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## 1. INTRODUCTION

This attachment is a summary of potential impacts to matters of national environmental significance (MNES) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). It has been prepared, as required by the final terms of reference, to describe the environmental values and assess the potential impacts of the project on MNES.

The EPBC Act provides for the protection of the environment, especially MNES. Under the act, actions likely to have a significant impact on MNES trigger assessment under the EPBC Act. MNES include:

- World Heritage properties.
- National Heritage places.
- Wetlands of international importance.
- Listed threatened species and ecological communities.
- Listed migratory species.
- Protection of the environment from nuclear actions.
- Commonwealth marine environment.

On 2 February 2010, Arrow Energy Pty Ltd (Arrow) referred the Surat Gas Project to the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC; previously known as the Department of Environment, Water, Heritage and the Arts) in Referral No. 2010/5344. On 26 March 2010, the Australian Government declared the project a controlled action due to its potential to significantly affect listed threatened species and ecological communities (s. 18 and s. 18A) and listed migratory species (s. 20 and s. 20A).

The Australian Government determined that the appropriate level of assessment was an environmental impact statement (EIS) and accredited the EIS process under the *Environmental Protection Act 1994* (Qld) (EP Act) in accordance with the bilateral agreement between the Australian and Queensland governments.

This document and the EIS provide the information required by the Australian Government to assess potential impacts on MNES and to decide whether or not to approve the project. The government may:

- Approve the controlled action.
- Approve the controlled action with conditions.
- Not approve the controlled action.

## 2. PROJECT OVERVIEW

Arrow proposes expansion of its coal seam gas operations in the Surat Basin through the Surat Gas Project. The need for the project arises from the growing demand for gas in the domestic market and global demand for energy and the associated expansion of liquefied natural gas export markets.

The project development area covers approximately 8,600 km<sup>2</sup> and is located approximately 160 km west of Brisbane in Queensland's Surat Basin (see Figure 2.1).

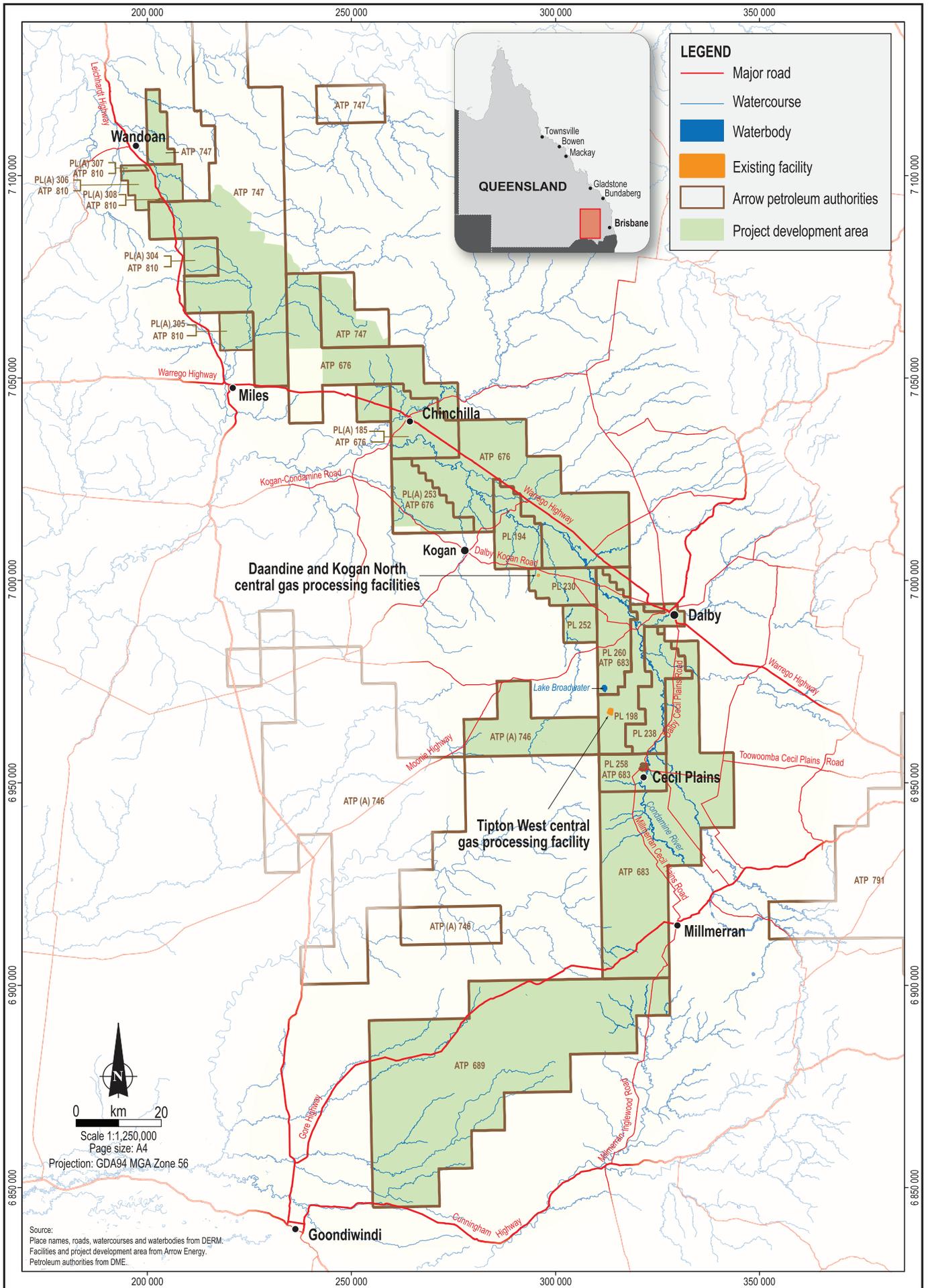
The project development area extends from the township of Wandoan in the north towards Goondiwindi in the south, in an arc through Dalby. Townships within or in close proximity to the project development area include Wandoan, Chinchilla, Kogan, Dalby, Cecil Plains, Millmerran, Miles and Goondiwindi. Project infrastructure, including coal seam gas production wells and production facilities (including both water treatment and power generation facilities where applicable), will be located throughout the project development area but not in towns. Facilities supporting the petroleum development activities, such as depots, stores and offices, may be located in or adjacent to towns.

The conceptual design presented in the EIS is premised upon sustained gas production from Arrow's Surat Basin gas fields of approximately 1,050 TJ/d. The sustained gas production comprises 970 TJ/d for LNG production and a further 80 TJ/d for supply to the domestic gas market.

A project life of 35 years has been adopted for EIS purposes. Ramp-up to sustained production levels is estimated to take between 4 and 5 years and is planned to commence in 2014. Following ramp-up, gas production will be sustained at approximately 1,050 TJ/d for at least 20 years, after which production is expected to decline.

Infrastructure for the project is expected to comprise:

- Approximately 7,500 production wells drilled over the life of the project at a rate of approximately 400 wells per year.
- Approximately 18 production facilities across the project development area, comprising:
  - Six field compression facilities.
  - Six central gas processing facilities.
  - Six integrated processing facilities.
- Low-pressure gas gathering lines to transport gas from the production wells to production facilities.
- Medium-pressure gas pipelines to transport gas between field compression facilities and central gas processing or integrated processing facilities.
- High-pressure gas pipelines to transport gas from central gas processing and integrated processing facilities to the sales gas pipeline.
- Water gathering lines (located in a common trench with the gas gathering lines) to transport coal seam gas water from production wells to treatment and storage facilities.



- Gas-powered electricity generation equipment co-located with production facilities, or electricity transmission infrastructure that will draw electricity from the Queensland electricity grid via third-party substations.

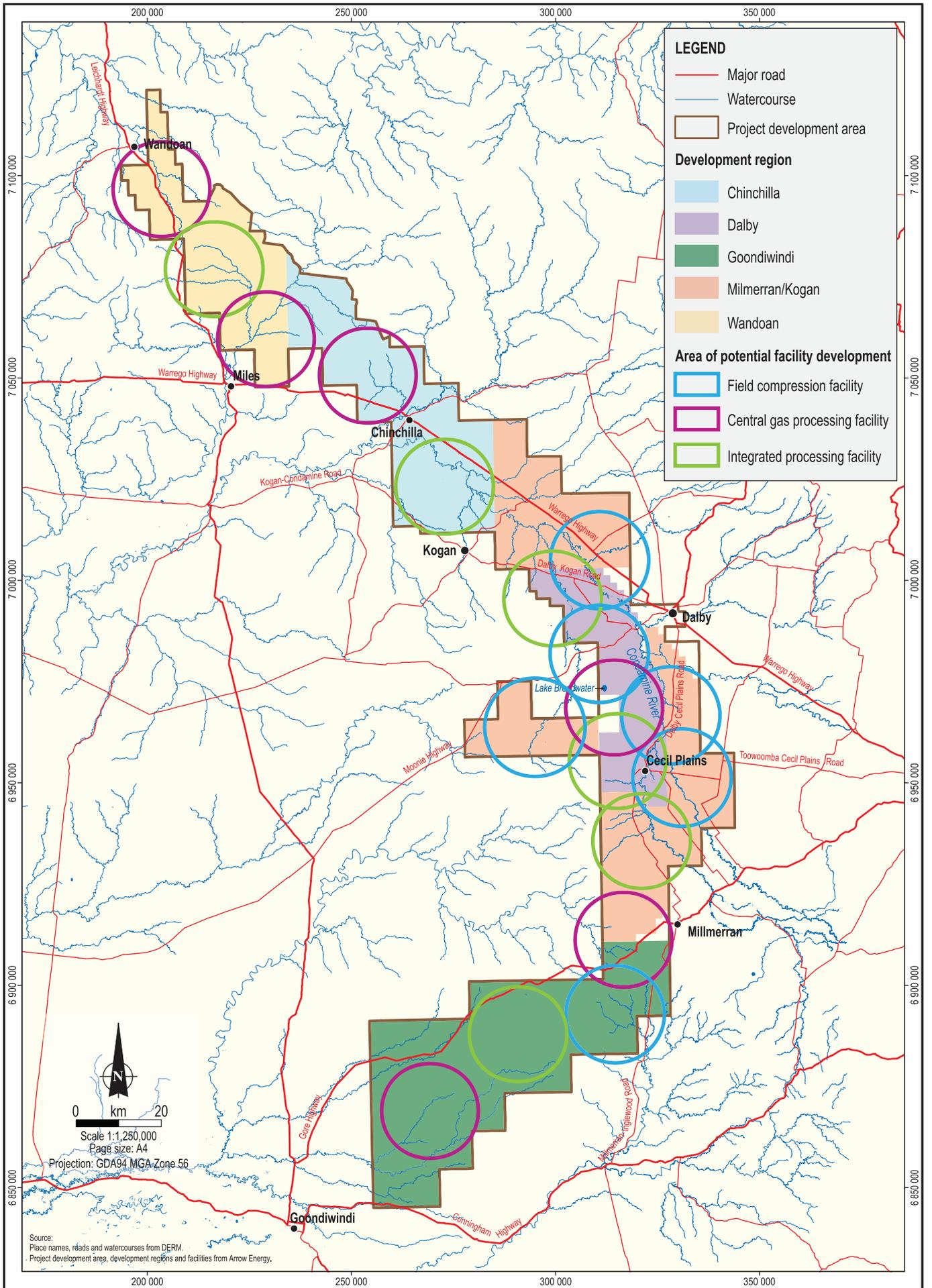
Further detail regarding the function of each type of production facility is described below:

- **Field compression facilities** will receive gas from production wells and are each expected to provide 30 to 60 TJ/d of first-stage gas compression. The compressed gas will be transported from field compression facilities in medium-pressure gas pipelines to multistage compressors at central gas processing facilities and integrated processing facilities where the gas will be further compressed to transmission gas pipeline operating pressure and dehydrated to transmission gas pipeline quality. Coal seam gas water will bypass field compression facilities and be pumped to an integrated processing facility for treatment.
- **Central gas processing facilities** will receive gas both directly from production wells and indirectly from field compression facilities. Central gas processing facilities are expected to each provide between 30 and 150 TJ/d of gas compression and dehydration. Coal seam gas water will bypass central gas processing facilities and be pumped to an integrated processing facility for treatment.
- **Integrated processing facilities** will receive gas from production wells and field compression facilities. Integrated processing facilities are expected to each provide between 30 and 150 TJ/d of gas compression and dehydration. Most of the coal seam gas water received at integrated processing facilities is expected to be treated using reverse osmosis and then balanced to ensure that it is suitable for the intended beneficial use (some of the water may bypass treatment where there is a suitable beneficial use for the untreated water). Coal seam gas water received from a field compression facility or from a central gas processing facility (feedwater), treated water, and brine concentrate will be stored in dams adjacent to integrated processing facilities.

It is envisaged that development of the Surat Gas Project will occur in five development regions: Wandoan, Chinchilla, Dalby, Millmerran/Kogan and Goondiwindi. Development of these regions will be staged to optimise production over the life of the project.

Arrow has established a framework to guide the selection of sites for production wells, pipelines and production facilities. The framework will also be used to select sites for associated infrastructure, such as access roads and construction camps. Environmental and social constraints to development identified through the EIS process coupled with the application of appropriate environmental management controls will ensure that protection of environmental values (resources) is considered in project planning. This approach will maximise the opportunity to select appropriate site locations that minimise potential environmental and social impacts.

Arrow has identified 18 areas that are nominated for potential facility development to facilitate environmental impact assessment (and modelling). These are circles of approximately 12 km radius that signify areas where development of production facilities could potentially occur. Conceptual production facility locations are depicted in Figure 2.2.



Arrow intends to pursue opportunities in the selection of equipment (including reverse osmosis units, gas-powered engines, electrical generators and compressors) and the design of facilities that facilitate the cost-effective and efficient scaling of facilities to meet field conditions. This flexibility will enable Arrow to better match infrastructure to coal seam gas production. It will also enable Arrow to investigate the merits of using template design principles for facility development, which may in turn generate further efficiencies as the gas reserves are better understood, design is finalised, or field development progresses.

### 3. ASSESSMENT METHODS

MNES identified in the EPBC Act referral submitted to the Australian Government on 2 February 2010 were investigated and assessed in the EIS. Technical studies were commissioned to describe the existing environment, identify environmental values, assess potential and residual impacts, and propose mitigation and management measures, as well as inspection and monitoring.

Technical studies relevant to the assessment of MNES include:

- Terrestrial Ecology Impact Assessment (Appendix K of the EIS).
- Aquatic Ecology Impact Assessment (Appendix J of the EIS).
- Aboriginal Cultural Heritage Impact Assessment (Appendix Q of the EIS).
- Non-Indigenous Heritage Impact Assessment (Appendix R of the EIS).

Arrow undertook an EPBC Protected Matters Search on 29 October 2009 to support Referral No. 2010/5344. The search identified 45 listed threatened species, 17 listed migratory species and six listed threatened ecological communities to be potentially present in or within 5 km of the project development area.

Further desktop searches were undertaken, which included searches of the following databases:

- Regional ecosystem mapping and high-value regrowth vegetation mapping (Queensland Government).
- Regional Ecosystem Description Database managed by the Department of Environment and Resource Management (DERM).
- Queensland Herbarium's records system (HERBRECS).
- Queensland Herbarium's site-based floristic database (CORVEG).
- DERM's WildNet, including a 10-km additional search buffer.
- Queensland Museum's fauna collections database, including a 10-km additional search buffer.
- Birds Australia Atlas, including a 10-km additional search buffer.
- Internal flora and fauna databases held by 3D Environmental and Osmotic Ecology.
- Biodiversity planning assessment for the Brigalow Belt South bioregion using DERM's Biodiversity Assessment and Mapping Methodology to provide information on biodiversity significance, essential habitat and regional wildlife corridors.

A further EPBC Protected Matters Search was undertaken on 21 February 2011 as part of the terrestrial ecology impact assessment study to capture any new species listed since the original search in 2009. For reasons unknown, one migratory species, common greenshank (*Tringa nebularia*), that was identified in 2009 was not identified in this search.

An additional threatened ecological community, Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions was identified as being potentially present in or within 5 km of the project development area after becoming listed as 'endangered' under the EPBC Act in March 2011.

Terrestrial flora and fauna field surveys were then conducted over two periods, from October to December 2009 and during May 2010, to provide baseline information and to assess the likelihood of MNES in the project development area.

