Forest	transected	347.4 - 347.8
Curtis Island State Forest	4,000	355
Great Barrier Reef QLD World Heritage Property	transected	354.4
Great Barrier Reef QLD - National Heritage Property	transected	354.4
Narran Lake Nature Reserve (Ramsar Wetland)*	430,000	Con 1
Shoalwater and Corio Bays Area (Ramsar)*	89,000	346

*Indicates that the alignment is within 5km of a catchment for the listed Ramsar wetland.

Essential habitat for EVR flora and fauna comprises vegetation in which an EVR species has been known to occur. Essential habitat in Queensland has been mapped by DERM using biological and/or non-biological habitat requirements of a particular EVR species. Locations where the alignment transects (or passes immediately adjacent to) essential habitat are listed in Table 8.3.

Table 8.3 Essential habitat transected by or in the vicinity of the alignment

KPs	Location	Species
254.5	near Kilburnie Road and the Anglo Coal Haul Road, Callide Timber Reserve	*Desmodium macrocarpum*
266.0–268.4	near Collards Creek, Callide Range	*Cycas megacarpa*
271.0	near Coal Road	*Cycas megacarpa*
281.5–282.1	Calliope Range	*Cycas megacarpa*
341.5–343.0	Gladstone State Development Area	*Graptophyllum excelsum*, *Macropteranthes leiocaulis*, *Cupaniopsis shirleyana*, *Hernandia bivalves*
357.6–357.8	Curtis Island	Koala
358.5–358.8	Curtis Island	Koala

The gas pipeline alignment has been selected to avoid major watercourses and wetlands. No Ramsar wetlands occur along or adjacent to the gas pipeline alignment. However, the alignment transects the Great Barrier Reef World Heritage Area between KPs 354.4 to 359.7.

The alignment also intersects two wetland areas listed on the Directory of Important Wetlands Database, Port Curtis and The Narrows. These areas are recognised for their diverse, structured mangrove communities, seagrass populations and importance as wader bird habitat. They also contain marine plant populations protected under the Queensland *Fisheries Act 1994*, further discussed in Volume 3 Chapter 10.

8.3.3 Flora species diversity

The gas pipeline alignment offers habitat for a diverse range of flora species. A total of 222 flora species were identified along the gas pipeline alignment during the field survey, including four EVR species, ten species identified as regionally significant and 21 non-native species. The gas pipeline alignment predominately transects non-remnant vegetation as well as remnant eucalypt, *Acacia* and *Callitris* woodland. Other vegetation types including vine thickets and mangrove forests are also transected in smaller areas in the north of the alignment.

8.3.4 Ecological/vegetation communities

The gas pipeline alignment predominantly traverses extensive cleared areas interspersed with patches of remnant vegetation . The gas pipeline right of way contains approximately 433ha of remnant vegetation belonging to 43 different REs. Most of the vegetation is comprised of eucalypt-dominated woodlands (326.4ha); although, other communities are represented. The REs transected by the alignment are listed in Figure 8.2 and the location and extent of all regional ecosystems is discussed in Volume 5 Attachment 15 and the locations and extents of all regional ecosystems is shown in Figure 1 to Figure 17 in Volume 5 Attachment 15.

149.00 149.50 150.00 150.50 151.00

24.00 24.50 25.00 25.50 26.00 26.50

Mount Morgan
Curtis Island
LNG facility location
GLADSTONE
350
300
Dawson Hwy
Baralaba
250
Biloela
Moura
Dawson Hwy
200
Main gas pipeline
Monto
Theodore
150
Eidsvold - Theodore Rd
100
Taroom
50
Wandoan
0
0
Taroom Rd
Roma
Woleebee Lateral
Condabri Lateral
ROMA
Warrego Highway
0
Miles
Chinchilla

0 25 50km

SCALE - 1 : 1,000,000 (at A3)
Latitude / Longitude
Geocentric Datum of Australia 1994

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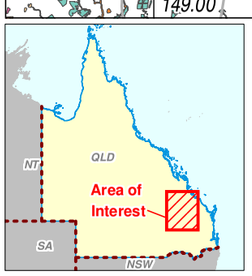

SOURCE INFORMATION

Preferred gas pipeline alignment provided by Origin Energy 03/11/2009

Roads
Department of Main Roads, Queensland 2010

Regional ecosystems mapping (version 6) and RE descriptions (version 6.0b)
Department of Environment and Resource Management) 2010

LEGEND

- Towns
- Pipeline kilometre point
- Gas pipeline route
- Roads
- LNG facility location

Regional Ecosystems - Version 6

Remnant vegetation containing endangered regional ecosystems
- Dominant
- Sub-dominant

Remnant vegetation containing of concern regional ecosystems
- Dominant
- Sub-dominant
- Non - remnant
- Remnant vegetation that is a least concern regional ecosystem

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Figure 8.2 Regional Ecosystems in the vicinity of the proposed alignment

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Table 8.4 Regional ecosystems transected by the gas pipeline alignment

RE	Description (REDD)*	EPBC	VMA	Bio
11.1.2	Samphire forbland on marine clay plains		LC	NC
11.1.4	Mangrove forest/woodland on marine clay plains		LC	NC
11.3.14	*Eucalyptus* spp., *Angophora* spp., *Callitris* spp. woodland on alluvial plains		LC	NC
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	E##	OC	OC
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines		LC	OC
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains		LC	NC
11.3.27	Freshwater wetlands		LC	OC
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains		OC	OC
11.5.1	*Eucalyptus crebra*, *Callitris glaucophylla*, *Angophora leiocarpa*, *Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces		LC	NC
11.5.21	*Corymbia bloxsomei* +/- *Callitris glaucophylla* +/- *Eucalyptus crebra* +/- *Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces		LC	NC
11.5.4	*Eucalyptus crebra*, *Callitris glaucophylla*, *C. endlicheri*, E. *chloroclada*, *Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces; deep sands		LC	NC
11.7.2	*Acacia* spp. woodland on Cainozoic lateritic duricrust; scarp retreat zone		LC	NC
11.7.4	*Eucalyptus decorticans* and/or *Eucalyptus spp.*, *Corymbia spp.*, *Acacia* spp., *Lysicarpus angustifolius* on Cainozoic lateritic duricrust		LC	NC
11.7.5	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks		LC	NC
11.7.6	*Corymbia citriodora* or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust		LC	NC
11.7.7	*Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia spp.* +/- *Eucalyptus* spp. on Cainozoic lateritic duricrust		LC	NC
11.9.1	*Acacia harpophylla-Eucalyptus cambageana* open forest to woodland on fine-grained sedimentary rocks	E	E	E
11.9.10	*Eucalyptus populnea, Acacia harpophylla* open forest on fine-grained sedimentary rocks.		OC	E

RE	Description (REDD)*	EPBC	VMA	Bio
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.	E	E	E
11.9.6	*Acacia melvillei +/- A. harpophylla* open forest on fine-grained sedimentary rocks.	E	E	E
11.9.7	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks		OC	OC
11.9.9	*Eucalyptus crebra* woodland on fine-grained sedimentary rocks		LC	NC
11.10.1	*Corymbia citriodora* open forest on coarse-grained sedimentary rocks		LC	NC
11.10.13	*Eucalyptus spp.* and/or *Corymbia spp*. open forest on scarps and sandstone tablelands		LC	NC
11.10.4	*Eucalyptus decorticans*, *Lysicarpus angustifolius +/- Eucalyptus spp*., *Corymbia spp., Acacia spp*. woodland on coarse-grained sedimentary rocks		LC	NC
11.10.7	*Eucalyptus crebra* woodland on coarse-grained sedimentary rocks		LC	NC
11.10.9	*Callitris glaucophylla* woodland on coarse-grained sedimentary rocks		LC	NC
11.11.10	*Eucalyptus melanophloia* woodland on deformed and metamorphosed sediments and interbedded volcanics		OC	OC
11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics		LC	NC
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding	E	E	E
11.11.3	*Corymbia citriodora*, *Eucalyptus crebra*, *E. acmenoides* open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges		LC	NC
11.11.4	*Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges		LC	NC
11.12.1	*Eucalyptus crebra* woodland on igneous rocks		LC	NC
11.12.2	*Eucalyptus melanophloia* woodland on igneous rocks		LC	NC
11.12.21	*Acacia harpophylla* open forest on igneous rocks. Colluvial lower slopes	E	E	E
11.12.3	*Eucalyptus crebra, E. tereticornis*, *Angophora leiocarpa* woodland on igneous rocks especially granite		LC	OC
11.12.6	*Corymbia citriodora* open forest on igneous rocks (granite)		LC	NC
12.1.2	Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains		LC	NC

RE	Description (REDD)*	EPBC	VMA	Bio
12.3.11	*Eucalyptus tereticornis, Eucalyptus siderophloia, Corymbia intermedia* open forest on alluvial plains near coast		OC	OC
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains		E	E
12.3.7	*Eucalyptus tereticornis*, *Callistemon viminalis*, *Casuarina cunninghamiana* fringing forest		LC	NC
12.11.14	*Eucalyptus crebra*, *E. tereticornis* woodland on metamorphics +/- interbedded volcanics		OC	OC
12.11.6	*Corymbia citriodora, Eucalyptus crebra* open forest on metamorphics +/- interbedded volcanics		LC	NC

Status: EPBC: E = Endangered; E## = Endangered only where weeping myall Acacia pendula occurs; VMA (Vegetation Management Status) = E = endangered, OC = of concern, LC = least concern, (T) = at threshold RE; Bio (Biodiversity Status): E = endangered; OC = of concern, NC = no concern at present. *Description = Regional Ecosystem Description Database (REDD) short description (Queensland Herbarium 2009).

EPBC Act listed threatened ecological communities and VMA listed endangered regional ecosystems

Approximately 2.5ha of endangered remnant vegetation occurs within the gas pipeline right of way. A full list of the endangered REs within the right of way is shown in Table 8.5. The gas pipeline alignment will transect six endangered REs corresponding to EPBC Act listed threatened ecological communities (TECs), one of concern RE that may potentially correspond to an EPBC Act listed TEC and one endangered RE that does not correspond to any EPBC Act listed TEC.

Four REs (11.9.1, 11.9.5, 11.9.6 and 11.12.21) are listed as endangered under the VMA and are also part of the EPBC Act listed endangered TEC 'Brigalow (*Acacia harpophylla* dominant and co-dominant)' have been observed within the gas pipeline right of way.

One RE (11.11.18) mapped as present along the alignment is listed as endangered under the VMA and as part of the EPBC Act listed Endangered TEC 'Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar bioregions'. This vegetation was mapped in the northern sections of the site as sub-dominant in a mosaic.

One RE (11.3.2) mapped within the study area is listed as of concern, where weeping myall (*Acacia pendula*) occurs, and forms part of the EPBC Act listed endangered 'Weeping myall woodlands'. RE 11.3.2 was observed in numerous locations in the vicinity of the alignment. However, the observed communities contained no significant stands of weeping myall and usually lacked a native understorey.

The endangered RE 12.3.3 (*Eucalyptus tereticornis* woodland to open forest on alluvial plains) was identified as occurring in mosaic in the eastern sections of the gas pipeline right of way on Curtis Island.

Table 8.5 Endangered regional ecosystems located within the gas pipeline right of way

Regional Ecosystem	Description (REDD)	EPBC TEC	Area within 40m Right of Way (ha)	Area within 5km buffer (ha)	2005 Area within bioregion (ha)	Length of alignment transected (m)	KPs
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	Brigalow (*Acacia harpophylla* dominant and co-dominant)	1.7	2,538.7	16,8841	300	40.8–41.0 38.0–38.5
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	0.1	587.6	4,518	40	358.5–358.8
11.12.21	*Acacia harpophylla* open forest on igneous rocks. Colluvial lower slopes	Brigalow (*Acacia harpophylla* dominant and co-dominant)	0.1	509.4	6,634	20	124.5 - 124.6
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains	Not Applicable	0.7	202.8	42,959	160	358.5–358.8

Note: length transected and KPs may not correspond due to some endangered REs occurring as subdominant in mosaics.

Of concern regional ecosystems listed under the VMA

Approximately 13.4ha of remnant vegetation listed as of concern occurs within the gas pipeline right of way. This equates to 3.3km (in total) of the gas pipeline length. This vegetation consists of seven different REs listed under the VMA. A full list of REs listed as of concern within the right of way is given in Table 8.6.

Table 8.6 Of concern regional ecosystems located within the gas pipeline right of way

RE	Description	Area within bioregion	Area within 40m right of way (ha)	Length of alignment transected (m)
11.3.2*	*Eucalyptus populnea* woodland on alluvial plains.	528,081	0.4	80
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	186,652	6.7	1,560
11.9.7	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks.	109,286	5.1	1,340
11.9.10	*Eucalyptus populnea, Acacia harpophylla* open forest on fine-grained sedimentary rocks.	83,507	0.3	100
11.11.10	*Eucalyptus melanophloia* woodland on deformed and metamorphosed sediments and interbedded volcanics.	88,019	0.4	80
12.3.11	*Eucalyptus tereticornis, Eucalyptus siderophloia, Corymbia intermedia* open forest on alluvial plains near coast.	47,883	0.2	40
12.11.14	*Eucalyptus crebra*, *E. tereticornis* woodland on metamorphics +/- interbedded volcanics.	30,130	0.5	120

* 11.3.2 is an EPBC Act listed TEC only where weeping myall *Acacia pendula* occurs

Least concern regional ecosystems listed under the VMA

Approximately 544ha of least concern remnant vegetation occurs within the gas pipeline right of way. This equates to approximately 111km of the pipeline length. This vegetation consists of 30 different regional ecosystems listed under the VMA. A full list of the REs identified as least concern within the gas pipeline right of way and the proposed clearing areas is included in Volume 5 Attachment 15.

The least concern REs occurring within the gas pipeline right of way included 96.1ha of *Eucalyptus* spp., *Corymbia* spp., *Acacia* spp., *Lysicarpus angustifolius* on Cainozoic lateritic duricrust (RE 11.7.4) and 42.6ha of mapped *Corymbia citriodora* open forest on coarse-grained sedimentary rocks (RE 11.10.1). These two REs were the most commonly observed least concern REs located within the gas pipeline right of way.

The largest area of least concern RE located within the gas pipeline right of way was located along the Condabri lateral. Least concern REs with a land zone of 7 (duricrusts and footslopes) and land zone 5 (uniform sand plains) were commonly grouped in this area. The harder lateritic geology is unfavourable for pasture development; consequently, these areas have generally undergone less clearing, leaving large remnant patches. The least concern REs 11.7.2, 11.7.4, 11.7.5, 11.7.6, 11.7.7, 11.5.21 and 11.5.4 occurred as stand-alone patches and were commonly grouped in different mosaics.

8.3.5 Regulated regrowth

The moratorium on clearing endangered regrowth in Queensland ended on 7 October 2009 and new arrangements for protecting regrowth commenced on 8 October 2009. . The 8 October 2009 regrowth vegetation datasets were valid between 8 October and 5 November 2009 and have been superseded by a dataset released by DERM on the 6 November 2009 (Version 2.0).

