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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

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Report

Bowen Gas Project SREIS

AUSTRALIA

Matters of National Environmental Significance Report

April 2014
42627140/01/0

Prepared for:
Arrow Energy Pty Ltd

Prepared by URS Australia Pty Ltd

URS

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ABBREVIATIONS

Abbreviation	Description
CSG	Coal Seam Gas
DERM	Department of Environment and Resource Management
DEWHA	Department of the Environment, Water, Heritage and the Arts (subsequently DSEWPaC, now Department of the Environment)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now Department of the Environment))
EHP	Department of Environment and Heritage Protection (formerly DERM)
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
GPS	Global Positioning System
HERBRECS	Queensland Herbarium flora database
HVR	High value regrowth
JAMBA	Japan-Australia Migratory Birds Agreement
MNES	Matters of National Environmental Significance
RE(s)	Regional Ecosystem(s)
REDD	Regional Ecosystems Description Database
TEC(s)	Threatened Ecological Communities

EXECUTIVE SUMMARY

The Bowen Gas Project (the Project) is expected to involve the development approximately 4,000 coal seam gas (CSG) production wells over a development area of approximately 8,000 km^2. The gas field is approximately 150 km south-west of Mackay, with the area extending from Glenden in the north to Blackwater in the south. A description of the Project is detailed below in the Description of the Proposed Action (Section 3).

Matters of National Environmental Significance (MNES) potentially impacted by the Project are discussed in this report. MNES potentially impacted by the Project include Threatened Ecological Communities (TEC), flora and fauna species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and migratory species.

Four TECs known to occur or potentially occurring in the Project area include (Section 7.1):

- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin;
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions; and
- Weeping Myall Woodlands.

Four MNES flora species known to occur or potentially occurring include (Section 7.2.1):

- black ironbox (*Eucalyptus raveretiana*);
- bluegrass (*Dichanthium setosum*);
- king bluegrass (*Dichanthium queenslandicum*); and
- *Aristida annua*.

Ten MNES fauna species or species habitat known to occur or potentially occurring in the Project area include (Section 7.2.2):

- northern quoll (*Dasyurus hallucatus*);
- ornamental snake (*Denisonia maculata*);
- Fitzroy River turtle (*Rheodytes leukops*);
- squatter pigeon (*Geophaps scripta scripta*);
- koala (*Phascolarctos cinereus*);
- south-eastern long-eared bat (*Nyctophilus corbeni*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- Australian painted snipe (*Rostratula australis*);
- red goshawk (*Erythrotriorchis radiatus*); and
- yakka skink (*Egernia rugosa*).

Migratory species protected under international agreements known to occur or potentially occurring within the Project area include (Section 7.3):

- fork-tailed swift (*Apus pacificus*);
- eastern great egret (*Ardea modesta*);
- cattle egret (*Ardea ibis*);
- white-bellied sea-eagle (*Haliaeetus leucogaster*);
- white-throated needletail (*Hirundapus caudacutus*);
- rainbow bee-eater (*Merops ornatus*);
- black-faced monarch (*Monarcha melanopsis*);
- spectacled monarch (*Symposiachrus trivirgatus,* syn. *Monarcha trivirgatus*);
- satin flycatcher (*Myiagra cyanoleuca*);
- rufous fantail (*Rhipidura rufifrons*);
- Latham's snipe (*Gallinago hardwickii*); and
- Australian painted snipe (*Rostratula australis*).

Potential impacts to MNES and other protected matters include habitat loss and fragmentation (Section 6.4), edge effects such as increased predation and weed incursion (Section 6.5), and flora and fauna mortality during clearing and construction (Section 6.6).

Mitigation and management of impacts for the Project include (Section 6.7 and 6.8):

- Avoidance of MNES and other protected matters in the planning stages of infrastructure development and layout (Section 6.8.1). Planning will be informed by pre-construction surveys to ground-truth any MNES on and surrounding the site proposed for infrastructure; and
- Management controls (Section 6.8.2) to be implemented during the construction and operation to ensure work is undertaken in a way that avoids and minimises impacts through the implementation of a number of mitigation commitments including disturbance exclusion zones (or management buffers) to effectively protect MNES values.

Section 7 of this report outlines an analysis of the likelihood of occurrence within the project area for MNES. Section 9 of this report provides detailed MNES profiles, potential habitat mapping and an assessment of specific potential impacts for MNES against the *MNES: Signficant Impact Guidelines 1.1* (2013). Specific avoidance, mitigtion and management measures for each species are detailed in Section 10.

Potential impacts (including downstream and cumulative impacts) specific to TECs, protected species and protected migratory species are discussed in relation to guidance within the policy statement on those subject areas. A residual impact evaluation and overall Project cumulative impacts Section are provided in Sections 11 and 12.

1 INTRODUCTION

1.1 Background

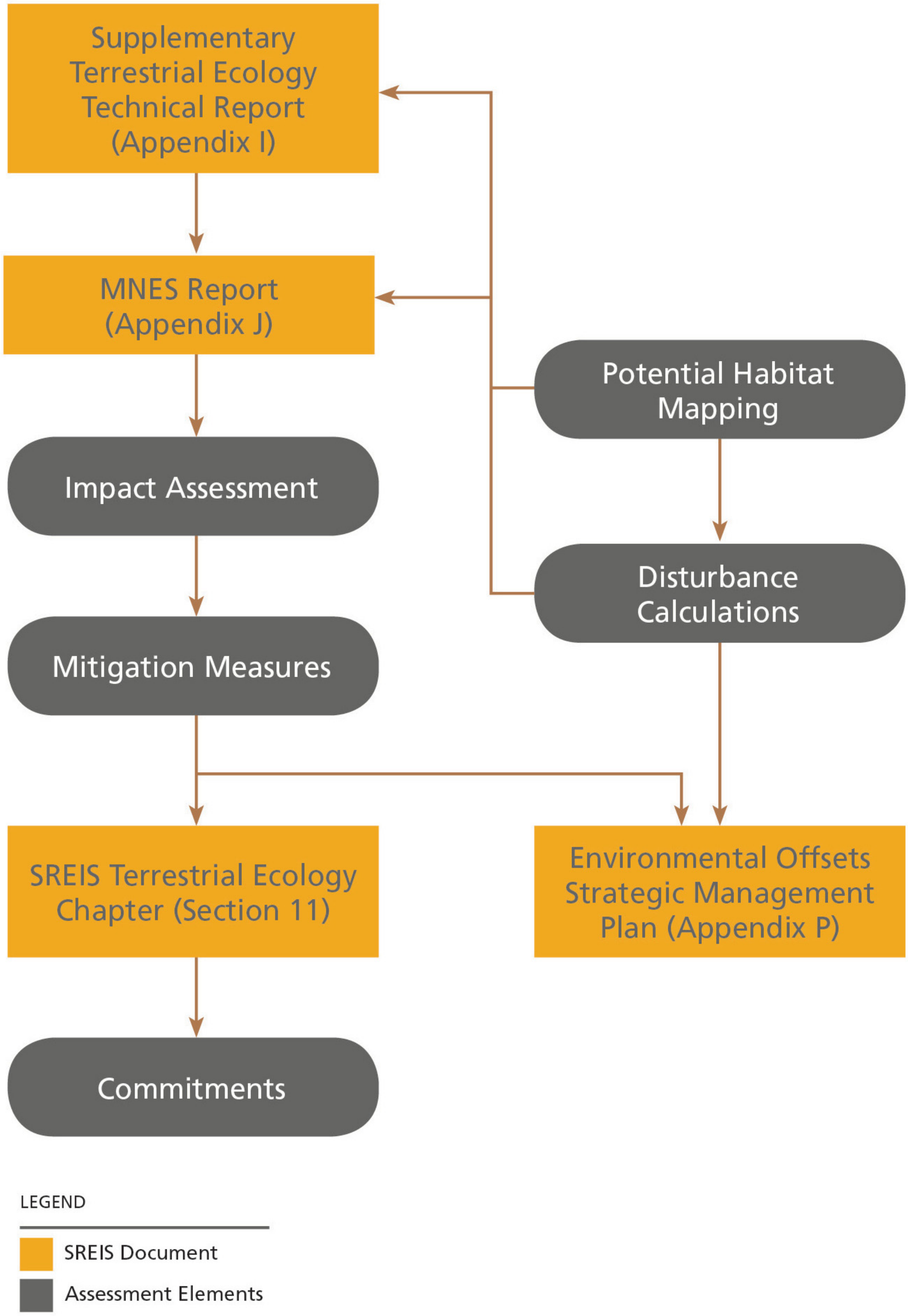
URS Australia Pty Ltd (URS) has been engaged by Arrow Energy Pty Ltd (Arrow) to undertake an assessment of Matters of National Environmental Significance (MNES) as part of a preparation of a Supplementary Report to the Environmental Impact Statement (SREIS) for the proposed development of the Bowen Gas Project (the Project).

This report provides an update to, and supersedes the previous MNES report to the EIS (Appendix CC of the EIS). This document is primarily a standalone report to the Commonwealth Department of the Environment and describes the existing environmental values and assesses the potential impacts of the Project on MNES as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This update to the Project MNES report for the SREIS includes a revision of the listed EPBC species in line with the most recent listings (Section 7), and also includes a revision and update of potential species habitat mapping to include processing of light detection and ranging (LiDAR) imagery that refines and improves habitat identification (Section 8). This refined potential habitat mapping has also been brought into the Protected Species profiles and impact criteria assessment (Section 9) to provide an updated assessment of potential species distribution within the Project area and any associated potential impacts and mitigation measures.

The ecological studies for the supplementary report to the EIS (SREIS) include a number of supplementary and updated assessments. The relationship between the various elements of the updated supplementary assessments is illustrated below in Figure 1-1. The assessments include:

- **Supplementary Terrestrial Ecology Assessment (SREIS Appendix I):** The Supplementary Terrestrial Ecology Technical Report is a standalone report that outlines the methodology and results of the supplementary assessment undertaken as part of the SREIS.
- **MNES Report (SREIS Appendix J):** The SREIS Matters of National Environmental Significance (MNES) report is a standalone document to provide an update to, and supersede the previous MNES report provided in the EIS.
- **Terrestrial Ecology Chapter (SREIS Section 11):** The SREIS terrestrial ecology chapter is an update to the EIS terrestrial ecology studies and is to be read in conjunction with the EIS terrestrial ecology chapter.
- **Environmental Offsets Strategic Management Plan (SREIS Appendix P):** This SREIS environmental offsets strategic management plan is a standalone report outlining the offsets strategy for the Project in line with relevant state and federal legislation and policy.



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BOWEN GAS PROJECT SREIS

ECOLOGY ASSESSMENT SUMMARY

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **1-1**

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1.2 EPBC Referral

The EPBC Act provides protection to 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;
- Migratory species protected under international agreements;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear actions; and
- A water resource in relation to coal seam gas (CSG) and large coal mining (the water trigger).

The environmental protection objectives for MNES for the Project are:

- To avoid or minimise impacts to EPBC Act listed threatened species habitat;
- To avoid or minimise EPBC Act listed threatened species loss or disturbance;
- To minimise and manage threatening processes such as land clearing, loss of biodiversity and land degradation from feral species;
- To avoid or minimise adverse impacts on threatened ecological communities (TECs) and associated biodiversity;
- To control the introduction or spread of pest flora or fauna;
- To protect areas identified for avoidance; and
- To avoid or minimise adverse impacts to water resources.

On 9 May 2012, Arrow referred the Project to the Commonwealth Department of the Environment (formerly Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)) in Referral No. 2012/6377.

On 15 June 2012, 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.

1.3 Project Overview

Arrow is seeking to develop gas reserves in the Bowen Basin for growing overseas gas markets. The Project petroleum tenures cover an area of approximately 8,000 km^2 within the gas exploration acreage. The tenures are located approximately 150 km south-west of Mackay, with the bulk of the area extending from Glenden in the north to Blackwater in the south (Figure 1-2).

An EIS has been prepared for the Project under Chapter 3 of the EP Act and s.133 of the EPBC Act. The purpose of the EIS is to inform a decision on whether the Project should proceed, and if so, under what conditions.

The final EIS was submitted to the Chief Executive of the Department of Environment and Heritage Protection (EHP) in February 2013 and released for public review and comment from 11 March 2013 to 23 April 2013. The Chief Executive of EHP received 53 submissions relating to the EIS during this time.

Under s.56 of the EP Act, following receipt of submissions, the proponent is required to prepare a supplementary report to address the matters raised in submissions and, based on the submissions, to include any corrections or clarifications to the EIS and provide further information and results from additional studies.

The Project SREIS has been prepared for this purpose. Further, the SREIS will present any material changes to the conceptual project description and undertake any further impact assessment deemed necessary as a result of these changes.

Since publication of the EIS, Arrow's field development plan and conceptual design for the Project have advanced. This progression is the result of ongoing exploration activities that have improved Arrow's understanding of the gas resource, as well as the evolution of Arrow's planning, engineering and operational processes. The following key changes have been made to the Project, and are further described in Section 3:

- Revised development planning and sequencing;
- Change to number, type and layout of wells and compression facilities;
- Changes to the number of water treatment facilities (WTFs) (co-located with central gas processing facilities (CGPFs));
- Changes to the nature of supply of electricity;
- Refined strategy for water management;
- Changes to construction techniques;
- Operations and maintenance changes; and
- Changes to the workforce and accommodation strategy.

The potential direct and indirect impacts of the Project on environmental values have been assessed using one of three impact assessment methods: significance assessment, risk assessment or compliance assessment; this study has used significance assessment. For further details refer to the Impact Assessment Method chapter (Section 6) of the EIS.

Further discussion of the existing environment, potential impacts and mitigation measures are outlined in the following chapters of the EIS:

- Terrestrial Ecology chapter (Section 17);
- Aquatic Ecology chapter (Section 16);

- Surface Water chapter (Section 15);
- Indigenous Cultural Heritage chapter (Section 25); and
- Non-Indigenous Cultural Heritage chapter (Section 26).