Aquatic ecology field surveys were undertaken at eleven sampling sites during November 2009 (early wet season) and May 2010 (after the wet season). An extensive desktop review was also undertaken to augment the field surveys to provide baseline information and to determine the likelihood of MNES occurring in the project development area.

Areas of Indigenous archaeological or cultural significance in the project development area were identified through a desktop study, including searches of relevant Indigenous cultural heritage databases and lists. Consultation had commenced with Indigenous (Aboriginal) parties, but formal negotiations on cultural heritage management and Indigenous land use have not been finalised. Arrow proposes to meet its 'duty of care' obligations under Queensland legislation either through a suitable native title agreement or agreements that do not expressly exclude cultural heritage or through an approved cultural heritage management plan. Arrow will comply with the *Aboriginal Cultural Heritage Act 2003* (Qld) as the project progresses.

Areas of known non-Indigenous heritage sites were identified through research and consultation with local groups and individuals. Zones with a high potential to contain historic sites and places were also identified and assessed. Targeted field investigations were then undertaken in these zones leading to the identification and documentation of additional historical places and sites.

## **4. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE IN THE EXISTING ENVIRONMENT**

The EPBC Protected Matters Searches, additional database surveys and field surveys undertaken for the terrestrial and aquatic ecology assessments identified 45 listed threatened flora and fauna species, 17 listed migratory species and six listed threatened ecological communities to be present or potentially present in or adjacent to the project development area. They also identified that the project will be undertaken in catchments that drain to or in the vicinity of two wetlands of international importance.

The Indigenous and non-Indigenous cultural heritage assessments did not identify any World Heritage properties or National Heritage places.

Additionally, no nuclear actions or Commonwealth marine environments were identified to be present in or adjacent to the project development area.

### **4.1 Wetlands of International Importance**

The EPBC Protected Matters Searches identified that the project will be undertaken in catchments that drain to or in the vicinity of wetlands of international importance: the Narran Lakes Nature Reserve and the Shoalwater and Corio Bays Area. There are no wetlands within the project development area of international importance.

The Narran Lakes Nature Reserve is a listed Ramsar wetland in northern New South Wales. The site is the terminal wetland of the Narran River, which is fed by the Condamine River. The Condamine River drains a substantial part of the project development area. Located approximately 75 km northwest of Walgett and 50 km northeast of Brewarrina, Narran Lake provides habitat for migratory species and is of cultural significance to Indigenous people. The wetland is located some 500 km by river from the project development area.

The Fitzroy River and its tributary the Dawson River drain the northern part of the project development area. The Fitzroy River flows to the sea southeast of Rockhampton. Its mouth is 50 km south of the Ramsar wetlands of the Shoalwater and Corio Bays Area. The site comprises five major estuarine and marine environments, which represent the largest area in central east Queensland containing representative coastal, subcoastal and aquatic landscapes and ecosystems. The wetland complex is more than 500 km by river from the project development area.

Figure 4.1 shows these wetlands relative to the project development area.



Due to the large distances between the project development area and the Narran Lakes Nature Reserve and the Shoalwater and Corio Bays Area wetlands, it is unlikely project-related activities will impact on these sites. Consequently, the assessment did not include these sites.

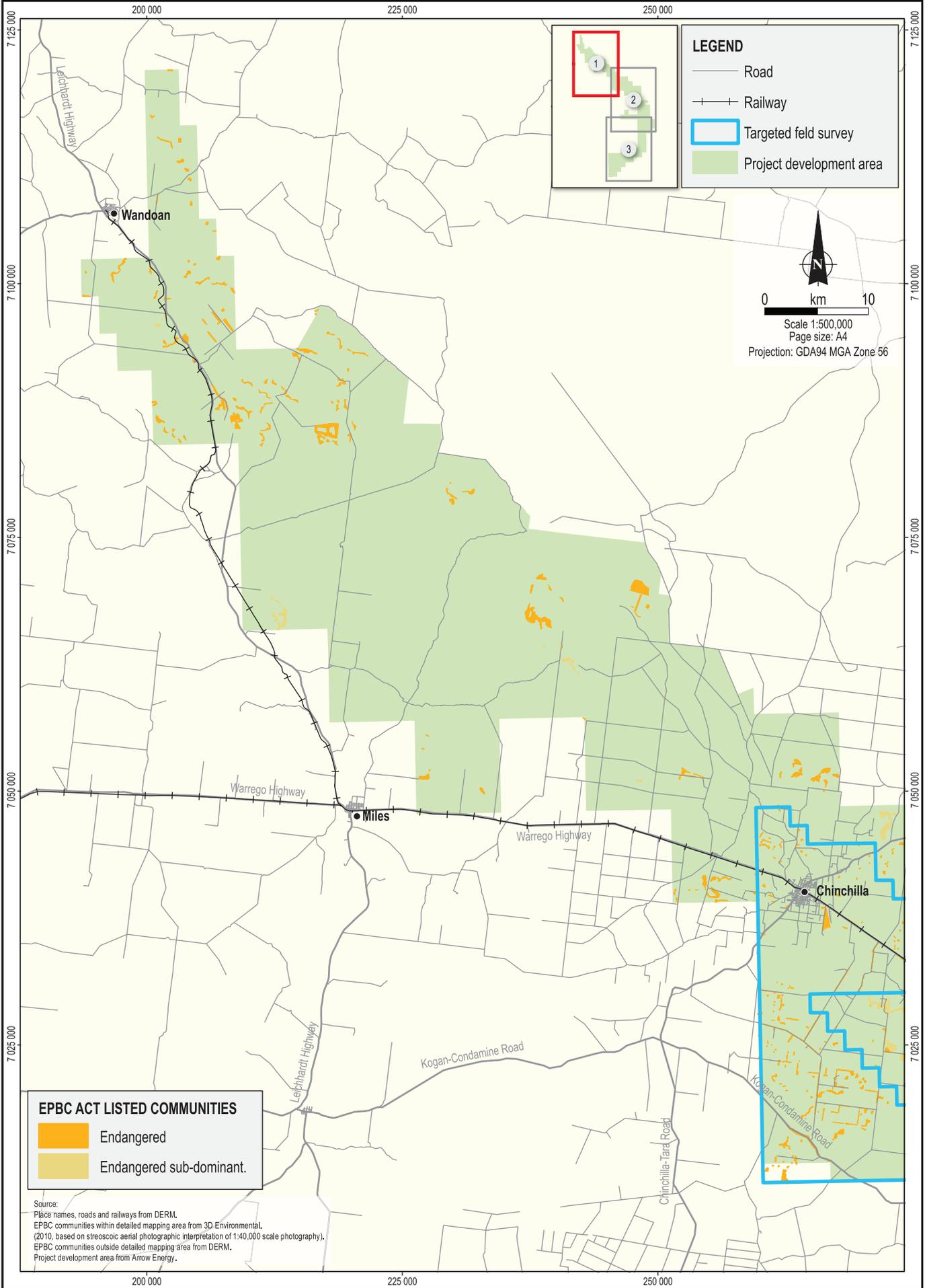
## **4.2 Listed Threatened Ecological Communities**

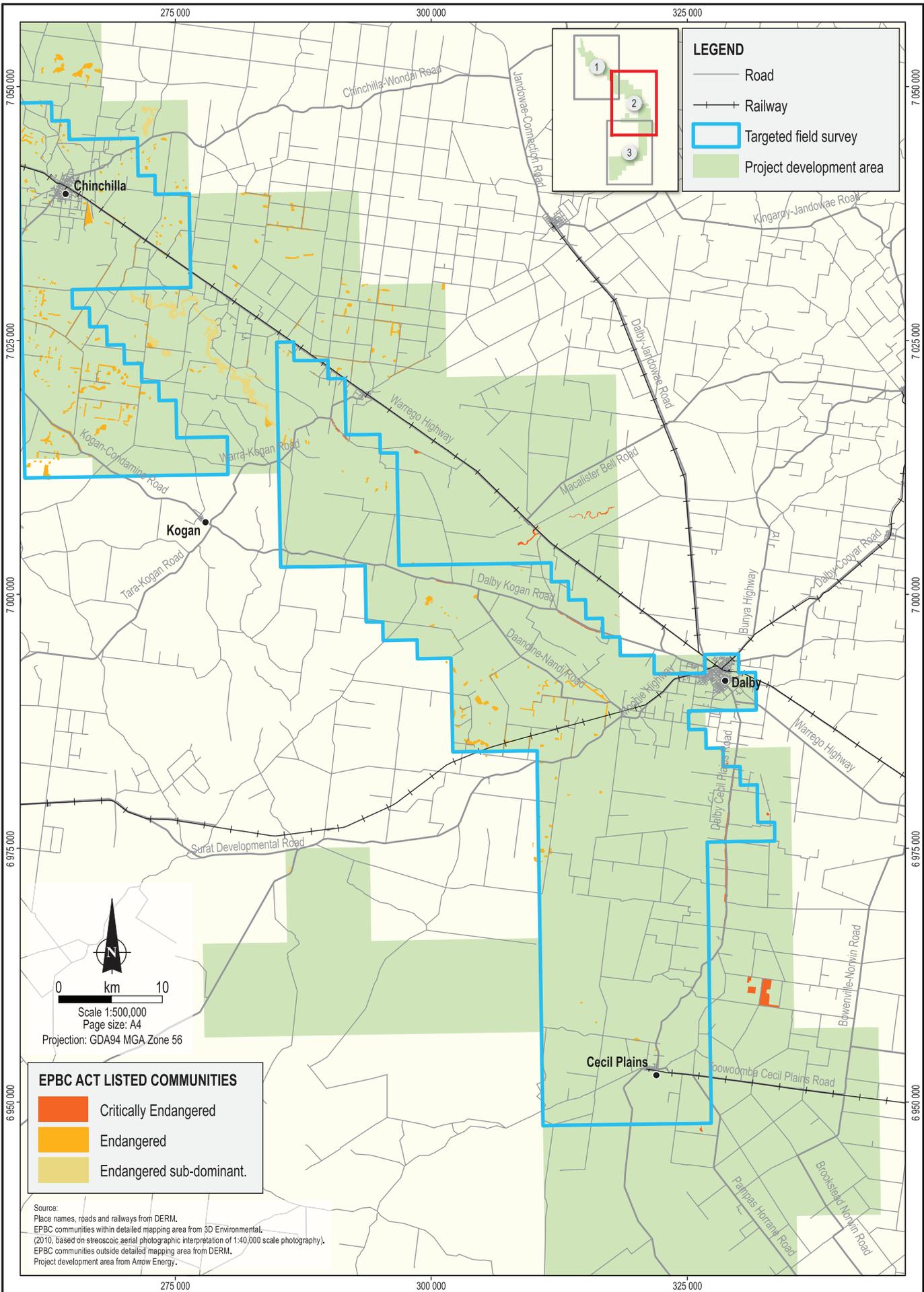
The EPBC Protected Matters Searches identified six listed threatened ecological communities as being present or potentially present in and adjacent to the project development area, based on their likelihood of occurrence according to distribution. These communities are represented by 13 regional ecosystems under Queensland legislation (*Vegetation Management Act 1999*), as well as regrowth vegetation in some listed communities (brigalow).

Of the six listed threatened ecological communities identified in the desktop search, two were confirmed during field surveys and the remaining four were not confirmed but are considered as possible or likely to occur based on previous records and vegetation mapping.

Table 4.1 summarises the listed threatened ecological communities along with their likelihood of occurrence within the project development area.

Figures 4.2a, b and c show the location of these ecological communities within the project development area as mapped by DERM and as a result of detailed field survey. The 'endangered sub-dominant' field on the figure indicates areas where a listed threatened ecological community is mixed with an ecosystem that has no EPBC significance.

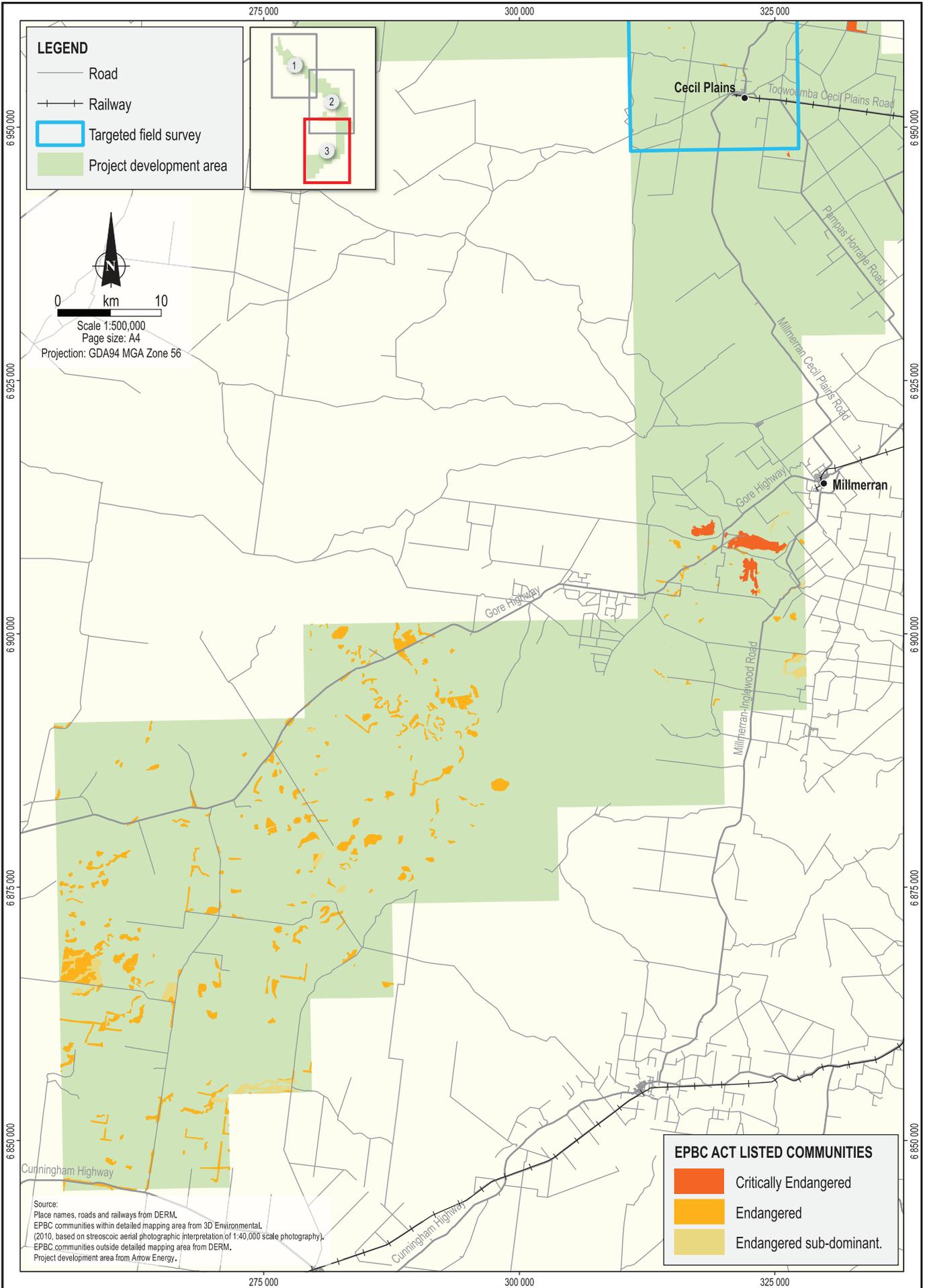




**EPBC ACT LISTED COMMUNITIES**

- Critically Endangered
- Endangered
- Endangered sub-dominant.

Source:  
 Place names, roads and railways from DERM.  
 EPBC communities within detailed mapping area from 3D Environmental.  
 (2010, based on stereoscopic aerial photographic interpretation of 1:40,000 scale photography).  
 EPBC communities outside detailed mapping area from DERM.  
 Project development area from Arrow Energy.



**LEGEND**

- Road
- +— Railway
- Targeted field survey
- Project development area

  
 0 km 10  
 Scale 1:500,000  
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 Projection: GDA94 MGA Zone 56

**EPBC ACT LISTED COMMUNITIES**

- Critically Endangered
- Endangered
- Endangered sub-dominant.

Source:  
 Place names, roads and railways from DERM.  
 EPBC communities within detailed mapping area from 3D Environmental.  
 (2010, based on stereoscopic aerial photographic interpretation of 1:40,000 scale photography).  
 EPBC communities outside detailed mapping area from DERM.  
 Project development area from Arrow Energy.