Following the moratorium, DERM released Regulated Regrowth mapping for the whole of Queensland. Table 8.7 has been created using Version 2.0 of the regulated regrowth mapping and lists the categories of regulated regrowth located within the vicinity of the gas pipeline alignment.

Table 8.7 Regulated regrowth areas within the vicinity of the gas pipeline alignment

Regrowth category	Area ha
Is a least concern regional ecosystem	50.3
Containing of concern regional ecosystems	54.8
Containing endangered regional ecosystems	26.5
Total regrowth with RoW	131.6

The Regulated Regrowth mapping does not identify the individual REs that the regrowth represents but indicates the expected conservation status of the regrowth community. Certain areas of endangered regrowth identified on the Regulated Regrowth mapping were ground-truthed during the field survey. The identified vegetation was found to represent regrowth communities of Brigalow (RE 11.9.1) at KPs 237 and 258.

8.3.6 Wetlands and waterways

The gas pipeline alignment has been selected to avoid major watercourses and wetlands. No Ramsar wetlands occur along or adjacent to the gas pipeline alignment. However, two nationally important wetland areas listed on the Directory of Important Wetlands Database, Port Curtis and The Narrows, are transected by the gas pipeline alignment and areas within the right of way near Gladstone/Port Curtis are mapped as part of state and local government wetland areas. The mudflats in this area are largely devoid of vegetation with isolated clumps of mangrove and forb species including yellow mangrove (*Ceriops tagal*), beaded glasswort (*Sarcocornia quinqueflora* ssp. *quinqueflora*), sea purslane (*Sesuvium portulacastrum*) and seablite (*Suaeda australis*). Salt couch (*Sporobolus virginicus*) and prickly couch grass (*Zoysia macrantha*) are also present, forming dense groundcover along the boundary of this mudflat area.

Generally, the larger freshwater ephemeral systems transected by the gas pipeline alignment predominantly exist as dry stream beds with occasional and mainly seasonal flooding overtopping the

channel into adjacent floodplains. According to the Queensland Wetland Mapping, the gas pipeline alignment intersects estuarine systems between KP 351.4–356.1, river and creek channel riverine systems at Roche Creek (KP 29.2), lacustrine systems at Dogwood Creek (KP Con 11.1), palustrine systems at KP 305 and many drainage line riverine systems. The more defined creek channel at Roche Creek was observed during field surveys. However, ground-truthing in the vicinity of Dogwood Creek (KP Con 11.1) found no lacustrine system.

Wetlands observed on Curtis Island are in good condition with some evidence of disturbance including grazing and litter. Large weed infestations of common prickly pear are present on the beach berms.

8.3.7 EVR flora species

Database searches identified 89 EVR flora species known to have ranges that overlap the gas pipeline study area, comprising of 10 species listed only under the EPBC Act, 56 species listed only under the NC Act and 23 species listed under both. Based solely upon habitat preference of these species, the gas pipeline right of way contains potential habitat for 62 species. However, all of the 89 species identified in the database searches have varying potential to occur within the gas pipeline right of way (refer Volume 5 Attachment 15).

Four species of EVR flora were observed as occurring within the vicinity of the gas pipeline alignment during the field surveys. These species are:

- Pedley's wattle (*Acacia pedleyi*) – listed as rare under the NC Act. This wattle was observed along the western areas of Callide Range located near to the Dawson Highway and is known to occur within the 40m gas pipeline right of way at KPs 257.1 and 257.8
- Ooline (*Cadellia pentastylis*) – listed as vulnerable under the NC Act and EPBC Act. All of the ooline observed were scattered trees in a non-remnant paddock at the base of a sandstone jump-up near KP Wol 1.65
- Large-fruited zamia palm (*Cycas megacarpa*) – listed as endangered under the NC Act and EPBC Act. This species was identified in numerous locations within the Calliope Range in the northern sections of the gas pipeline alignment and are known to occur with the gas pipeline right of way at KPs (260, 262, 262.1, 266, 268, 269.35, 271.45, 272.1, 272.2 and 275.6). More than 100 individuals were observed within the vicinity of the gas pipeline alignment between KPs 260 – 272.2
- Smooth-barked bonewood (*Macropteranthes leiocaulis*) – listed as rare under the NC Act. This species was found as one isolated plant located to the west of the gas pipeline right of way at KP 38.1 in an unmapped patch of the endangered RE 11.9.5.

In addition to the EVR species observed during this field visit, a preliminary terrestrial ecology report was compiled by C. Eddie (Boobook) during August 2009 (Boobook 2009). This preliminary survey identified *Polianthion minutiflorum* (small-flowered polianthion) which is listed as vulnerable under both the NC Act and the EPBC Act. This species was observed 300m east of the gas pipeline alignment at KP 103. The preliminary survey also identified a small population of ironbarks which may possibly represent *Eucalyptus virens* (listed as endangered under the NC Act and EPBC Act) located at KP 101.9, 103 and east of 104; but all populations of this species require field confirmation.

8.3.8 Regionally significant species

A total of 49 regionally significant flora species were identified by database searches from the gas pipeline study area. Based solely on habitat preference of these species, the gas pipeline right of way

contains potential habitat for 45 species. However, all of the 49 species identified in the database searches have potential to occur within the gas pipeline right of way to some extent.

Nine regionally significant species were recorded within the vicinity of the gas pipeline alignment during the field surveys. These species include:

- *Acacia aprepta* was observed in numerous locations in the southern sections of the gas pipeline alignment. This species is usually associated with duricrust (Land Zone 7) and is widespread and common in the area
- *Acacia shirleyi* forms monospecific stands (RE 11.7.2) in numerous locations intersected by the alignment in the southern and central sections of the gas pipeline alignment
- *Corymbia bloxsomei* forms one of the main vegetative descriptors of RE 11.5.21 which occurs in numerous locations intersected by the alignment in the southern sections of the gas pipeline route
- *Dodonaea biloba* was observed in numerous locations in the south of the gas pipeline alignment, usually in RE 11.7.7.
- *Dodonaea macrossanii* was observed in numerous locations in the central sections of the gas pipeline alignment within the sandstone area of Rockybar/Fairylands
- *Eucalyptus bakeri* was observed in numerous locations in the southern sections of the gas pipeline alignment, mostly restricted to the Condabri lateral
- *Eucalyptus camaldulensis* was observed in ephemeral streams and dry drainage lines in the southern sections of the alignment
- *Homoranthus melanostictus* was commonly observed in the central sections of the gas pipeline alignment within the sandstone area of Rockybar/Fairylands
- *Callistemon viminalis* was observed in larger ephemeral streams such as Collards Creek in the north and Cockatoo Creek in the central sections of the alignment.

8.3.9 Species of other conservation significance

Plants of cultural significance

Several plant species recorded along the gas pipeline alignment were/are traditionally used by the Indigenous people of central and southern Queensland for food, medicine, timber and tools including mangroves, wattles, grasstrees, quinine bushes and eucalypts. A full list of these species and their uses is provided in Volume 5 Attachment 15, Section 3.5.3. These species were found throughout the right of way in varying densities.

Plants of commercial significance

The dominant canopy species recorded along the alignment are considered potential commercial resources including pink bloodwood (*Corymbia intermedia*), lemon-scented/spotted gum (*Corymbia citriodora*), narrow-leaved red ironbark (*Eucalyptus crebra*) and Queensland blue gum (*Eucalyptus tereticornis*). The Burdekin plum (*Pleiogynium timorense*) is also considered a potential commercial resource. These species may be useful resources in engineering for poles, railway sleepers and mining timbers and in construction for fencing, house frames and flooring, as well as other uses including hardwood manufacture.

Although the myrtaceous canopy species suitable for commercial hardwood were observed throughout the right of way, the alignment will only intersect known commercial timber resources at the Callide Timber Reserve between KPs (254 - 258.2) and the Targinie State Forest between KPs (347.4 - 347.8).

Plants of recreational significance

Areas along the gas pipeline route may hold recreational value through fishing, boating, birdwatching and bushwalking. Mangrove shrublands along the western coastline of Curtis Island and the eastern coast of the mainland provide shelter and breeding grounds for fish species, and associated mudflats and beaches provide an opportunity to observe wader bird species in their natural habitat.

The areas of higher wilderness values and intact wooded areas along the gas pipeline route may also provide some value to birdwatchers and bushwalkers alike, whilst offshore areas provide safe mooring areas for small boats during bad weather.

8.3.10 Significant weed species

A total of 21 non-native flora species were identified along the gas pipeline alignment during the field survey including eight declared plants as listed in Table 8.8 and the location of weeds observed during the survey is shown in Figure 50 of Volume 5 Attachment 15 . These species predominantly occur in low densities with denser patches observed along roadside verges. Three Weeds of National Significance (WONS) were observed in scattered locations during the field survey. Of particular note is the presence of parthenium weed (*Parthenium hysterophorus*) in the northern sections of the alignment (identified at KP 320.5).

Table 8.8 Declared weeds observed along the gas pipeline alignment

Botanical name	Common name	CTH*	QLD*	Site observed (KP)
Bryophyllum delagoense	mother-of-millions	---	2	Identified from four locations (257, 182.6 170, Con 31, Con 35).
Cryptostegia grandiflora	rubber vine	WONS	2	Collards Creek in the Callide Range (267.5, 266 and Curtis Island 356).
Lantana camara	common lantana	WONS	3	Occurs throughout. Prevalent in Callide Range and dry streams to the north of Callide Range.
Lantana montevidensis	creeping lantana	---	3	Occurs throughout. Prevalent in Callide Range.
Macfadyena unguis-cati	cat´s claw creeper	---	3	Occupies many ephemeral streams in the northern and central sections of the gas pipeline alignment. (257, 214, 224.7, 217.6, 239.6).
Opuntia stricta	common prickly pear	---	2	Scattered throughout the study area. No dense infestations identified.
Opuntia tomentosa	velvet tree pear	---	2	Scattered throughout the study area. No dense infestations identified.
Parthenium hysterophorus	parthenium	WONS	2	Northern sections within the CIC at KP 320.5.

*CTH (Australian Weeds Strategy): WONS = Weeds of national significance; QLD (Land Protection [Pest and Stock Route Management] Act 2002): 1 = Class 1 declared plant, 2 = Class 2 declared plant, 3 = Class 3 declared plant.

It should be noted that conditions were not optimal for detection of weeds, especially spring-summer annuals. Anecdotal evidence suggests parthenium is present in Collards Creek in the north of the alignment and requires field confirmation after suitable rainfall. It is also considered likely that giant rat's tail grass (*Sporobolus pyramidalis* and *S. natalensis*) likely to be present in areas where surveys were not conducted east of the Callide Range. Given that these declared weeds are considered likely to occur with the alignment it is suggest further weed surveys in these areas are required following substantial rainfall.

Non-declared weeds were also observed along the gas pipeline alignment generally in low densities although some denser patches of Mexican poppy (*Argemone ochroleuca* ssp. *ochroleuca*) were recorded in association with the ephemeral streams throughout the study area, African lovegrass (*Eragrostis curvula*) was observed on light granite-derived soils of Callide Range and also in disturbed sandy soils between Miles and Gurulmundi. The pasture weed Mayne's pest (*Verbena aristigera*) was observed in most pastures in the central sections of the gas pipeline alignment.

8.3.11 Fauna species diversity

A review of fauna databases identified a large number of fauna species recorded or potentially occur within the gas pipeline study area. A total of 711 fauna species were identified from databases, comprising 28 invertebrates, 46 fish, 43 amphibians, 137 reptiles, 362 birds and 95 mammals. During the field assessment, 182 terrestrial fauna species were recorded, comprising five amphibians, 19 reptiles, 124 birds and 34 mammals. Table 8.9 summarises the number of species identified from desktop studies, those recorded during field studies and those potentially present in habitats along the alignment.

Table 8.9 Number of species identified from desktop studies, recorded during field studies and potentially present

	Desktop assessment	Recorded during field assessment	Potentially present (including recorded)
EVR (including Back on Track)	70	5	48
Regionally significant	95	5	85
EPBC Act listed Migratory	38	7	37
Common (least concern)	490	143	-
Introduced	21	8	-

8.3.12 EVR fauna species

Database searches identified 66 EVR fauna species previously recorded from the gas pipeline study area, or with geographic ranges that overlap the gas pipeline study area. These comprised two invertebrates, one fish, four amphibians, 16 reptiles, 31 birds and 12 mammals. Of these species,

- Five are listed only under the EPBC Act
- 22 are listed under both the EPBC Act and the NC Act
- 39 are listed only under the NC Act.

Four additional species (two reptiles, one bird and one mammal) that are not listed under either the EPBC Act or the NC Act have been ranked as High priority under the Back on Track species prioritisation framework, and have therefore been included here as EVR species.

Based on the desktop habitat review, 48 of these 68 listed EVR species could potentially utilise habitats along the gas pipeline alignment. Further details are provided in Volume 5 Attachment 15.

Five EVR fauna species were recorded along the gas pipeline alignment during the field assessment. These were:

- Squatter pigeons (*Geophaps scripta scripta*) were recorded at five locations along the mainland sections of the alignment: Welshs Rd, 5km west of KP 35; Crowsdale-Camboon Road at KPs 209.7 and 212.6, the western boundary of the Callide Timber Reserve at KP 254.0; and Duck Holes Road at KP 294.4.
- Two glossy black-cockatoos (*Calyptorhynchus lathami*) were observed flying over Bottle Tree Creek at KP Con 36.7
- Beach stone-curlew (*Esacus magnirostris*) and eastern curlew (*Numenius madagascariensis*) were both recorded in the vicinity of Laird Point on Curtis Island (approximately KP 356).
- Little pied bat (*Chalinolobus picatus*) was recorded at KPs Con 11.5 (Dogwood Creek), Con 36.7 (Bottle Tree Creek) and 103.4 (Fairyland).

8.3.13 Regionally significant fauna species

A further 95 fauna species of regional significance were identified from desktop studies. These comprised seven fish, 12 amphibians, 15 reptiles, 29 birds and 32 mammals. Of these species:

- 57 are listed as non-EVR priority taxa within the South East Queensland bioregion
- 18 are listed as priority taxa within the Brigalow Belt South bioregion
- 20 are listed as priority taxa within both bioregions or are listed in the relevant action plan.

Based on the desktop habitat review, 85 of these 96 regionally significant species could potentially utilise habitats within the gas pipeline corridor (refer Volume 5 Attachment 15).

Four fauna species identified as regionally significant within the Brigalow Belt South bioregion were recorded along the mainland sections of the gas pipeline alignment during the field assessment. These were:

- Hoary wattled bat (*Chalinolobus nigrogriseus*) at KP Con 11.5 (Dogwood Creek)
- Grey-crowned babbler (*Pomatostomus temporalis*) at 15 locations
- Australian bustard (*Ardeotis australis*) near KPs 145.3, 175.7, 200.9 and 203.2
- Unspotted yellow-sided ctenotus (*Ctenotus ingrami*) beside Collards Creek at KPs 266.6 and 267.5.