And the following sections and technical reports of the SREIS:

- Surface Water chapter (Section 8);
- Hydrology and Geomorphology chapter (Section 9);
- Aquatic Ecology chapter (Section 10);
- Terrestrial Ecology chapter (Section 11);
- Supplementary Terrestrial Ecology Technical Report (Appendix I);
- Supplementary Aquatic Ecology Technical Report (Appendix H);
- Supplementary Surface Water Technical Report (Appendix F); and
- Supplementary Hydrology Technical Report (Appendix G).

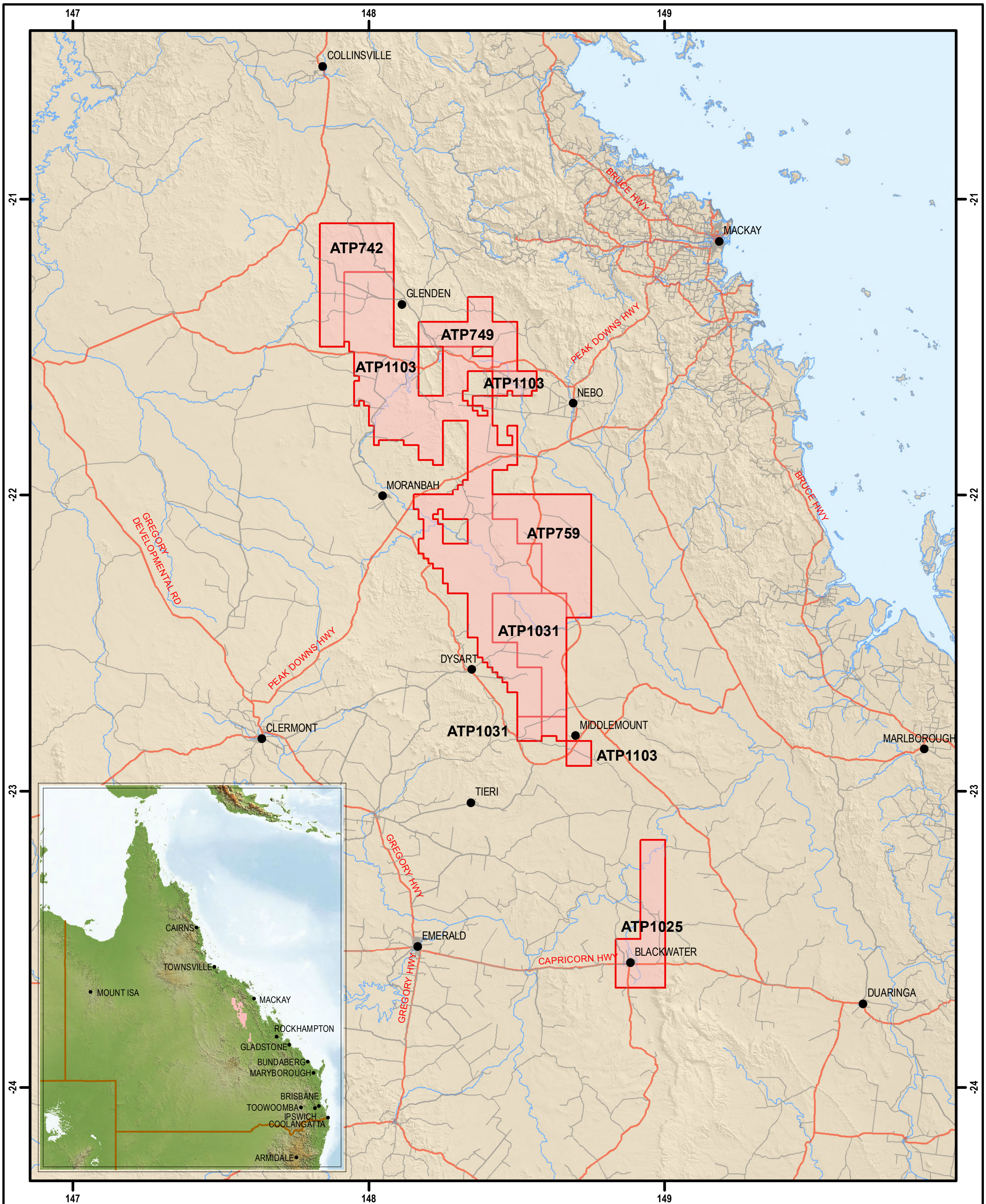
1.4 Environmental Framework and Coal Seam Gas Approvals Process

CSG resources are extensive, requiring widespread development to recover the resource over the life of the Project, which is expected to be in the order of 40 years. The yield from target coal seams is variable across the resource, leading to uncertainty about the number, timing and location of wells required to dewater the coal seams and extract the gas. Prior to considering environmental and social constraints, selection of the ideal location of infrastructure required to treat the CSG water and process the gas is also uncertain. This is driven by exploration results, landowner consultation and optimisation of both well placement and water and gas gathering systems.

This lack of certainty about the preferred location of infrastructure is an issue for environmental impact assessment, because the impacts at a specific location cannot be fully understood, scoped and assessed at the planning phase. However, they can be described based on the typical impacts inherent to individual Project activities.

To overcome uncertainty inherent to the planning of CSG projects, Arrow has developed the Environmental Framework for the Project to identify impacts in the planning phase and manage the potential impacts in the construction and operation phases.

This is achieved through the application of environmental controls that reflect the sensitivity or vulnerability of environmental values of each development area and identifies development which is not appropriate for the area. This is achieved through the identification of constraints to development and the establishment of environmental management controls required to facilitate Project activities in constrained areas. Constraints mapping is an integral part of the Environmental Framework and is informed by the environmental impact assessment process undertaken in this EIS. Constraints mapping guides site and route selection that seeks to avoid and minimise impacts, thereby protecting environmental values of each development area. Further details regarding the Environmental Framework are contained within Section 4 of this report.



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Projection: Geographic (GDA94)

Bowen Gas Project Tenements

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BOWEN GAS PROJECT SREIS

REGIONAL PROJECT LOCATION

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: 1-2

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1.5 The Proponent

Arrow is an integrated energy company with interests in CSG field developments, pipeline infrastructure, electricity generation and a proposed LNG Plant. In Queensland, Arrow operates gas projects at Moranbah in the Bowen Basin and around Dalby in the Surat Basin. Arrow's four operational gas producing projects currently account for about 20% of Queensland's overall domestic gas supply.

Arrow is a Queensland-based wholly owned subsidiary of Arrow Energy Holdings Pty Ltd, a 50:50 joint venture between a subsidiary of Royal Dutch Shell plc (Shell) and a subsidiary of PetroChina Company Limited. The joint venture took ownership of Arrow on 23 August 2010.

Arrow's registered office address in Australia is: Level 39, 111 Eagle Street, Brisbane, Queensland, 4000

1.5.1 Environmental Record

Arrow is committed to continual improvement through their integrated health, safety and environmental management system (HSEMS) (refer to the Health and Safety chapter (Section 30) of the EIS). Arrow Energy Holdings Pty Ltd and/or its subsidiaries have received three penalty infringement notices (PINs) relating to non-compliances with Environmental Authority (EA) conditions issued under the EP Act. The PINs are related to:

- Unauthorised clearing of a Category B Environmentally Sensitive Area (ESA);
- Unauthorised release of CSG water to land; and
- Sediment and erosion controls not implemented.

Arrow is not aware of any other fines or prosecutions for breaches of environmental legislative requirements in the past five years. A copy of the Arrow Environmental Policy is provided in Figure 1-3.

1.6 Community Consultation

Arrow is committed to building long-term, mutually beneficial relationships with the community. Arrow aspires to understand community interests and form partnerships to resolve potential issues, while simultaneously enhancing project activities in the Bowen Basin. The Project stakeholders are individuals or organisations that may be interested in or affected by the proposed Project and are often referred to as 'the community'.

The Project consultation process commenced in 2010 and will continue throughout the life of the Project. Jan Taylor and Associates Australia (JTA) were engaged by Arrow to provide support for the EIS community consultation. This section provides a summary of this communication and consultation process. Details of consultation activities and outcomes are documented fully in the Consultation Report (Appendix A of the SREIS).

Environmental Policy

Policy Statement

Arrow Energy promotes sustainable environmental practices as part of our commitments, beliefs and values.

Scope and Responsibility

This Policy applies to all personnel involved in Arrow operations and it is a cornerstone to the Arrow Management System.

The Chief Executive Officer and the leadership team are responsible for the implementation, review, update and enforcement of this Policy and each employee, consultant, contractor and service provider is responsible for actively participating in and implementing this Policy.

Practice, Implementation and Supporting Documents

Arrow Energy ensures all elements of the Environmental Policy are implemented by:

- Seeking continuous improvement in managing significant environmental impacts by clearly defining objectives and targets and evaluating them through transparent review and implementation processes.
- Establishing programs to reduce environmental impacts, conserve and recycle resources, reduce waste and pollution, and improve processes to help protect the natural environment as well as monitoring and measuring performance.
- Ensuring all of our activities comply with all applicable environmental laws and regulations.
- Promoting a culture where employees and service providers are aware of environmental impacts affecting their work and promptly report any environmental impacts or incidents while encouraging improvements.
- Monitoring Policy implementation at all relevant Arrow controlled workplaces, and periodically reviewing and updating.

Expectations

- Maintaining open and transparent communications with employees, community, government and other stakeholders.
- Communicating expectations to all employees and service providers and holding them accountable for their performance.
- Operating within compliance with all applicable environmental laws and regulations.
- Collaborating with stakeholders and participating in research and development, aimed at enhancing knowledge and improving our environmental performance.
- Employing new and improved technologies and developing industry partnerships that are aimed at reducing the carbon emission per unit of production and improving cost/benefit balance.
- Our Environmental Policy plays a vital role in Arrow's Sustainable Development Policy.

Andrew Faulkner, Chief Executive Officer
18th Day April 2011, Review Date: April 2014

Doc No: 99-V-POL-0002

1.6.1 Consultation Program

The consultation program was designed with the intent to:

- Identify and manage stakeholder relationships;
- Select appropriate communication methods and processes to meet stakeholder needs and expectations;
- Provide accurate, relevant and up-to-date information to stakeholders and the broader community;
- Comply with the EP Act; and
- Fulfil requirements of the Project's Terms of Reference (ToR).

Arrow designed its program to be targeted to the communities of concern based on an understanding of the region as:

- A highly developed brownfield area, where many of the communities of interest are purpose built mining towns, and where many community members have a high level of knowledge and association with the extractive industries; and
- The high level of development in the region resulting in a considerable level of consultation fatigue.

As a result, Arrow's consultation program for the EIS has been divided into three key phases, described below. In addition, prior to the public consultation for the EIS, Arrow undertook two rounds of consultation in the region: one from September to November in 2010, the other in October 2011. These were undertaken to provide a foundation for community relationships in the study area and inform interested stakeholders.

1.6.1.1 *Phase 1*

Phase 1 (February to August 2012) included the preliminary planning required for the Project's stakeholder and community engagement in early 2012. Phase 1 also involved the initial round of public consultation which took place in June 2012, prior to the release of the draft ToR. This phase was designed to provide stakeholders and the broader community with an overview of the Project, advise them of the upcoming draft ToR release, and assess stakeholder and community views, issues and concerns. The focus of this phase was the public 'roadshow' that saw detailed information sessions held in Moranbah, Dysart, Middlemount and Blackwater, a staffed drop-in session in Glenden and one on ones with local council stakeholders.

1.6.1.2 *Phase 2*

Phase 2 (September to December 2012) was designed to provide a Project update and the provision of preliminary findings of the EIS to address issues and concerns raised by stakeholders during pre-EIS and Phase 1 consultation. These issues and concerns included Project timing, social investment, impacts on the community such as housing and accommodation, environmental issues such as impacts on groundwater, and business and procurement opportunities. Information sessions were held in Moranbah, Middlemount and Blackwater and staffed drop-in sessions in Dysart and Glenden. One on one sessions were also available for interested local council stakeholders.

1.6.1.3 *Phase 3 Consultation – January to April 2013*

Phase 3 consultation activities included the public exhibition period for the EIS. This phase commenced in January 2013 and continued through to April 2013.

A range of activities were undertaken to provide information to the community about the results of the EIS, including drop-in sessions and community information sessions.

1.6.1.4 *Ongoing Consultation*

Following on from Phase 3, Arrow will continue to build and maintain relationships with stakeholders as the Project progresses, including through its community relations and Project staff and its Brighter Futures community investment program.

Through Arrow's various consultation avenues, the company will continue to seek to address the key concerns of community members and stakeholders.

1.6.2 *Key Issues Raised*

Table 1-1 details the subjects raised by the community during the Project consultation program to date.

Table 1-1 Key Subjects Raised During the Consultation Program

Location	Issues Raised
Moranbah	• Impact on aquifers including zonal isolation and the use of cement; • Casing of wells and potential for gas leaks into water supply; • Health impacts of CSG; • Increase in traffic volume, impacts on roads and impact on safety; • Impact on health and emergency services and their ability to cater for the increase in population; • Tracking population growth including fly-in / fly-out (FIFO) and drive-in / drive-out (DIDO) workers to mitigate impacts; and • EIS process and approval.
Glenden	• Impacts on the police services, housing and accommodation; • Worker's camp arrangements (wet or dry camps); and • Operational enquiries including flaring and fire management plans.
Middlemount	• Acquisition of easements and Arrow's relations with landholders.
Dysart	• Local contractor opportunities; • Project timeframes; • Staffing requirements; • Location of infrastructure; • Road impacts; • Social impacts – current issues of concern with Dysart include drug and alcohol abuse, domestic violence and other anti-social behaviour; • Brighter Futures enquiries; • Landholder negotiation process; and • Impact of FIFO / DIDO on population statistics and the census and the flow on effects including under-resourcing of police force.

Location	Issues Raised
Blackwater	• Responsibility for rehabilitation of sites and groundwater; • Issues experienced by CSG and shale gas industries in the USA; • Difference between QLD and NSW regulations and impacts on the projects; • Salt and brine management; • Desalination and beneficial uses of water; • Recovery of groundwater system post CSG drilling; • Impact on coal mining and Authorities to Prospect; • Future of the Bow Energy power station and associated pipeline licence; • Likelihood of the Project going ahead; • Likelihood of drilling in Blackwater township; and • Water trading process.