**Table 4.1 Listed threatened ecological communities and their likelihood of occurrence, structure and location within the project development area**

EPBC Act–Listed Threatened Ecological Community	EPBC Status	Likelihood of Occurrence	Location and Structure of Community
Brigalow ( <i>Acacia harpophylla</i> dominant and co-dominant)	‘Endangered’	Present	Field observations and regional ecosystem mapping suggest that <i>A. harpophylla</i> dominant and co-dominant communities are a common, although highly fragmented, ecosystem. These communities are recognised under the Vegetation Management Act as regional ecosystems (REs) 11.3.1, 11.4.3, 11.4.10, 11.9.5 and 11.9.6.
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	‘Critically endangered’	Present	This community was identified in narrow strips along road verges and stock routes. It is recognised under the Vegetation Management Act as REs 11.3.21 and 11.3.24.
Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions	‘Endangered’	Likely	It is likely that small pockets occur in flood plain habitats in the project development area, particularly in areas from Chinchilla northwards. It is recognised under the Vegetation Management Act as RE 11.3.3. This community occurs as a sub-dominant community in association with RE 11.3.25 and 11.3.4.
White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland	‘Critically endangered’	Likely	This is considered likely in the Captains Mountain area south of Millmerran. It is recognised under the Vegetation Management Act as RE 11.8.2a.
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	‘Endangered’	Possible	There is some potential for this ecological community to occur in small patches of brigalow throughout the project development area. It is recognised under the Vegetation Management Act as REs 11.8.3 and 11.9.4a.
Weeping Myall Woodlands	‘Endangered’	Possible	This community is often associated with RE 11.3.2, which occurs extensively in the project development area. Field surveys did not locate any examples of this community, although scattered weeping myall trees were observed to be associated with RE 11.4.12, and it is therefore considered possible.

### 4.3 Listed Threatened Flora and Fauna Species

The EPBC Protected Matters Searches identified 47 listed threatened flora and fauna species as being potentially present within the project development area and the 5 km buffer, based on their likelihood of occurrence according to the distribution of species and their habitats:

- Eight threatened bird species.
- Four threatened mammal species.
- One threatened fish species.
- Eight threatened reptile species.
- Twenty-six threatened plant species.

These listed species are identified as potentially occurring within the project development area with varying regularity. Some are restricted in extent and habitat (e.g., five-clawed worm-skink

(*Anomalopus mackayi*)), while others are widely distributed (e.g., brigalow scaly-foot (*Paradelma orientalis*)) and others are nomadic and most likely vagrant (e.g., Australian painted snipe (*Rostratula australis*)).

Only three of these species (lobed blue-grass (*Bothriochloa biloba*), small-leaved wax flower (*Philotheca sporadica*) and Hando's wattle (*Acacia handonis*)) were recorded during the field surveys, while the remaining 42 species are either known from previous records or are considered possible, likely or unlikely occurrences based on the presence of suitable habitat within the project development area.

The assessment of habitat suitability was undertaken to identify areas likely to support 'general' habitat and 'core' habitat.

General habitats are those with regional ecosystems that may be used less regularly by fauna.

Core habitat within the project development area is a combination of critical and essential habitat (as mapped by DERM) for EPBC Act-listed species (however, there are other important habitat areas for EPBC Act-listed species that do not fall within the essential habitat classification). Core habitat areas comprise regional ecosystems that are likely to be regularly inhabited by or are of high importance to the listed species.

Where essential habitat data for species was not readily available, i.e., those recorded infrequently within the project development area, core and general habitat types were determined by carrying out the following:

- Compiling a list of regional ecosystems from the essential habitat factors provided by DERM under the Vegetation Management Act.
- Compiling a list of regional ecosystems based on cross-referencing regional ecosystem maps and known location data.
- Vetting resultant lists of regional ecosystems for each species, based on known habitat requirements, to remove erroneous regional ecosystems.
- Segregating the regional ecosystems into core and supplementary habitats (those habitats used by species but not considered 'core' habitat) by comparing the Regional Ecosystem Description Database with habitat requirements known for each species.
- Testing the validity of the resultant list of regional ecosystems for each species in field surveys.
- Modifying the resultant maps to account for factors that cannot be included in descriptions of regional ecosystems, e.g., species distributions, proximity to highly valuable habitat and patch size.

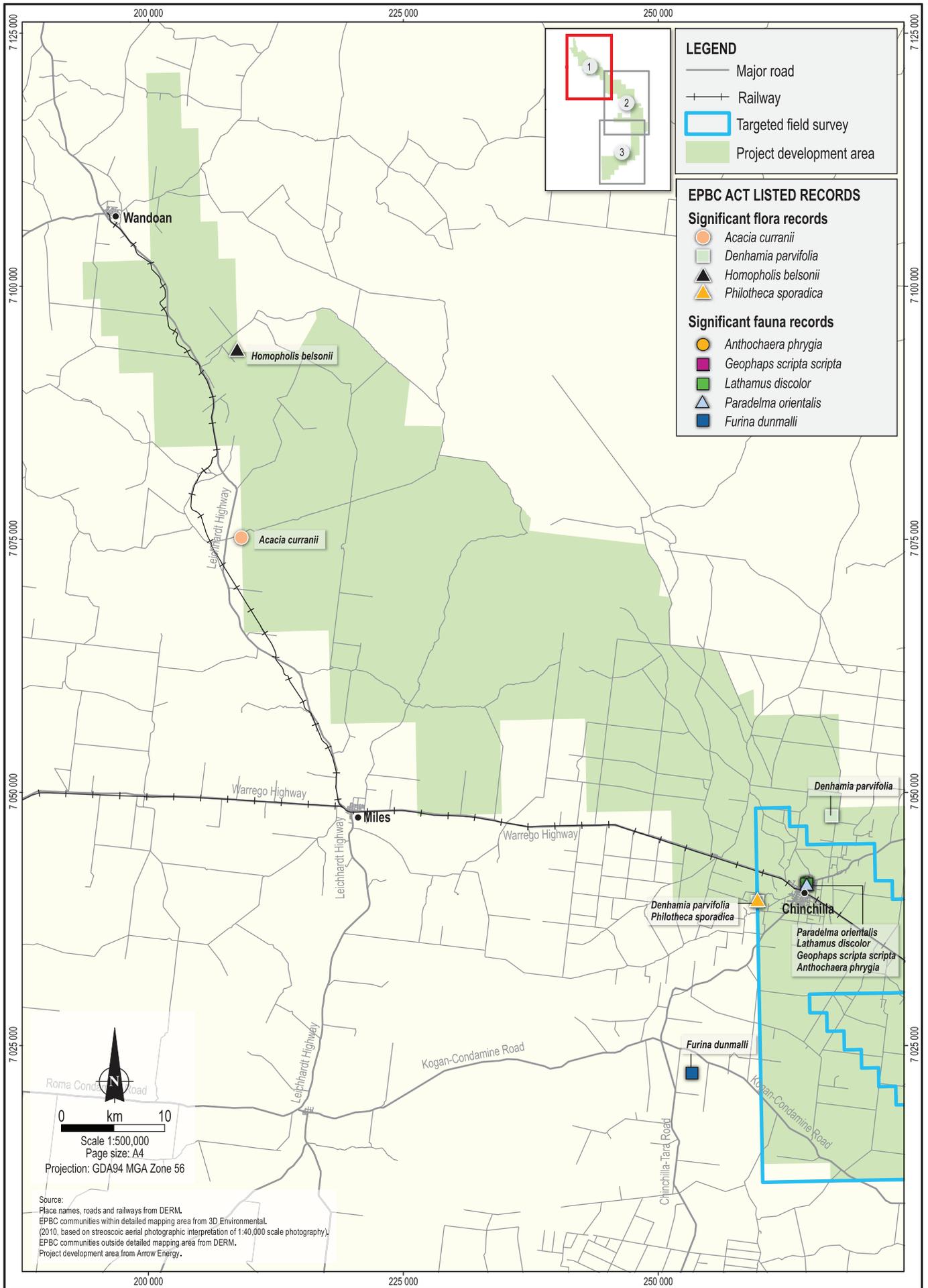
In cases where specific habitat requirements of various fauna species could not be assigned to individual regional ecosystems, such as rock outcrops, presence of water or specific host plant species, regional ecosystems that regularly contained the necessary habitat attributes for a particular species were assigned as core habitat.

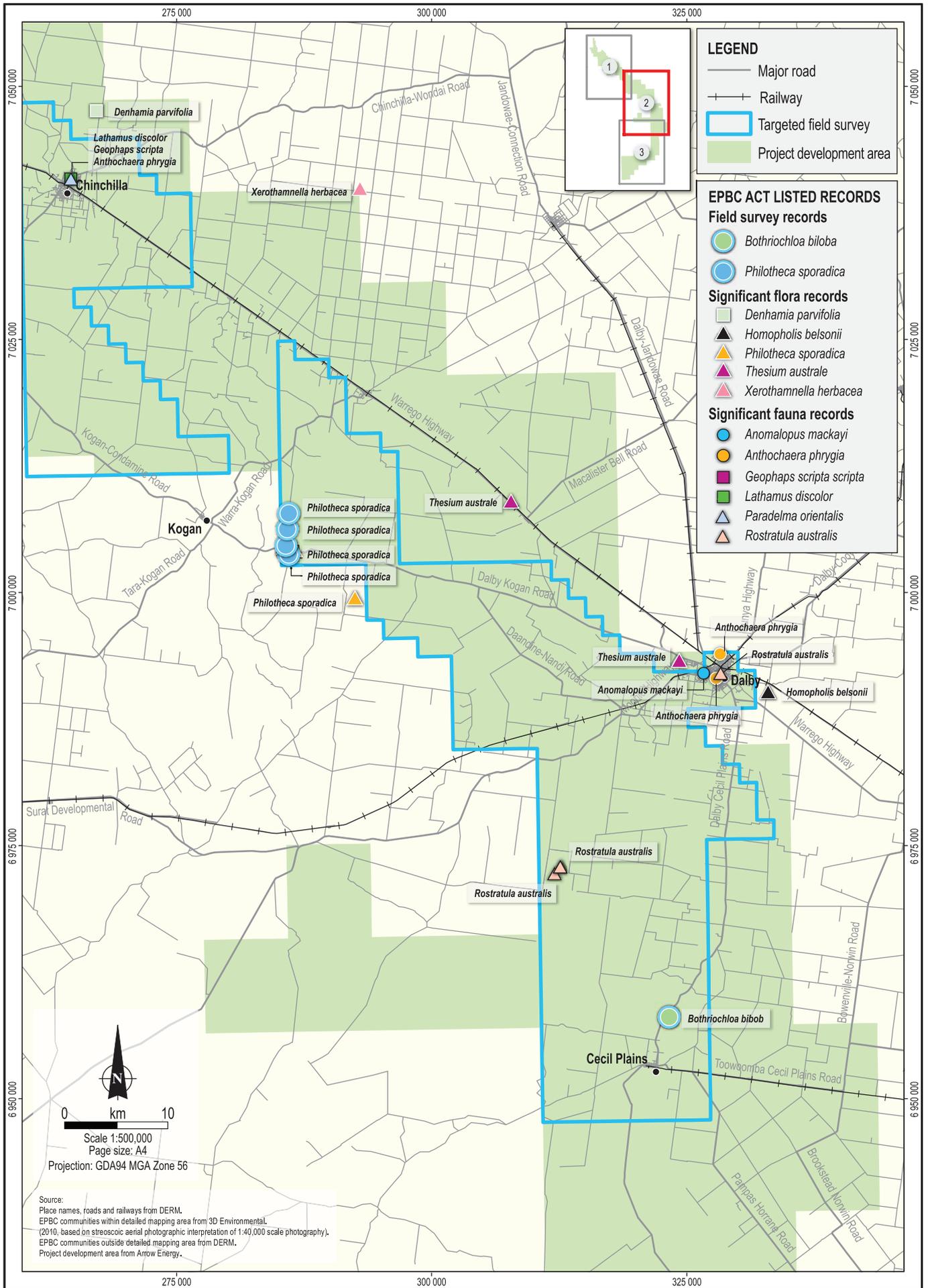
Table 4.2 summarises the listed threatened flora and fauna species along with their likelihood of occurrence within the project development area and their preferred habitat. Detailed habitat requirements and ecology for each individual species are provided in Appendix K (Terrestrial Ecology Impact Assessment) and Appendix J (Aquatic Ecology Impact Assessment) of the EIS.

Figures 4.3a, b and c show locations of the listed threatened flora and fauna species previously recorded in the study area from both field survey associated with this study and spatially attributed records from database searches.

Figures 4.4a, b and c show the location of areas of known habitat and otherwise suitable habitat for the threatened flora and fauna species, indicating areas of their possible occurrence within the project development area.

Lake Broadwater is an important wetland which is likely to provide suitable habitat for threatened flora and fauna species and could also be seasonally inhabited by EPBC Act-listed species, such as the Murray cod and migratory birds.





**LEGEND**

- Major road
- Railway
- Targeted field survey
- Project development area

**EPBC ACT LISTED RECORDS**

**Field survey records**

- Bothriochloa biloba*
- Philotheca sporadica*

**Significant flora records**

- Denhamia parvifolia*
- Homopholis belsonii*
- Philotheca sporadica*
- Thesium australe*
- Xerothamnella herbacea*