One species identified as regionally significant within the South East Queensland bioregion was recorded on Curtis Island, this being barking owl (*Ninox connivens*).

8.3.14 Other fauna species of conservation significance

An additional 38 bird species listed as migratory under the EPBC Act were identified from the gas pipeline study area, not including EVR or regionally significant fauna also listed as migratory. Based

solely on the desktop habitat review, 37 of these 38 listed migratory species could potentially utilise habitats within the gas pipeline corridor (refer Volume 5 Attachment 15).

Seven bird species listed as migratory were recorded at various locations along the gas pipeline gas pipeline alignment during the field assessment. These were:

- Rainbow bee-eater (*Merops ornatus*) at 31 locations
- Satin flycatcher (*Myiagra cyanoleuca*) at KPs 70.0, 257.1, 267.5 and Wol 32.1
- Rufous fantail (*Rhipidura rufifrons*) at KPs 239.6 and 320.5
- Eastern reef egret (*Egretta sacra*) on Curtis Island
- White-bellied sea-eagle (*Haliaeetus leucogaster*) on Curtis Island
- Whimbrel (*Numenius phaeopus*) on Curtis Island
- Pacific golden plover (*Pluvialis fulva*) on Curtis Island.

8.3.15 Common fauna species

The desktop study and field survey indicate the gas pipeline corridor is utilised by a large number of common fauna species. A total of 528 common native fauna species was identified as potentially present by the database searches (excluding EVR and regionally significant fauna). These comprised 26 invertebrates, 34 fish, 25 amphibians, 108 reptiles, 294 birds (including the 38 species listed as migratory under the EPBC Act) and 41 mammals.

Common native fauna species recorded during the field survey totalled 143 species, including four frogs, 16 reptiles, 116 birds and seven mammals.

8.3.16 Animal pest species

Twenty-one introduced species have been recorded within the gas pipeline corridor, including three fish, one amphibian, seven birds and 10 mammals. The most recent pest distribution maps produced by Biosecurity Queensland indicate that red fox (*Vulpes vulpes*), cat (*Felis catus*), wild dog (*Canis lupus familiaris*), European rabbit (*Oryctolagus cuniculus*), feral pig (*Sus scrofa*) and cane toad (*Rhinella marina*) are all likely to occur along the full length of the alignment (DEEDI 2009).

Eight introduced species were recorded (from visual observation, tracks, scats or sign) along the gas pipeline alignment during the field assessment. These were:

- Feral pig (*Sus scrofa*) at KPs 97.2 and 146.1
- Goat (*Capra hircus*) at KP 144.1
- European rabbit (*Oryctolagus cuniculus*) at seven sites
- Brown hare (*Lepus capensis*) at KPs 232.9 and Con 1.5
- Feral cattle (*Bos taurus*) on Curtis Island
- Feral horses (*Equus caballus*) on Curtis Island
- Cane toad (*Rhinella marina*) at KPs 70.0 and 234.3 and on Curtis Island.

In addition, dingo/wild dog (*Canis lupus dingo/familiaris* were indistinguishable in this assessment) was recorded at nine locations.

8.3.17 Fauna habitats

Fourteen different broad faunal habitats (plus non-remnant habitat) are transected by the gas pipeline alignment, based on stratification of the 43 REs transected by the alignment into habitats. These are described in Table 8.10, along with the REs to which they correspond (where relevant).

All of the identified habitat types are theoretically potential habitat for at least some EVR species, depending on ecological conditions such as condition and connectivity (Volume 5 Attachment 15, Table 4.3). Key habitats and significant ecological areas are described in Sections 8.3.19 and 8.3.20.

Fauna habitats mapped for this assessment do not include high-quality regrowth vegetation. Significant portions of the alignment are mapped as non-remnant but are vegetated with high-quality regrowth (i.e. not cleared for at least 20 years). In total, 164.2ha of high-quality regrowth is transected by the gas pipeline alignment, comprising 7.5% of the entire alignment length (Table 8.7). High-quality regrowth vegetation will have some habitat value for a wide range of fauna, potentially including some EVR species.

Table 8.10 Faunal habitats within the gas pipeline gas pipeline corridor

Fauna habitat	Description	Area within 40m right of way (ha)	% of total alignment length
Brigalow / Belah	Open forest and woodland dominated by Brigalow (*Acacia harpophylla*) and / or Belah (*Casuarina cristata*). May include eucalypts such as mountain yapunyah (*Eucalyptus thozetiana*), inland grey box (*E. microcarpa*) or Dawson gum (*E. cambageana*). Corresponds to REs 11.4.3, 11.7.1, 11.9.1, 11.9.5, 11.9.6 and 11.12.21.	1.7	0.10
Semi-evergreen vine thicket and vine forest	Closed forest including semi-evergreen vine thicket, microphyll vine forest and notophyll vine forest. Corresponds to REs 11.3.11, 11.8.3, 11.9.4a, 11.10.8, 11.11.5, 11.11.18, 11.12.4, 12.2.2, 12.3.1, 12.11.4 and 12.11.12.	0.1	0.01
Floodplain eucalypt woodland	Woodland to open forest dominated by Queensland blue gum (*Eucalyptus tereticornis*) on alluvial floodplains. Other eucalypts may also be present. Corresponds to REs 11.3.4, 12.3.3 and 12.3.11.	7.6	0.43
Riparian eucalypt woodland	Queensland blue gum (*E. tereticornis*) or river red gum (*E. camaldulensis*) woodland fringing drainage lines, often with paperbarks or casuarinas. Corresponds to RE 11.3.25 and 12.3.7.	6.5	0.37
Spotted / lemon-scented gum woodland	Open forest dominated by spotted/lemon-scented gum (*Corymbia citriodora*). Corresponds to REs 11.10.1 and 11.12.6.	54.9	3.12
Poplar box woodland	Woodland dominated by poplar box (*Eucalyptus populnea*). Corresponds to RE 11.3.2, 11.9.10, 11.9.7, 11.11.9 and 11.12.17.	5.7	0.32
Ironbark woodland	Woodland dominated by ironbarks including narrow-leaved red ironbark (*Eucalyptus crebra*), silver-leaved ironbark (*E. melanophloia*), dusky-leaved ironbark (*Eucalyptus fibrosa* ssp. *nubila*) and gum-topped ironbark (*Eucalyptus decorticans*). Corresponds to REs 11.3.6, 11.5.5, 11.7.7, 11.8.4, 11.9.9, 11.10.4, 11.10.7, 11.11.10, 11.12.1, 11.12.2 and 12.11.7.	61.7	3.51

Fauna habitat	Description	Area within 40m right of way (ha)	% of total alignment length
Mixed eucalypt woodland & open forest	Woodland or open forest dominated by a variety of *Eucalyptus* and / or *Corymbia* species. Corresponds to REs 11.3.9, 11.3.14, 11.3.26, 11.3.29, 11.5.1, 11.5.2, 11.5.3, 11.5.4, 11.5.8, 11.5.9, 11.5.20, 11.5.21, 11.7.4, 11.7.6, 11.9.2, 11.9.13, 11.10.13, 11.11.3, 11.11.4, 11.11.15, 11.12.3, 11.12.5, 12.5.1, 12.11.6, 12.11.14, 12.11.17, 12.11.18 and 12.11.20.	250.7	14.26
Callitris woodland	White cypress pine (*Callitris glaucophylla*) woodland, often with eucalypts such as silver-leaf ironbark (*E. melanophloia*). Corresponds to RE 11.10.9.	8.6	0.49
Acacia woodland	Woodland dominated by *Acacia* species. Corresponds to RE 11.7.2.	15.5	0.88
Shrubland	Mixed shrubland including shrubland on natural scalds, brush box (*Lophostemon confertus*) tall shrubland and montane shrubland. Corresponds to REs 11.7.5, 11.12.14 and 11.12.18.	7.1	0.40
Mangroves	Mangrove shrubland to forest on marine clay plains. Corresponds to REs 11.1.4 and 12.1.311.7.1.	2.4	0.14
Saltpan	Saltpan vegetation including samphire forbland, *Sporobolus* grassland, herbland and sedgeland on marine clay plains. Corresponds to REs 11.1.1, 11.1.2 and 12.1.2.	9.5	0.68
Freshwater wetlands	Freshwater wetlands including lakes, billabongs, oxbows and depressions on floodplains. Corresponds to RE 11.3.27.	0.9	0.05
Watercourses	Creeks and rivers, both perennial and seasonal. Range from small ephemeral or seasonal drainage lines, through larger creeks often including waterholes, to rivers.	-	-
Non-remnant	Includes areas of regrowth and non-remnant vegetation as well as cleared land.	1,325.91	75.39

8.3.18 Biodiversity Planning Assessments

Biodiversity Planning Assessments have been completed for the Brigalow Belt South and South East Queensland bioregions (Environmental Protection Agency (EPA) 2006a, 2008a). These assessments have identified the biodiversity significance (state, regional or local) of all areas of remnant vegetation within the bioregion, based on a combination of criteria derived from geographic information system (GIS) based spatial data and expert opinion from specialist flora and fauna panels (EPA 2006b,c,d, 2008b,c,d).

Total areas gas pipeline to be cleared are summarised by their biodiversity significance in Table 8.11. The great majority (92.6%) of habitat gas pipeline to be cleared along the alignment has been assessed as being of state significance.

Table 8.11 Biodiversity significance category areas to be cleared

Biodiversity significance	Total area to be cleared within the right of way (ha)	% of total within the right of way to be cleared
State habitat for EVR taxa	0.5	0.1
State	415.9	92.6
Regional	22.0	4.9
Local or other values	10.9	2.4
TOTAL	449.3	

8.3.19 Key habitats

Two key fauna habitats were identified within the gas pipeline corridor, based on their high significance as habitat for significant fauna, faunal biodiversity values, refugia and wildlife corridors. The values, significance and extent of each key habitat transected by the alignment are discussed below.

Riparian and floodplain eucalypt woodlands

Riparian woodland fringing watercourses and floodplain eucalypt woodland along the gas pipeline alignment comprise a key habitat due to their significance as wildlife corridors and refugia, their high levels of moisture and nutrients and relatively complex vegetation structure. Strips of riparian woodland habitat are particularly significant in the highly cleared and fragmented landscapes comprising much of the alignment, where they may be the only continuous woodlands in largely treeless landscapes.

Queensland blue gums (*Eucalyptus tereticornis*) typically dominate riparian and floodplain eucalypt woodlands, and hollows in mature trees provide important shelter and nesting sites for a range of arboreal mammals, birds and bats, including significant fauna such as glossy black-cockatoo (*Calyptorhynchus lathami*), south-eastern long-eared bat (*Nyctophilus corbeni*) and little pied bat (*Chalinolobus picatus*). Riparian and floodplain eucalypt woodlands also provide habitat for a range of other significant fauna, including Dunmall's snake (*Furina dunmalli*), grey goshawk (*Accipiter novaehollandiae*) and black-chinned honeyeater (*Melithreptus gularis*).

Riparian and floodplain eucalypt woodlands support a wide range of resident and nomadic fauna, and many migratory species use this habitat on a seasonal basis, emphasising the significance of these

habitats for wildlife migration corridors. These habitats often comprise important wildlife refugia, with many animals moving into them as surrounding areas dry out. Particularly significant are areas where permanent water remains during dry periods, such as waterholes and billabongs.

Narrow bands of riparian and/or floodplain eucalypt woodland habitat are crossed by the alignment at Dogwood Creek (KP Con 11.0-11.7), Roche Creek (KP 29.2), Pump Creek (KP 182.6), Larcom Creek (KP 320.5) and between KPs 358.5 – 358.8 on Curtis Island. Additional unmapped (non-remnant) strips of riparian habitat are crossed at Bungaban Creek (KP 44.4), Cockatoo Creek (KP 69.1), Kroombit Creek (KP 239.6), Callide Creek (KP 242.6), Bell Creek (KP 277.6), Sand Gully (KP 288.1) and Calliope River (294.8). In total, 14.0ha of these key habitats (7.5ha of floodplain eucalypt woodland and 6.5ha of riparian eucalypt woodland) is proposed to be cleared along the gas pipeline right of way.

Brigalow/Belah remnants

Brigalow (*Acacia harpophylla*) / Belah (*Casuarina cristata*) habitats within the study corridor are remnants of a formerly more widespread and now severely cleared and fragmented habitat. Brigalow/Belah provides habitat for significant species including rough collared frog (*Cyclorana verrucosa*), Brigalow scaly-foot (*Paradelma orientalis*), golden-tailed gecko (*Strophurus taenicauda*), woma (*Aspidites ramsayi*) and painted honeyeater (*Grantiella picta*). Belah is an essential food resource for the glossy black-cockatoo (*Calyptorhynchus lathami*) in inland southern Queensland.

With minor exceptions (described below), the gas pipeline alignment avoids existing areas of Brigalow/Belah habitat, and minor realignments to further avoid this habitat were made based on field observations. As an example, a section of the alignment at the eastern end of the Woleebee lateral (KPs Wol 34.5 – Wol 35.9) was realigned to pass to the north of a strip of Brigalow/Belah habitat. An unmapped 2ha patch of Brigalow was observed approximately 50m south of KP Wol 6.6 – Wol 6.75 and the route was realigned to the north to avoid this patch. Similarly, at KP 237.3 the alignment passes just to the west of two small Brigalow patches, also avoiding a narrow shade line of Brigalow regrowth. Other minor realignments to avoid Brigalow habitat were made at KPs 7.3, 35.8 and 89.0.

There are some small areas of Brigalow/Belah habitat that are transected by the alignment, with a total proposed clearing area of 1.7ha. These include:

- At KP Wol 29.5 a narrow strip of degraded Brigalow habitat is transected on a low steep scarp. The alignment crosses the narrowest and most degraded point of the habitat, avoiding better quality habitat to the north
- The alignment traverses the edge of a mapped patch of Brigalow habitat at KP 47.8-47.9. Realignment of the route approximately 50m to the east, through a 40m wide gap in the existing vegetation, will avoid this patch entirely
- The alignment passes along the western edge of an unmapped Brigalow strip at KP 40.1-40.8, then transects this patch at KP 40.8 – 41.0
- A larger unmapped patch of Brigalow is transected at KP 38.0 – 38.4.

Some additional small areas of Brigalow/Belah habitat potentially transected by the alignment were unable to be ground-truthed due to access constraints, notably at KP 55.7-56.1 and 124.5-125.0. The first of these was confirmed as comprising Brigalow (RE 11.9.5) during surveys for the Surat-Gladstone Pipeline (AECOM 2009). Field verification of these patches will be undertaken prior to construction and, if necessary, minor realignment applied to avoid clearing of these areas.

In each of the above cases, Brigalow habitat forms part of the EPBC Act-listed TEC Brigalow (*Acacia harpophylla*) dominant and co-dominant.