1.6.3 Stakeholders

In order to develop a comprehensive list of key stakeholders, Arrow identified Project boundaries as part of the ToR which enabled identification of potentially affected landholders and tenement holders. Arrow was able to expand on this initial list of stakeholders by:

- Identifying self-nominated individuals during consultation activities, via the freecall telephone number or email address; and/or
- Arrow compiling a list of interested parties.

These groups, organisations and individuals are broadly identified in Table 1-2.

Table 1-2 EIS Stakeholder List

Stakeholder Group	Organisation / Representative (name / title as at July 2012)
Political	• Local councillors; • Local state members of parliament; • Local Commonwealth members of parliament; and • Queensland and Australian Government Ministers.
Government agencies	*Queensland Government agencies*: • Department of Premier and Cabinet; • Department of Environmental and Heritage Protection; • Department of Natural Resources and Mines; • Department of State Development, Infrastructure and Planning; • Department of Education, Training and Employment; • Department of Housing and Public Works; • Queensland Health; • Department of Transport and Main Roads; • Department of Communities, Child Safety and Disability Services; • Department of Community Safety; • Department of Energy and Water Supply; • Queensland Police Service; • Queensland Water Commission; • Coordinator General; and • Department of Justice and Attorney-General.

Stakeholder Group	Organisation / Representative (name / title as at July 2012)
	Commonwealth Government agencies: • Department of Sustainability, Environment, Water, Populations and Communities; • Department of Climate Change and Energy Efficiency; • Department of Resources; Energy and Tourism; and • Department of Agriculture, Fisheries and Forestry. *Local councils*: • Isaac Regional Council; • Central Highlands Regional Council; and • Whitsunday Regional Council.
Landholders and occupiers	Adjacent or close to the infrastructure components of the Project.
Peak bodies	• Queensland Resources Council; • Australian Petroleum Production & Exploration Association (APPEA); • Chamber of Commerce and Industry Queensland; • Property council of Queensland; and • Real Estate Institute Queensland.
Mining companies*	• Cockatoo Coal Ltd • BHP Coal Pty Ltd • BHP Mitsui Coal Pty Ltd • Anglo Coal Australia Pty Ltd • Isaac Plains Coal Management Pty Ltd • Peabody Energy • Vale Australia Pty Ltd • Eagle Downs Coal Management Pty Ltd • New Hope Corporation Ltd • Aquila Resources Ltd • Bengal Coal Pty Ltd • Caledon Resources Ltd • Glencore Coal Queensland Pty Ltd • Bowen Basin Coal Pty Ltd (Jellinbah) • Rio Tinto Coal Australia Pty Limited • Stanmore Coal Limited • QCoal Pty Ltd • Queensland Coal Corporation Pty Ltd • U&D Mining Ltd • Australia Pacific Coal Ltd • Carabella Resources Ltd • Moreton Resources Ltd • Liberty Resources Ltd • Middlemount Coal Pty Ltd • Rocklands Richfield Pty Ltd • Samgris Resources Pty Ltd • Wesfarmers Limited (Curragh) • Bandanna Energy Ltd • Scott Creek Coal Pty Ltd

Stakeholder Group	Organisation / Representative (name / title as at July 2012)
	• Queensland Coal Investments Pty Ltd • Whitehaven Coal Ltd
Local industry and businesses	• AgForce; • Moranbah Traders Association; • Cotton Growers Central Highlands; • Proserpine and Mackay Canegrowers; and • Significant local business operators.
Bowen Basin interest groups	• Bowen Basin Local Leadership Group; • Bowen Basin Community Engagement Network; • Bowen Basin Mayors Group; and • Rental Affordability Taskforce.
Regional communities	• Moranbah; • Dysart; • Middlemount; • Glenden; • Blackwater; and • Nebo.
Environmental groups	• Environmental Defenders Office Queensland; • Fitzroy Basin Association; • Mackay Conservation Group; • Greenpeace; • Queensland Conservation Council; and • Friends of the Earth.
Health	• Moranbah Hospital; • Mackay Hospital; • Capricornia Division of General Practice Ltd; • Emerald Hospital; • Rockhampton Hospital; and • Medical services providers.
Community and interest groups	• Community service groups and peak bodies (such as Moranbah and District Support Services; • Country Women's Association; • Progress associations; • Heritage groups; • Sporting groups; • Action groups (such as Lock the Gate and Moranbah Action Group); • Community health and emergency service providers; • Religious groups; • Employment and training agencies; • Senior citizen representatives; • Parents and citizens groups; • Education groups; • Pastoral and farming groups; and • Social welfare groups.
Education	• Kindergartens; • Primary Schools;

Stakeholder Group	Organisation / Representative (name / title as at July 2012)
	• High Schools; • Coalfields Training Excellence Centre; • MRAEL Group; and • TAFE.
Media	*Print*: • Queensland Country Life; • Mackay Daily Mercury; • Miners Midweek; • Moranbah and District Advertiser; • Central Queensland News; and • Blackwater Herald. *Radio*: • ABC Rockhampton; and • 4RFM. *Television*: • ABC Capricornia – Rockhampton; • Channel Seven – regional; • Southern Cross (Channel Ten) – regional; and • WIN TV (Channel 9).

* The mining companies reflected in the above table are miners that Arrow have engaged with over the previous 2 years.

1.7 Schedule 4 Summary Table

Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 details matters that are to be addressed by a draft EIS. Table 1-3 below provides a summary of the Schedule 4 requirements and details the relevant Sections of this report where the matters are addressed.

Table 1-3 Summary of EPBC Regulations Schedule 4

Schedule 4 Section Number		Title and Details	Report Cross-Reference
1		General Information	
1.01		The background of each action including:	
	a)	The title of the action	Section 1
	b)	The full name and postal address of the designated proponent	Section 1.3
	c)	A clear outline of the objective of the action	Section 1.2
	d)	The location of the action	Section 1.2
	e)	The background to the development of the action	Section 1.2
	f)	How the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action	Section 1.1
	g)	The current status of the action	Section 1.1

Schedule 4 Section Number		Title and Details	Report Cross-Reference
	h)	The consequences of not proceeding with the action	Section 3.6
2		Description	
2.01		A description of the action, including:	
	a)	All the components of the action	Section 3.1
	b)	The precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts	Section 3.1 and 4
	c)	How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts	Sections 3.2, 3.3 3.4 and 3.5
	d)	Relevant impacts of the action	Sections 6, 9, 10 and 13
	e)	Proposed safeguards and mitigation measures to deal with relevant impacts of the action	Sections 6.7, 6.8, 10, 11 and 13
	f)	Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action	Section 2.3 and 2.4
	g)	To the extent reasonably practicable, any feasible alternatives to the action, including:	
		If relevant, the alternative of taking no action	Section 3.6
		A comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action	Section 3.1. A number of alternatives are described in the project description and area also specifically impact assessed against for each relevant study throughout the impacts and mitigation chapters of the EIS
		Sufficient detail to make clear why any alternative is preferred to another	Alternative's with the worst case impact scenario have been utilised for the impact assessment within each relevant study throughout the impacts and mitigation chapters of the

Schedule 4 Section Number		Title and Details	Report Cross-Reference
			EIS
	h)	Any consultation about the action, including	
		Any consultation that has already taken place	Sections 1.4.1, 1.4.1.1, 1.4.1.2, and 1.4.1.3
		Proposed consultation about relevant impacts of the action	Section 1.4.1.3
		If there has been consultation about the proposed action – any documented response to, or result of, the consultation	Section 1.4.2
	i)	Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views	Section 1.4.3
3		<u>Relevant Impacts</u>	
3.01		Information given under paragraph 2.01 (d) must include:	
	a)	A description of the relevant impacts of the action	Sections 6, 9, 10, 11 and 13
	b)	A detailed assessment of the nature and extent of the likely short term and long term relevant impacts	Sections 6, 9, 10, 11 and 13
	c)	A statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible	Sections 9, 10, 11 and 13
	d)	Analysis of the significance of the relevant impacts	Sections 9
	e)	Any technical data and other information used or needed to make a detailed assessment of the relevant impacts	Sections 6, 8, 9, 10 and 13
4.		<u>Proposed Safeguards and Mitigation Measures</u>	
4.01		Information given under paragraph 2.01 (e) must include:	
	a)	A description, and an assessment of the expected or predicted effectiveness of, the mitigation measures	Sections 6, 9, and 10
	b)	Any statutory or policy basis for the mitigation measures	Section 6, 9, and 10
	c)	The cost of the mitigation measures	Individual mitigation measures are not individually costed, although the Project economics consider the costs of implementing all mitigation measures and Project decisions will be made on this basis.
	d)	An outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental	Section 6.12

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Schedule 4 Section Number		Title and Details	Report Cross-Reference
		auditing	
	e)	The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program	Within mitigation measures and commitments, the name of the agency responsible for endorsing or approving the mitigation measure or monitoring program is identified, where appropriate.
	f)	A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent	Sections 6 and 9
5		<u>Other Approvals and Conditions</u>	
5.01		Information given under paragraph 2.01 (f) must include:	
	a)	Details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:	
		What environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy	Section 2
		How the scheme provides for the prevention, minimisation and management of any relevant impacts	Sections 6 and 9
	b)	A description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action	Sections 1.1 and 2
	c)	A statement identifying any additional approval that is required	Section 2.3
	d)	A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action	Sections 6, 9 and 10
6		<u>Environmental Record of Person Proposing to Take the Action</u>	
6.01		Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:	
	a)	The person proposing to take the action	Section 1.3
	b)	For an action for which a person has applied for a permit, the person making the application	Section 1.3
6.02		If the person proposing to take the action is a corporation – details of the corporation's environmental policy and planning framework	Section 1.3.1

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Schedule 4 Section Number		Title and Details	Report Cross-Reference
7		Information Sources	
7.01		For information given in a draft public environmental report or environmental impact statement, the draft must state:	
	a)	The source of the information	Section 14
	b)	How recent the information is	Section 14
	c)	How the reliability of the information was tested	Sections 5.7, 6.7 and 8
	d)	What uncertainties (if any) are in the information	Sections 5.7, 6.7 and 8

2 LEGISLATIVE CONTEXT

The following section describes legislation relevant to protection of MNES relevant to the Project.

2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act establishes and governs an Australian Government administered environmental assessment and approval system. This operates in addition to but separate from state and territory systems. The EPBC Act determines impacts upon matters of national environmental significance as the primary trigger for Australian Government involvement in environmental protection.

On 9 May 2012, Arrow referred the Project to DSEWPaC in Referral No. 2012/6377. On 15 June 2012, 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). At the time of the referral, it was considered the proposed action had the potential to have a significant impact because of the following:

- Clearing of important habitat had the potential to have a significant impact on listed threatened species and ecological communities and listed migratory species; and
- There was a significant degree of uncertainty in relation to the calculation of impacts as the physical locations of infrastructure (wells, pipelines and access tracks) had not been determined and there was insufficient information around water related impacts, such as storage of produced salt and water and potential impacts to water quality that could impact on listed threatened species and ecological communities and listed migratory species.

2.1.1 Changes to the EPBC Act

2.1.1.1 Water Resource Trigger

Changes made to the EPBC Act on 22 June 2013, resulted in water resources in relation to CSG and large coal mining developments now being considered as a MNES. In accordance with this legislative change, on 17 October 2013, the Commonwealth Minister for Environment determined that water resources were a controlling provision under Sections 24D and 24E of the EPBC Act for the Project. This was due to the information available to the Minister at that time, indicating that the Project may potentially directly or indirectly result in a substantial change to the hydrology and quality of water resources impacted by Project activities. In making the decision, the Minister recognised that previously submitted documents, as well as subsequent documentation will be considered in the decision regarding the water resources controlling provision.

As such, the controlling provisions under the EPBC Act that now apply to the Project are:

- Wetlands of international importance (Ramsar wetlands) (sections 16 and 17B);
- Listed threatened species and ecological communities (sections 18 and 18A);
- Listed migratory species (sections 20 and 20A); and

- Water resources (sections 24D and 24E).

2.1.1.2 Independent Expert Scientific Committee

On 14 April 2013, EHP sought advice from the Independent Expert Scientific Committee (IESC) on CSG and large coal mining developments in relation to the Project. Advice was sought regarding the adequacy of the draft EIS with respect to the following elements, considered in the assessment of the Project under sections 24D and 24E of the EPBC Act:

- The potential for hydraulic stimulation to enhance interconnection of groundwater aquifers and adequately address the implications of such interconnection on groundwater quality and level;
- The potential for interconnection of aquifers and/or CSG contamination in target and non-target aquifers particularly at fault lines, with or without fraccing;
- Details on groundwater impacts due to the Project taking account of cumulative impacts incorporating coal and gas projects already operating in the location; and
- The management of impacts on waterways and water quality and the management of saline groundwater extracted from the gas wells.

The final publically released EIS for the Project and this SREIS have aimed to address these specific areas of assessment through the surface water, groundwater and hydrogeological studies contained in these publications. Furthermore, the SREIS contains additional information pertaining to hydrology and geomorphology to address sections 24D and 24E of the EPBC Act and the potential impacts on MNES.

This SREIS, through the bilateral agreement between the State and Commonwealth Governments, is accredited as one of the accepted assessment pathways to satisfy Section 8 of the EPBC Act.

2.2 Environmental Protection Act 1994

The EP Act is intended to protect the environment of Queensland, and sets out the relevant approval and regulation framework.