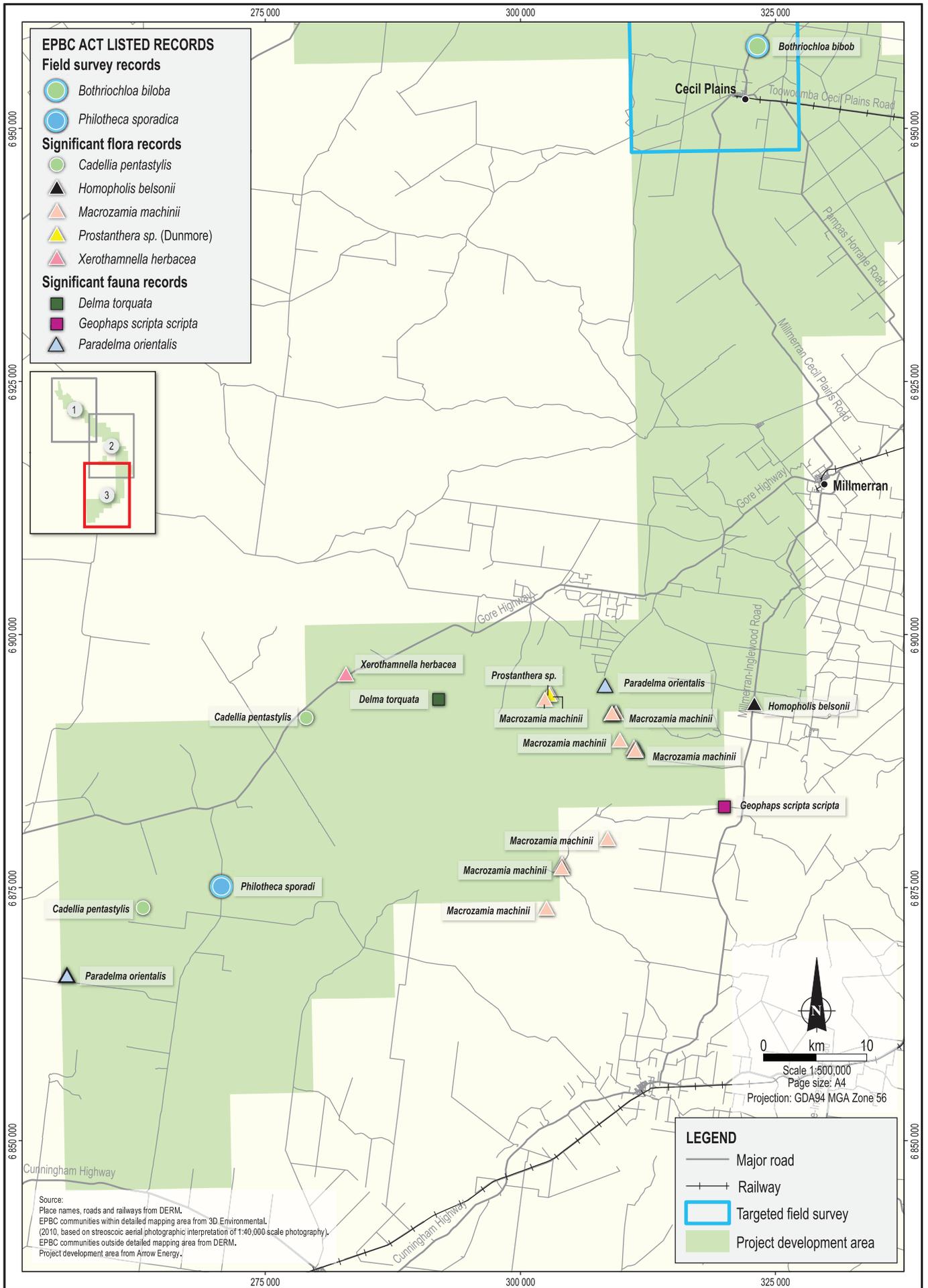
**Significant fauna records**

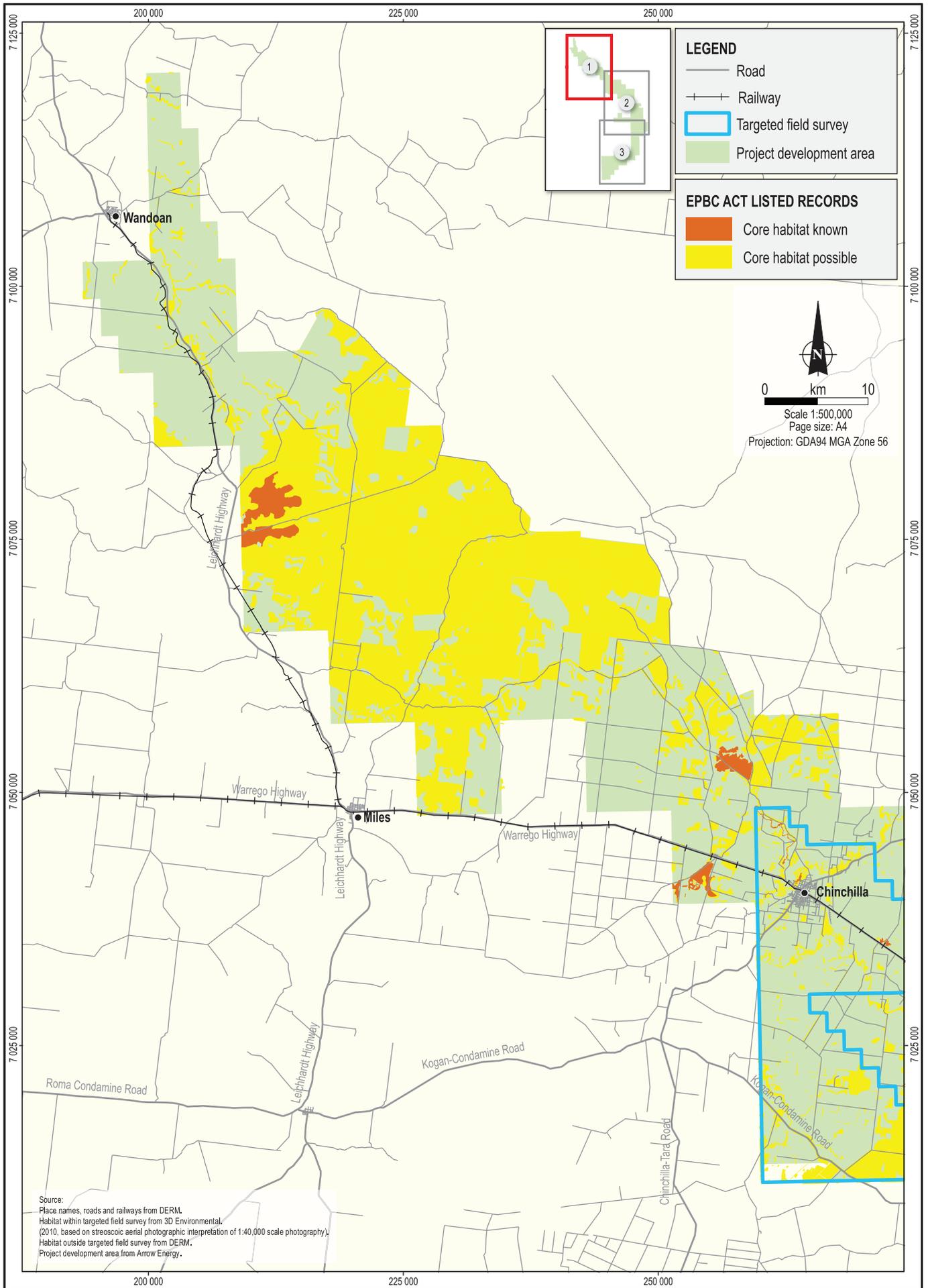
- Anomalopus mackayi*
- Anthochaera phrygia*
- Geophaps scripta scripta*
- Lathamus discolor*
- Paradelma orientalis*
- Rostratula australis*

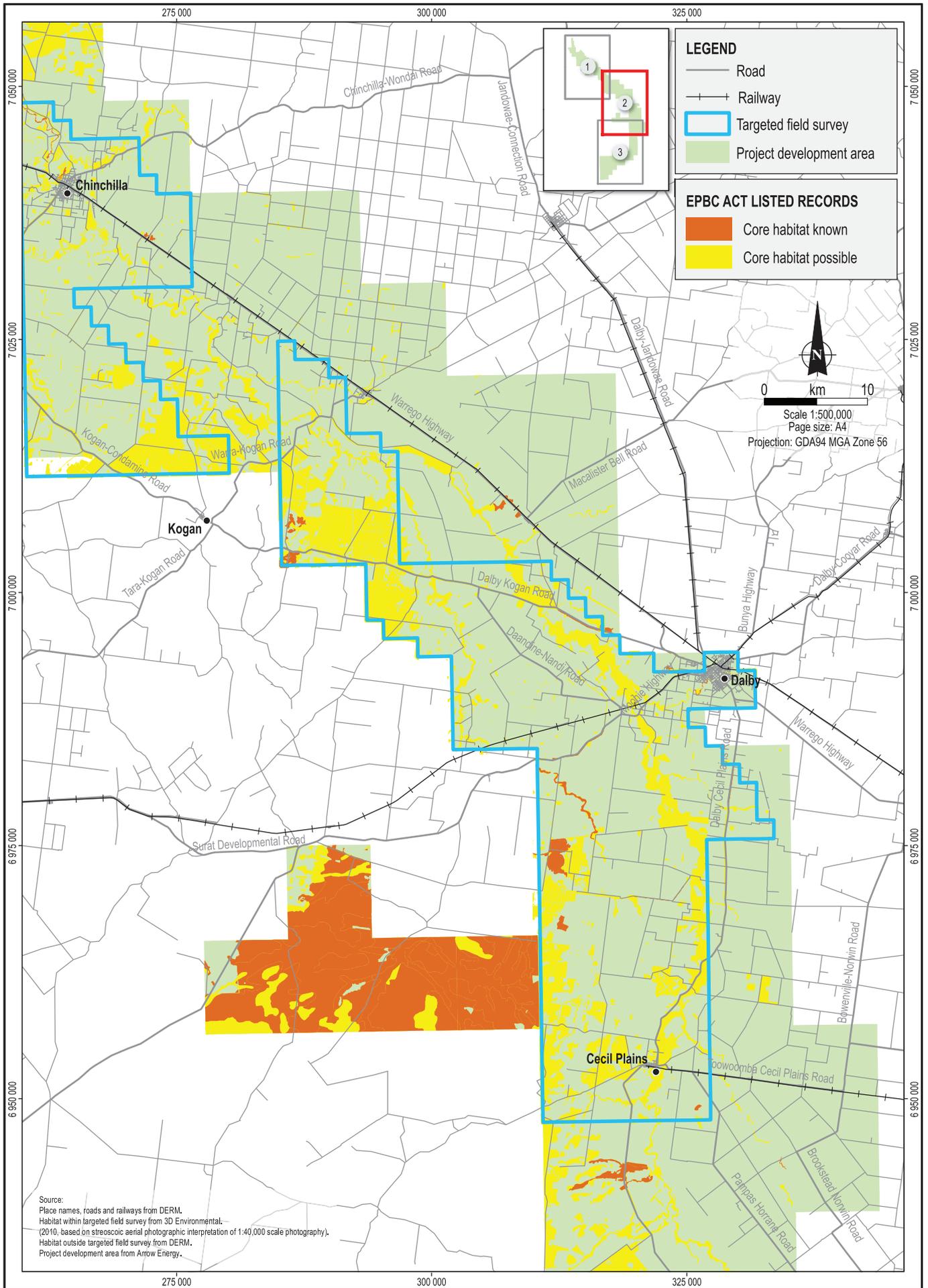
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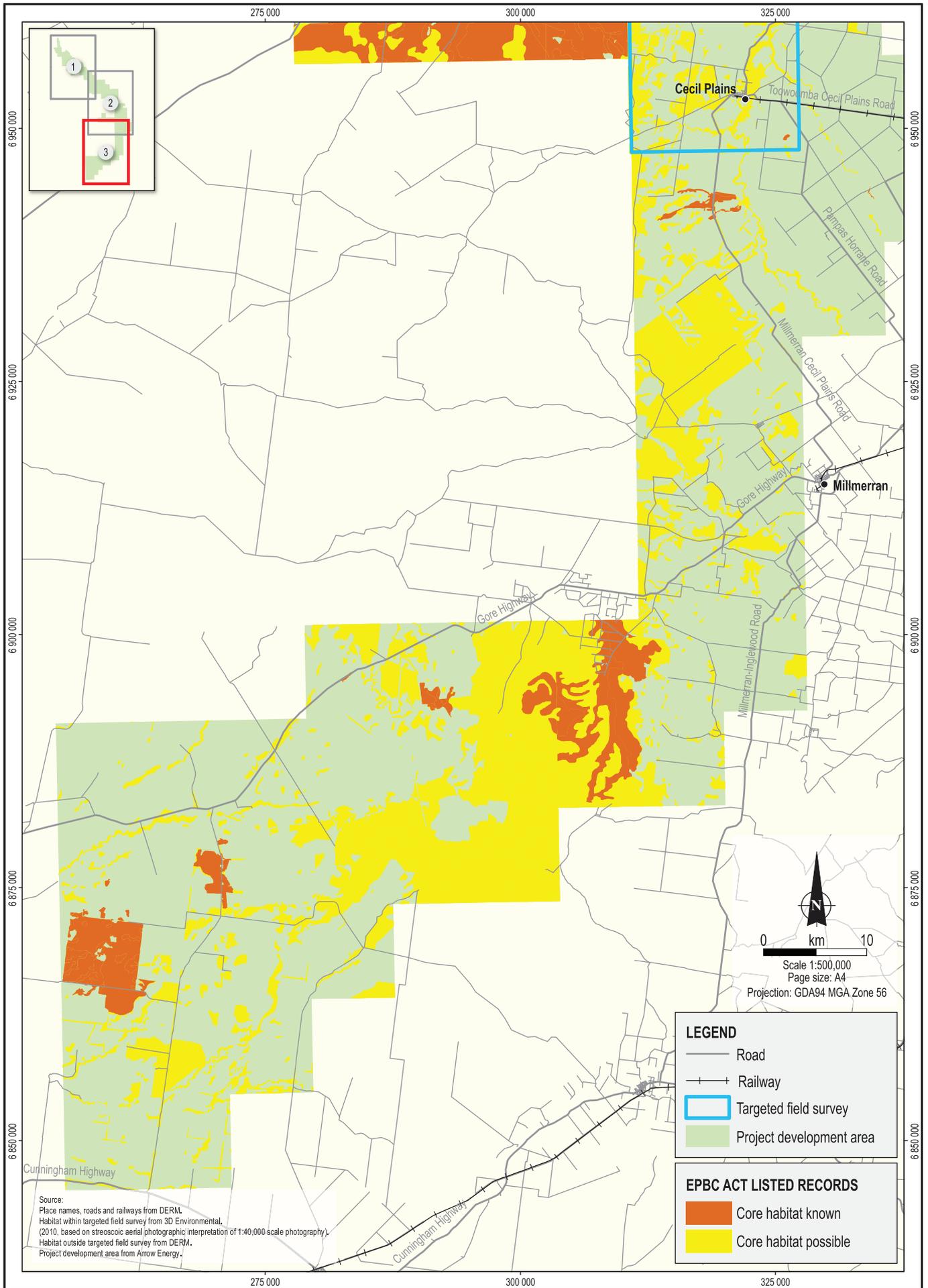
Scale 1:500,000  
Page size: A4  
Projection: GDA94 MGA Zone 56

Source:  
Place names, roads and railways from DERM.  
EPBC communities within detailed mapping area from 3D Environmental.  
(2010, based on stereoscopic aerial photographic interpretation of 1:40,000 scale photography).  
EPBC communities outside detailed mapping area from DERM.  
Project development area from Arrow Energy.