8.3.20 Significant ecological areas

The alignment has been selected to avoid areas of high ecological value wherever practicable. Even so, it is not possible to avoid all areas that may have significant ecological values over the total length of the gas pipeline. Four areas along the gas pipeline alignment were identified by this assessment as significant ecological areas because of their integrated flora, fauna and habitat values.

Callide and Calliope ranges

The Callide Range (KPs 255–271) and Calliope Range (KP 281.5–282.1) comprise a relatively intact tract of remnant vegetation with state-significant corridor values (Figure 8.3), linking important refugia such as Kroombit Tops to Don River State Forest. A large population of the endangered large-fruited zamia palm (*Cycas megacarpus*) was recorded along the Callide Range section of the alignment between KPs 260–272, and this species has also been recorded close to the location where the alignment crosses the Calliope Range (AECOM 2009). Another EVR plant, the rare Pedley's wattle (*Acacia pedleyi*), was also recorded along the alignment on the Callide Range between KPs 271–272.

Port Curtis and The Narrows

Sensitive intertidal habitat surrounding the crossing from the mainland to Curtis Island comprises part of the Port Curtis wetland, listed as being of national significance in the Directory of Important Wetlands (Blackman et al. 1999). The alignment crosses a large expanse of intertidal saltpan habitat to the west of Friend Point between KPs 351.7–354.4, with several small bands of mangroves.

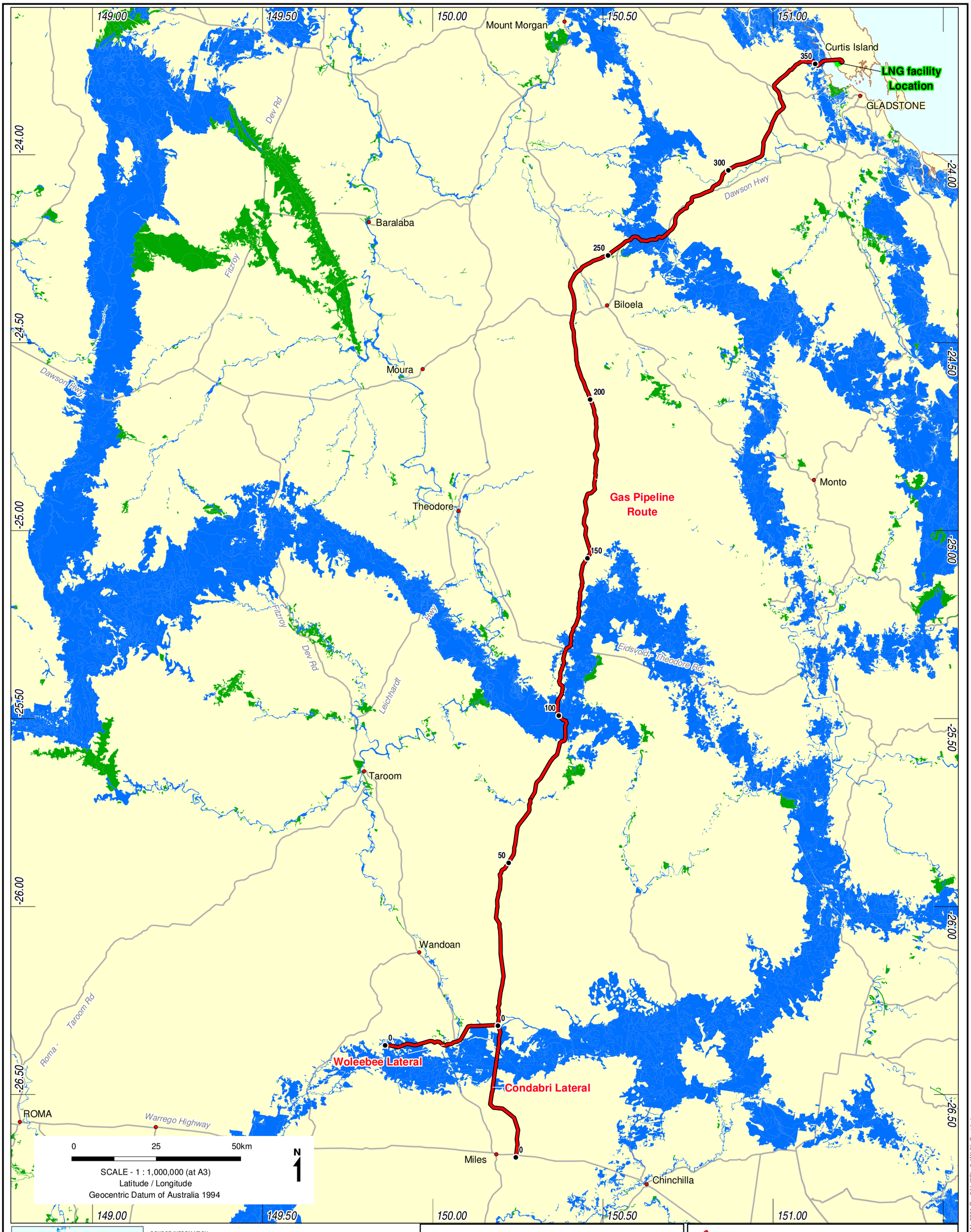
These intertidal flats provide feeding habitat for a range of migratory waders and other shorebirds. Intertidal habitat on the southern side of the Friend Point area has been identified as a major shorebird feed site, while a major shorebird roost site has been identified adjacent to the alignment on the tip of Friend Point (EPA 2003).

Several EVR species have been recently recorded in or adjacent to this area, including beach stone-curlew and eastern curlew utilising the saltpan habitat (Sandpiper 2009), along with yellow-bellied glider (*Petaurus australis australis*) and squatter pigeon (*Geophaps scripta scripta*) in adjacent woodland habitat. The Curtis Island crossing point does not have the extensive saltpan habitat that occurs adjacent to Friend Point, but beach stone-curlew (*Esacus magnirostris*) and eastern curlew (*Numenius madagascariensis*) have been recently recorded in this area.

Sandstone Belt (Rockybar/Fairyland)

The broad band of remnant vegetation between KPs 90–105 forms a large intact tract of vegetation linking the Expedition, Palmgrove, Isla Gorge and Precipice national parks to a number of state forests including Rockybar SF, Borania SF and Camboon SF.

This area has state-significant wildlife corridor values (Figure 8.3) and includes large areas of rocky sandstone habitat, including shallow gorges, cliffs, outcrops and loose surface rock. It is known to contain populations of EVR flora species such as small-flowered polianthion (*Polianthion minutiflorum*), recorded in this area during preliminary surveys for the gas pipeline), Isla Gorge mahogany (*Eucalyptus rubiginosa*), pumpkin gum (*Eucalyptus pachycalyx*) and Cracow wattle (*Acacia calantha*).



SOURCE INFORMATION

Preferred gas pipeline alignment provided by Origin Energy 03/11/2009

Roads
Department of Main Roads, Queensland 2009

Protected Areas and EPBC listed communities
Department of Environment and Resource Management (DERM) 2009

LEGEND

- Town
- Pipeline kilometre point
- Road
- Gas pipeline route
- LNG facility location

Biodiversity Planning Assessment

- State
- Regional

AUSTRALIA PACIFIC LNG

AUSTRALIA PACIFIC LNG PROJECT

Volume 3 Chapter 8
Figure 8.3 Wildlife Corridor

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This area comprises potential habitat for the endangered northern quoll (*Dasyurus hallucatus*), and populations of the vulnerable shiny-leaf ironbark (*Eucalyptus virens*) are possibly present. Little pied bat (*Chalinolobus picatus*) was recorded near the northern edge at KP 103 during the field assessment. The Rockybar/Fairyland area is also potential habitat for a range of other threatened fauna, including collared delma (*Delma torquata*), yakka skink (*Egernia rugosa*), Brigalow scaly-foot (*Paradelma orientalis*), common death adder (*Acanthophis antarcticus*), squatter pigeon (*Geophaps scripta scripta*) and large-eared pied bat (*Chalinolobus dwyeri*).

Gurulmundi – Barakula

The alignment passes through sections of a large tract of remnant habitat to the north of Gurulmundi State Forest between KPs Wol 3.0–Wol 10.5, and south-west of Barakula State Forest at KPs Con 5.5–Con 42 and KPs 1–50.5. This area is part of one of the largest relatively intact patches of remnant habitat in the Brigalow Belt South bioregion and includes areas with state-significant wildlife corridor values (Figure 8.3).

The Woleebee lateral transects an area known for its significant botanical values, with known populations of numerous EVR flora species including curly-barked wattle (*Acacia curranii*), Gurulmundi heath-myrtle (*Micromyrtus carinata*), Gurulmundi fringe myrtle (*Calytrix gurulmundensis*), ooline (*Cadellia pentastylis*), pink donkey-orchid (*Diuris tricolour*) and rainforest cassia (*Senna acclinis*). One of these, ooline (*Cadellia pentastylis*), was recorded in the area during flora surveys.

Three EVR fauna species were recorded in this area during the field assessment: glossy black-cockatoo (*Calyptorhynchus lathami*), squatter pigeon (*Geophaps scripta scripta*) and little pied bat (*Chalinolobus picatus*). It is potential habitat for a range of threatened fauna species, including golden-tailed gecko (*Strophurus taenicauda*), yakka skink (*Egernia rugosa*), Brigalow scaly-foot (*Paradelma orientalis*) and yellow-bellied glider (*Petaurus australis australis*), as well as a range of threatened plants.

8.4 Potential impacts

8.4.1 Flora

Although the majority of the alignment traverses cleared land, impacts such as edge effects and fragmentation (generally associated with vegetation clearing) will be unavoidable in places due to the scale of the gas pipeline. These impacts are expected to be most severe in large remnant areas with minimal existing disturbance such as the sandstone areas in the central sections of the gas pipeline route. In other areas, the vegetation has undergone significant broad-scale clearing, and the impacts on the local flora in these areas are expected to be minimal.

Potential impacts of the gas pipeline on flora values may include:

- Decrease in total area of remnant and/or regrowth vegetation in the bioregion and subregion
- Disturbance and/or degradation of vegetation communities
- Loss and/or disturbance of coastal wetland areas
- Loss or harm to EVR and regionally significant flora species and populations
- Disturbance and/or degradation of EVR and regionally significant flora habitat areas
- Loss of cultural, economic and recreational values

- Introduction and/or spread of weed species.

The main source of impact on flora will be clearing the right of way during gas pipeline construction, which will involve removing trees, shrubs, stumps and other obstacles to provide access for gas pipeline construction. Whilst the flora assessment and analysis have adopted a standard 40m clearing width for calculating potential impacts, it is expected that vegetation clearance will be minimised as far as practicable, particularly at sensitive areas such as endangered REs or watercourses.

Whilst the impacts of the gas pipeline on the local flora are not inconsequential, it is important to note that natural regrowth will be encouraged over much of the area disturbed by construction. In addition, the gas pipeline is likely to be decommissioned within several decades. Decommissioning will involve the pipeline being left in the ground, such that further disturbance will not be necessary following construction. Provided that natural regrowth is encouraged by future landholders, the impacts associated with clearing for construction and maintenance of the gas pipeline are considered to be reversible within all REs.

The Australia Pacific LNG Project is one of a number proposed in the greater Queensland gas fields' area and the cumulative impacts of these projects may increase the severity and frequency of potential impacts to flora values in the region. Cumulative impacts of the Australia Pacific LNG Project and other existing and proposed activities are addressed in Volume 3 Chapter 25.

8.4.2 Proposed clearing of remnant vegetation

The 40m gas pipeline right of way comprises a total land area of 1,759ha. Of this, approximately 1,326ha or 75.4% is considered non-remnant vegetation (including cleared lands) and 433ha or 24.6% is considered remnant vegetation under the VMA.

The gas pipeline alignment avoids, wherever possible, endangered regional ecosystems listed under the VMA and threatened ecological communities listed under the EPBC Act by positioning the alignment through existing cleared areas adjacent to or within these remnants. However, construction of the gas pipeline is expected to disturb six endangered regional ecosystems corresponding to EPBC Act-listed threatened ecological communities, one of concern regional ecosystem that can correspond to an EPBC Act-listed threatened ecological community and one endangered RE that does not correspond to any EPBC Act-listed threatened ecological community. The combined total area of endangered regional ecosystem disturbed by clearing of the 40m-wide gas pipeline right of way is 2.5ha out of the 433ha of remnant vegetation within the entire pipeline footprint.

Approximately 13.4ha of remnant vegetation classified as of concern occurs within the gas pipeline right of way. This vegetation consists of seven different REs listed under the VMA. The of concern REs occurring within the gas pipeline right of way generally consist of two different REs (RE 11.3.4 and RE 11.9.7).

Approximately 417ha of least concern remnant vegetation occurs within the gas pipeline right of way. This vegetation consists of 30 different REs listed under the VMA. The least concern regional ecosystems are represented by a wide variety of vegetation types. Table 8.12 summarises the proposed remnant vegetation impacts within the gas pipeline right of way.

Table 8.12 Proposed remnant vegetation impacts within gas pipeline right of way

VMA status	Area (ha)	% of gas pipeline footprint
Endangered	2.5	0.1
Of concern	13.4	0.8
Least concern	417.0	23.7
Cleared land and non-remnant vegetation	1325.9	75.4
Total	1758.8	

8.4.3 Vegetation fragmentation and disturbance

The gas pipeline has the potential to impact upon the overall condition and integrity of vegetation communities along the gas pipeline alignment through construction, operational and decommissioning activities. Potential impacts to vegetation on site may include fragmentation of vegetation communities and an increase in edge effects associated with clearing activities, changes to hydrological regimes, an increase in erosion susceptibility and an increase in air pollution and dust emissions associated with construction activities. As most flat fertile land in the Brigalow Belt South bioregion has undergone historic disturbance events, the effects of vegetation fragmentation and disturbance will be most severe in large remnant areas with minimal existing disturbance such as the sandstone areas (Rockybar/Fairyland) in the central sections of the gas pipeline corridor.

Modification of the microclimate

Fragmentation and edge creation associated with clearing activities may lead to changes in the micro-climate of vegetation communities through changes in solar penetration, humidity, air and soil temperature and soil moisture. Modification of the micro-climate can directly affect seed viability and germination, growth rates and fruit production of certain plant species, as well as impact upon the distribution of animal species which facilitate seed dispersal and pollination (Rowley et al. 1993). These changes are not expected to directly impact upon the resilient, hardy flora species associated with the open eucalypt communities and saltpan vegetation, but mangrove shrublands and semi-evergreen vine thickets located in the northern sections of the route may be impacted upon, leading to a loss of some sensitive plant species.

Modification of the floristic structure and composition

Clearing and vegetation disturbance associated with the gas pipeline may provide an opportunity for fast growing, colonising species, such acacias and weed species, to establish which can lead to changes in the floristic structure and composition of vegetation communities. Colonisation by these species may lead to an increase in competition for resources such as light, nutrients and space and changes to the micro-climate through shading (Sindel 2000).