The EP Act requires that the Project’s likely environmental impacts should be assessed and measures proposed to avoid or minimise any adverse impacts. Arrow has prepared a voluntary EIS for the Project in accordance with the EP Act. The EP Act EIS statutory process involves:

- Application by Arrow to the chief executive to prepare an EIS for a project (s.70);
- Chief executive determines whether an EIS is appropriate for the Project (s.72);
- Chief executive prepares a ToR notice for the Project (s.42);
- Public Notification of draft ToR for comment (s.43);
- Chief executive to issue Final ToR for the Project (s.46);
- Preparation of a voluntary EIS by Arrow in accordance with the ToR;
- Submission of the voluntary EIS to the chief executive (s.47);

- Chief executive decides whether the EIS addresses the Final ToR and may proceed to public notification (s.49);
- Public notification of the EIS for comment (s.51);
- Public submissions on the EIS made to the chief executive (s.54);
- Arrow is provided copies of the submissions and prepares a response (s.56); and
- Chief executive prepares and Assessment Report making a recommendation whether to approve, approve with conditions, or not approve the Project (s.57).

2.2.1 Changes to the EP Act

Recent amendments to the EP Act have streamlined the approvals pathway of some environmental approvals and activities regulated under the EP Act. These changes were introduced through the *Environmental Protection (Greentape Reduction) and Other Legislation Amendment Act 2012* (Greentape Reduction Act), which commenced on 31 March 2013 and results in the following relevant changes:

- Replacement of Chapters 4, 5, 5A and 6 with a new Chapter 5 to create a single approval process for EAs; and
- Introduction of a licensing model proportionate to environmental risk.

The changes introduced through the Greentape Reduction Act have not changed the requirements for Arrow to secure EAs for the Project. It has however, provided opportunities for Arrow to seek a Project wide EA encompassing all of the activities proposed as part of the Project, or if the Project did not qualify for a Project wide EA, Arrow can apply for what is known as an amalgamated corporate authority if the relevant criteria have been met.

2.3 Other Legislation

The following list identifies other Commonwealth and State legislation relevant to the Project:

- *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act);
- *Sustainable Planning Act 2009* (SP Act);
- *Native Title Act 1993* (NTA);
- *Aboriginal Cultural Heritage Act 2003*;
- *Transport Infrastructure Act 1994*;
- *Water Supply (Safety & Reliability) Act* 2008;
- *Strategic Cropping Land Act 2011*;
- *Nature Conservation Act 1992* (NC Act);
- *Fisheries Act 1994*;
- *Water Act 2000*;
- *Work Health and Safety Act 2011*;
- *Vegetation Management Act 1999* (VM Act);
- *Forestry Act 1959*;

- *Land Protection (Pest and Stock Route Management) Act 2002* (LPIP & SRMA); and
- *Queensland Heritage Act 1992*.

3 Description of the Proposed Action

3.1 Overview

Arrow proposes to develop the CSG resource of the Project area for international markets, and potentially domestic sale. This will require exploration, field development, gas production, gas transport and export as outlined in Figure 3-1. The Project includes the field development and gas production stages of this process.

A conceptual description of the Project was prepared to inform the EIS. The project description formed the basis for which all initial baseline environmental studies were undertaken and guided the approach for how impact assessment studies were conducted for the EIS.

Since publication of the EIS for public comment in Q1 2013, Arrow's field development plan and conceptual design for the Project has advanced. This progression is the result of ongoing exploration activities that have improved Arrow's understanding of the gas resource and the evolution of Arrow's concept design, planning and operational processes.

Refinements to the basis of design, including revised typical arrangements, configurations, construction methods and CSG infrastructure design are being undertaken by Arrow to prepare for the front-end engineering design (FEED) phase and incorporate new design elements to improve efficiencies and reduce the Project's disturbance footprint. It should be noted that Project-specific design details will be determined during FEED.

Table 3-1 below presents the changes that have occurred to the project description subsequent to publishing the EIS. Where the changes to Project elements are described in more detail within this chapter a cross reference to the relevant section is provided in the table.

An indicative Project location and development areas is provided in Figure 3-2.

Table 3-1 Project Changes Since Release of the EIS

EIS Section	EIS Project Description	SREIS Description of Change
4.3 – Major Infrastructure Components	Integrated processing facility (IPF) – to treat (dehydrate) and compress the gas to export pressure, and treat water for beneficial use.	The term IPF is no longer being used and is now incorporated into CGPF. WTFs will be co-located at CGPFs. Simply a change to naming convention.
4.3.1 – Production Facilities Figure 4-4: Indicative Facilities Layout	For the purpose of the EIS, production facility locations were assumed to be located somewhere near the centre of each development area (**17** in total) of **12 km radius**.	Due to expected low gas pressures, as a result of the preliminary engineering undertaken in the concept select phase, the number of development (or drainage) areas has increased to **33** in total, however; each of these drainage areas now represent an approximate **6 km** radius catchment area for gathering well production (gas and water), and distributing to surface production facilities located at or near the centre of drainage area. These 33 drainage areas will be developed over the Project life, however; Arrow does not expect all facilities to be operating together at one single time. The number and location of development areas has been revised – this influences the indicative location of facilities.
4.3.1.1 –Facility Gas Compression Table 4-2: Production Facility Compression Types	Detailed information in the Project Description chapter (Section 3, Table 3-2) of the SREIS outlines a comparison between compression types presented in the EIS and the new case for the SREIS.	See SREIS Project Description chapter (Section 3, Table 3-2) for a comparison between compression types presented in the EIS and the new case for the SREIS.
4.3.1.1 – Range of Facility Sizes Table 4-3	Production facility area requirements: • FCF = 200 x 250 m (17 in total) • CGPF = 600 x 250 m (5 in total) • IPF = 800 x 250 m + up to 1 km^2 for dams (3 in total)	Production facility area requirements: • FCF = 200 x 380 m (maximum size) (33 in total) • CGPF = 500 x 250 m + up to 0.6 km^2 for dams (2 in total) (dimensions are provisional, may vary following design review).
4.3.1.2 –Field Compression Facilities	Field compression facilities (FCFs) were to be installed to boost the gas pressure to enable transportation of the gas over long distances.	FCFs will be installed to boost the gas pressure and enable transportation of the gas over long distances. FCFs will also now include a water transfer station (WTS) to facilitate transfer of water from FCF to FCF en route to a CGPF.
4.3.1.2 – Field Compression Facilities	Previously electrical power was to be reticulated to an FCF from the nearest CGPF or IPF.	It is presently anticipated that electrical power will be reticulated to FCFs from a central location, which will be the CGPFs for Phase 1 of the development, and strategic FCFs for subsequent phases. An FCF will receive high voltage power via Arrow owned 66 kV distribution network from where the voltage is stepped-down to 11 kV for distribution to users within the facility and to wellhead facilities.

EIS Section	EIS Project Description	SREIS Description of Change
4.3.1.2 – Field Compression Facilities	At an FCF, water was to be received from the local production area gathering systems, collected in a storage tank, and pumped to the closest IPF.	At an FCF, water will be received from the local production area gathering systems, collected in storage tanks, and pumped to another FCF or to a CGPF, whichever is the closest.
4.3.1.3 – Central Gas Processing Facilities	Gas was to be compressed to reach a high pressure (10,200 to **15,000** kPag).	The gas will be compressed to reach high pressure (10,200 to **13,500** kPag).
4.3.1.3 – Central Gas Processing Facilities	A combination of **screw and reciprocating compression** was assumed as the reference case for the EIS.	**Centrifugal compressors** are proposed to be used as part of the SREIS case.
4.3.1.3 – Central Gas Processing Facilities	Gas flows at the Project's CGPFs were likely to range between **60** and **210 TJ/d**.	Peak installed capacity at the CGPFs is likely to be between **360 TJ/d to 450 TJ/d.**
4.3.1.3 – Central Gas Processing Facilities	The gas was to be received at the facility at a controlled pressure of approximately **40 kPag at the inlet manifold and 30 kPag at the suction to compression.**	The gas will be received at the CGPF from the FCFs at a controlled pressure of approximately **3,100 kPag at the inlet manifold and 3,000 kPag at the suction to compression.**
4.3.1.3 – Central Gas Processing Facilities	A slug catcher will separate any bulk water in the gas before it is directed to the first stage of compression.	Any bulk water in the gas is separated in a slug catcher before the gas is directed to the first stage of compression. Water collected at the slug catcher will be collected in the utility dam to avoid contaminating the WTF with the corrosion inhibitor.
4.3.1.3 – Central Gas Processing Facilities	At a CGPF, water was to be received from the local production area gathering systems, or from gathering systems of adjacent production areas via low pressure trunklines. The water was to be collected either in a utility dam or tank and pumped, via a WTS to an IPF.	At the co-located WTF, produced water will be collected, treated and then stored onsite for distribution to the end user, which may include, for example irrigation, mine wash water, water utility company or town water supply.
4.3.1.4 – Integrated Processing Facilities	IPF.	The term 'IPF' **is no longer being used for the SREIS case**. WTFs will now be co-located with the CGPFs not at the previously named IPFs.
4.3.2 – Production Well Development	Up to **6,625 production wells** were expected to be drilled throughout the Project area over the approximate 40 year Project life to maintain gas supply to the LNG plant.	Approximately **4,000 production wells** will be drilled throughout the Project area over life of the Project (approximately 40 years) to maintain gas feed to the LNG plant.

EIS Section	EIS Project Description	SREIS Description of Change
4.3.2 – Production Well Development Figure 4-6: Indicative SIS Well Schematic	Surface-in-seam (SIS) chevron wells in a dual lateral configuration were proposed to be used on a nominal 800 m grid pattern. Multi-seam hydraulically fractured: vertical, cased and cemented wells, which are perforated and fracture-stimulated to provide formation access. It was proposed that up to 25% of wells developed could potentially be hydraulically fractured.	Currently, development plans involve drilling and completion of MBLs as the base case well type, with a multi-seam hydraulically fractured well as a potential alternative: • Multi Branch Laterals (MBLs): multi branched horizontal wells drilled in-seam to intersect a vertical producer; and • Multi-seam hydraulically fractured: vertical, cased and cemented wells, which are perforated and fracture-stimulated to provide formation access. As with the EIS, it is proposed that up to 25% of wells developed could potentially be hydraulically fractured.
4.3.2 – Production Well Development	No reference in the EIS Project Description chapter (Section 4) to groundwater monitoring bores.	Groundwater monitoring bores in accordance with Arrow's statutory obligations
4.3.3.1 – Surface-in-seam Chevron Wells	A horizontal, SIS, dual-lateral in a chevron configuration. This design included two production laterals per well (and therefore requires that three holes are drilled, from three separate surface locations, to provide one "dual lateral producer").	The preferred well type is an MBL well, which will be grouped together on multi-well pads. A multi-well pad will be comprised of either 4 wells (2 vertical production conduits plus 2 lateral wells), 8 wells (4 vertical production plus 4 lateral) or 12 (6 vertical production plus 6 lateral) wells. See the Project Description chapter (Section 3.3.1) of the SREIS for further details on layout and configuration of wells.
4.3.3.1 – Surface-in-seam Chevron Wells	On a nominal 800 m grid pattern, an indicative density of one producer well per 160 to 320 acres (65 to 130 ha) was typically expected.	Wells will be clustered together onto common well pads, wherever practicable.
4.3.3.1 – Surface-in-seam Chevron Wells	During the drilling phase, each well pad was to occupy an area of 8,100 m^2 (90 by 90 m) such that for each SIS dual-lateral producer, the required collective well pad area (for the three separate pads) was to be 24,300 m^2.	During the drilling phase, the estimated multi-well pad area will be 130 x 175 m (4 wells pad), 130 x 235 m (8 wells pad) and 130 x 295 m (12 wells pad).
4.3.3.1 – Surface-in-seam Chevron Wells	Once the well is installed, the footprint was to be reduced to approximately 10 by 10 m such that for each SIS dual-lateral producer, the required collective well pad operational area (for the three separate pads) would be approximately 17 by 17 m.	The area required for drilling is only temporary; post drilling, the site can be rehabilitated down to the area required for the operational footprint. The estimated operational footprint is 100 m x 155 m (4 well pad), 100 m x 215 m (8 well pad) and 100 m x 275 m (12 well pad).
4.3.3.2 – Multi-seam Hydraulically Stimulated Vertical Well	During the drilling phase each well pad would occupy an area of approximately 8,100 m^2 (90 m x 90 m).	During the drilling phase each single-well pad may occupy an area of 16,900 m^2 (130 m x 130 m).

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EIS Section	EIS Project Description	SREIS Description of Change
4.3.5 – Power Generation and Distribution	Integrated power generation was presented as the preferred option to supply power to the production facilities in the EIS.	In this SREIS, integrated power generation is considered a temporary alternative if grid connection is not completed on time. Under this option, it is proposed to develop temporary power generation (electrical power) utilising CSG as a fuel source at selected CGPFs and FCFs as required for approximately two years of the initial development. See the Project Description chapter (Section 3.6) of the SREIS for the revised description of electricity supply for the Project.
4.3.7 – Water Treatment and Storage Facilities	Total associated water volume to be extracted over the life of the Project is estimated at approximately **264.3 GL (over 40 years)** Average production = **7 GL/a** Peak production = **10 GL/a**	Estimated total water produced is **153 GL** Average production = **4.25 GL/a (average is over 36 years)** Peak production = **10.4 GL/a**
4.3.7 – Water Treatment and Storage Facilities	The term 'IPF' was used in the EIS to describe the facility that would contain both gas compression and processing equipment and also a WTF. The EIS presented the following dam sizes (per WTF): • Aggregation dam – 600 ML; • Treated water dam – 600 ML; and • Brine dam (x2) – 960 ML.	For the SREIS, the term 'IPF' is no longer considered and the WTFs will be co-located with the two CGPFs with the potential of a third WTF to be constructed near Blackwater. As part of the SREIS reference case and for planning purposes, the following preliminary dam sizing (per WTF) has been adopted (based on a nominal facility throughput of 20 ML/d): • Associated water storage (feed) dam – 400 ML (providing a minimum of 20 days storage); • Clear (treated) water dam – 600 ML; and • Brine storage dam(s) – 1,800 ML.
4.3.10 – SCADA and Telecommunications	The High Speed Backbone Network (HSBN) was to interconnect the FCFs, CGPFs and the IPFs as well as extending where required into the well fields.	The HSBN will interconnect the FCFs and CGPFs as well as extending into the well fields.
4.3.10 – SCADA and Telecommunications	The HSBN was to be implemented by either buried fibre optic cable or microwave links. Fibre optic cables were also to be assessed for use within upstream facilities to reduce site cabling installations.	The HSBN will include buried Fibre Optic Cable and Microwave Radio links. Where practical, the fibre optic cables will be placed in the same easement as the low pressure gas gathering pipelines and medium pressure infield pipelines. Arrow communications tower specifications are for long term free standing towers. Arrow towers meet CAA guidelines. Depending on the geography they range in height from 65 to 100 m conceptually. It is estimated there would be 4 towers.