Source:  
Place names, roads and railways from DERM.  
Habitat within targeted field survey from 3D Environmental.  
(2010, based on stereoscopic aerial photographic interpretation of 1:40,000 scale photography).  
Habitat outside targeted field survey from DERM.  
Project development area from Arrow Energy.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Birds				
Australian painted snipe <sup>1</sup>	<i>Rostratula australis</i>	'Vulnerable'	Likely	The habitat within the project development area that might support this species includes waterbodies, particularly those with a mosaic of fringing vegetation and open mudflats. Probably restricted to Lake Broadwater.
Regent honeyeater	<i>Anthochaera phrygia</i>	'Endangered'	Possible	The habitat for this species consists of dry eucalypt woodland and open forest, woodland, and rural and urban areas with mature eucalypts. This species favours box-ironbark associations.
Squatter pigeon (southern)	<i>Geophaps scripta scripta</i>	'Vulnerable'	Present <sup>6</sup>	Squatter pigeons occur along the inland slopes of the Great Dividing Range west to Longreach and Charleville. The southern subspecies inhabits the southern portion of this range. Preferred habitat includes dry sclerophyll woodland with grassy understorey, nearly always near permanent water, and occasionally sown grasslands and pastures.
Black-breasted button-quail	<i>Turnix melanogaster</i>	'Vulnerable'	Unlikely	This species is restricted to coastal and near-coastal regions of southeastern Queensland and northeastern New South Wales. The main populations occur within southeast Queensland. Preferred habitat includes drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. No known habitat within the project development area.
Red goshawk	<i>Erythrorichis radiatus</i>	'Vulnerable'	Unlikely	This species is sparsely dispersed across coastal and subcoastal Australia, from western Kimberley Division to northeastern New South Wales, and occasionally on continental islands. Habitat includes coastal and subcoastal areas in wooded and forested lands of tropical and warm-temperate Australia. There is one historical record of the species from Lake Broadwater; however, this is expected to be of a transient individual, not a permanent population.
Star finch (eastern), star finch (southern)	<i>Neochmia ruficauda ruficauda</i>	'Endangered'	Unlikely	This species is believed to extend north to Bowen, west to beyond Winton and, based on recent records, south to near Wowan. It occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water. No confirmed records of this species within the project development area.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Birds (cont'd)				
Superb parrot	<i>Polytelis swainsonii</i>	'Vulnerable'	Unlikely	This species occurs only in southeastern Australia. Vagrants have also been recorded in southern Queensland. It mainly inhabits forests and woodlands dominated by eucalypts. Records from the early 1900s are doubtful. No recent records in the project development area.
Swift parrot	<i>Lathamus discolor</i>	'Endangered'	Unlikely	Records from southern Queensland have come from the Gold Coast, Noosa, Toowoomba, Warwick and Lockyer Valley areas and records from southeastern South Australia have come from the Bordertown-Naracoorte area. Habitat includes dry sclerophyll eucalypt forests and woodlands and occasionally wet sclerophyll forests. No recent (1980+) records of this species found within the project development area.
Mammals				
Greater long-eared bat	<i>Nyctophilus corbeni</i>	'Vulnerable'	Possible	This species could be present in the project development area. Preferred habitat includes dry open woodland (box or ironbark, savannah) and mallee, particularly riparian vegetation (river red gum ( <i>Eucalyptus camaldulensis</i> ), bull oak ( <i>Allocasuarina luehmannii</i> ), belah ( <i>Casuarina cristata</i> ) and cypress ( <i>Callitris</i> spp.)), also vine thickets.
Spotted-tailed quoll	<i>Dasyurus maculatus maculatus</i>	'Endangered'	Possible	The spotted-tailed quoll ( <i>Dasyurus maculatus maculatus</i> ) is known to inhabit a variety of forested habitats, and may be present in the project development area within vine thickets, and dry sclerophyll forests.
Large-eared pied bat, large pied bat	<i>Chalinolobus dwyeri</i>	'Vulnerable'	Unlikely <sup>2</sup>	The species' current distribution is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, through to the vicinity of Ulladulla, New South Wales, in the south. Habitat includes sandstone cliffs, fertile woodland valleys, rainforest and moist eucalypt forest at high elevation. It is very unlikely that this species would be present in the project development area.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Mammals (cont'd)				
Northern quoll	<i>Dasyurus hallucatus</i>	'Endangered'	Unlikely	The northern quoll ( <i>Dasyurus hallucatus</i> ) is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Cooktown in Queensland and as far west into central Queensland as the vicinity of Carnarvon Range National Park. Preferred habitat includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert.
Fish				
Murray cod, goodoo	<i>Maccullochella peelii peelii</i>	'Vulnerable'	Likely	The species is known to exist in the general area. Despite not appearing in the field surveys, there could potentially be remnant populations of wild fish present, and Murray code is known to be stocked as a recreational species. The watercourses within the Condamine River catchment and Lake Broadwater could provide habitat for the species.
Reptiles				
Brigalow scaly-foot	<i>Paradelma orientalis</i>	'Vulnerable'	Present	This species has been previous recorded within the project development area. Largely restricted to the Brigalow Belt bioregion, it extends from approximately 200 km southwest of Charters Towers, south to Bendidee National Park and Eena State Forest. More prevalent in habitats that have few weeds and that consist of undisturbed ground surfaces with ground cracks or fallen debris or native tussock grasses. Most records occur in remnant habitats, but the species can also occur in young regrowth (two to three years old) and in modified habitats.
Dunmall's snake	<i>Furina dunmalli</i>	'Vulnerable'	Present	This species has been historically recorded from Lake Broadwater and is also possible in other regions. Most records occur in remnant vegetation, including brigalow, open woodland and even tall forests. The species may occur in any woodland or forest vegetation type within the project development area, but it is probably absent from disturbed vegetation.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Reptiles (cont'd)				
Five-clawed worm-skink	<i>Anomalopus mackayi</i>	'Vulnerable'	Likely	The habitat within the project development area may support this species. The species prefers low open grassland with scattered trees to open grassy dry eucalyptus and callitris forest or woodland. Regional ecosystem (RE) 11.3.21 provides habitat for the species, occurring as scattered remnants adjacent to stock routes in the Dalby area (Dalby Cecil Plains Road Significant Environmental Area).
Collared delma	<i>Delma torquata</i>	'Vulnerable'	Possible	This species ranges from Rockhampton in the north, south to Kenmore and inland to the Bunya Mountains. Preferred habitat includes rocky areas associated with dry open eucalypt forests, although the species has also been recorded from semi-evergreen vine thickets.
Fitzroy River turtle, Fitzroy tortoise, Fitzroy turtle	<i>Rheodytes leukops</i>	'Vulnerable'	Possible <sup>4</sup>	The species was not recorded during field surveys; however, the database search indicates it could potentially be present within the northernmost section of the project development area within the Fitzroy drainage basin.
Grassland earless dragon	<i>Tympanocryptis pinguicolla</i>	'Endangered'	Possible	Based on genetic studies, the grassland earless dragon ( <i>Tympanocryptis pinguicolla</i> ) does not occur in Queensland; and the earless dragon species located within the project development area is more closely related to the Eyrean earless dragon ( <i>Tympanocryptis tetraporophora</i> ). The Darling Downs earless dragon is recognised as endangered under Queensland legislation as a new species, <i>Tympanocryptis cf. tetraporophora</i> ; however, DSEWPAC has not formally recognised this change. MNES database searches predict the presence of <i>Tympanocryptis pinguicolla</i> within the project development area, and hence the possibility of occurrence of this new species was retained for assessment purposes. RE 11.3.21 provides habitat for this species. It is predominantly found between Toowoomba and Cecil Plains, within grasslands, including those on roadside verges. No known records west of Wilkie Creek.
Bell's turtle, Namoi River turtle, Bell's saw-shelled turtle	<i>Eelseya belli</i>	'Vulnerable'	Unlikely	In Queensland, this species is only known from Bald Rock Creek. The project development area does not encompass this location.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Reptiles (cont'd)				
Yakka skink	<i>Egernia rugosa</i>	'Vulnerable'	Possible	The yakka skink has a disjunct distribution, with isolated populations occurring from St George, north to Coen on Cape York Peninsula. Habitat includes dry forests and woodlands, including poplar box alluvial soils, low ridges, cypress on sands, belah, mulga and gum-barked coolibah ( <i>Eucalyptus intertexta</i> ).
Plants				
Austral toadflax, toadflax	<i>Thesium australe</i>	'Vulnerable'	Present	This species is known from database records to be present in the project development area. Preferred habitat includes roadside remnant and non-remnant grasslands and poplar box ( <i>Eucalyptus populnea</i> ) grassy woodlands on heavy soil alluvium.
Belson's panic	<i>Homopholis belsonii</i>	'Vulnerable'	Present	This species is known to be present in the project development area. There are existing HERBRECS records 4 km east of Dalby, in belah ( <i>Casuarina cristata</i> ) and yarran ( <i>Acacia melvillei</i> ) vegetation on grey to black alluvial soils. The Dalby to St George Stock Route is known to host significant populations of this plant.
Cobar greenhood orchid	<i>Pterostylis cobarensis</i>	'Vulnerable'	Present	This species is known to be present in the project development area, from a single collection approximately 7 km north of Chinchilla on Auburn Road, with additional records to the north within Barakula State Forest. It usually occurs in localised populations and is known to occur in woodland of cypress pine, eucalypt woodland, open mallee, or cypress ( <i>Callitris</i> spp. shrubland) on low stony ridges and slopes, among rocks on low hills, and on slopes above streams.
Curly-bark wattle	<i>Acacia curranii</i>	'Vulnerable'	Present	This species has previously been recorded in the northwest of the project development area to the east of Gurulmundi. Suitable habitat includes dry sclerophyll forests and semi-arid woodlands where they may occur as widely scattered thickets in very species-rich healthy scrub with emergent eucalypts.
Finger panic grass	<i>Digitaria porrecta</i>	'Endangered'	Present	Existing database records indicate presence within the project development area. Suitable habitat includes non-remnant derived grasslands on alluvium and cracking clays, native grasslands (RE 11.3.21), and eucalypt woodlands on heavy alluvial soils.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Plants (cont'd)				
Hando's wattle, Percy Grant wattle <sup>4</sup>	<i>Acacia handonis</i>	'Vulnerable'	Possible <sup>5</sup>	Populations are known to occur approximately 10 to 20 km north of the project development area. Potential for additional populations within Barakula State Forest and in any suitable habitat adjoining the forest.
Lobed blue-grass <sup>4</sup>	<i>Bothriochloa biloba</i>	'Vulnerable'	Present	This species is present in the project development area. Existing database records indicate presence within the project development area in grasslands and woodland on alluvium. Existing records occur 2 km south of the Condamine River and 10 km north of Cecil Plains on roadsides.
An unnamed cycad	<i>Macrozamia machinii</i>	'Vulnerable'	Present	This species is known to be present in the project development area in the southeastern parts in the Wondul Range, north of Inglewood. Habitat includes woodlands on undulating to hilly terrain at 300 to 500 m, with deep sandy soils, and on lateritic ridges.
Small-leaved wax flower <sup>4</sup>	<i>Philothea sporadica</i>	'Vulnerable'	Present	This species is present in the project development area. Preferred habitat includes rocky lateritic and sandstone rises and low ridges in mixed eucalypt/callitris woodlands.
An unnamed mint-bush	<i>Prostanthera</i> sp. (Dunmore)	'Vulnerable'	Present	This species is known from database records to be present in the project development area on the boundary between Wondul Range National Park and Badgery State Forest.
Small-leaved denhamia	<i>Denhamia parvifolia</i>	'Vulnerable'	Present <sup>6</sup>	Two records exist within the project development area. Preferred habitat is remnant brigalow with a softwood species understorey or vine thicket elements (RE 11.3.1, 11.4.3, 11.5.16, 11.8.3, 11.9.4a, and 11.9.5), although it may occur in non-remnant vine thickets throughout the project development area.
An unnamed acanthus	<i>Xerothamnella herbacea</i>	'Endangered'	Present	This species is known from database records to be present in the project development area. Preferred habitat is brigalow ( <i>Acacia harpophylla</i> )/belah ( <i>Casuarina cristata</i> ) communities on alluvium or clay plains.
Hawkweed	<i>Picris evae</i>	'Vulnerable'	Likely <sup>7</sup>	This species is known from database records to be present in the project development area. Preferred habitat includes eucalyptus open grassy woodland, Queensland blue grass ( <i>Dichanthium sericeum</i> ), and non-remnant roadsides, paddocks and cultivated areas.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Plants (cont'd)				
An unnamed member of the Scrophulariaceae family	<i>Microcarpaea agonis</i>	'Endangered'	Possible	The only known occurrence of this species is approximately 6 km outside of the project development area within RE 11.3.18. Possibly occurring due to the population's close proximity to the project development area.
Austral cornflower, native thistle	<i>Rhaponticum australe</i>	'Vulnerable'	Possible	This species could be present in the project development area. It is known from a large number of sites, ranging from Cania Gorge west of Gladstone, to Mount Moffat in the north, to Gatton in the south. It grows in eucalypt open forest with grassy understorey and native grasslands on roadsides and on road reserves with forest river gum ( <i>Eucalyptus tereticornis</i> ) and rough-barked apple ( <i>Angophora floribunda</i> ) on black clay soil.
An unnamed member of the Mimosaceae family	<i>Acacia wardellii</i>	'Vulnerable'	Possible	This species is known from populations 20 to 30 km south-southwest of the project development area in addition to areas south of Roma, southwest of Chinchilla and in the Thomby Range in southeast Queensland. Possible occurrence along the western margins of the project development area south of the Condamine Kogan Road.
Gurulmundi heath-myrtle	<i>Calytrix gurulmundensis</i>	'Vulnerable'	Possible	Records in the Waaje and Gurulmundi Wildflower areas in <i>Triodia</i> sp. grassland and shrubland suggest a possibility of the species occurring in the northern parts of the project development area. This species occurs in patches of shrubland on very shallow soils, in habitat consistent with RE 11.7.5.
Ooline, scrub myrtle	<i>Cadellia pentastylis</i>	'Vulnerable'	Possible	This species is recorded in brigalow open forest and fragmented softwood scrub vegetation in the Stones Country Resources Reserve West Gurulmundi area located west of the project development area. Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll vegetation, where it may be locally dominant in the canopy layer or occurring as an emergent. A population is also known from the Wiaga Creek area in southern portions of the project development area. Herbarium records from this area date back to 1918, and the status of this population is not presently known.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Plants (cont'd)				
An unnamed member of the Sterculiaceae family	<i>Commersonia argentea</i>	'Vulnerable'	Unlikely	This species occurs from near Injune and west along the Great Dividing Range towards Tambo in central Queensland. Its distribution overlaps with: <ul style="list-style-type: none"> <li>• Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.</li> <li>• The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.</li> <li>• Bluegrass (<i>Dichanthium</i> spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South).</li> <li>• Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant).</li> <li>• White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.</li> </ul>
Shiny-leaved ironbark	<i>Eucalyptus virens</i>	'Vulnerable'	Unlikely <sup>8</sup>	This species has been recorded as far south as Inglewood and as far west as Mt Moffatt. It inhabits plateaux, sandstone escarpments or sandy soils on low rises. Suitable habitat does not exist within the project development area.
Tall velvet sea-berry	<i>Haloragis exalata</i> subsp. <i>velutina</i>	'Vulnerable'	Unlikely <sup>8</sup>	This species occurs from near Kempsey, north to Carnarvon National Park inland of Bundaberg. It occurs in rainforest and rainforest margins and adjacent grassland and open grassy woodland above 500 m altitude. Suitable habitat does not exist within the project development area.
King blue-grass	<i>Dichanthium queenslandicum</i>	'Vulnerable'	Unlikely <sup>8</sup>	Known from the Brigalow Belt North and South bioregions with records from the northern Darling Downs, Burnett, Leichhardt, South Kennedy and Mitchell pastoral districts. Potential habitats within the project development area are REs 11.3.2 and 11.3.21 and Non-remnant derived grasslands on cracking clay. This species is unlikely to be present, as no records exist in the vicinity of the project development area.
An unnamed member of the Asclepiadaceae family	<i>Tylophora linearis</i>	'Endangered'	Unlikely	This species grows in dry scrub, open forest and woodlands. Database records indicate this species and its habitat occur outside of the project development area.

**Table 4.2 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Plants (cont'd)				
Queensland white gum, Queensland western white gum, lapunyah, scrub gum	<i>Eucalyptus argophloia</i>	'Vulnerable'	Possible <sup>3</sup>	This species is known only from a small area northeast of Chinchilla. It grows in association with brigalow ( <i>Acacia harpophylla</i> ) or grey box ( <i>Eucalyptus microcarpa</i> ) on flat terrain in areas that were formerly open forest. Database records indicate populations may occur north of the project development area on heavy alluvial soils.
An unnamed member of the Lamiaceae family	<i>Westringia parvifolia</i>	'Vulnerable'	Unlikely	This species is known from a small area near Yelarbon and Inglewood in southeast Queensland. It grows with mallee box ( <i>Eucalyptus bakeri</i> ) and green mallee ( <i>E. viridis</i> ) and between clumps of spinifex ( <i>Triodia</i> sp.) on sandy and stony soils. Database records indicate this species and its habitat occur outside of the project development area.
Wandering pepper-cress	<i>Lepidium peregrinum</i>	'Endangered'	Unlikely	This species occurs in scattered refugia in northeastern New South Wales and southeastern Queensland. Historically it was recorded from the Blue Mountains, northeastern New South Wales and southeastern Queensland. Based on database records and literature review, this species does not occur in the project development area.

1. Also listed as migratory (see Table 4.3).
2. Downgraded from Possible in EPBC referral to Unlikely.
3. Upgraded from Unlikely in EPBC referral to Possible.
4. Identified during EIS field surveys.
5. Downgraded from Present in EPBC referral to Possible.
6. Upgraded from Possible in EPBC referral to Present.
7. Downgraded from Present in EPBC referral to Likely.
8. Downgraded from Likely in EPBC referral to Unlikely.

## 4.4 Listed Migratory Species

The EPBC Protected Matters Searches identified 17 listed migratory species as being present or potentially present within the project development area:

- Five migratory terrestrial bird species.
- Nine migratory wetland bird species.
- Three migratory marine bird species.

Further desktop assessment (as described in section 3), identified 12 additional migratory species with previous records of occurrence in the project development area.

Six of these migratory species were recorded during the field surveys, which included the white-throated needletail (*Hirundapus caudacutus*), great egret (*Ardea modesta*), rainbow bee-eater (*Merops ornatus*), spectacled monarch (*Symposiarchus trivirgatus*), rufous fantail (*Rhipidura rufifrons*) and Lantham's snipe (*Gallinago hardwickii*). All other migratory species identified have been assessed as being possible, likely or unlikely to occur based previous records and the presence of suitable habitat within the project development area (see Table 4.3).

Nearly half of the migratory species known to occur within the project development area are wader species, typical of estuarine habitats. These species may occur at Lake Broadwater and other permanent and semi-permanent watercourses, which are likely to provide suitable habitat for listed migratory species.

Detailed habitat requirements and ecology of each individual species are provided in the Terrestrial Ecology Impact Assessment (Appendix K of the EIS).