In the long-term, changes to the floristic structure and composition of vegetation communities can lead to loss of native biodiversity and an increase in weed infestations, loss of fauna habitat value, increase in fire fuel loads and changes in the RE classification and subsequent conservation management requirements. Although the maximum clearing width for the gas pipeline right of way is limited to 40m, fast growing, colonising species (such acacias and weed species) may alter the floristic structure of habitats along the alignment. This alteration is expected to be temporary, provided that natural

regrowth is encouraged following rehabilitation (much of the right of way) and during the decommissioning phase and by future land holders.

Modification of fire regimes

Weed infestations and colonisation by shrubby pioneer species have the potential to increase fire fuel loads, and vehicle exhaust and plant equipment (such as welders) may also increase the risk of fire during construction and operational activities. These two factors have the potential to increase the frequency and severity of fires which can significantly impact upon the floristic composition and structure of vegetation.

Eucalypt forests and woodlands such as those present within the gas pipeline corridor are adapted to periodic fires and their species richness and diversity relies on these events to germinate seeds and reduce competition. However, fire frequency can have a significant impact on these areas as too frequent burns may not allow plants to reach maturity and produce sufficient seed before the next burn event. This can allow faster growing species to quickly colonise and can also affect biodiversity as ecosystems generally take longer to recover from hot, high fuel load fires (Department of Environment and Conservation, Western Australia (DEC WA) 2009). Eucalypt forests and woodlands make up the majority of remnant vegetation within the right of way and occur throughout the length of the alignment.

Modification of hydrological regimes

Construction activities associated with the gas pipeline may require temporary flow diversion. However, given the prevailing dry conditions and ephemeral nature of the watercourses and drainage lines present, this is unlikely to significantly impact upon vegetation in the short-term.

Long-term modification to surface and groundwater flows may lead to a change in floristic composition and loss of biodiversity, (particularly a loss of aquatic plant species), changes to adjacent springs, creeklines and downstream rivers. The right of way has generally been selected to avoid running adjacent to major watercourses and, where crossing watercourses is unavoidable, the intersection has been chosen at right angles to reduce impacts to hydrological regimes. No springs were observed within the gas pipeline right of way.

Intertidal areas in the northern sections of the route support marine plant vegetation which is dependent on specific hydrological regimes. Diversion of tidal flows to mudflats caused by changing microtopography in this area may reduce current hypersaline conditions, allowing marine plants, such as salt couch (*Sporobolus virginicus*) and beaded glasswort (*Sarcocornia quinqueflora* ssp. *quinqueflora)*, to expand their distribution in this area. Mangrove shrublands on Curtis Island and the mainland may also be impacted upon by changes to tidal flows as they have specific tolerances to salinity and inundation (Blasco et al. 1996).

Air pollution and dust emissions

Construction and clearing activities have the potential to generate dust which can settle on neighbouring vegetation. Dust can scour leaf surfaces, increase leaf temperature and shading and interfere with the photosynthesis processes necessary to convert sunlight into energy, leading to a decrease in plant growth (Thompson et al. 1984). Plant species with erect, hairy or shiny leaves such as mangrove species are most susceptible to damage, whilst studies have shown species with drooping, waxy leaves (such as eucalypts) are unable to retain large amounts of dust and therefore are not as affected (Chaston and Doley 2006). Therefore, mangrove shrublands and saltpan

vegetation in the intertidal areas may be impacted upon by dust emission in the absence of suitable controls. Further information on dust emissions can be found in Volume 5 Chapter 13.

8.4.4 Adjacent coastal wetlands

Construction of the gas pipeline route would require the clearing of 11.7ha of coastal wetland vegetation in the Port Curtis wetland area (out of 2,610ha occurring within a 5km buffer of the alignment). Construction activities associated with the gas pipeline have the potential to further impact on retained and adjacent coastal wetland vegetation through modification of tidal flows, increased boat traffic and boat wash, debris and dust emissions, and erosion (refer Volume 3 Chapter 10 and Volume 3 Chapter 12).

8.4.5 EVR and regionally significant flora species and their habitats

EVR flora species

Four species of EVR flora were observed as occurring within the vicinity of the gas pipeline alignment during the field surveys. These species are:

- Pedley's wattle (*Acacia pedleyi*) – listed as rare under the NC Act
- Ooline (*Cadellia pentastylis*) – listed as vulnerable under both the NC Act and EPBC Act
- Large-fruited zamia palm (*Cycas megacarpus*) – listed as endangered under both the NC Act and EPBC Act
- Smooth-barked bonewood (*Macropteranthes leiocaulis*) – listed as rare under the NC Act.

Through narrowing and refinement of the gas pipeline corridor to minimise potential impacts and adequate mitigation measures, the potential for the gas pipeline to affect EVR flora species is considered low. However, where identified populations of EVR species coincide with areas where there are limited alternative route options (due to physical, engineering, community or other constraints), direct impact to those populations may be unavoidable. In this instance, the highest potential impacts relate to species which are known to have restricted distributions and spatial extents.

Impacts to EVR flora are most likely to occur in Callide Range and the Calliope Range, where populations of the endangered large-fruited zamia palm (*Cycas megacarpa*) appear to occupy all potential alignment options. This species was identified in numerous locations within the Calliope Range in the northern sections of the alignment and are known to occur with the right of way at KPs 260, 262, 262.1, 266, 268, 269.35, 271.45, 272.1, 272.2 and 275.6. More than 100 individuals were observed throughout this area. Given the conservation status of this species and the possible number of plants to be removed within the gas pipeline right of way, there is potential for construction of the gas pipeline to have a significant impact on this species. Management options to reduce impacts are described in sections 8.5.1 and 8.5.3.

The other EVR species observed within the gas pipeline right of way that is known to have a restricted distribution was Pedley's wattle (*Acacia pedleyi*), which was observed along the western areas of Calliope Range within the gas pipeline right of way at KPs 257.1 and 257.8. Its distribution is known to be restricted to the Callide and Calliope ranges. Given direct avoidance of this species is unlikely, adequate mitigation measures will be needed to reduce the impacts to this species (Section 8.5).

In the western sections of the Woleebee lateral, the alignment has been selected to intersect the steeper areas of two sandstone jump-ups. The gas pipeline alignment in these areas naturally coincides with the areas of greater historical disturbance and the area is generally cleared

and dominated by pasture grasses. It is anticipated less than 10 individuals of ooline (*Cadellia pentastylis*) will need to be removed during gas pipeline construction. However, the larger individual trees and more densely clustered populations located at the base of the steeper sections of the sandstone jump-ups to the north and the south of the gas pipeline alignment will be avoided.

It is not anticipated that there will be any significant impact to smooth-barked bonewood (*Macropteranthes leiocaulis*). An area of incorrectly mapped endangered RE (11.9.5) suggested that the species was located in the centre sections of the gas pipeline route. The one example observed was not located within the right of way and impacts to this species can be avoided by avoiding the endangered community in which it was observed.

To account for plants that were possibly dormant and/or unidentifiable during the survey and sections of the right of way not surveyed the precautionary principle was adopted as part of the methodology. Therefore, EVR species identified in the desktop assessment with potential to occur within the gas pipeline right of way are considered to be present

Regionally significant flora

Based solely on habitat preference, the gas pipeline alignment contains potential habitat for 45 species. Of those 45 species, a total of ten regionally significant flora species were recorded during the field survey. Of these, seven species (Miles mulga *Acacia aprepta,* lancewood *Acacia shirleyi,* Bloxsome's yellow bloodwood *Corymbia bloxsomei,* Darling Downs hopbush *Dodonaea biloba,* inland hopbush *Dodonaea macrossanii,* Baker's mallee *Eucalyptus bakeri* and mouse bush *Homoranthus melanostictus*) were observed in high numbers and are common within the vicinity of the alignment. As such the proposed clearing for the gas pipeline right of way is unlikely to have a significant impact on local and regional populations. The two other species, river red gum (*Eucalyptus camaldulensis*) and weeping bottlebrush (*Callistemon viminalis*), were abundant and common in riparian habitat along the larger watercourses. Any clearing of these species will be restricted to a limited number of individuals where the right of way intersects larger streams and watercourses. This minimal amount of clearing is unlikely to have a significant impact on local or regional populations of these two species.

In addition to the nine species mentioned above, Cracow ironbark *(Eucalyptus corynodes*) is another regionally significant flora species observed during a preliminary survey conducted in August. This species was observed within the Rockybar-Fairylands portion of the gas pipeline route (C. Eddie, pers. comm.).

It is anticipated clearing for the gas pipeline right of way will have minimal impact on the regionally significant flora species observed.

8.4.6 Cultural, economic and recreational values

The gas pipeline may result in the clearing of common plant species with cultural or recreational value. Potential impacts to the cultural values of vegetation have been discussed in Volume 3 Chapter 18.

The clearing and modification of mangrove and saltmarsh vegetation where the pipeline intersects with the estuarine environments on the east coast of the mainland and the west coast of Curtis Island may have a localised impact from a reduction in fish breeding grounds (refer Volume 3 Chapter 10 and Volume 3 Chapter 20).

The alignment will intersect known timber resources at the Callide Timber Reserve between KPs 254 - 258.2 and the Targinie State Forest between KPs 347.4 - 347.8. It is likely that clearing for the gas pipeline right of way will remove timber resources of economic value from these areas. However, the clearing for the right of way represents 0.2% of the 9,634ha within the Callide Timber Reserve and

0.2% of 545ha in the Targinie State Forest. Given the size of these two timber resources and the minimal clearing required for the gas pipeline right of way, potential impacts are not considered significant to the overall economic value of vegetation in these areas.

8.4.7 Weeds

The introduction and/or spread of weed species may be facilitated by the movement of vehicles and plant equipment during construction and operational activities. Weed species and infestations have the ability to out-compete with native species for resources, such as light and nutrients, thereby reducing biodiversity and altering hydrological and fire regimes and geomorphic processes (Sindel 2000). They may also harm native animals and humans through consumption or contact, and can facilitate animal pest movement and disease spread.

Weed infestations can also harbour animal pest species. Pest animals can cause root damage by digging and lead to a loss in biodiversity by foraging on seeds and fruit. Clearing activities and weed invasion may also increase exposure to stress conditions such as insect attack, wind damage and fungal attack (Rowley et al. 1993).

The spread of weeds can also have a significant impact on the ability for land to be used for agriculture. Given that large areas of the route intersect areas currently utilised for grazing, the impact of weeds in these areas has the potential to be significant.

Numerous declared weeds were observed within the vicinity of the gas pipeline alignment and of particular note is the presence of parthenium weed (*Parthenium hysterophorus*) in the north of the route (KP 320.5). Both Banana Shire Council and Dalby Regional Council spend significant resources keeping these local government areas free of parthenium weed. Any advancement of this weed in a southerly direction will have significant consequences for environmental and agricultural values within the vicinity of the route.

In addition to the declared weeds observed, it should be noted that conditions were not optimal for detection of weeds, especially spring-summer annuals. Anecdotal evidence suggests parthenium is present in Collards Creek in the north of the gas pipeline alignment and requires field confirmation after suitable rainfall. It is also considered likely that giant rat's tail grass (*Sporobolus pyramidalis* and *S. natalensis*) likely to be present in areas where surveys were not conducted east of the Callide Range. Given that these declared weeds are considered likely to occur with the alignment it is suggest further weed surveys in these areas are required following substantial rainfall.

In the absence of any mitigation or control measures, the likelihood that the Project may facilitate the spread of weeds is high. Weed control measures to avoid and mitigate such impacts are outlined in Section 8.5.4.

8.4.8 Fauna

The gas pipeline alignment has been selected to avoid as many large and connected areas of remnant habitat as possible (refer to Figures 18 to 33 in Volume 5 attachment 15). Even so, it is not possible to avoid all areas that may provide high-quality fauna habitat over the total length of the gas pipeline.

Construction of the gas pipeline will require some clearing of vegetation and therefore loss of fauna habitat. A full list of fauna habitats and the areas to be cleared is shown in Table 8.13. This is unlikely to result in a significant long-term impact on common fauna, because similar habitats are available in areas adjacent to the gas pipeline alignment and which they would utilise.

Nevertheless, some potential fauna impacts remain and these include:

- Removal of habitat such as mature vegetation, hollow-bearing trees and fallen logs, and therefore loss of shelter, breeding, nesting, perching and foraging resources
- Disturbance to rocky outcrops and therefore shelter for reptiles and small mammals
- Disturbance to fauna movement corridors and dry season fauna refuges (predominantly associated with creeks)
- Unearthing burrowing fauna species during construction
- Trenchfall – the potential for fauna to fall into and become trapped in the open pipeline trench during construction.

8.4.9 Removal of mature vegetation and tree hollows

Compared to larger areas of fauna habitat present in the surrounding area, relatively small areas of habitat are proposed to be cleared along most of the gas pipeline alignment. The total area of each faunal habitat proposed to be cleared is shown in Table 8.13, with a combined total of approximately 563ha to be cleared. The table shows the amount of each habitat to be cleared as a percentage of the total area of that habitat present within a 10km buffer zone centred on the gas pipeline alignment, with very low percentages in each case except for freshwater wetland habitat. Although only a small area (0.9ha) would need to be cleared for the gas pipeline right of way, it comprises 20% of freshwater wetland habitat within the 10km buffer. The main area of this habitat mapped along the gas pipeline alignment was at Dogwood Creek, which was observed to be dry in the vicinity of the alignment during the field assessment.

Table 8.13 Habitat areas (ha) proposed to be cleared (assuming a 40m right of way)

Habitat	Estimated area to be cleared (ha)	Estimated area within 5km buffer (ha)	Area to be cleared (% of total area within buffer)
Mixed eucalypt woodland and open forest	250.7	85,209.7	0.29
Ironbark woodland	61.7	32,878.2	0.19
Spotted / lemon-scented gum open forest	54.9	15,686.9	0.35
Acacia woodland	15.4	2,994.6	0.52
Saltpan	9.5	1,030.1	1.16
Callitris woodland	8.6	5,086.4	0.17
Riparian woodland	6.5	2,480.4	0.26
Floodplain eucalypt woodland	7.5	3,170.0	0.2.4
Shrubland	7.1	1,614.2	0.44
Poplar box woodland	5.7	3,901.2	0.15
Mangroves	2.4	1,579.4	0.15

Habitat	Estimated area to be cleared (ha)	Estimated area within 5km buffer (ha)	Area to be cleared (% of total area within buffer)
Brigalow / Belah	1.7	3,755.9.	0.05
Freshwater wetlands	0.9	4.6	20.49
SEVT and vine forest	0.1	2,319.9	< 0.01
Total	432.9	162,025.1*	0.27

* Total remnant habitat within the corridor includes areas of additional habitats (for example, bluegrass grassland, she-oak woodland) that are not transected by the gas pipeline alignment but are present within the 10km buffer.