EIS Section	EIS Project Description	SREIS Description of Change
4.3.11.1 - Depots	Depots were proposed to be located at four IPF facilities – see Figure 4-9 of the EIS Project Description chapter (Section 4).	Depots (including storage yards) will be located adjacent to the two CGPFs.
4.3.11.2 – Accommodation Facilities	Accommodation for the construction and operation workforce of the Project was expected to include a combination of temporary workforce accommodation facilities and permanent housing. These accommodation facilities were expected to be located in the vicinity of an IPF.	It is currently envisaged that purpose-built accommodation will be constructed as follows: • Two main villages located near the CGPFs. • To reduce driving distances and its associated risks, several smaller temporary villages (currently estimated to be four) are expected to be required when the facilities associated with the drainage area furthest away from the CGPFs are under construction. As the majority of the operation and maintenance personnel are expected to be sourced from outside the Project area, accommodation villages co-located with the Central Operating Bases will be built to house the Project personnel. See the Project Description chapter (Section 3.9) of the SREIS for details on the revised workforce and accommodation strategy.
4.3.11.3 – Borrow Pits	The Project construction and operations activities will require foundation aggregate for construction of camps, roads and production facilities.	The Project construction activities will require crushed rock, gravel, sand and soil for construction of roads and tracks, production facilities and accommodation camps. The materials will be purchased from commercial quarries and / or borrow pits on Arrow land will be developed.
4.3.11.3 – Borrow Pits (Concrete)	No mention in EIS Project Description of concrete.	Concrete required for the construction of the facilities will be sourced from local suppliers. Temporary batching plants will be established as necessary for areas that are remote from fixed plants.
4.3.12 - Workforce	Peak total Project workforce was expected to occur in September 2016 with 1,760 personnel. Two smaller peaks were expected to occur in December 2019 with 1,342 personnel and in May / June 2046 with 1,300 personnel.	The daily construction workforce is expected to peak at around 2,450 personnel in 2018. From 2017 to 2019 the average daily workforce is expected to be over 1,000 personnel which coincides with the construction of the two CGPFs and the Phase 1 FCFs. The average daily construction workforce will reduce to around 500 to 900 personnel from 2020, after which it will further reduce to 400 or less personnel from 2028 onwards.

EIS Section	EIS Project Description	SREIS Description of Change
4.3.13 – Workforce Accommodation	Workforce accommodation was assumed to be co-located with the IPFs.	It is currently envisaged that purpose-built accommodation will be constructed as follows: • Two main villages located near the CGPFs. • Several smaller temporary villages (currently estimated to be four) are expected to be required when the facilities associated with the drainage area furthest away from the CGPFs are under construction See the Project Description chapter (Section 3.9) of the SREIS for details on the revised accommodation strategy.
4.4 – Development Planning	For the purpose of the EIS, production facility locations were assumed to be located somewhere near the centre of each development area (**17** in total) of **12 km radius**. The indicative layout of production facilities across the Project area were presented in Figure 4-4 of the EIS Project Description (Section 4).	Due to expected low gas pressures, as a result of the preliminary engineering undertaken in the concept select phase, the number of development (or drainage) areas has increased to **33** in total, however; each of these drainage areas now represent a **6 km radius** catchment area for gathering well production (gas and water), and distributing to surface production facilities located at or near the centre of drainage area. These 33 drainage areas will be developed over the Project life, however; Arrow does not expect all facilities to be operating together at one single time. The number and location of development areas has been revised – this influences the indicative location of facilities. See the Project Description chapter (Section 3.2) of the SREIS for details on the revised development planning and sequencing for the Project.
4.5 – Development Sequence	**14** development regions were presented in the EIS.	The overall Project development area has been sub-divided into **9** development regions. See the Project Description chapter (Section 3.2) of the SREIS for details on the revised development planning and sequencing for the Project.
4.6 - Construction	No outline of pipeline crossing construction techniques	The SREIS case presents three options for pipeline crossings depending on the nature of each specific crossing: • Open cut; • Horizontal directional drilling; and • Bored. See the Project Description chapter (Section 3.7.6) of the SREIS for detailed on the types of construction for pipeline crossings.

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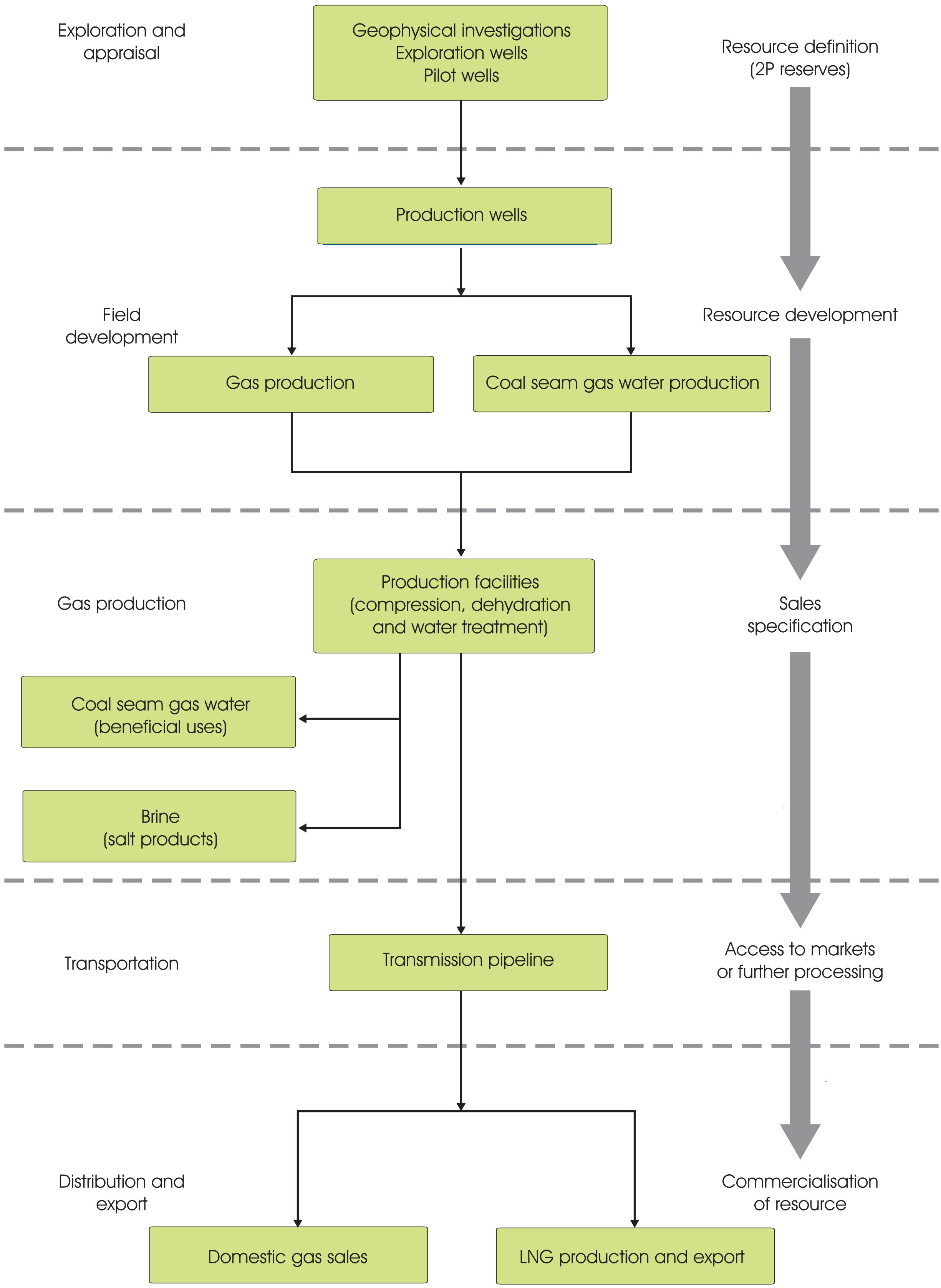
EIS Section	EIS Project Description	SREIS Description of Change
4.6.1 – Construction Schedule	Project was to commence production from the first phase of facilities in January 2017, with facilities construction required in the 2015 to 2016 period, and initial well drilling **commencing in 2016**.	The Project will commence production from the first phase of facilities in January 2018, with facilities construction required in the 2016 to 2017 period, and **initial well drilling potentially commencing in 2015.**
4.6.2 – Production Wells and associated and linear infrastructure / access roads	Production wells were to be installed progressively throughout the Project life, **starting in 2016**.	Production wells will be drilled progressively throughout the Project life, **potentially starting in 2015** and ending in 2041.
4.6.2 – Production Wells	Production wells (construction).	See the Project Description chapter (Section 3.3 and 3.7.2) of the SREIS for details on construction for revised well types.
4.6.2 – Production Wells	Well site completions	Additional information incorporated. See the Project Description chapter (Section 3.7.2) of the SREIS for additional information on well completions.
4.6.3 – Gathering Systems	Trenching	Additional information incorporated. Plough-in is also being considered as a construction method for gathering systems as part of the SREIS reference case (this was not considered in the EIS). See the Project Description chapter (Sections 3.7.3.1 and 3.7.3.2) of the SREIS for further details on trenching and plough-in.
4.6.4 – Production Facilities	No mention of off-site pre-fabrication and assembly.	In order to minimise the site construction activities, off-site pre-fabrication and assembly will be used to the maximum practicable extent.
4.6.6 – Power Generation Facilities	Power generation facilities were to be located within the production well sites and production facility sites and the subsequent construction methods are similar to those described for construction of production facilities.	This SREIS reference case is based on electrical power being predominantly used to drive the upstream equipment located at each of the facilities. This is the preferred approach, however; Arrow has included an option for temporary gas powered generation for approximately two years of the initial Project development in the case connection to the national grid is delayed. In specific cases, power for remote wellheads may be generated on-site by gas fired engines during the Project life. It is proposed that up to 10% (400) of all wells may potentially be gas powered due to being unfeasible to connect to powerlines See the Project Description chapter (Section 3.6) of the SREIS for details on construction of transmission lines and the distribution network.

EIS Section	EIS Project Description	SREIS Description of Change
4.6.7 – Construction Workforce	A peak construction workforce of approximately **1,540 personnel** was expected to occur in 2016, when three IPFs in Area 4, Area 5 and Area 7 and one CGPF in Area 6 were to be constructed.	The daily construction manpower is expected to peak at around **2,450 personnel** in 2018.
4.7.3 – Production Facilities	The operational life of a production facility was expected to be approximately **30 years**.	The CGPFs are expected to be suitably maintained and overhauled so as to operate for the full Project life. The FCFs will typically have an operational life of between 15 and 25 years each.



Source: Client supplied data

BOWEN GAS PROJECT SREIS

PROJECT DEVELOPMENT ACTIVITIES

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **3-1**

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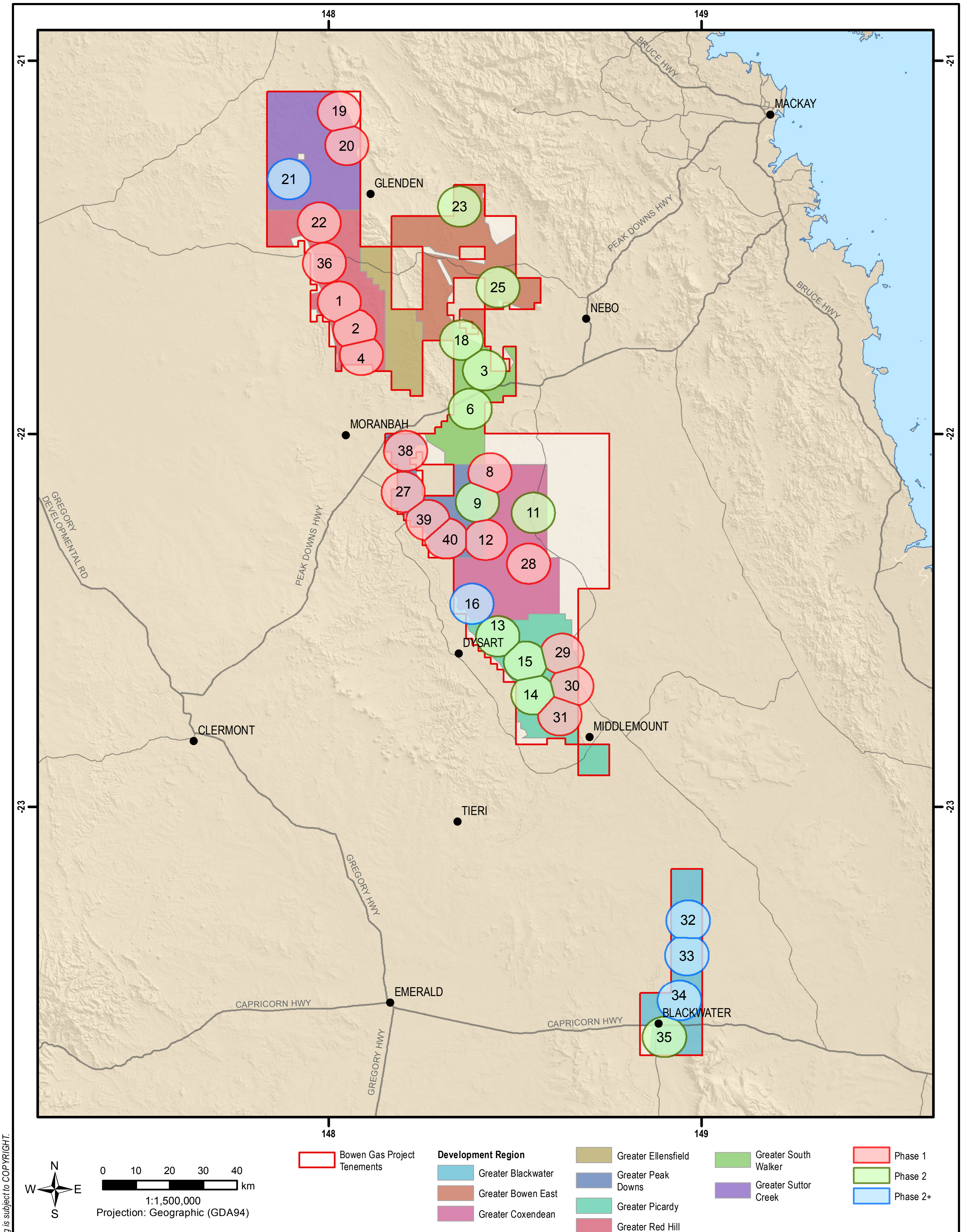

Source: Client Supplied Data; Roads and Locations from MapInfo Streets Pro, 2011; Topography sourced from Hole-filled seamless SRTM data V4, CIAT

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BOWEN GAS PROJECT SREIS

INDICATIVE PROJECT LOCATION AND DEVELOPMENT AREAS

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: 3-2

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A number of sections within the SREIS Project Description chapter (Section 3) describe in full detail the revisions to the Project listed above, including:

- Revised Development Planning and Sequencing (Section 3.2);
- Change to Number, Type and Layout of Wells (Section 3.3);
- Water Treatment Facilities (Co-located with CGPF) (Section 3.4);
- Revised Strategy for CSG Water Management (Section 3.5);
- Changes to Supply of Electricity (Section 3.6);
- Changes to Construction Techniques (Section 3.7);
- Operations and Maintenance Changes (Section 3.8); and
- Changes to Workforce and Accommodation Strategy (Section 3.2).