**Table 4.3 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Migratory Terrestrial Bird Species				
Rainbow bee-eater*	<i>Merops ornatus</i>	Migratory	Present	The rainbow bee-eater is distributed across much of mainland Australia and occurs on several nearshore islands. It occurs mainly in open forests and woodlands, shrublands, and various cleared or semi-cleared habitats, including farmland and areas of human habitation. This species was recorded within the project development area during field surveys. It is common and widespread.
Rufous fantail*	<i>Rhipidura rufifrons</i>	Migratory	Present	The rufous fantail was recorded within the project development area during field surveys. The species prefers wet forests, of which there are none in the project development area. Transient individuals are present rather than permanent populations.
White-bellied sea-eagle	<i>Haliaeetus leucogaster</i>	Migratory	Present	The white-bellied sea-eagle is known from previous records to occur in the project development area. It is likely to be restricted to Lake Broadwater and the Condamine River.
Spectacled monarch*	<i>Symposiarchus trivirgatus</i>	Migratory	Present	The spectacled monarch ( <i>Symposiarchus trivirgatus</i> ) is found predominantly along coastal northeast and eastern Australia occupying the understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation. These habitats are uncommon in the project development area.
White-throated needletail*	<i>Hirundapus caudacutus</i>	Migratory	Present	The white-throated needletail is recorded in all coastal regions of Queensland and New South Wales, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. It was recorded within the project development area during field surveys and is considered to be common and widespread.
Regent honeyeater	<i>Anthochaera phrygia</i>	Migratory	Possible	The habitat for the regent honeyeater consists of dry eucalypt woodland and open forest, woodland, and rural and urban areas with mature eucalypts; it favours box-ironbark associations. Transient individuals from the south near Warwick have been recorded previously near the project development area; however, these are not permanent populations.
Black-faced monarch	<i>Monarcha melanopsis</i>	Migratory	Possible <sup>§</sup>	Occurs along coastal northeast and eastern Australia. Prefers understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation.

**Table 4.3 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Migratory Terrestrial Bird Species (cont'd)				
Satin flycatcher	<i>Myiagra cyanoleuca</i>	Migratory	Possible <sup>s</sup>	In Queensland the satin flycatcher ( <i>Myiagra cyanoleuca</i> ) is widespread, although scattered in distribution. Found mostly in coastal areas however occasionally further west, this species is vagrant and is likely to be uncommon. Uncommon migrant to eastern Australia. Favours densely vegetated gullies in forests and tall woodlands.
Migratory Wetland Bird Species				
Latham's snipe, Japanese snipe*	<i>Gallinago hardwickii</i>	Migratory	Present	The range of Latham's snipe extends inland over the eastern tablelands in southeastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales. Preferred habitat includes open, freshwater wetlands with low, dense vegetation; however, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. This species is known from previous records and was recorded within the project development area during field surveys.
Australian painted snipe <sup>†</sup>	<i>Rostratula australis</i>	Migratory	Likely	The habitat of the Australian painted snipe within the project development area includes waterbodies, particularly those with a mosaic of fringing vegetation and open mudflats. This species is likely to be restricted to Lake Broadwater.
Australian cotton pygmy-geese	<i>Nettapus coromandelianus albipennis</i>	Migratory	Possible	There are suitable freshwater waterbodies within the project development area to support the Australian cotton pygmy-geese. There have previously been records in the general area.
Curlew sandpiper	<i>Calidris ferruginea</i>	Migratory	Possible	In Queensland, scattered records of the curlew sandpiper occur in the Gulf of Carpentaria, with widespread records along the coast south of Cairns and sparsely scattered records inland. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater.

**Table 4.3 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Migratory Wetland Bird Species (cont'd)				
Marsh sandpiper, little greenshank	<i>Tringa stagnatilis</i>	Migratory	Possible	The marsh sandpiper is widespread in coastal Queensland, but few records exist north of Cooktown. Preferred habitat includes permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, salt pans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats, as well as sewage farms and saltworks.
Sharp-tailed sandpiper	<i>Calidris acuminata</i>	Migratory	Possible	The sharp-tailed sandpiper is common both on intertidal and inland waters. Preferred habitat includes muddy edges of shallow fresh or brackish water. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater.
Wood sandpiper	<i>Tringa glareola</i>	Migratory	Possible	In Queensland, there are sparsely scattered records of the wood sandpiper, generally around Cairns and further south. Preferred habitat is freshwater wetlands. There is suitable habitat within the project development area.
Bar-tailed godwit	<i>Limosa lapponica</i>	Migratory	Possible <sup>§</sup>	The bar-tailed godwit ( <i>Limosa lapponica</i> ) is widespread along the east and southeast coasts of Queensland, and usually prefers sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. It is also often found inland in small numbers.
Pacific golden plover	<i>Pluvialis fulva</i>	Migratory	Possible <sup>§</sup>	Widespread in coastal regions, the white-winged black tern it can be found far inland along major river systems, including the Darling Rivers and tributaries.
White-winged black tern	<i>Chlidonias leucopterus</i>	Migratory	Possible**	Locally common around the Queensland coastline, this species is also found around inland waterbodies during seasonally favourable conditions. Presence likely to be limited to Lake Broadwater.
Caspian tern	<i>Hydropogone caspia</i>	Migratory	Possible**	Common around the Queensland coastline, this species is also found around inland waterbodies during seasonally favourable conditions. Presence likely to be limited to Lake Broadwater.
Common sandpiper	<i>Actitis hypoleucos</i>	Migratory	Possible <sup>§</sup>	A Scarce summer migrant to eastern Australia, the common sandpiper ( <i>Actitis hypoleucos</i> ) is known to inhabit the edges of rivers and streams from coastal areas to far inland.

**Table 4.3 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Migratory Wetland Bird Species (cont'd)				
Red-necked stint	<i>Calidris ruficollis</i>	Migratory	Possible <sup>§</sup>	Distributed along most of Australia's coastland, the red-necked stint ( <i>Calidris ruficollis</i> ) will move inland when conditions are suitable during times of temporary floodwaters. Likely to be scarce and only seen during times of passage through the area.
Little curlew	<i>Numenius minutus</i>	Migratory	Possible <sup>§</sup>	The little curlew ( <i>Numenius minutus</i> ) is a vagrant species not common to the area. If found, it is likely to be on dry grasslands during times of passage.
Whimbrel	<i>Numenius phaeopus</i>	Migratory	Possible <sup>§</sup>	Common along the coast of Queensland, the whimbrel ( <i>Numenius phaeopus</i> ) is vagrant to the area and is only likely to be found during times of passage.
Ruff	<i>Philomachus pugnax</i>	Migratory	Possible <sup>§</sup>	Widely scattered at several locations throughout Queensland, this species likely to be found around wetlands and semi-temperate waterbodies. Vagrant species not common to the area.
Black-tailed godwit	<i>Limosa limosa</i>	Migratory	Unlikely	The black-tailed godwit is mainly coastal and usually prefers sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. It is also often found inland in small numbers.
Common greenshank, greenshank	<i>Tringa nebularia</i>	Migratory	Unlikely	In Queensland, the common greenshank is widespread in the Gulf country and eastern Gulf of Carpentaria. It has been recorded in most coastal regions, possibly with a gap between north Cape York Peninsula and Cooktown. Habitat preferences include a wide variety of inland and sheltered coastal wetlands, such as mudflats, saltmarshes and mangroves.
Migratory Marine Bird Species				
Great egret, white egret*	<i>Ardea modesta</i>	Migratory	Present	The great egret is widespread in Australia. Preferred habitat includes a wide range of wetland habitats, including inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial. This species was recorded within the project development area during field surveys.
Cattle egret	<i>Ardea ibis</i>	Migratory	Likely	The cattle egret is widespread and common within Australia. Preferred habitat includes tropical and temperate grasslands, wooded lands and terrestrial wetlands.

**Table 4.3 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

Species		EPBC Act Status	Likelihood of Occurrence	Location and Preferred Habitat
Common Name	Scientific Name			
Migratory Marine Bird Species (cont'd)				
Fork-tailed swift	<i>Apus pacificus</i>	Migratory	Possible	The fork-tailed swift is a non-breeding visitor to all states and territories of Australia. In Queensland, they are widespread west of the Great Divide, and they are commonly found west of the line joining Chinchilla and Hughenden. Preferred habitat includes inland plains, but they also occur above foothills or in coastal areas.

\*Identified during EIS field surveys.

†Also listed as 'vulnerable' (see Table 4.2).

§As identified in a search of DERMs WildNet.

\*\*As identified in a search of Birds Australia.

## **5. ISSUES AND POTENTIAL IMPACTS**

Project activities have the potential to cause both direct and indirect impacts on MNES, with the level of impact depending upon the type of activity proposed (e.g., field development, construction of roads or operation of infrastructure). Further details of activity assessment and project phases are provided within the EIS main report.

### **5.1 Habitat Fragmentation and Isolation of Populations**

Vegetation clearance has the potential to impact upon intact corridors that connect the landscape. These corridors facilitate movement of species and help to ensure genetic diversity among populations. Site clearing during construction of the wells, pipeline and facilities will be the main cause of habitat loss; however, Arrow does not plan to construct well sites or production facilities near aquatic ecosystems.

Discounting habitat degradation that occurs due to edge effects (which are raised in Sections 5.3 and 5.4), fragmentation resulting from project activities may lead to:

- An altered landscape (and hence habitat) mosaic.
- Modification of large core unmodified habitats that may be structurally varied, contain source populations and have high habitat heterogeneity.
- Increased barriers to movement, isolating populations or reducing movement rates.
- Reduced movement of aquatic biota.
- Impacts to significant wildlife corridors.

Clearing within corridors may isolate populations or reduce movement, thereby creating subpopulations within a larger population. The severity of the impact of modifying vegetation within corridors will have varied effects on movement rates, with the magnitude of impact being directly related to the final location of infrastructure and the extent to which MNES can be avoided. In the event that avoidance is not possible, production facilities are likely to have a less significant impact than wells, gathering lines and access tracks because production facilities are relatively non-linear in extent and will most likely only affect the movement of smaller ground dwelling species (some small lizards) and arboreal mammals.

### **5.2 Habitat Loss or Degradation**

Known and potential MNES habitat may be lost through clearing of vegetation for the gas and water gathering systems, access roads, temporary camps, production wells, production facilities and any borrow pits.

Habitat degradation could result from dust generated by vehicle movement, noise, light spill, decline in water quality, or the spread and invasion of pest flora and fauna species and exposure to contaminants.

A decline in water quality could result from unplanned discharges of sediment-laden water, sanitary wastewater or contaminated water. Accidental spillage of sanitary wastewater could increase the occurrence of algal blooms due to its slightly higher temperature and nutrient-rich composition.

If exotic plants are not managed, the project has the potential to increase their abundance and facilitate their dispersal, which may have negative economic and social effects, as well as negative

impacts on native vegetation and biodiversity. Mechanisms of weed dispersal from project activities are generally associated with:

- Crossing the watercourses during pipeline construction or vehicle washdown runoff, particularly for aquatic weeds.
- Movement of equipment and machinery, particularly machinery sourced from adjacent regions.
- Ground disturbance, such as grading, removal and relocation of topsoil.

Project-related activities have the potential to increase pest fauna abundance, which could lead to increased competition with and predation of native fauna, as well as habitat degradation (e.g., through wallowing and foraging by feral pigs). In particular, pest abundance and distribution may increase due to:

- The construction of linear infrastructure, which may create pathways and increase dispersal capability.
- The construction of dams, which can provide a permanent water source for feral animals and thereby increase their abundance and distribution. In addition, dams may attract cane toads, increasing the risk of toxic ingestion in predatory species, such as grey snake, common death adder and black-necked stork.
- Putrescible waste dumps, which can become a food resource for a variety of pest fauna species, leading to an increase in their abundance.

Lake Broadwater has been identified as potential habitat for MNES species. The Lake Broadwater catchment has already been significantly affected by surrounding agriculture. As a result, sedimentation is likely to already be high; and minor soil disturbance upstream may lead to additional sediment contributions. However, other unmitigated impacts, particularly weed infestation and altered water quality, have the potential to affect environmental values. These impacts could reduce the value of Lake Broadwater to migratory species.

### **5.3 Fauna Mortality**

Not including fauna mortality associated with habitat loss and degradation, fauna mortality can potentially result from entrapment in the pipe trench and dams, vehicle strikes, increased predation, or displacement and starvation as a result of vegetation clearance.

### **5.4 Edge Effects**

Edge effects occur where project activities encroach on the perimeter of a vegetation community. The extent, structural complexity and type of disturbance at the perimeter of the community determines the degree to which ecosystem function is affected, particularly the extent to which the community can continue to provide viable habitat. Changes resulting from edge effects include modified composition and structure of the community (as perimeter plants are exposed to different light conditions and the drying affects of wind) and refuge loss (as fauna species withdraw deeper into the community).

### **5.5 Alteration of Ecological Processes**

There is the potential for the alteration of ecological processes, including fire frequency, fire extent and surface water flow conditions, to occur as a result of project activities.

Specifically, the project will be conducting construction activities (i.e., welding) and operations activities (i.e., flaring) that have the potential to increase the risk of ignition and fire if not conducted

in accordance with applicable procedures. Furthermore, the clearing of forests will alter the natural burning patterns through artificially created fire breaks along access roads and pipeline right of way (ROWs).

Increased erosion and surface water flow disturbance may result from emergency discharge, ground clearance, physical obstructions and increased runoff due to ground compaction. This flow disturbance and altered water quality could impact on vegetation communities and fauna, particularly migratory species around natural wetlands that are MNES.

## **5.6 Project Activities with Potential to Impact MNES**

Project activities that may cause potential adverse impacts on MNES during the construction, operations and decommissioning phases of the project are described below.

### **Construction**

The project activities most likely to adversely impact on MNES are the construction of production wells and associated low- and medium-pressure gas and water gathering pipelines and the construction of high-pressure gas pipelines, through:

- Site clearance.
- Ground disturbance and soil movements.
- Potential spills of hazardous materials.
- Vehicle movement (which potentially leads to fauna strikes and the spread of weeds and pathogens).
- Construction activities that create barriers to fauna movement or pathways for pest species.
- Trenching (which, when left open, may entrap animals and interfere with fauna movement pathways).
- Light and noise emissions.
- Storage of putrescible waste.

Construction of the production facilities will also involve these activities; however, they will be localised to the site, which will be selected to reduce impacts on terrestrial flora and fauna.

### **Operations**

During operations, the following project activities could impact upon environmental values:

- Release or spill of waste water or hazardous materials.
- Vehicle movements.
- Light and noise emissions.
- Storage of putrescible waste.

### **Decommissioning**

During the decommissioning phase, impacts on MNES will be similar to those of the construction and operations activities. These will occur in addition to the removal of infrastructure (e.g., pipelines and foundations), which will involve ground disturbance. These activities will predominately occur in previously disturbed areas.

## **6. ENVIRONMENTAL PROTECTION OBJECTIVES**

The environmental protection objectives for MNES are:

- To minimise EPBC Act-listed habitat loss and fauna mortality.
- To avoid or minimise adverse effects on and to protect terrestrial ecosystems and associated biodiversity and habitat of EPBC communities.
- To control the introduction or spread of new or existing pest flora or fauna.
- To protect areas identified for avoidance.

## 7. AVOIDANCE, MITIGATION AND MANAGEMENT MEASURES

Avoidance, mitigation and management measures have been proposed to achieve the identified environmental protection objectives.

Vegetation communities described as MNES under the EPBC Act and classified by regional ecosystems under Queensland's Vegetation Management Act are protected secondarily under the EP Act. The Environmental Protection Regulation 2008 provides a mechanism to enforce the EP Act and allows an assessment of the risk that an environmentally relevant activity poses to environmentally sensitive areas. The classification of Category A, Category B and Category C environmentally sensitive areas are based on a ranking of environmental sensitivity and enable the protection of EPBC communities through assigned buffers.

### 7.1 Avoidance

As a matter of standard procedure, Arrow undertakes a desktop site selection process followed by a detailed, field-based ecological assessment to identify and avoid sensitive locations known to be of value to EPBC Act-listed flora and fauna species. Key construction activities (such as clearing) will be routinely supervised by ecologists to ensure that the activity is being conducted in a responsible manner and within the approved area.