An important potential impact on fauna is the loss of hollow-bearing trees. A large number of Australian fauna species are dependent on tree hollows for shelter and nesting, including parrots, owls, possums, gliders and bats. Mature trees with hollows are limited in many of the rural lands of Queensland, where widespread clearing has removed much of the mature vegetation. Hollows suitable for use by many fauna species do not form until eucalypts are at least 120 years old, with large hollows rare in trees under 220 years old (Gibbons and Lindenmayer 2002). Therefore, lost hollows may not be replaced for very long periods.

Large hollow-bearing trees are especially important habitat in strips of riparian vegetation along watercourses in otherwise cleared land. Even single or widely scattered mature hollow-bearing trees can be important habitat, such as for hollow-roosting bats.

Hollow-bearing trees are present in varying but limited numbers in eucalypt woodland habitats along the alignment, with some of the highest-quality hollow-bearing habitat occurring in riparian and floodplain eucalypt woodland along watercourses.

8.4.10 Disturbance to rocky outcrops

Rocky outcrops and loose surface rocks provide essential habitat for a wide range of reptiles and amphibians, as well as some small mammals. Damage or loss of rocky outcrops or loose surface rocks can impact on a range of small ground fauna species. Where rock habitat is limiting, such impacts are likely to result in decline or loss of rock-dependent fauna species, and may be difficult to reverse.

Few large areas of rock outcrops or extensive surface rocks were observed along the gas pipeline alignment. Notable exceptions included extensive rock and low cliffs along the sandstone belt in the vicinity of Rockybar/Fairylands (KPs 90-105), the vicinity of the Cockatoo Creek crossing (KP 69) and a steep jump-up near the Calliope Range at KP 257.7. Low scarps and jump-ups with significant numbers of loose surface rocks were observed at KPs Con 2.3, Wol 1.6, Wol 12.0 and Wol 29.5.

The Calliope Range itself (KPs 281.5-282.1) was assessed in the desktop study only, but field surveys conducted for the Surat-Gladstone Pipeline in this area observed extensive steep rocky habitat and suggested that caves may be present (AECOM 2009). If present, caves may provide habitat for cave-roosting bats, including large-eared pied bat (*Chalinolobus dwyeri*) and Semon`s leaf-nosed bat (*Hipposideros semoni*).

Anabat surveys recorded the cave-dependent eastern horseshoe-bat (*Rhinolophus megaphyllus*) at two locations in the Callide Range (KPs 257.8 and 263.6), suggesting there may be suitable cave roost habitat in the vicinity of the alignment (this slow-flying species has been recorded flying up to 2km from the roost to forage: van Dyck and Strahan 2008). If caves are present, it is likely this short

section of the alignment (approximately 600m) comprises only a small proportion of cave habitat in the clifflines observed in the Callide and Calliope Range sections of the gas pipeline corridor.

8.4.11 Disturbance to movement corridors

Several large continuous areas of remnant habitat are traversed by the gas pipeline alignment. In particular, these are crossed in the vicinity of Barakula State Forest (KPs Con 5.5 – Con 42.0), Gurulmundi State Forest (KPs Wol 3.0 – Wol 10.5), the sandstone belt in the Rockybar/Fairyland area (KPs 89.5 – 105) and the Callide and Calliope ranges (KPs 255.0 – 271.0, 281.5 – 282.1). Each of these areas of remnant habitat has state-significance as a wildlife corridor on a landscape scale (Figure 8.3), linking a number of large wildlife refugia across the bioregion, such as the Barakula, Expedition, Isla Gorge and Kroombit Tops regions.

The gas pipeline will contribute to the fragmentation of habitat in these areas. Habitat fragmentation is a major cause of population decline in many wildlife species. Linear clearing, corridors such as the gas pipeline right of way, act as a linear barrier to fauna movement that can lead to the subdivision and isolation of fauna populations. The barrier effect of such clearing tends to divide large continuous populations into smaller isolated populations, each of which is more susceptible to extinction than large populations.

Between the large remnant corridors listed above, the gas pipeline alignment traverses extensively cleared agricultural land. At a number of locations the route crosses riparian and floodplain eucalypt woodland habitat fringing major and minor watercourses, which have important fauna values as refugia for wildlife during dry periods and as corridors facilitating the movement of migratory and nomadic species. Such refugia and corridors are particularly important where the wider environment is severely fragmented through clearing for agriculture, as is the case for much of the gas pipeline route. Fragmentation and disturbance of these habitats may be reversible in the medium to long term through revegetation and habitat rehabilitation programs.

8.4.12 Unearthing burrowing fauna species during construction

Direct impact on some fauna species may occur through being physically unearthed during construction of the pipeline trench. Many larger and more mobile fauna, such as birds, kangaroos and larger reptiles, are likely to move away from the construction disturbance. However, smaller burrowing fauna and species that shelter in soil cracks (especially nocturnal species) are likely to remain under the surface, and therefore risk being dug up and injured or killed.

A broad range of burrowing and crack-dwelling fauna, including frogs, lizards, snakes and small mammals, are potentially present along the entire length of the alignment. Significant fauna species vulnerable to being unearthed include small reptiles and amphibians such as the rough collared frog, short-necked worm-skink, Cooloola snake-skink, ornamental snake, grey snake and Dunmall's snake.

8.4.13 Trenchfall

During construction, an open trench will be required to lay the pipeline. Ground-dwelling fauna may fall into the trench and become trapped and exposed to overheating, dehydration, predation and/or drowning. Fauna entrapment within pipeline trenches (trenchfall) has been recognised as a key environmental issue by the Australian Pipeline Industry Association (APIA) Code of Environmental Practice (2009).

Information from other Australian pipeline projects has shown that pipeline trenches can trap high numbers of terrestrial animals (including EVR species), particularly reptiles, frogs and small mammals,

with the potential for very high levels of mortality. Entrapment and mortality figures vary widely depending on factors such as location, habitat, weather conditions, orientation of the trench and season of construction. Previous surveys of fauna trenchfall in Australian pipeline trenches have documented entrapment rates ranging from 1.0 to 13.7 animals per kilometre of open trench, with mortality rates ranging from 3.0 to 52.5% (Doody et al. 2003; Woinarski et al. 2000). To help reduce potential impacts from trenchfall, the length of open trench should be the minimum practicable at any one time. Other mitigation measures to reduce impacts from trenchfall are outlined in Section 8.5.6.

8.4.14 Potential impacts on EVR fauna

Of the 48 EVR fauna species identified as potentially utilising preferred habitat within the gas pipeline corridor, 31 have the potential to be impacted to some extent by the gas pipeline, due to potential effects on habitat or direct impacts (

Table 8.14). These include one butterfly, one fish, two amphibians, 14 reptiles, seven birds and six mammals (refer to Volume 5 Attachment 15 for more information on impact analyses).

Several EVR fauna species identified as potentially occurring within the gas pipeline corridor are species that are nomadic, highly mobile or occupy very large home ranges (

Table 8.14). These include squatter pigeon (*Geophaps scripta scripta*), black-necked stork (*Ephippiorhynchus asiaticus*), black-chinned honeyeater (*Melithreptus gularis*), glossy black-cockatoo (*Calyptorhynchus lathami*), square-tailed kite (*Lophoictinia isura*) and grey-headed flying-fox (*Pteropus poliocephalus*). Given the relatively small amount of remnant habitat proposed to be cleared by construction of the gas pipeline compared to surrounding similar habitat (Table 8.13) and the area over which individuals of these species range, no significant impact is likely upon these species. Several other species are unlikely to be resident and are only occasionally expected to use habitats along the alignment (

Table 8.14), including the estuarine crocodile (*Crocodylus porosus*), red goshawk (*Erythrotriorchis radiatus*), radjah shelduck (*Tadorna radjah*) and Australian swiftlet (*Aerodramus terraereginae*).

Several other EVR fauna species have the potential to be directly impacted if they are present within the gas pipeline corridor in forest and woodland habitats, but also have preferred habitat types that are well represented in the immediate vicinity of the gas pipeline alignment (

Table 8.14). These species include the northern quoll (*Dasyurus hallucatus*), yellow-bellied glider (*Petaurus australis australis*), false water-rat (*Xeromys myoides*), little pied bat (*Chalinolobus picatus*), Brigalow scaly-foot (*Paradelma orientalis*), yakka skink (*Egernia rugosa*), short-necked worm-skink (*Anomalopus brevicollis*), golden-tailed gecko (*Strophurus taenicauda*) and common death adder (*Acanthophis antarcticus*). Although there is potential for some direct impact on these species, the small amount of habitat to be cleared combined with the implementation of appropriate mitigation recommendations (see Section 8.5) would result in minimal potential for significant impact on these EVR fauna species.

Eighteen EVR species (two amphibians, 13 reptiles and three mammals) are susceptible to falling into the open trench during construction and becoming trapped, potentially resulting in significant mortality at the local level (

Table 8.14). Specific mitigation actions to reduce the impacts of trenchfall are outlined in Section 8.5.6.

Detailed distributions of several EVR fauna species identified are poorly known, as they are particularly secretive or cryptic in their habits. These include the collared delma (*Delma torquata*),

ornamental snake (*Denisonia maculata*), Dunmall's snake (*Furina dunmalli*), grey snake (*Hemiaspis damelii*) and yellow-naped snake (*Furina barnardi*). In the absence of such data, it should be assumed that the ornamental snake, Dunmall's snake and grey snake are present within their respective broad ranges, especially in remnant woodland and Brigalow habitats on cracking clay soils. The distribution and habitat preferences of yellow-naped snake are too poorly understood to predict their potential habitat or occurrence along the alignment, but measures to reduce impacts on the other three small snakes are likely to also mitigate impacts on the yellow-naped snake, should it be present.

Two EVR species are considered sensitive to potential impacts from gas pipeline construction: the pale imperial hairstreak (*Jalmenus eubulus*) and beach stone-curlew (*Esacus magnirostris*).

The pale imperial hairstreak is a threatened butterfly restricted to Brigalow-dominated woodlands and open-forests, breeds only in old-growth Brigalow, and does not recolonise regrowth or areas that have been disturbed (Eastwood et al. 2008). There is a low possibility that pale imperial hairstreak may be present in mature Brigalow within the vicinity of the alignment, with most Brigalow habitat observed during the field assessment consisting of small and/or disturbed patches. Given very small areas of potential mature Brigalow habitat are proposed to be cleared, the likelihood of significant impact on this species is low.

The beach stone-curlew is a rare bird found around the coast and offshore islands of northern and eastern Australia from north-eastern NSW to north-western WA. Beach stone-curlews have been recorded close to the alignment on both sides of The Narrows: at Laird Point, near KP 356.0; and in saltpan habitat south of Friend Point near KP 353.6 (Sandpiper 2009). Although a highly mobile species, beach stone-curlews are believed to be sensitive to human disturbance, which is considered a significant threat (Garnett and Crowley 2000). Impacts from disturbance during construction of the gas pipeline are only likely to be significant if the work affects nesting, which typically occurs on beaches during October to December.

Table 8.14 EVR fauna potentially occurring in gas pipeline corridor and potential impacts

Common name *Scientific Name*	EPBC Act[1]	NC Act[1]	Potential impacts
Invertebrates			
pale imperial hairstreak *Jalmenus eubulus*		V	Habitat loss (old growth Brigalow).
Fish			
Murray cod *Maccullochella peelii*	V		Habitat loss (snags, riparian vegetation).
Amphibians			
tusked frog *Adelotus brevis*		V	Direct impact (unearthing), trenchfall.
rough collared frog *Cyclorana verrucosa*		R	Direct impact (unearthing), trenchfall.
Reptiles			
common death adder *Acanthophis antarcticus*		R	Habitat loss (vegetation and leaf litter), trenchfall.

Common name *Scientific Name*	EPBC Act[1]	NC Act[1]	Potential impacts
short-necked worm-skink *Anomalopus brevicollis*		#	Direct impact (unearthing), habitat loss (vegetation, logs), trenchfall.
woma *Aspidites ramsayi*		R	Direct impact (unearthing), trenchfall.
estuarine crocodile *Crocodylus porosus*		V	No significant impact.
collared delma *Delma torquata*	V	V	Direct impact (unearthing), trenchfall
ornamental snake *Denisonia maculata*	V	V	Direct impact (unearthing), trenchfall
yakka skink *Egernia rugosa*	V	V	Direct impact (unearthing), habitat loss (logs), trenchfall.
yellow-naped snake *Furina barnardi*		R	Direct impact (unearthing), trenchfall.
Dunmall's snake *Furina dunmalli*	V	V	Direct impact (unearthing), habitat loss (logs), trenchfall.
grey snake *Hemiaspis damelii*		E	Direct impact (unearthing), trenchfall.
Cooloola snake-skink *Ophioscincus cooloolensis*		R	Direct impact (unearthing), trenchfall.
Brigalow scaly-foot *Paradelma orientalis*	V	V	Habitat loss (vegetation, logs), trenchfall.
Fitzroy River turtle *Rheodytes leukops*	V	V	Habitat disturbance (riffle zones and pools, riparian vegetation).
golden-tailed gecko *Strophurus taenicauda*		NT	Habitat loss (vegetation), trenchfall.
rusty monitor *Varanus semiremex*		R	Habitat loss (mangroves), trenchfall.
Birds			
grey goshawk *Accipiter novaehollandiae*		R	Habitat loss (dense vegetation).
Australian swiftlet *Aerodramus terraereginae*		R	No significant impact.
glossy black-cockatoo *Calyptorhynchus lathami*		V	Reduction of feeding resources (Belah), reduction of nest sites (tree hollows).
black-necked stork *Ephippiorhynchus asiaticus*		R	No significant impact.

Common name *Scientific Name*	EPBC Act[1]	NC Act[1]	Potential impacts
red goshawk *Erythrotriorchis radiatus*	V	E	No significant impact.
beach stone-curlew *Esacus magnirostris*		V	Habitat loss (saltmarsh), disturbance.
squatter pigeon (southern) *Geophaps scripta scripta*	V	V	No significant impact.
painted honeyeater *Grantiella picta*		R	Habitat loss (mistletoe)
sooty oystercatcher *Haematopus fuliginosus*		R	No significant impact.
Lewin's rail *Lewinia pectoralis*		R	Habitat loss (wetland vegetation).
square-tailed kite *Lophoictinia isura*		R	No significant impact.
hooded robin (southeast) *Melanodryas cucullata cucullata*		#	Habitat loss and fragmentation.
black-chinned honeyeater *Melithreptus gularis*		R	No significant impact.
powerful owl *Ninox strenua*		V	Habitat loss (dense vegetation, hollow trees).
eastern curlew *Numenius madagascariensis*		R	No significant impact.
Australian painted snipe *Rostratula australis*	V	V	No significant impact.
little tern *Sterna albifrons*		E	No significant impact.
radjah shelduck *Tadorna radjah*		R	No significant impact.
black-breasted button-quail *Turnix melanogaster*	V	V	Habitat loss (vine thicket).
Mammals			
large-eared pied bat *Chalinolobus dwyeri*	V	V	No significant impact.
little pied bat *Chalinolobus picatus*		R	Loss of roost sites (tree hollows).
northern quoll	E		Habitat disturbance, trenchfall.