3.2 Major Infrastructure Components

Arrow will divide the Project area into a number of development areas, with timing of the development of each of these areas sequenced to meet production targets. Each development area will include:

- A production facility - which may be a:
  - FCF – a gas pressure boosting station to allow onward transport of remotely located gas to a CGPF and pumping of water to a CGPF; and
  - CGPF – to treat (dehydrate) and compress the gas to export pressure. CGPFs will also be co-located with a WTF;
- Production wells – to access the coal seams and evacuate in-situ water and CSG;
- Field gathering systems – low and medium pressure pipeline networks to gather water and gas to a production facility;
- Access roads;
- Power distribution facilities and possible temporary power generation at facilities; and
- Monitoring and telecommunication facilities.

The following key project components have been identified as having potential impacts to MNES.

3.2.1 Central Gas Processing Facilities

EIS Project development planning featured IPFs in addition to the CGPFs. The total area for each IPF was estimated at 120 ha. The CGPFs (without WTFs) at the EIS stage were 15 ha in size.

Current Project development has CGPFs (with WTFs) replacing IPFs (this term is no longer used). Current Project planning has each CGPF at up to 72.5 ha (including 60 ha for a WTF).

This equates to an approximate decrease of 62.5 ha for each facility due to the combination of a WTF and CGPF.

The changes to the numbers of CGPFs as presented in the EIS base case versus the updated SREIS project description are shown above in Table 3-1.

3.2.2 Field Compression Facilities

Due to the low wellhead pressures in the Bowen Basin, FCFs will be installed to boost the gas pressure to enable the transportation of the gas over long distances. FCFs will also include a WTS to facilitate transfer of water from FCF to FCF en route to a CGPF.

EIS planning estimated that each FCF was to be 200 by 250 m, or 5 ha. Current Project planning has the largest FCFs at 200 x 380 m or 7.6 ha. This equates to an increase of 2.6 ha for the largest of the FCF facilities. The largest FCF footprint has been used to provide a worst-case scenario.

Changes to the numbers of FCFs as presented in the EIS and SREIS are shown above in Table 3-1.

3.2.3 Wells & Well Pads

As reported in the EIS, up to 6,625 production wells were to be drilled throughout the Project area over the approximate 40 year Project life. The current planning for a conceptual development footprint is for approximately 4,000 production wells to be drilled throughout the Project area over life of the Project. This entails a reduction in the order of 2,625 wells from the original estimate.

In addition to reducing the number of wells, by positioning multiple wells on one well pad, the number of well pads has been reduced. The updated Project Description (Chapter 3 of the SREIS) introduces the use of multi-well pads with up to 12 wells being constructed on a single Pad.

The pad sizes and number of wells per pad has been standardised to facilitate construction. These standardised well configuration footprints are presented in Table 3-2 below. The table presents the footprint of each well pad configuration during the drilling and construction phase, after which, the size of the well pad is reduced for operations. More detail on the well pad configurations is provided in Section 3.3 of the Project Description Chapter of the SREIS.

Table 3-2 SREIS Multi-Well Pad Disturbance Footprint

Well Pad	Disturbance Footprint
4 wells (2 vertical production + 2 lateral)	130 m x 175 m (22,750 m^2)
8 wells (4 production + 4 lateral)	130 m x 235 m (30,550 m^2)
12 wells (6 production + 6 lateral)	130 m x 295 m (38,350 m^2)

This reduction in well numbers and well pads translates to a decrease in the amount of land disturbed for wells and construction of associated linear infrastructure such as trunk lines, gathering lines and access tracks. As the multi-well pads consolidate a group of wells at one surface location, targeting multiple coal seams, they will typically result in:

- A reduction in the total number of well pad sites;
- A reduction in the individual pad area required per well;

- A reduction in the number of gathering lines, resulting in a significantly reduced construction and disturbance footprint; and
- Increase the average distance between any two well sites.

The project design changes since the EIS to the conceptual development footprint have resulted in a decrease to the project disturbance footprint as outlined below in Table 3-3.

Table 3-3 EIS & SREIS Estimated Maximum Disturbance Areas of the Conceptual Footprint

Infrastructure	EIS		SREIS	
	Number	Disturbance	Number	Disturbance
Wells (production + lateral)	6,625	16,098 ha	4,000	5,977 ha
Linear Infrastructure	7,287.5 km*	18, 219 ha	3,494 km	8,734 ha
FCF	17	85 ha	33	251 ha
CGPF	5	75 ha	2	25 ha
IPF	3	320 ha	NA	NA
WTF	NA	NA	2	120 ha

* based on an estimated average length of gathering line and associated infrastructure per well.

Due to the nature of CSG development, the specific construction footprint for the life of the Project is still to be determined. A layout has been designed for Phase 1 of the Project which has been used to also estimate the potential disturbance limit for the life of the Project. The disturbance limits calculated are a conservative maximum disturbance estimate and it is highly anticipated that the likely actual disturbance during the Project will be lower than those impacts estimated. In addition to this built in conservativeness to the maximum disturbance calculations, disturbance impacts are likely to be further reduced by the mitigation commitments for site scouting and avoidance of impacts where possible at the planning and pre-construction stages.

3.2.4 Well Designs

Multi Branch Lateral Wells

Traditionally, vertical wells are used in CSG developments whereby a single well is drilled vertically from the ground surface to the target coal seams. The Arrow SREIS base case design is a surface-in-seam, MBL type well (see Figure 3-3).

In CSG developments the term “lateral” is primarily used to describe “in-seam” drilling, where a well trajectory is maintained within a generally horizontal single coal seam.

A ‘lateral’ well is drilled from one well pad to the target coal seam and then geo-steered in-seam to intersect a previously drilled vertical production well at the corresponding mirrored well pad[1]. After intersecting the vertical production well, a number of open-hole ‘side-tracks’ (laterals) are constructed (see Figure 3-3). This horizontal well provides a pathway for both gas and water to drain and enter the vertical well. The vertical well acts as a production conduit for pumping gas and water to the surface.

[1] Note, there are lateral wells on each well pad drilled in opposite directions to each corresponding vertical production well.

The multi-branch configuration significantly improves reservoir drainage whilst reducing the requirement for dedicated horizontal holes drilled from the surface (i.e. reducing the development surface footprint).

All horizontal well sections are completed either open-hole, or with a slotted composite liner. The production section of the vertical well is generally under-reamed, exposing the coal formation; a tubing-conveyed artificial lift system will be installed below this interval to facilitate water production to surface.

Each well pad for the development scenario will be a multi-well pad (i.e. more than one well per pad). A well pad will consist of both lateral and production wells and will be mirrored by an additional well pad (with the same number of wells) 400 m apart (see Figure 3-3).

At multi-well pad sites, each producing well will have an artificial lift system (pump) and production control and metering skid. It is envisaged that the wells will be aligned at the surface in a row.

For the SREIS case the pad sizes and therefore number of wells per pad has been standardised to facilitate construction and includes the well configurations as presented in Table 3-4 below. The table also presents the estimated footprint of each well pad configuration during both the drilling and operational stages.

Table 3-4 SREIS Well Configurations

Well Pad	Drilling Footprint	Operational Footprint
4 wells (2 vertical production + 2 lateral)	130 m x 175 m (22,750 m^2)	100 m x 155 m (15,500 m^2)
8 wells (4 production + 4 lateral)	130 m x 235 m (30,550 m^2)	100 m x 215 m (21,500 m^2)
12 wells (6 production + 6 lateral)	130 m x 295 m (38,350 m^2)	100 m x 275 m (27,500 m^2)

The area required for drilling is only temporary; post drilling the site can be rehabilitated down to the area required for the operational footprint. This estimated operational footprint includes erosion and sediment control buffer and may be reduced further between return rig visits for well intervention / well maintenance dependent on individual well access requirements.

As the multi-well pads consolidate a group of wells at one surface location, targeting multiple coal seams, they will typically thus allow:

- A reduction in the total number of well pad sites;
- A reduction in the individual pad area required per well;
- A reduction in the number of gathering lines, resulting in a significantly reduced construction and disturbance footprint; and
- Increase the average distance between well sites.

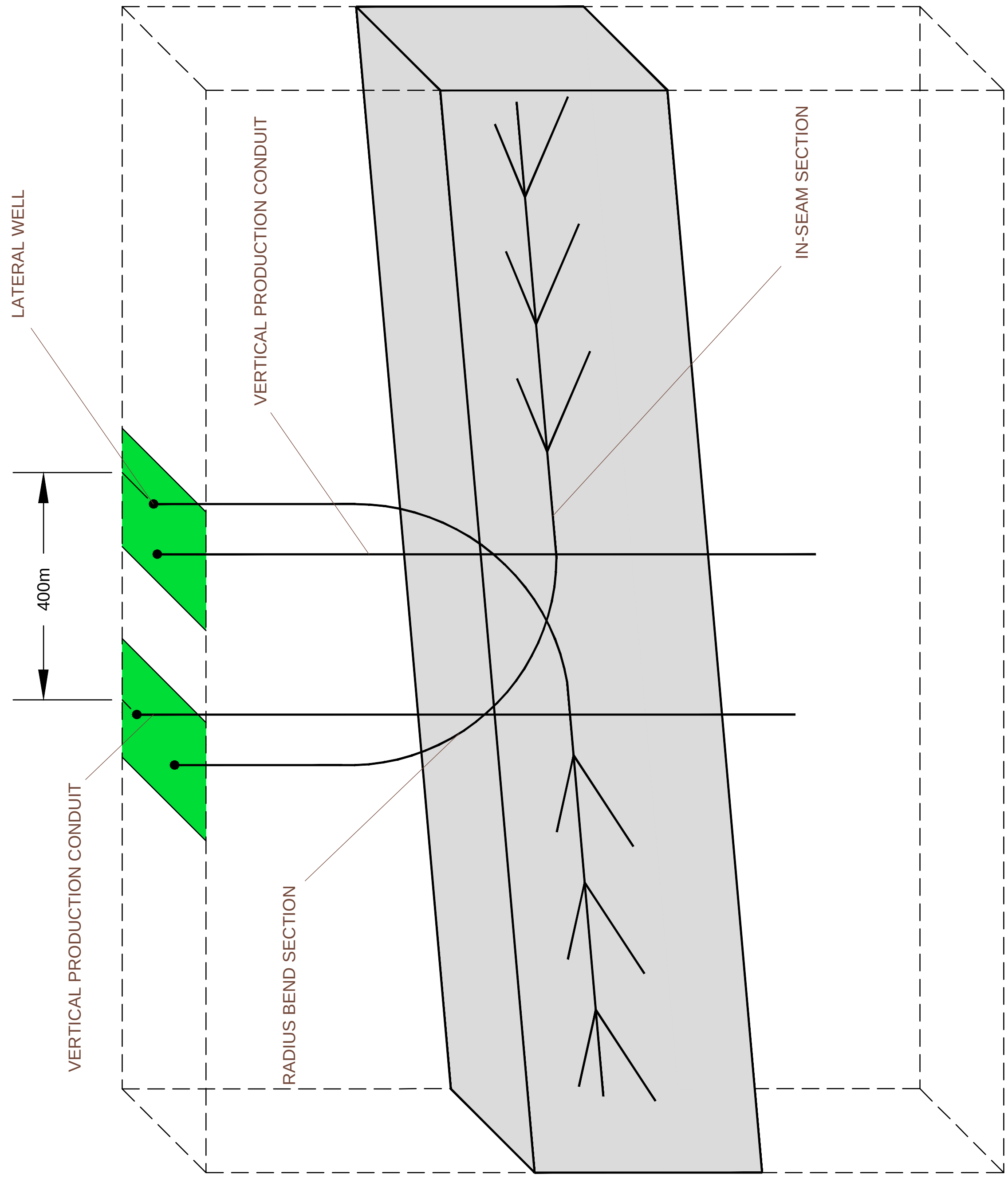
Production wells are typically drilled to between 150 m to 800 m in depth. To prevent the loss of water from any upper groundwater aquifers that may be intersected, the top section of each well is cased with steel and cement.