Arrow will avoid, where practicable, listed threatened ecological communities and the habitat of listed flora, fauna and migratory species, as follows:

- Avoid the following areas:
  - Wondul Range National Park, Bendidee National Park and Lake Broadwater Conservation Park (Category A ESAs).
  - Chinchilla Sands Local Fossil Fauna Site.
  - 'Critically endangered' EPBC Act-listed communities within the project development area (REs 11.3.21, 11.3.24, and 11.8.2a), including three natural grassland road reserves (Dalby Kogan, Dalby Cecil Plains and Dalby St George Road).
- Aim to avoid:
  - Additional national- and state-listed communities: Brigalow (REs 11.3.1, 11.4.3, 11.4.10, 11.9.5, 11.9.6), Semi-evergreen vine thickets (REs 11.9.4a, 11.8.3), Weeping Myall Woodlands, and Coolibah – Blackbox Woodlands (RE 11.3.3).
  - Category B ESAs.
  - Category C ESAs, including Gurulmundi State Forest, Bendidee State Forest, Binkey State Forest and Barakula State Forest.
  - Wyaga-Kindon Ooline populations.
  - Stock routes and state or bioregional wildlife corridors.
  - Essential and core habitat (supporting listed wildlife species).
  - State forests and resources reserves.

- State-listed ‘of concern’ regional ecosystems.
- Manage potential impacts to Category A, B and C ESAs through implementation of the buffers proposed in Table 7.1.
- Where avoidance is not possible, implement an offset strategy approved by a relevant government agency and comply with reporting conditions of an offset plan.

**Table 7.1 Proposed buffer distances from the ESA boundary**

ESA Category	Proposed Activities within the ESA*, †	Proposed Activities within 200 m of the ESA Boundary*, †	Proposed Activities within a Secondary Protection Zone <sup>§, †</sup>
Category A	None	Low-impact activities	Limited petroleum activities within 800 m of the primary protection zone.**
Category B: excluding regional ecosystems with ‘endangered’ status	Low-impact activities	Low-impact activities	Limited petroleum activities within 300 m of the primary protection zone.**
Category B: regional ecosystems with an ‘endangered’ status	Limited petroleum activities	Limited petroleum activities	Limited petroleum activities within 300 m of the primary protection zone.**
Category C: excluding regional ecosystems with an ‘of concern’ status, state forests and timber reserves	Low-impact activities	Low-impact activities	Limited petroleum activities within 300 m of the primary protection zone.**
Category C: regional ecosystems with an ‘of concern’ status, state forests and timber reserves	Limited petroleum activities	Limited petroleum activities	Limited petroleum activities within 300 m of the primary protection zone.**

\*Low-impact activities include the limited prescribed activities, which do not result in the clearing of native vegetation, cause disruption to soil profiles through earthworks or excavation or result in significant disturbance to land. Examples of such activities include but are not limited to soil surveys; topographic, cadastral and ecological surveys; and traversing land by car or foot via existing access tracks or routes.

†Limited petroleum activities include well sites not exceeding 1 ha of disturbance and multi-well sites not exceeding 1.5 ha of disturbance, geophysical surveys, ecological and geological surveys, gathering or flow pipelines from a wellhead to the initial production facility, supporting access tracks and road, and communication and power lines necessary for the undertaking of petroleum activities. The definition excludes construction of dams, borrow pits, production facilities and construction camps.

§ESA buffers (derived from the guidelines under the EP Act, Model Conditions for Level 1 Environmental Authorities for Coal Seam Gas Activities) will be applied unless the activity occurs in pre-existing cleared areas or significantly disturbed land within the buffer and no reasonable or practicable alternatives exist.

\*\*Primary protection zone is considered to be within 200 m of the ESA boundary.

## 7.2 General Measures

The following mitigation and management measures have been developed to address the potential impacts on MNES, including EPBC Act-listed communities, flora, fauna and migratory species.

- Design gathering lines and tracks to avoid watercourses, drainage lines and riparian area (particularly permanent watercourses or perennial aquatic habitat), where practicable.
- Implement a 100-m buffer zone from the high bank of all watercourses to ensure that no development or clearance occurs within these buffers (other than construction of watercourse

crossings for roads, pipelines and discharge infrastructure and associated stream monitoring equipment).

- Conduct preconstruction clearance surveys and include as a minimum:
  - Vegetation mapping at a scale suitable for site specific planning.
  - Identification of core habitats and listed species
  - Identification of site-specific sensitive areas that require avoidance or buffer areas.
- Conduct preconstruction clearance surveys to identify any additional areas that may need to be avoided.
- Ensure boundaries are clearly marked for site-specific sensitive areas that require avoidance.
- Clear areas progressively and implement rehabilitation as soon as practicable following construction and decommissioning activities.
- Design facilities to ensure natural surface water flows are not impounded, e.g., by installing culverts on roads and stormwater diversion ditches around production facilities.
- Develop fire plans for field compression facilities, central gas processing facilities and integrated processing facilities.
- Demarcate buffers and inform workers and machinery operators of buffer locations when working within the vicinity of national- and state-listed communities and areas identified for potential avoidance.
- Consider the preconstruction clearance survey baseline characterisation when rehabilitating project sites.
- Implement site planning, preparation and management requirements in accordance with a developed and approved decommissioning and rehabilitation plan.
- Decommission the pipeline corridors in a manner that minimises potential impacts on the environment.
- Identify areas for rehabilitation.
- Prioritise areas for rehabilitation based on the preconstruction clearance survey baseline characteristics.
- Advise, through procedures and plans, on requirements for rehabilitation in identified areas that are no longer in use.
- Reinstate self-supporting drainage lines.
- Inspect rehabilitation areas after decommissioning for regrowth similar to the surrounding environment.
- Minimise the disturbance footprint and vegetation clearing.
- Confine project traffic to designated roads and access tracks, where practicable.
- Erect fauna-exclusion fences around project dams.

- Dispose of food scraps in large skips or bins that prevent animal access. Empty these storage devices regularly in a manner that does not involve disposal to onsite trenches or waste dumps.
- Select plant species for the purposes of rehabilitation that are specific to the original ecosystem and of local provenance, wherever practicable.
- Identify declared weeds during the preconstruction clearance survey.
- Develop a declared weed and pest management plan in accordance with the Petroleum Industry - Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Undertake species-specific management for identified declared weed species at risk of spread through project activities (mesquite, parthenium, African love grass and lippia). Increase weed control efforts in areas particularly sensitive to invasion. The pest management plan should include as a minimum: training; management of pest spread; management of pest infestations; and monitoring effectiveness of control measures.
- Design washdown facilities to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas. Treat or dispose of washdown solids in a registered landfill.
- Do not wash down vehicles in watercourses.
- Install and maintain sediment and erosion control structures at work sites.
- Use coal seam gas water for dust suppression on roads or for construction and operations activities authorised in the environmental authority, in accordance with the water quality parameters described in the environmental authority.
- Prohibit disturbance or harassment of wildlife and the unauthorised collection of flora and forest products.
- Apply appropriate international, Australian and industry standards and codes of practice for the handling of hazardous materials (such as chemicals, fuels and lubricants).
- Apply appropriate international, Australian and industry standards and codes of practice for the design and installation of infrastructure associated with the storage of hazardous materials (such as chemicals, fuels and lubricants).
- Carry out corrective immediately upon the identification of any contamination of soil or groundwater that has occurred as a result of project activities.
- Ensure all relevant personnel are made aware of the location and extent of weed infestations in the vicinity of the work area and the risks involved in moving from one site or property to another.
- When sourcing maintenance materials, ensure that such materials as bedding sand, topsoil, straw bales and sand bags are only brought to site after it is ascertained that the materials are not contaminated with weeds and plant or animal pathogens. A Weed Hygiene Declaration form must be requested from the supplier where there is possible risk of contamination in products.
- Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites.
- Train field personnel to identify key pest species and to maintain constant vigilance of weeds and pest fauna species throughout the project life to ensure early detection and intervention.

- Avoid transport of equipment across watercourses unless an appropriate crossing that minimises disturbance to the watercourse bed and banks and to riparian vegetation, is available.
- Locate self-contained portable toilet facilities at designated work sites at appropriate distances from watercourses, ensuring that they are accessible to all operations, maintenance personnel and are regularly maintained. Disposal of sewage and greywater from toilet facilities via a chemical treatment system or transport municipal sewage plant using a licensed contractor.

### **7.3 Additional Measures for Ecological Communities**

In addition to the general measures identified above, further commitments have been made to protect significant ecological communities. These include:

- Construct production wells, gathering lines and access tracks within cleared areas, where practicable, with the aim of avoiding remnant vegetation and high-value regrowth.
- Minimise the width of construction ROWs within areas of sensitivity to the greatest extent practicable without compromising the safety of workers.
- Ensure relevant workers, including contract plant and machinery operators, are made aware of the location of significant remnant vegetation and buffers and are guided by qualified personnel when clearing is undertaken.
- Avoid damaging standing trees not identified for removal. Limit the scraping of standing tree trunks and breaking of limbs by equipment as far as practicable.

### **7.4 Additional Measures for Flora Species**

In addition to the general measures identified above, further commitments have been made to protect significant flora species. These include:

- Translocate or propagate significant species (that are amenable to this process) where it is deemed necessary for use during rehabilitation or in offsets, in accordance with relevant legislation.
- Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals.
- Avoid damaging standing trees not identified for removal. Limit the scraping of standing tree trunks and breaking of limbs by equipment as far as practicable.
- Where avoidance is not possible, implement an offset strategy approved by a relevant government agency and comply with reporting conditions of an offset plan.

### **7.5 Additional Measures for Fauna Species**

In addition to the general measures identified above, further commitments have been made to protect significant fauna species. These include:

- Design dams to have an egress (escape point) for wildlife.
- Give direction to retain woody debris, logs and rocks where practicable. These should be spread over part or all of the corridor or, as a minimum, piled along the edge of the cleared corridor to provide refuge for crossing fauna where practicable.

- During rehabilitation works, care will be taken when moving stockpiled logs and vegetation to avoid fauna mortality.
- Where possible, use appropriately trained personnel or a wildlife handler to capture injured wildlife. If further action is required, consult with a qualified vet to determine appropriate action.
- Minimise the time a trench is left open. Construct exit points when construction is within 1 km of native vegetation, using appropriate material. Provide fauna refuges, such as sawdust-filled bags, regularly through areas of high fauna activity.
- Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals.
- Fell trees away from existing stands where practicable. Where trees unavoidably fall into a stand, leave trees in situ to emulate natural tree fall and provide habitat for ground-dwelling species where practicable.
- Retain habitat trees, where practicable.
- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques.
- Assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards allowing fauna to escape.
- Minimise light spill from project activities to reduce disturbance to nocturnal fauna.
- Retain woody debris, logs and rocks for use in rehabilitation. These should be spread over part or all of the corridor or, as a minimum, piled along the edge of the cleared corridor to provide refuge for crossing fauna.
- Implement speed limits on project-controlled roads to reduce the potential for vehicle collisions with wildlife.
- Obtain all relevant permits required under the *Fisheries Act 1994* (Qld), including permits for construction of waterway barriers or disturbance of fish habitat.
- Ensure flumes used to construct watercourse crossings are suitably sized to maintain flows and enable fish passage.

## **7.6 Additional Measures for Migratory Species**

In addition to the general measures identified above and fauna specific measures, further commitments have been made to protect significant migratory species. These include:

- Avoid construction activities in waterbodies frequented by migratory species.
- Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals.
- Use appropriately trained personnel or a wildlife handler to capture injured wildlife, where possible. If further action is required, consult with a qualified vet to determine appropriate action.

## 7.7 Recovery Plans

Recovery plans have been made under the EPBC Act for some listed threatened species and ecological communities. The following recovery plans are in place for species and ecological communities present or considered possible or likely to occur in the project development area:

- Draft Queensland Brigalow Belt Reptile Recovery Plan. (Richardson, 2008)
- National recovery plan for the Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ecological community. (McDonald, 2010)
- National recovery plan for the grassland earless dragon (*Tympanocryptis pinguicolla*). (Robertson & Evans, 2009)
- National recovery plan for the Murray cod (*Maccullochella peelii peelii*). (National Murray Cod Recovery Team, 2010)
- Regent honeyeater (*Anthochaera phrygia*) recovery plan 1999 to 2003. (Regent Honeyeater Recovery Team, 1999)

Relevant details from the recovery plans have been considered in the assessment of impacts and implementation of mitigation and management measures.

## 7.8 Offsets

An EPBC Act offset plan will be developed following the Draft Policy Statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC, 2007). This offset plan will be submitted within the time frame requested by DSEWPAC and could potentially be jointly developed to meet offsets under state legislation.

The EPBC Act offset plan will include the:

- Area in hectares of required land to offset proposed disturbance.
- Locations of proposed offset areas (including maps).
- Connectivity of the offset areas in relation to other communities and corridors.
- Communities and habitat types to be secured.
- Timing of securing offset areas.
- Details of how the offset areas will be legally binding (mechanisms for long term protection).
- Management and rehabilitation programs for the offset areas.

Offsets will be based on the residual impact once alternative measures to avoid impacts have been implemented.

## **8. SUMMARY OF IMPACT ASSESSMENT**

The avoidance, mitigation and management measures will avoid adverse impacts or reduce the severity of their magnitude on MNES.

Two threatened ecological communities have been identified for total avoidance. Avoidance of other MNES ecological communities, flora and fauna species habitat and individuals will occur (where possible) through the implementation of mitigations outlining the requirements for preconstruction survey site assessment. Table 8.1 shows the predicted significance of impacts prior to implementation of management procedures (unmitigated impacts), and the significance of impacts following implementation of recommended management actions (residual impacts). The table identifies a low or moderate residual impact once avoidance, mitigation and management measures have been implemented.

**Table 8.1 Impact assessment, showing unmitigated and residual impact significance**

MNES	Values Sensitivity	Pre Mitigated Impacts		Summary of Mitigation Measures	Residual Impact	
		Magnitude	Significance		Magnitude	Significance
<b>Threatened Ecological Community</b>						
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Extremely high	Major	Major	Avoid	NA	NA
White Box-Yellow Box- Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Extremely high	High	Major	Avoid	NA	NA
Brigalow ( <i>Acacia harpophylla</i> dominant and co-dominant)	High	High	High	<ul style="list-style-type: none"> <li>Implement general mitigation measures. (for all threatened ecological communities)</li> <li>Construct production wells, gathering lines and access tracks within cleared areas, where practicable, with the aim to avoid remnant vegetation and high-value regrowth. (for all threatened ecological communities)</li> </ul>	Low	Moderate
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	High	Moderate	Moderate		Low	Moderate

**Table 8.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

MNES	Values Sensitivity	Pre Mitigated Impacts		Summary of Mitigation Measures	Residual Impact	
		Magnitude	Significance		Magnitude	Significance
<b>Threatened Ecological Community (cont'd)</b>						
Weeping Myall Woodlands	High	Moderate	Moderate	<ul style="list-style-type: none"> <li>Minimise the width of construction easements within sensitive areas to the greatest extent practicable without compromising the safety of workers. (for all threatened ecological communities)</li> <li>Ensure relevant workers, including contract plant and machinery operators, are made aware of the location of significant remnant vegetation and buffers and are guided by qualified personnel when clearing is undertaken. (for all threatened ecological communities)</li> <li>Avoid damaging standing trees not identified for removal. Limit the scraping of standing tree trunks and breaking of limbs by equipment as far as practicable. (for all threatened ecological communities)</li> </ul>	Low	Moderate
Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions	Moderate	Low	Low		Negligible	Low

**Table 8.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

MNES	Values Sensitivity	Pre Mitigated Impacts		Summary of Mitigation Measures	Residual Impact	
		Magnitude	Significance		Magnitude	Significance
<b>Fauna- Mammals, Reptiles and Birds (migratory and non-migratory)</b>						
Greater long-eared bat ( <i>Nyctophilus corbeni</i> )	Moderate	Moderate	Moderate	<ul style="list-style-type: none"> <li>Implement general mitigation measures. ( for all listed mammals, reptiles and birds)</li> <li>Design dams to have an egress (escape point) for wildlife.</li> <li>Avoid construction activities in waterbodies frequented by migratory species. (for all listed migratory birds)</li> <li>Where possible, use appropriately trained personnel or a wildlife handler to capture injured wildlife. If further action is required, consult with a qualified vet to determine appropriate action. (for all listed mammals, reptiles and birds)</li> <li>Minimise the time a trench is left open. Construct exit points when construction is within 1 km of native vegetation, using appropriate material. Provide fauna refuges, such as sawdust-filled bags, regularly through areas of high fauna activity. (for Spotted-tailed quoll and listed reptiles)</li> </ul>	Low	Low
Spotted-tailed quoll ( <i>Dasyurus hallucatus</i> )	Moderate	High	Moderate		Low	Low
Grassland earless dragon ( <i>Tympanocryptis pinguicolla</i> )	High	High	High		Moderate	Moderate
Fitzroy River turtle, Fitzroy tortoise, Fitzroy turtle ( <i>Rheodytes leukops</i> )	High	Moderate	High		Low	Moderate
Yakka skink ( <i>Egernia rugosa</i> )	Moderate	High	Moderate		Low	Low