Common name *Scientific Name*	EPBC Act[1]	NC Act[1]	Potential impacts
Dasyurus hallucatus			
Semon's leaf-nosed bat *Hipposideros semoni*	E	E	No significant impact.
south-eastern long-eared bat *Nyctophilus corbeni*[2]	V	V	Loss of roost sites (tree hollows).
yellow-bellied glider (southern) *Petaurus australis australis*		#	Habitat loss (hollows, feed trees), direct impact during clearing.
koala (SEQ only) *Phascolarctos cinereus*		V	Habitat loss, direct impact during clearing, trenchfall.
golden-tipped bat *Phoniscus papuensis*		R	No significant impact
grey-headed flying-fox *Pteropus poliocephalus*	V		No significant impact
false water-rat *Xeromys myoides*	V	V	Habitat loss (mangroves), trenchfall.

[1] Status: EPBC: E = Endangered, V = Vulnerable. NC Act: E = endangered; V = vulnerable; R = rare; NT = near threatened. # = Not listed under NC Act, but ranked as high priority by DERM Back On Track Species Prioritisation Framework.

[2] Listed under the EPBC Act as *Nyctophilus timoriensis*.

8.5 Mitigation and management

The alignment has been selected to avoid areas of high ecological value where practicable. Mitigation and management measures have been developed with the aim of avoiding impacts where practicable through alignment changes undertaken prior to and during the field surveys. Areas identified as endangered REs, essential habitat for EVR species and riparian vegetation have been avoided as far as possible. It is recognised that further refinement of the alignment may be required at a local scale for constructability and to further mitigate impacts.

8.5.1 Further field survey

The alignment in the Callide Infrastructure Corridor and within the Gladstone State Development Area between the Bruce Highway (KP 325.2) and Friend Point (KP 354.5) will be determined in conjunction with the Department of Infrastructure and Planning and other proponents following further detailed survey.

Prior to finalising the alignment, walk-through surveys for the endangered large-fruited zamia palm (*Cycas megacarpa*) will be conducted along the Callide Range (KP 255-271) and Calliope Range KP 281.5-282.1) crossings to identify the locations of individuals within the vicinity of the gas pipeline alignment.

Pedley's wattle (*Acacia pedleyi*) was observed within the gas pipeline right of way in the Calliope Range between KPs 257-258. A population mapping exercise for this species will be conducted along the Callide Range crossing (KPs 255-271) at the same time as the surveys for large-fruited zamia palm.

Further surveys for the presence of shiny-leaf ironbark (*Eucalyptus virens*) in the central section of the route along the sandstone belt (KP 90-105) will also be conducted. Little is known about this species and the potential presence of a population will be confirmed prior to construction. This tree species is large and often scattered in distribution, so avoiding direct impact on this species may be possible by minor alignment changes and reducing the right of way width in places. The Callide and Calliope Ranges, Port Curtis and the Narrows, Sandstone Belt (Rockybar/Fairyland) and Gurulmundi – Barakula sections of the gas pipeline route are all identified as sensitive ecological areas in Section 8.3.20.

8.5.2 Vegetation

Vegetation clearing will be limited to the minimum possible extent and existing tracks and cleared areas will be utilised where possible to minimise the total extent of remnant vegetation to be cleared for the gas pipeline. Other measures to reduce the overall impact on vegetation values along the gas pipeline alignment include:

- The proposed 40m right of way will be reduced to the minimum required for safe construction in areas identified as significant vegetation communities or habitat areas
- Any supporting infrastructure such as: construction machinery, site offices and worker facilities, will be located on areas already cleared or open areas with little understorey
- Clearing of native vegetation in and adjacent to watercourses will be restricted where practicable and any diverted hydrological flows will be reinstated post construction
- Construction activities within and near watercourses will be restricted to dry weather conditions where practicable
- All construction personnel will be restricted to within the gas pipeline right of way and designated access tracks and construction personnel will need to be adequately informed as to which tracks are to be used
- Where rehabilitation includes native vegetation and the area is not naturally regenerating, local indigenous species will be sourced preferably from a local seed bank
- Effective sediment and erosion control will be implemented to minimise indirect impacts on surrounding areas
- Any vegetation clearing in and adjacent to watercourses will be restricted where practicable. Also, any diverted hydrological flows will be reinstated post construction to minimise subsequent disturbance to vegetated areas and reduce erosion potential leading to sediment runoff
- Dust suppression measures for cleared construction areas and vehicle tracks will be employed to reduce dust emissions
- Indirect effects caused by dust, water movement and weeds around areas will be monitored, particularly in areas supporting conservation significant species
- Trees will be felled into the construction site or in natural slots between stands of trees to minimise damage to other trees during the clearing process. Machinery contact with standing trees on vegetated margins will be avoided
- All hazardous substances and materials (including fuels, oils and chemicals) will be stored, handled and disposed of in accordance with standard procedures to minimise potential leakage to the environment

- Vegetated buffer areas will be retained. Regeneration and revegetation efforts will be employed in these areas to enhance visual amenity, promote native biodiversity, reduce weed invasion and improve habitat quality. Revegetation/re-seeding efforts will be based on soil types, existing location vegetation characteristics and endemism of selected species
- Rehabilitation success will be monitored in accordance with a monitoring program. Further rehabilitation works may be required in areas where vegetation establishment has been less than acceptable. Such works will be conducted in consultation with the relevant landholder and will be consistent with Section 4.8 of the Australian Pipeline Industry Association Code of Environmental Practice– Onshore Pipelines (APIA 2009)
- Where the clearing of native vegetation cannot be avoided, environmental offsets will be developed in accordance with Section 8.5.7.

8.5.3 Significant flora species

A vegetation management/monitoring plan will be developed and implemented prior to the beginning of any construction work to mitigate the potential impacts of gas pipeline construction on significant flora species. Measures will include:

- Where possible reduce right of way widths near areas of conservation significant species
- Where avoidance is not possible, develop translocation plans where EVR flora species populations are to be cleared. Plans will include a relocation strategy to translocate existing populations to designated vegetation buffer areas (of suitable habitat) within the gas pipeline study area as well as a re-seeding strategy to ensure there is no net loss of significant flora species for the site. A detailed monitoring program will also be included as part of this plan
- Consideration will be given to constructing the gas pipeline under part of the Calliope Range (KPs 281.5-282.1) by Horizontal Directional Drilling (HDD), so as to minimise impacts on the endangered large-fruited zamia palm (*Cycas megacarpa*) population recorded on this section of the alignment. It will be noted that flora studies for the Surat-Gladstone Pipeline EIS have also recommended HDD through this short section of range, immediately adjacent to the Australia Pacific LNG's gas pipeline alignment (AECOM 2009)
- Pre-clearing surveys will be undertaken prior to all clearing activities within remnant vegetation areas and riparian areas to identify the presence of EVR and other significant flora species. Where populations are identified, the alignment will be realigned or the right of way narrowed where practicable so as to avoid damage or loss of these populations
- An awareness presentation and/or an identification handbook for the identified conservation significant species will be supplied to the gas transmission-relevant pipeline construction crews to highlight the importance of the EVR species and avoid accidental impacts.

8.5.4 Weeds

Given that infestations of parthenium weed (*Parthenium hysterophorus*) are located in the northern sections of the gas pipeline route, consideration should be given to starting construction of the gas pipeline in the south and proceeding in a northerly direction. This will minimise the potential for spread of parthenium weed into the Banana and Dalby local government areas.

A weed and pest biosecurity management plan will be developed, incorporated into environmental management plans and implemented during all construction and operation of the gas pipeline to minimise the potential for introduction and/or spread of weed species and plant pests and diseases

within and beyond the study area. This plan will be based upon principles specified in the Queensland Biosecurity Strategy 2009-14 (Department of Primary Industries and Fisheries (DPIF) 2008) and the Regional Pest Management Strategy 2004 – 2009 (CPMG 2004) for managing weed species and plant diseases, and will include:

- Weed and plant pest and disease awareness covered in induction program to educate personnel entering the construction site or associated areas (e.g. laydown areas or temporary accommodation facilities) on how to identify and report weeds and potential plant disease and how to prevent the introduction and spread through initiatives such as vehicle washdown procedures. This program will also aim to educate personnel of the potential impacts of weeds and plant disease on the environment and primary production as well as the implications to individuals for failure to comply
- Vehicle washdown procedures and identification of designated washdown facilities and authorised inspectors including consultation with Western Downs and Banana Regional Councils. Washdown facilities should include both permanent and portable. All vehicles and plant equipment will be cleaned and certified weed-free prior to entering the construction site. Also, all materials, including gravel, mulch, packing material, sand and soil, will have the appropriate vehicle and equipment hygiene declarations prior to entering the site. Vehicles and equipment will be cleaned prior to exiting a known declared weed contaminated area prior to moving to other areas to reduce the potential to introduce or spread these weeds within or beyond the study area
- Agreed management measures in anticipation of potential outbreaks of weeds or plant pests and diseases will be incorporated into the relevant environmental management plans. Personnel will be nominated, be appropriately trained and will be available to ensure that any weed infestations or plant pest and diseases can be managed and controlled quickly with minimal disruption to operations or disturbance to the environment
- Management procedures for the control of weed infestations and plant pest and diseases. Procedures will be developed in accordance with the local government and other relevant pest management plans and procedures and include some, all or a combination of manual, chemical, biological and cultural control methods. Requirements for personnel undertaking control measures will be outlined to ensure personnel involved are aware and qualified to store and handle chemicals and for the timing of applications (e.g. prior to seeding)
- Surveillance of the right of way and adjacent surrounds prior to, during and after gas pipeline construction to monitor known weed species will be conducted. Surveillance should be conducted following wetter periods to aid in the identification of weed species
- An ongoing monitoring program will be developed and implemented to assess the effectiveness of mitigation measures and a reporting program which provides for the systematic review and update of the weed and plant biosecurity management plan will be developed to ensure the overall success of the plan.

Following consultation with landholders affected by the alignment, specific attention needs to be given to the potential for spread of parthenium weed in a southerly direction and the potential for new infestations of giant rat's tail grass in the northern areas of the alignment. The lack of these weeds in the right of way and surrounding areas needs to be a key performance measure for the plant biosecurity management plan.

8.5.5 Rehabilitation

Successful rehabilitation of vegetation values within the study area is a key focus of Australia Pacific LNG's mitigation efforts.

Consultation with landholders will provide information about future land use planned for areas utilised for the gas pipeline right of way. Provided that natural regrowth is endorsed by future land holders, rehabilitation of the right of way during the operation and decommissioning phases is considered as a major impact reduction measure.

Rehabilitation measures will be developed and incorporated into environmental management plans and implemented to maintain and enhance the vegetation values within the gas pipeline right of way and minimise potential impacts of the gas pipeline on adjacent vegetation. These will consider current and proposed management practices to develop key strategies that meet Australia Pacific LNG's sustainability objectives (Section 8.1.1) including natural regeneration, habitat restoration and fauna colonisation.

The rehabilitation measures will include strategies to manage and enhance vegetation onsite during all phases of the Project and requires an understanding of the existing environment to determine the resistance and resilience of ecosystems to potential impacts (Hale and Lamb 1997). Information on the vegetation structure and species composition, including abundance, will be collected at established benchmark (reference) sites prior to commencement of construction of the gas pipeline and used to compare and monitor the effectiveness of rehabilitation efforts during the life of the gas pipeline. A minimum of two reference sites will be identified in each ecosystem type to accommodate natural variability. Sites will be located within designated vegetated buffer/retained areas within or adjacent to the study area.

Natural regeneration and revegetation strategies will be incorporated into the measures to maximise its successful implementation. Natural regeneration will be promoted and assisted with active management of weeds and animals pests and edge effects such as colonisation by native pioneer species to encourage native plant growth and natural migration of plant species from adjacent vegetated areas (Bradley 2002). Revegetation may be undertaken where natural regeneration proves ineffective or where fast establishment of vegetation cover is required such as in cleared areas prone to erosion (Temple and Bungey 1980). Revegetation/re-seeding efforts will be based on information gathered from benchmark sites on soil types and existing local vegetation characteristics. Species will be endemic and sourced locally, where practicable to promote natural provenance within the gas pipeline study area and fauna habitat will be established to facilitate seed dispersal and pollination and improve the overall value of retained vegetated areas.

The rehabilitation measures will include a detailed monitoring program to assess the effectiveness of management efforts and identify the need for additional works to be undertaken (such as weed control). Monitoring programs will be undertaken regularly, throughout the life of the gas pipeline, to allow comparison with established benchmark sites.

8.5.6 Fauna

Thirty-one fauna species could potentially be impacted to some extent by the gas pipeline, with two species considered sensitive to potential impacts from its construction (Section 8.4.8). The gas pipeline may also have potential impacts on common native fauna. To avoid or minimise these impacts, mitigation measures are detailed in Table 8.15.

Table 8.15 Fauna management and mitigation recommendations

Relevant KP	Issue	Management and mitigation recommendation
Full corridor	Removal of mature vegetation	The clearance footprint will be the minimum width required to safely construct the gas pipeline through all patches of remnant vegetation and fauna habitat. Where possible, trimming of branches will occur rather than tree removal.
Full corridor	Clearing of hollow-bearing trees	All trees that contain hollows will be retained wherever practicable. Where such trees cannot be retained the hollow will be left on the ground adjacent to the cleared corridor to provide habitat for ground-dwelling fauna.
Full corridor	Bird and bat nesting and roosting sites	A pre-clearance inspection prior to construction will identify potential important nesting or roosting sites for bird and bat species (for example hollow trees, raptor nests). If present, construction will be timed to avoid seasons where nesting and reproduction are concentrated, where reasonably practicable.
Wol 29.5–29.6 38.0–38.4 40.8–41.0 47.8–47.9 55.7–56.1 124.5–125.0	Clearing of Brigalow/Belah habitat	The alignment passes through several short sections containing remnant Brigalow/Belah at the KPs given. The disturbance footprint will be the minimum width required to safely construct the gas pipeline through sections of Brigalow / Belah habitat. Following construction, cleared timber will be respread over the easement to provide habitat for ground-dwelling reptile species. Where practicable, minor realignment will be applied (subject to the findings of detailed field survey) to minimise the clearing footprint or avoid the habitat altogether (e.g. KP 47.8-47.9).
11.0–11.7, 29.2, 182.6, 320.5, 358.5–358.8	Riparian and floodplain eucalypt woodland	All watercourses with fringing riparian woodland or floodplain eucalypt woodland will be crossed at right angles to minimise the distance transected. Clearing widths will be the minimum practicable within this habitat and the route will be aligned to avoid mature trees with hollows and permanent waterholes and billabongs. Where practicable, construction will occur during the dry season to avoid interruption of drainage.
Full corridor	Trenchfall - fauna or livestock trapped in the open pipeline trench	Trenching will occur progressively to minimise the period of time the trench is open and the length of open trench. The length of open trench at any one time will be the minimum practicable. Ramps and trench plugs with slopes of no greater than 50% (APIA 2009) will be located at least every 500m to assist escape for some species. Where possible, trench plugs will coincide with stock and wildlife trails. Sawdust-filled hessian sacks used to support pipes prior to laying-in will be soaked in water and placed in pairs at appropriate intervals. Branches, ramped gangplanks or similar will also be used to create 'ladders' at regular intervals to assist small fauna to exit the trench (APIA 2009). Consideration will be given to the use of temporary fencing to exclude access to the trench by livestock and larger native wildlife.