Multi-seam Hydraulically Stimulated Vertical Well

If required, up to 25% of wells may be developed utilising hydraulic stimulation. If this occurs it would only be in the latter stages of the Project development. Further assessment of hydraulically stimulated wells would be presented as part of the EA approvals process. This would include development of a site specific execution plan for hydraulic stimulation near known faults detailing: well numbers, type and location; number of multi-seamed wells to be constructed; grid spacing, potential for multiple simulation events; and details of storage facilities. It should be noted that the well pad dimensions presented in this document are specifically for the MBL well type and may need to be revised to accommodate hydraulic stimulation operations.

Associated Linear Infrastructure

The change from single-well lease pads to multi-well lease pads has allowed a reduction in the disturbance caused by the Project. By reducing the number of well pads, not only has the total area for required well pads been reduced, the number and length of gathering lines has also been significantly reduced (see Table 3-2 and Table 3-3) All associated linear infrastructure will be designed to be co-located in the same easement wherever practical.



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BOWEN GAS PROJECT SREIS

WELL PAD LAYOUT CROSS-SECTION

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: 3-3

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3.2.5 *Water Treatment Facilities (Co-located with CGPF)*

The term IPF is no longer being used by the Project. WTFs for the treatment of CSG associated water, storage of brine, and temporary storage of treated waters will be located adjacent to the CGPFs. Treated water will be provided where possible to a beneficial use.

It should be noted that the preferred disposal method of waste salt concentrate from the Projects brine storage dams will be to landfill and is not expected to commence until approximately 30 years after commencing water production.

Produced water from each drainage area will be directed, after degassing, to a feed water dam adjacent to each WTF. The feed dam is an important part of the treatment process as it allows for surge capacity, sediment settlement, homogenous mixing, liberation of residual volatile compounds and oxidation of some organics and metals.

From the feed water dam, water will be transferred into the pre-treatment stage of the WTF. Reverse osmosis (R.O.) technology is currently being considered as the most appropriate treatment process coupled with some form of suitable pre-treatment such as membrane or media filtration and hardness removal. Investigation and evaluation of new and emerging technologies will continue to determine applicability to operations based on economics, energy consumption, brine recovery, regulations and operational and environmental footprint of the associated technology.

Treatment will produce appropriate quality water for beneficial reuse and will be stored in treated water dams prior to being distributed to end-users in the local area.

Disposal of CSG water to water courses may be necessary when beneficial use options are not economically or technically feasible, or in the case of residual volumes which are those volumes of CSG water that cannot be feasibly managed through beneficial use due to operational, technical, environmental or economic constraints. Brine from the WTF will be discharged into concentrated brine dams where salt will concentrate through the evaporation process before it is suitably disposed of in registered landfills.

As part of the SREIS project description and for planning purposes, the following preliminary dam sizing (per WTF) has been adopted (based on a nominal facility throughput of 20 ML/d):

- Associated water storage (feed) dam of 400 ML;
- Brine storage dam(s) of up to 1,800 ML; and
- Clear (treated) water dam of up to 600 ML.

These sizes will be examined in more detail to account for optimisation, specific site conditions and parameters for each region.

All dams will be designed in accordance with regulatory requirements, including monitoring equipment, metering, level indicators and telemetry.

Other infrastructure associated with the water treatment and storage facilities will comprise:

- Transfer pipelines and associated pumps and controls to provide interconnection between the WTFs. The linking of facilities will provide additional flexibility to cope with variations or spikes in water production; and

- A network of distribution pipelines to convey treated water to end users. There will be a practical limitation on the distance water can be transported using this type of system. The network location and its extent will be dependent on location(s) of the end users.

3.2.5.1 *Brine and Salt Management*

Brine is a significant by-product of the water treatment process and requires specific measures to manage its storage and subsequent use or disposal. CSG water quality varies across the Project development area from high-quality water to highly saline water. Assuming an average salt concentration of 4,500 mg/L, Arrow expects that treatment of CSG water will generate in the order of 4.5 t of salt per megalitre of CSG water treated. Figure 3-4 presents the brine management options and the expected average and peak annual volumes of brine production.

A range of management options for end use or disposal of brine and salt were considered, including:

- Beneficial Use (Selective Salt Recovery);
- Disposal to a Regulated Waste Facility (Suitably-licensed Landfill);
- Injection into a Suitable Formation; and
- Discharge (Ocean Outfall).

Arrow has evaluated these options in a systematic and transparent multi-criteria assessment (MCA) process (see the Arrow CSG Water and Salt Management Strategy (Appendix D) of this SREIS). Disposal to a Regulated Waste Facility has been identified as the preferred option.

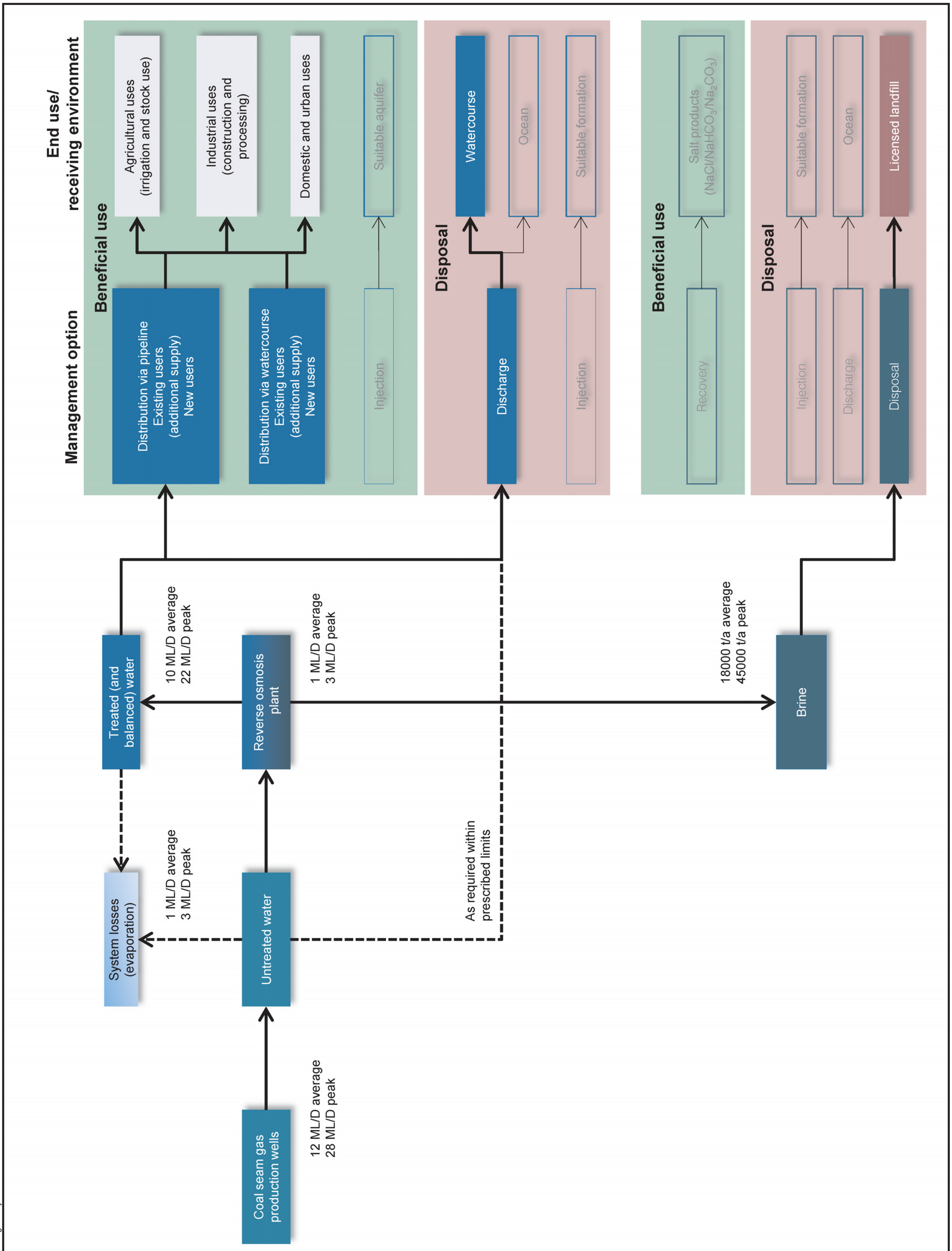
As presented in the EIS, the base case for brine management for the Project consists of disposal to a RWF. Brine produced as part of the CSG water treatment process would be piped to brine dams, located near each of the three proposed WTFs. Crystallisation would take place via conventional solar evaporation. Once the brine has evaporated to a solid product, it would be transported to the RWF.

It should be noted that disposal of the waste salt concentrate to landfill is not expected to commence until approximately 30 years after commencement of water production.

For the purpose of assessing the maximum expected vehicle movements (and associated vehicle emissions), the EIS assumed transport to and disposal of this waste salt concentrate at Townsville. However, Arrow is looking to encourage other suitably licensed landfill sites to be developed locally in response to the demand created by the CSG industry and to be available to accept brine (as a salt concentrate) produced in its operations and as such reduce vehicle movements.

As a possible optimisation, enhanced evaporation options, applying thermal, chemical and/or mechanical assistance to reduce storage requirements, will be considered.

Disposal of salt will not be required until later in the life of the Project. Further information on disposal of brine and salt is presented within the Project Description chapter (Section 3) of the SREIS.



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BOWEN GAS PROJECT SREIS

CSG WATER AND SALT MANAGEMENT OVERVIEW

3.3 Development Planning

As discussed at the beginning of this chapter, development of the CSG field and production facilities will be progressive, extending in a phased approach over the life of the Project. This is because the yield from the target coal seams is variable across the gas field leading to uncertainty about the precise number, timing and location of wells required to extract the gas from the coal seams.

The Project's assessment and approval process reflects this phased approach to the CSG field development. As the Project progresses the phased approach requires more detailed information to inform decisions about the Project's ongoing development, under what controls, whether requisite environmental authorities and permits should be granted, and under what conditions.

An EA under the EP Act is required to commence construction and operation on a petroleum lease (PL). The EA sets out the detailed conditions under which a project must be constructed and operated within a PL. Detailed information is required to enable an application to be assessed and is typically presented in an Environmental Management Plan (EM Plan).

Arrow will have a valid EA before a PL can be granted by Queensland Department of Natural Resources and Mines (NRM). An initial development plan, which typically covers the first five years of development, will be submitted with the application. The initial development plan will contain detailed information about the nature and extent of activities to be carried out under the lease within the specified time period. Subsequent development plans will be required to provide detailed information about the development of further PLs.

Arrow proposes to stage its applications for PLs and the associated environmental authorities (or amendments to existing environmental authorities) throughout the Project life, as additional PLs are required to support ongoing gas field development. Development plans will be prepared for each stage of the Project and will be guided by the results of exploration, previous operational experience, and environmental and social constraints.

A typical development plan will include (but not be limited to) the following:

- The exploration and appraisal history and status;
- Geological and reservoir modelling and subsurface development schemes;
- The number of wells to be drilled, their location, sequencing and spacing to meet the required production rates;
- The location, quantity and size of production facilities;
- The quantity of water produced and subsequent treatment and storage requirements;
- The pipeline networks needed to transport gas and water;
- The high-level operations philosophy for the field layout;
- Capital and operating expenditures as well as schedule estimates; and
- Risk and opportunity register.

Environmental and social design specifications relevant to the Project have been included in the Constraints Mapping report (Appendix BB) of the EIS, which forms the basis of the framework established by Arrow to address the current uncertainty about the location of infrastructure. The framework approach allows Arrow to analyse potential constraints during detailed planning and consists of constraint maps and environmental controls that will inform site selection and the preparation of development plans, as well as the environmental management of construction, operation and decommissioning activities. Further details on the framework approach and constraints mapping are provided in Section 4.

3.3.1 Environmental and Social Constraints

Development planning within the Project area is also guided by potential environmental and social constraints. Environmental and social constraints have been considered in the preliminary design of the Project from which potential impacts were assessed in the EIS. Arrow's HSEMS includes a number of design specifications (Table 3-5) that aim to minimise environmental and social impact, and hence inform the development plans.

Table 3-5 HSEMS Design General Requirement

Aspect	Design Specification
Air Quality	• Reduction of nitrogen dioxide emissions through selection of low NO_x gas engines for power generation; and • Minimisation of flaring by selling ramp up gas to domestic markets.
Greenhouse Gas	• Reduction of greenhouse gas emissions through selection of high-efficiency drivers for compressors; and • Minimisation of greenhouse gas emissions through the use of flares rather than venting at facilities.
Geology, Landform and Soils	• Avoid unstable slopes where possible, or design to address slope and soil stability issues.
Groundwater	• Avoid natural springs; and • Construct dams using material capable of containing the water and brine.
Surface Water	• Avoid wetlands.
Ecology	• Avoid Category A* ESAs; • Avoid national parks; • Avoid wetlands (e.g., Lake Vermont); • Minimise construction footprint through centralisation of WTFs; and • Minimise construction footprint through placement of gas and water gathering lines within the same trench.
Social	• Manage impacts on local communities through the construction phase by using FIFO workforces and accommodating them in camps. Maximise employment of local people and minimise FIFO arrangements for operations. • Avoid locating wells and infrastructure within 200 m of sensitive receptors.
Cultural Heritage	• Avoid significant heritage sites.
Hazard and Risk	• Fire and gas detection systems; • Emergency shutdown systems; • Emergency pressure release systems; and • Fire suppression systems in high-risk locations.

*Category A ESAs are all areas designated as national park under the NC Act as well as conservation parks, forest reserves, and the Wet Tropics World Heritage areas.

3.4 Development Sequence

Arrow will stagger the development of each resource area to sustain the required production rate, and may vary the rate of development subject to the LNG Plant demand. Production well installation, facility construction, operation, decommissioning and rehabilitation will therefore occur concurrently at different locations throughout Project life.

The life of a production well will vary in accordance with the density of wells, the gas extraction rate and the production performance of the well. Modelling of well life is based on probabilities and averages and Arrow's current modelling suggests an average well life of 15 to 20 years. Once the wells cease production, the well sites will be decommissioned and rehabilitated and new wells will be established either in the same gas field or in a new development area.