**Table 8.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

MNES	Values Sensitivity	Pre Mitigated Impacts		Summary of Mitigation Measures	Residual Impact	
		Magnitude	Significance		Magnitude	Significance
<b>Fauna- Mammals, Reptiles and Birds (migratory and non-migratory) (cont'd)</b>						
Brigalow scaly-foot ( <i>Paradelma orientalis</i> )	Moderate	Moderate	Moderate	<ul style="list-style-type: none"> <li>• Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals. (for all listed mammals, reptiles and birds)</li> <li>• Fell trees away from existing stands where practicable. Where trees unavoidably fall into a stand, leave trees in situ to emulate natural tree fall and provide habitat for ground-dwelling species where practicable. (for Spotted-tailed quoll and listed reptiles)</li> <li>• Retain habitat trees, where practicable. (for all listed mammals, reptiles and birds)</li> <li>• Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques. (for all listed mammals and birds)</li> <li>• Assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards, allowing fauna to escape. (for the Greater long-eared bat and listed birds)</li> </ul>	Low	Low
Dunmall's snake ( <i>Furina dunmali</i> )	Moderate	Moderate	Moderate		Low	Low
Australian painted snipe ( <i>Rostratula australis</i> )	Moderate	Moderate	Moderate		Moderate	Moderate
Regent honeyeater ( <i>Anthochaera phrygia</i> )	Moderate	Moderate	Moderate		Moderate	Moderate
Squatter pigeon (southern) ( <i>Geophaps scripta scripta</i> )	Moderate	Low	Low		Low	Low

**Table 8.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

MNES	Values Sensitivity	Pre Mitigated Impacts		Summary of Mitigation Measures	Residual Impact	
		Magnitude	Significance		Magnitude	Significance
<b>Fauna- Mammals, Reptiles and Birds (migratory and non-migratory) (cont'd)</b>						
All migratory species	Moderate	Low to Moderate	Low to Moderate	<ul style="list-style-type: none"> <li>Minimise light spill from project activities to reduce disturbance to nocturnal fauna. (for all listed mammals, reptiles and birds)</li> <li>Retain woody debris, logs and rocks for use in rehabilitation. (for Spotted-tailed quoll and listed reptiles)</li> <li>During rehabilitation works, care will be taken when moving stockpiled logs and vegetation to avoid fauna mortality. (for Spotted-tailed quoll and listed reptiles)</li> <li>Implement speed limits on project-controlled roads to reduce the potential for vehicle collisions with wildlife. (for Spotted-tailed quoll and listed reptiles)</li> </ul>	Low to Moderate	Low to Moderate
<b>Fauna- Fish</b>						
Murray cod, goodoo ( <i>Maccullochella peelii</i> )	Moderate	Moderate	Moderate	<ul style="list-style-type: none"> <li>Implement general mitigation measures where applicable.</li> <li>Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals.</li> <li>Obtain all relevant permits required under the Fisheries Act, including permits for construction of waterway barriers or disturbance of fish habitat.</li> </ul>	Low	Low

**Table 8.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

MNES	Values Sensitivity	Pre Mitigated Impacts		Summary of Mitigation Measures	Residual Impact	
		Magnitude	Significance		Magnitude	Significance
<b>Fauna- Fish (cont'd)</b>						
				<ul style="list-style-type: none"> <li>Ensure flumes used to construct watercourse crossings are suitably sized to maintain flows and ensure fish passage.</li> </ul>		
<b>Flora</b>						
Small-leaved wax flower ( <i>Philotheca sporadica</i> )	Extremely high	Major	Major	<ul style="list-style-type: none"> <li>Implement general mitigation measures.</li> <li>Translocate or propagate significant species (that are amenable to this process) where it is deemed necessary for use during rehabilitation or in offsets, in accordance with relevant legislation.</li> <li>Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals.</li> <li>Avoid damaging standing trees not identified for removal. Limit the scraping of standing tree trunks and breaking of limbs by equipment as far as practicable.</li> <li>Where avoidance is not possible, implement an offset strategy approved by relevant government agency and comply with reporting conditions of an offset plan.</li> </ul>	Low	Moderate
Austral toadflax, toadflax ( <i>Thesium australe</i> )	High	Moderate	Moderate		Low	Moderate
Belson's panic ( <i>Homopholis belsonii</i> )	High	High	High		Low	Moderate
Curly-bark wattle ( <i>Acacia curranii</i> )	High	High	High		Moderate	Moderate
Hando's wattle, Percy Grant wattle. ( <i>Acacia handonis</i> )	High	Moderate	Moderate		Low	Moderate
Small-leaved denhamia ( <i>Denhamia parvifolia</i> )	High	Moderate	Moderate		Low	Moderate
Austral cornflower, native thistle ( <i>Rhaponticum australe</i> )	High	Moderate	Moderate		Low	Moderate
Ooline, scrub myrtle ( <i>Cadellia pentastylis</i> )	High	Moderate	Moderate		Moderate	Moderate
Hawkweed ( <i>Picris evae</i> )	High	Moderate	Moderate		Low	Moderate
<i>Acacia wardellii</i>	High	Low	Moderate		Low	Moderate
Cobar greenhood orchid ( <i>Pterostylis cobarensis</i> )	Moderate	Moderate	Moderate		Low	Low
Finger panic grass ( <i>Digitaria porrecta</i> )	Moderate	Moderate	Moderate		Low	Low
Lobed blue grass ( <i>Bothriochloa biloba</i> )	Moderate	High	Moderate		Moderate	Moderate

The Surat Gas project will aim to avoid species and communities of MNES. Planning will use constraints mapping to consider MNES and the conceptual layout will be refined as a result of pre-clearance and ecological surveys. Pre-clearance surveys will be undertaken prior to vegetation clearance in areas potentially containing MNES. Data collection will then be ongoing and used to refine areas of known and possible core habitat for threatened species.

Any site assessment or field survey undertaken during the monitoring process will be done at optimal times, by a suitably qualified person, and in accordance with the following DSEWPAC survey guidelines.

- Survey guidelines for Australia's threatened birds (DSEWPAC, 2010a).
- Survey guidelines for Australia's threatened bats (DSEWPAC, 2010b).
- Survey guidelines for Australia's threatened mammals (DSEWPAC, 2011a).
- Survey guidelines for Australia's threatened fish (DSEWPAC, 2011b)
- Survey guidelines for Australia's threatened reptiles (DSEWPAC, 2011c).

Best practice site assessment and ecological survey methods appropriate for each listed threatened species, migratory species, their habitat and listed threatened ecological communities will be applied, and a record will be kept and submitted to the Australian government on request.

Ecological and pre-clearance surveys inform any further refinement of the conceptual gas field layout, particularly the location and arrangement of production facilities and routes for medium pressure gas pipelines. The outcome of field surveys informs the detailed design of the gas field and selection of equipment and construction methods that address the environmental constraints. The environmental management controls (standard operating procedures) applicable to the proposed activities at the selected sites or routes are identified and incorporated in the work plans.

Table 8.2 shows the predicted significance of impacts prior to implementation of management procedures (unmitigated impacts), and the significance of impacts following implementation of recommended management actions (residual impacts). This table is a summary of species with high to major residual impacts as it assumes that the species were not avoided. The following summarises some of the characteristics of the species found in Table 8.2:

- ***Anomalopus mackayi***. Mainly occurs in native grasslands in which Arrow intends to avoid.
- ***Delma torquata***. Has been found as a small number of individuals and is found approximately 12 km west of Wondul Range National Park. The bulk of records occur outside the project development area and is often found in very small, restricted populations. Pre-clearance surveys will reduce the change of affecting this species.
- ***Macrozamia machinii***. This species is mainly located at Wondul Range in which Arrow intends to avoid. Other location where this species is found Arrow will aim to avoid.
- ***Xerothamnella herbacea***. There was one single record of this species and as Arrow is committed to avoidance of key species, this one location will be avoided.
- ***Calytrix gurulmundensis***. This species was found outside the project development area or is just along the border of it. Arrow will attempt to determine the presence of this species through surveys.
- ***Prostanthera sp. (Dunmore)***. Arrow will identify the presence through surveys and avoid where possible.

- ***Microcarpaea agonis***. The only known occurrence is found approximately 6 km outside of the project development area. Arrow will still try to identify the presence of these species prior to clearance and use appropriate buffers to protect the species.

Overall, Arrow's objective is to avoid MNES through constraints mapping, ecological and pre-clearance surveys. Where avoidance is not possible, Arrow will minimise the area of habitat or number of species affected by reducing the right of way and workspace requirements and through tactical (micro) siting or realignment. Recovery plans and offset plans will also be implemented on a site-specific basis.

**Table 8.2 Impact assessment, showing unmitigated and residual impact significance for species of high sensitivity**

Unmitigated Significance Assessment			Effectiveness of Mitigation Measures		Residual Significance Assessment					
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Avoidance*	Others†	Avoidance			Others		
					Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Sensitivity Ranking	Magnitude Ranking	Significance Ranking
<b><i>Anomalopus mackayi</i></b>										
Extremely high	Major	Major	Effective	Low	Extremely high	Major	Moderate	Extremely high	High	Major
<b><i>Delma torquata</i></b>										
Extremely high	Major	Major	Effective	Moderate	Extremely high	Negligible	Moderate	Extremely high	High	Major
<b><i>Macrozamia machinii</i></b>										
Extremely high	Major	Major	Totally effective	Unknown – variable	Extremely high	Negligible	Moderate	Extremely high	Major	Major
<b><i>Xerothermella herbacea</i></b>										
Extremely high	High	Major	Totally effective	Unknown – untested	Extremely high	Negligible	Moderate	Extremely high	Moderate	High
<b><i>Calytrix gurulumundensis</i></b>										
Extremely high	High	Major	Totally effective	Unknown	Extremely high	Negligible	Moderate	Extremely high	Moderate	High
<b><i>Prostanthera sp. (Dunmore)</i></b>										
High	Major	Major	Totally effective	Unknown – untested	High	Negligible	Low	High	High	High
<b><i>Microcarpaea agonis</i></b>										
Extremely high	High	Major	Totally effective	Unknown	Extremely high	Negligible	Moderate	Extremely high	Moderate	High

\* No clearing of vegetation within areas of core habitat known or core habitat possible.

† Clearing of core habitat known and possible is unavoidable.

## 9. PROPOSED DISTURBANCE LIMITS

Although EPBC Act-listed communities and habitat will be avoided where possible and the footprint minimised, there will be residual impacts from loss of vegetation and habitat.

Ecological and preconstruction clearance surveys will be undertaken to inform the integration of the environmental framework into the conceptual gas field design, particularly the location and arrangement of production facilities and routes for medium pressure gas pipelines. The environmental framework will be used to guide site and route selection and identify the applicable environmental management measures.

An assessment of the potential clearance required for project activities will be undertaken to propose disturbance limits for each identified MNES community and species. The threatened communities present or potentially present in the project development area and their extents, as defined by Queensland Government mapping and from targeted field surveys, are listed in Table 9.1, along with a preliminary estimate of the area likely to be disturbed.

**Table 9.1 Preliminary disturbance areas for EPBC Act-listed threatened ecological communities**

Ecological Community	EPBC Act Status	Existing Within Project Development Area (ha)	Conceptual Disturbance Area (ha)
Brigalow ( <i>Acacia harpophylla</i> dominant and co-dominant)	Endangered	9,899	Not defined at this time
Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	990	0 (No disturbance authorised)
Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions	Endangered	259	Not defined at this time
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	104	0 (No disturbance authorised)
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	31*	Not defined at this time
Weeping Myall Woodlands	Endangered	0.25 <sup>†</sup>	Not defined at this time

\* Inferred, based on certified ecosystem mapping.

<sup>†</sup> Not recorded in field surveys or identified within the project development area. Small isolated stands possible.

## 10. INSPECTION AND MONITORING

This section describes proposed inspection and monitoring for MNES. The inspection and monitoring will observe and report on the performance of the proposed mitigation and management measures, with a focus on facilitating early intervention and remediation of identified non-conformances or the implementation of adaptive management if required.

A set of inspection and monitoring measures have been designed to extend throughout the project and beyond decommissioning phases. The process of landscape recovery may be ongoing well beyond the life of the project and the risk of impact from disease, exotic species or changes to the population dynamics of threatened species will continue until the process of landscape stabilisation is complete.

Inspection and monitoring measures include:

- Inspect areas of avoidance to ensure that boundaries are clearly marked prior to clearing activities.
- Monitor clearing activities to ensure marked boundaries are adhered to.
- Inspect marked areas after clearing activities to ensure areas of avoidance remain and that no unauthorised encroachment has occurred.
- Supervise construction activities in sensitive areas to ensure appropriate methods (e.g., narrowing of ROW) are being implemented, where required
- Inspect and manage open trenches in accordance with the following:
  - Inspect trenches for the presence of fauna daily (preferably in the morning), as well as immediately prior to closing a trench.
  - Have appropriately trained personnel remove any fauna from a trench to minimise stress to the animal and to avoid personal injury.
  - Record details of trapped fauna for inclusion in the DERM Wildnet database.
- Carry out routine monitoring of rehabilitation success.
- Inspect and monitor the success of newly propagated or translocated listed species, in accordance with the approved translocation or management plan.
- Inspect erosion and sediment control measures following significant rainfall events to ensure effectiveness of measures are maintained.
- Routinely inspect for pest flora and evidence of pest fauna species within project disturbed areas.
- Inspect food scrap bins and exclusion fences to ensure they are properly operated and maintained.
- Develop monitoring programs that are site-specific and based on the identified risk to the conservation or maintenance of a viable population.

## 11. CUMULATIVE IMPACTS

The Surat Gas Project lies within the Brigalow Belt South Bioregion and contains vegetation communities and flora and fauna species of national significance. This bioregion is a major pastoral and agricultural area with much of the natural vegetation heavily cleared as a result of land development. The resulting landscape is one of isolated patches of remnant, disturbed and regrowth vegetation, which vary in size, shape and isolation. This is evident in the network of linear vegetation (both remnant and regrowth) along road verges and fence lines; and by the few larger stands of vegetation containing unbroken habitat preserved in areas that are either unsuitable for agriculture, or that have been preserved through alternative use.

Developments with the potential to contribute to cumulative impacts are those within the same bioregion and have contiguous project boundaries with the Surat Gas Project. These include other coal seam gas developments, the Arrow Surat Pipeline, Cameby Downs Coal Expansion, Elimatta Coal and Wandoan Coal projects. Other less relevant developments are those with negligible predicted impacts to MNES. The cumulative impact assessment targeted ecological values that are at a greater residual risk of cumulative impact.

Two potential cumulative impacts to terrestrial ecology were identified:

- Habitat loss and fauna mortality.
- Fragmentation of habitat and isolation of populations.

These impacts are the result of vegetation clearance and ground disturbance works during construction.

An assessment of cumulative impacts identified three ecological communities, nine flora species and seven fauna species with high potential for cumulative impact. The ecological communities are:

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland (critically endangered).
- Brigalow (*Acacia harpophylla* dominant and co-dominant) (endangered).
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (endangered).

The nine flora species are curly-bark wattle (*Acacia curranii*), *Acacia wardellii*, ooline (*Cadellia pentastylis*), *Calytrix gurlmundensis*, *Belson's panic* (*Homopholis belsonii*), *Microcarpaea agonis*, small-leaved wax flower (*Philothea sporadic*), *Prostanthera sp.* (Dunmore), and *Xerothamnella herbacea*.

The seven fauna species are, collared delma (*Delma torquata*), brigalow scaly-foot (*Paradelma orientalis*), five-clawed worm-skink (*Anomalopus mackayi*), grassland earless dragon (*Tympanocryptis cf. tetraporphora*), Dunmall's snake (*Furina dunmalli*), Australian painted snipe (*Rostratula australis*), and regent honeyeater (*Anthochaera phrygia*).

The successful management of cumulative impacts to MNES should be managed at the individual project scale and can best be managed at the individual project scale and assisted by a collaborative approach between the proponents of interacting developments, particularly in regards to ongoing ecological studies and habitat offsets.

## 12. REFERENCES

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