Relevant KP	Issue	Management and mitigation recommendation
		Qualified fauna spotters and handlers will be employed to survey the open trench and remove any trapped fauna species. Such surveillance will occur along the entire length of the trench and not merely those areas described as fauna habitats or sensitive areas, as trench fall can entrap significant numbers of fauna along any part of the trench. Fauna searches will be conducted at least daily, preferably in the early morning. Fauna spotters and handlers will be qualified or appropriately trained to assess and handle any injuries to native fauna or livestock that may occur due to trenchfall. Qualified veterinarian staff employed in the local area will be utilised to assess and treat or euthanise (as necessary) any large native vertebrates or livestock.
Full Corridor	Increased vehicular traffic and roadkill	Appropriate measures will be applied to ensure vehicles remain on designated access roads and tracks and within defined gas pipeline construction area and temporary accommodation facility sites (e.g. workforce education, signs, boundary markers and fences). Vehicle movements will be minimised, especially at night. Vehicles shall travel at appropriate speeds that minimise environmental risks, and measures will be taken to ensure speed limits are appropriate and are being observed. Existing roads and tracks will be utilised for access where practicable (APIA 2009).
Full corridor	Soil compaction effects on burrowing fauna	Soil compaction has the potential to reduce habitat quality for burrowing and crack-utilising fauna, including significant species such as the rough collared frog, short-necked worm-skink, ornamental snake, grey snake and Dunmall's snake. To minimise the extent of compaction, appropriate measures will be applied to ensure vehicles remain on designated access roads and tracks and within the defined gas pipeline construction area and temporary accommodation facility sites (e.g. workforce education, signs, boundary markers and fences). Vehicle parking will be restricted to the gas pipeline construction area and other designated areas (APIA 2009). As part of the rehabilitation, soils will be scarified as required.
Full corridor	Revegetating corridor (post construction)	Where practicable, native shrubs will be allowed to regenerate to reduce the barrier to fauna movement, especially by small ground-dwelling fauna. Spreading of logs, hollows and dead timber across the disturbed areas within woodland fauna habitats will be carried out to facilitate small ground fauna movement. Bare vehicle tracks will be minimised following the rehabilitation of the corridor post-construction. Roads and bare tracks can be barriers to movement of small ground-dwelling fauna species. Ideally, a grassed, winding track and infrequent vehicle access will prevent the establishment of bare vehicle tracks.
Full corridor	Mosquito breeding grounds	Equipment and materials used during construction will be stored in a manner that prevents retention of water. Drainage systems will be protected during construction to prevent surface water retention wherever possible. Natural drainage patterns will be protected during construction where practicable and reinstated immediately following construction.

8.5.7 Environmental offsets

Offsets under the EPBC Act

Environmental offsets are a viable option to managing residual impacts onsite, notably where mitigation measures outlined in Section 8.5 cannot be fully implemented or where suitable mitigation measures to mitigate impacts are not available. Environmental offset policies (some at draft stage) have been developed at the Commonwealth and state level and may involve:

- Direct offsets aimed at on-ground maintenance and improvement of habitat or landscape values through:
  - Long-term protection of existing habitat, such as acquisition and inclusion of land under protected estate and covenanting arrangements on private land
  - Restoration or rehabilitation of existing degraded habitat
  - Re-establishment of habitat
- Indirect offsets aimed at improving the knowledge, understanding and management leading to improved conservation outcomes including:
  - Implementation of recovery plan actions including surveys
  - Contributions to relevant research or education programs
  - Removal of threatening processes
  - Contributions to appropriate trust funds or banking schemes that can deliver direct offsets through a consolidation of funds and investment in priority areas
  - Ongoing management activities such as monitoring, maintenance, preparation and implementation of management plans and so forth.

The Draft Policy Statement (DEWHA 2007) provides for the use of environmental offsets under the EPBC Act to maintain or enhance the heath, diversity and productivity of the environment as it relates to matters protected by the EPBC Act (matters of national environmental significance and more broadly for actions involving the Commonwealth). Offsets are actions taken outside a development site that compensate for the impacts of that development and provide an opportunity to achieve long-term conservation outcomes whilst providing flexibility to undertake development which will have an environmental impact.

Environmental offsets should be selected in accordance with the principles of the draft policy, that is:

- Environmental offsets should be targeted to the matter protected by the EPBC Act (i.e. being impacted)
- A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents
- Environmental offsets should deliver a real conservation outcome
- Environmental offsets should be developed as a package of actions, which may include both direct and indirect offsets
- Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'

- Environmental offsets should be located within the same general area as the development activity
- Environmental offsets should be delivered in a timely manner and be long lasting
- Environmental offsets should be enforceable, monitored and audited.

In regard to the Commonwealth policy, matters of national environmental significance applicable to the gas pipeline and where offsets may be necessary include two EPBC-listed endangered TECs. It is also likely the gas pipeline right of way will involve removal of two EPBC-listed threatened flora species and sections of the right of way will be located within the Great Barrier Reef World Heritage Area.

As such, environmental offsets to counterbalance these potential impacts may be considered to maintain and enhance overall environmental values along the gas pipeline route.

Offsets under Queensland Government policies

Environmental offsets

Under the Queensland Government Environmental Offsets Policy (EPA 2008e), environmental offsets provide measures to be taken to counterbalance certain unavoidable negative environmental impacts of a particular project and can be applied to several aspects including vegetation management, loss of habitat and biodiversity.

This policy provides policies for specific areas of environmental management and outlines the principles in which environmental offsets must be selected these principles are:

- Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy
- Environmental impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact
- Offsets must achieve an equivalent or better environmental outcome
- Offsets must provide environmental values as similar as possible to those being lost
- Offset provision should minimise the time-lag between the impact and delivery of the offset
- Offsets must provide additional protection to environmental values at risk, or additional management actions to improve environmental values
- Offsets must be legally secured for the duration of the offset.

Vegetation management offsets

The Policy for Vegetation Management Offsets (DERM 2009) under the VMA provides criteria for vegetation offsets including limitations of offsets, values and regional ecosystems, ecological equivalence and legal requirements with the intention of:

- Conserving remnant vegetation (including endangered, of concern and least concern REs) and vegetation in declared areas
- Ensuring clearing activities do not cause land degradation
- Preventing the loss of biodiversity

- Maintaining ecological processes.

The objective of this policy is to ensure the long-term conservation of REs in Queensland and meet the requirements of the regional management code and offsets. Vegetation management offsets must meet the requirements of the criteria outlined in this policy that covers limitations, RE types and values, ecological equivalence, legal security and implementation and management.

For mining activities under the *Environmental Protection Act 1994*, endangered regional ecosystems are recognised based on their biodiversity status as specified in the Regional Ecosystem Description Database (REDD). For other impacts, endangered regional ecosystems are as defined under the VMA. It should be noted that this policy does not apply to petroleum activities as clearing applications under the VMA and *Sustainable Planning Act 2009* are not required.

Using the VMA status, the gas pipeline right of way will transect approximately 2.8ha of endangered, 16.6ha of 'of concern' and 544ha of least concern remnant vegetation, representing a wide variety of vegetation types. Using the biodiversity status for analysis, the gas pipeline right of way will transect approximately 3.3ha of endangered RE. The minimum requirements for potential offsets areas to counterbalance these impacts are summarised in Table 8.16

Table 8.16 Minimum requirements for potential vegetation management offsets

Minimum offset requirements
Offset limitations
• An offset area must be land-based, that is, it must not be a financial contribution, and may be located on land owned by the applicant or by a third party • An offset area must not be: – Currently mapped as remnant vegetation, unless it is under threat of clearing (i.e. a valid clearing approved under the VMA exists) or is identified as an advance offset approved under this policy and protected by a legally binding mechanism – On land the subject of an offset arrangement administered any government – Vegetation to be retained under an approval issued under any government Act or a category A, B or C area shown on a property map of assessable vegetation – Regulated regrowth that is a restricted area under the regrowth vegetation code • An offset area may be a category X area shown on a property map of vegetation, regulated regrowth vegetation outside a restricted area or other regrowth vegetation that has the necessary functioning regional ecosystems • An offset area may be used to satisfy other offset requirements under another Act or policy (e.g. the Biodiversity Offsets policy)
Values and regional ecosystems
• An offset area must be the same broad vegetation group as the area proposed to be impacted • An offset area for endangered and of concern regional ecosystems must be a RE with the same or higher conservation status than the RE proposed to be impacted • An offset area for connectivity must be located within an ecological corridor as defined under this policy or adjacent to an existing area of remnant vegetation or a restricted area such as

Minimum offset requirements
essential regrowth habitat as defined under the regrowth vegetation code • An offset area for wetlands must be a wetland RE listed in the regional vegetation management code or a RE associated with a natural significant wetland that has the same or higher conservation status than the RE proposed to be impacted • An offset area for watercourses must be a RE that has the same or higher conservation status than the RE proposed to be impacted and a RE associated with a watercourse at least the same stream order as the watercourse proposed to be impacted
Ecological equivalence
• An offset area must be ecologically equivalent to area proposed to be impacted in terms of strategic position in landscape, species diversity, condition of vegetation, landscape context attributes (e.g. patch size, connectivity and context) and special values
Legal security
• An offset area must be legally secured by a legally binding mechanism within four months of the development approval or consistent with the timeframes identified in a legally binding agreement • An offset area must be supported by an offset area management plan

Biodiversity offsets

The objectives of the Queensland Government draft Policy for Biodiversity Offsets (DERM 2009) are to improve the long-term protection and viability of the State's biodiversity, to increase the area of habitat restored and enhanced and to ensure development in Queensland is ecologically sustainable. It provides criteria for identifying and utilising biodiversity offsets to counterbalance an impact that causes a loss of biodiversity values.

Under the draft policy, biodiversity offsets must achieve an equivalent or better environmental outcome for the biodiversity values impacted and may include direct offsets (such as acquiring lands to be included in a protected estate or rehabilitation and protection of regrowth vegetation), or indirect offsets including removing threats to biodiversity values, providing fauna assisted crossings and implementing actions of a recovery plan, biodiversity action plan or management plan.

The draft Policy for Biodiversity Offsets may provide a useful guide to calculate potential offsets based on the conservation status of the values impacted. However, the policy in its present form is a consultation draft and is subject to considerable change. Therefore, it is not considered further here.

An offsets strategy will be developed for the identification of potential offset areas, in consultation with DERM, consistent with Queensland and Commonwealth offsets policies.

8.6 Conclusions

8.6.1 Assessment outcomes

Table 8.17 provides a summary of the potential impacts on terrestrial ecology within the gas pipeline study area and how mitigation measures are proposed to meet the sustainability objectives of the gas pipeline. A risk assessment has been undertaken to identify potential risks, causes and consequences for terrestrial ecology associated with the construction, operation and decommissioning of the gas pipeline.

The risk assessment process is described in Volume 1 Chapter 4. Mitigation measures to reduce the risk have been nominated and the residual risk has been calculated. The residual risk level for terrestrial ecology impacts is identified in Table 8.17. Residual risk has been mitigated to as low as reasonably practicable, based on the project risk criteria.

Table 8.17 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
Sensitive environmental areas such as DERM identified ESAs Flora and fauna species diversity Regional ecosystems, TECs and community diversity Essential habitat for significant species	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas.	Removal of or damage to Internationally nationally, state and locally significant protected areas Long term decrease in population size Reduced area of occupancy Fragmentation of populations Habitat degradation and removal Disrupt the breeding cycle of a population	Direct loss through clearing Increases in light, noise and dust Modified fire regime Increased human presence Introduction and establishment of harmful invasive species Disease Introduction	The alignment where practicable has been selected to avoid areas of high ecological value, including Ramsar wetlands, national parks and conservation parks. Avoidance or offset of known significant habitat and endangered regional ecosystems and their associated flora and fauna species Undertake pre-disturbance scouting for significant species and communities Implementation of Environmental Management Plans to reduce impacts where potential issues are identified Implementation of appropriate weed hygiene measures including weed wash-downs.	Low

Environmental values	Sustainability principles	Potential impacts	Possible causes	Mitigation and management measures	Residual risk level
EVR and regionally significant species Endangered, of concern and least concern REs EPBC Listed TECs Commercial and culturally significant species BPA identified corridors	Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	Loss of habitat for EVR Species. Reduction in listed TECs and REs Loss of Area for potential recruitment of threatened flora species Fauna nesting habitat loss due to loss of mature hollows. Reduction in fauna habitat connectivity (for example gliders) Fragmentation of bioregional corridors Removal of riparian vegetation. Removal and fragmentation of mangrove communities	Direct loss through clearing during construction. Removal of potential recruitment pathways and corridors Weed invasions as a result of inadequate rehabilitation of the right of way. Failure to identify significant species during clearing and maintenance Failure to replace adequate fauna habitat removed during construction	Develop an offset plan for vegetation and for threatened species (large-fruited zamia palm, *Cycas megacarpus*) Environmental offsets will be developed and established in accordance with the principles of the Queensland Government Environmental Offsets Policy Implementation of Environmental Management Plan to reduce impacts where potential issues are identified Implementation of weed hygiene measures Develop and implement rehabilitation management measures to rehabilitate areas affected by the alignment using correct species Rehabilitation should include fauna habitat as well as vegetation such as placement of logs on the right of way Where significant fauna habitat has been identified (following ground-truthing) the development should consider introducing compensatory habitat in accordance with individual species management guidelines	Medium Low (post-offset)

8.6.2 Commitments

To manage potential impacts on terrestrial ecology associated with the construction, operation and decommissioning of the gas pipeline, Australia Pacific LNG will:

- Conduct surveys for large-fruited zamia palm and Pedley's wattle along the Callide Range (KP 255-271) and Calliope Range (KP 281.5-282.1), and for shiny-leaf ironbark and other endangered, vulnerable or rare plants (i.e. EVR, as listed under state legislation) in the central section of the route (KP 90-105) and develop strategies to reduce impacts
- Limit vegetation clearing to the minimum practicable extent along the gas pipeline right of way
- Undertake pre-clearing surveys to identify the presence of endangered, vulnerable or rare and other significant flora and fauna species where they are likely to occur. Where populations are identified, the gas pipeline route will be realigned or the right of way narrowed for short distances, where safe, to reduce damage or loss of these populations
- Develop and implement biosecurity management plan for weeds and pest animals
- Work with regional councils in weed control and contribute to the construction of a permanent weed washdown facility in the Banana Shire
- Develop a vegetation offsets program in consultation with the Queensland Department of Environment and Resource Management and the Commonwealth Department of Environment, Water, Heritage and Resources.

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