3.4.1 Development Areas

Field development has advanced since publication of the EIS, with the overall Project development area now being subdivided into nine development regions to enable a phased approach to exploration; appraisal, piloting and development. These development regions have been further separated into 33 smaller drainage areas (Figure 3-2).

The 33 drainage areas are presented in Figure 3-2 as circles. Each of these circles represents a 6 km radius catchment area for gathering well production (gas and water) to surface production facilities located at or near the centre of each circle. Each of these centrally located surface production facilities will be an FCF (therefore 33 in total).

Across the lifecycle of the Project, the planning basis is that two CGPFs will be installed, which will both treat the gas for pipeline specification and will be co-located with WTFs to treat the produced water for onward use. One CGPF will serve the drainage areas in the north, whilst the second will service the drainage areas in the south of the Project area. A third WTF in the Blackwater region is being considered by Arrow.

Facilities to be constructed within the drainage areas include:

- Wells;
- Wellhead facilities;
- Low pressure water and gas gathering systems;
- FCFs (to boost the gas pressure for export to the CGPF);
- WTS (to pump the water for transfer from the FCFs to the CGPF);
- Medium pressure infield pipelines (to transport the gas from the FCF to the CGPF); and
- Infrastructure required for power distribution.

The first development phase of the Project targets the highest confidence regions. It is currently expected that 17 drainage areas will be developed during Phase 1 (year 0 to year 5 of production). In addition, both CGPFs and their co-located WTFs will also be developed in Phase 1.

Development of 11 drainage areas is expected during Phase 2 (year 6 to year 10 of production) with the remaining five drainage areas being developed in Phase 2+ (year 11 onwards).

The current development sequence is a preliminary layout, and may be revised as Project understanding matures. As studies progress and further exploration, appraisal, pilot and production data becomes available; it is possible that the currently proposed development sequence will be revised. However, any such alternative or additional areas will be developed in a similar manner and using the same or similar facilities building blocks as described within this section.

Environmental constraints mapping (Constraints Mapping report (Appendix BB) of the EIS) is being utilised by the Project development team for planning and site selection activities of all facilities and infrastructure beyond the conceptual stage.

4 ENVIRONMENTAL FRAMEWORK

Arrow uses an environmental framework to reduce the uncertainty about potential impacts of CSG development. This is done by identifying environmental constraints and proposing environmental management controls that will apply to development in a particular area. The environmental framework ensures planning and development of CSG fields will occur with consideration of environmental, social and cultural constraints commencing at the outset, during the planning and preliminary design phase.

In order to establish an environmental framework for the Project, it is first necessary to identify the environmental and social values associated with the Project area. Environmental values are identified during a number of technical specialist assessments of the potential impacts associated with the design, construction, operation and maintenance and rehabilitation of the proposed Project.

This section outlines how the environmental framework approach has been applied to the Project. The framework approach was developed for Arrow's Surat Gas Project EIS (Arrow, 2011) and has also been adopted for this EIS.

A key premise of environmental impact assessment is that the location, type, scale and duration of development is known; thus enabling the assessment of impacts from proposed construction, operation and maintenance activities on the environmental values at that place, at the nominated time. However this approach is not suitable for CSG field development projects.

For the proposed Project, development of the CSG field and production facilities will be progressive, extending over the life of the Project which is approximately 40 years. Unlike conventional gas resources, CSG resources are extensive, requiring widespread field development to recover the resource. The yield from target coal seams is variable across the gas field. This leads to uncertainty about the precise number, timing and location of wells required to dewater the coal seams and extract the gas.

This lack of certainty about the preferred location of infrastructure is an issue for the EIS because the detailed impacts at any specific location cannot be fully determined. However, they have been described in the EIS based on the typical impacts of CSG project activities. With that knowledge, greater certainty about potential impacts has been achieved by identifying those areas that are not amenable to certain types of development and if they were developed, how development should proceed. This has been achieved through the identification of constraints to development and the establishment of environmental management controls that will apply to Project activities in constrained areas.

As stated above, the EIS has not been able to consider the exact locations of all wells, pipelines and other associated infrastructure for the entire Project life. However, as required under the EP Act, the EIS does provide enough information about the impacts of the Project to enable the administering authority to decide whether the Project should proceed and, for the purposes of the bilateral assessment for the EPBC Act process, to provide the Commonwealth Environment Minister sufficient information to make a decision about the Project.

The siting of CSG infrastructure for this Project is a process of progressive refinement informed by exploration, resource validation, gas field design and environmental assessment to optimise the recovery of economic reserves. It has commenced with the development of a base case or conceptual layout that describes how wells, gathering systems and production facilities might be arranged to extract and process gas (refer to Section 3). The base case has informed the assessment of impacts given in the EIS and it represents the estimated maximum disturbance scenario in terms of impact assessment.

As discussed above, the inherent nature of CSG development has resulted in the approach adopted for this Project being the identification of constraints to development and the establishment of environmental management controls that should apply to Project activities in constrained areas. Known as the environmental framework, this approach is a process developed by Arrow for managing impacts in the planning phase and in the construction and operation phases through the application of environmental controls that reflect the sensitivity or vulnerability of environmental values.

Constraints mapping, an integral part of the environmental framework, is informed by the environmental impact assessment and guides site and route selection that seeks to avoid and minimise impacts, thereby protecting environmental values.

Sections 4.1 to 4.3 explain the application of the framework approach to the EIS, and how the environmental framework will integrate with Arrow's HSEMS.

4.1 Objective of Environmental Framework

The principal objective of the environmental framework is to inform the Project planning and design in the protection of environmental values within the Project area (as defined in government policies and regulations or as an attribute of the environment that is conducive to ecological health, public amenity or safety). Further, the environmental framework identifies appropriate environmental management controls for Project activities, having regard to the constraints imposed by the environmental values.

Implementation of the environmental framework will enable Arrow to:

- Address uncertainty regarding potential impacts of the location and timing of Project infrastructure development, through consideration and avoidance of constrained areas during detail planning and design;
- Identify constraints to CSG development in the Project area, having regard to the sensitivity of identified environmental values;
- Document the constraints through mapping or the establishment of guidelines (including buffers, thresholds and trigger levels) to inform site and route selection for CSG infrastructure;
- Develop environmental management controls to address the identified constraints; and
- Integrate the environmental framework with the HSEMS.

The framework approach ensures that planning and development of CSG fields will occur in an orderly manner, applying environmental management controls (avoidance, mitigation and management) that reflect of the level of sensitivity of environmental values.

4.2 Constraints Development

Current state government and Commonwealth government approvals granted for CSG projects within the region were reviewed to understand the values and conditions that have been of consideration to regulatory bodies.

In the environmental authorities for recently approved CSG projects, petroleum activities have been separated into three categories:

- Low impact petroleum activities;
- Essential petroleum activities; and
- Petroleum activities.

'Low impact petroleum activities' have been defined as: 'essential petroleum 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 (e.g. soil surveys, topographic surveys, cadastral surveys, ecological surveys and traversing land by car or foot via existing access tracks or routes or in such a way that does not result in permanent damage to vegetation).

'Essential petroleum activities' are defined as activities that are essential to bringing the resource to the surface and are only the following:

- Low impact petroleum activities;
- Single well sites not exceeding 1 hectare disturbance and multi-well sites not exceeding 1.5 ha disturbance;
- Associated infrastructure located on a well site necessary for the construction and operations of wells:
  - water pumps and generators;
  - flare pits;
  - above ground containers and chemical / fuel storages;
  - sumps for residual drilling material and drilling fluids;
  - dams to contain stimulation flow back waters that are not significant or high hazard dams;
  - erosion and sediment and control structures;
  - pipe laydown and vegetation stockpile areas; and
  - a temporary camp associated with a drilling rig that may involve sewage treatment works that are not release works;
- Communication and power lines that are necessary for the undertaking of petroleum activities and that are located within well sites, well pads and pipeline right of ways without increasing the disturbance area of petroleum activities;
- Ecological surveys, geophysical surveys, topographic or cadastral surveys or geological surveys (including seismic and geotechnical petroleum activities);
- Gathering / flow pipelines from a well head to the initial compression facility; and

- Supporting access tracks.

'Petroleum activities' are all activities that are not classified as either 'low impact petroleum activities' or 'Essential petroleum activities'.

Using these definitions, a matrix of constraint levels with associated petroleum activities and mitigation / control measures was developed to govern broad decision making and planning processes. This is outlined in Table 4-1.

Also listed in Table 4-1 are the appropriate levels of environmental management controls for construction, operation and maintenance, and decommissioning activities undertaken in the constrained areas. The controls apply cumulatively (i.e. controls applicable to Project activities in highly constrained areas incorporate the controls that apply to Project activities in moderate and least constrained areas).

Table 4-1 Permissible Project Activities Based on Level of Constraint

Constraint	Project Activity			Environmental Management Control
	Low Impact Petroleum Activities	Essential Petroleum Activities	Petroleum Activities	
No go	Yes	No	No	Site-specific environmental management measures
High	Yes	Yes	No	Site-specific environmental management measures
Moderate	Yes	Yes	Yes	Specific environmental management measures
Low	Yes	Yes	Yes	Standard environmental management measures

This matrix is used as a guide for preferentially locating Project activities within low (or no) constraint areas and moving up constraint levels when it is not possible or feasible to locate activities within the preceding constraint level.

The level of constraint will determine the type of activity that can take place within the mapped constraint area. The constraint categories provide an indication of the level of approval or assessment that may be required and any additional management controls that may be necessary from developing within that area (for example, providing offsets or the clearing of vegetation). An explanation of the categories and some of the additional work that may be required is found below:

No go areas: The only activities to be undertaken in these areas will be low impact petroleum activities, as defined above. Examples of these areas would include; nature refuge areas, national parks, towns, residences etc. No-go areas within the Project area include:

- Registered significant Indigenous and non-Indigenous cultural heritage sites;
- Homevale National Park; and
- The towns of Coppabella, Middlemount and Blackwater.

High constraint areas: In addition to the mapped constraint, development within these areas would most likely require additional assessment and/or approval processes. Such processes may include flora or fauna surveys, and rehabilitation or relocation programs. Consultation with stakeholders is probable. Extra conditions may be imposed (such as limiting the width of right-of-ways, limiting road widths or development footprint areas). Offsets may be required. Costs of development in these areas will probably be higher than in non-constrained areas. Examples of these areas would include: endangered regional ecosystems (REs), sensitive receptor buffers and buffer zones of no-go areas.

Moderate constraint areas: In addition to the mapped constraint, development within these areas may require additional approval processes. Such processes may include flora or fauna surveys and rehabilitation or relocation programs. Consultation with stakeholders might be required. Certain types of infrastructure might require site specific mitigation measures and if possible, be required to be located elsewhere. Offsets might be required. Costs of development in these areas may be higher than in non-constrained areas. Examples of these areas might include least concern remnant vegetation or areas with visual amenity values.

Low constraint areas: In addition to the mapped constraint, development within these areas may require additional approval processes. Such activities might include mitigation activities or implementation of management plan activities. Offsets are unlikely. Costs of development in these areas may be slightly higher than in non-constrained areas.

Initial assessment of the Project area was undertaken (see Appendix BB of the EIS), and using various datasets, values within the following categories were identified and mapped:

- Natural environment and ecology;
- Surface water;
- Land tenure;
- Land use;
- Cultural heritage (indigenous and non-indigenous);
- Landscape and visual amenity;
- Engineering; and
- Roads.

4.3 Constraints Analysis

The method for undertaking constraints analysis is described in the following section. Presentation of the constraints maps produced for the Project area are provided in the Constraints Mapping report (Appendix BB) of the EIS.

4.3.1 Methodology

Constraints analysis was undertaken to construct a number of GIS datasets or layers for each relevant environmental aspect, and then a spatial analysis was undertaken to determine the level of constraint.

Two analyses were performed. The first involved determining the level of constraint posed by each environmental aspect. The second evaluated the cumulative effect of combining certain layers (e.g., all nature conservation related environmental aspects).

Analysis was performed on each individual environmental constraint in isolation from other constraints. Where multiple constraints overlapped, the highest level of constraint prevailed. The individual constraints were then compiled into a combined layer where all constraints could be viewed on one map. All individual constraints layers and the combined constraints maps are presented in Constraints Mapping (Appendix BB of the EIS).

The maps are restricted to a resolution of 1:100,000 or higher due to the accuracy of the base information. Queensland and Australian government Geographic Information Systems (GIS) data is typically collated at 1:100,000 or 1:250,000 scale. At the scale of 1:100,000, a distance of 1 mm on the map is equal to 100 m on the ground. Detailed mapping compiled through field surveys is more accurate, but is limited by the method and accuracy of the equipment used to acquire the data. Where available, more detailed data was used, but the maps are still restricted to the scale of the least detailed mapping.

To facilitate conceptual design of the CSG fields, constraints analyses was undertaken based on available Queensland and Australian government GIS data and advice and information from the technical specialists.

Constraints were identified for:

- Natural environment and ecology;
- Surface water;
- Land tenure;
- Land use;
- Cultural heritage (including indigenous and non-indigenous);
- Landscape and visual amenity; and
- Roads.

The criteria that defined the constraints for natural environment and ecology, and surface water are described below.

4.3.1.1 Natural Environment and Ecology

Constraints mapping for natural environment / ecology and surface water is based upon the ESA mapping categories performed by EHP. Two ESA categories are defined under the Environmental Protection Regulation 2008 (Categories A and B) with a third category defined within the Code of environmental compliance for mining lease projects (Category C). In addition to ESA categories, other significant values have been included in the natural environment and ecology constraints mapping. These values include;

- Areas identified as possessing significant conservation value;
- Confirmed EPBC Act listed species habitat; and
- EHP mapped high value regrowth.

The breakdown of the ESA categories and other values in conjunction with the constraint matrix has been used to determine the level of activity within each constraints category. The constraints categories identified by constraints mapping are outlined below in Table 4-2. For further detail on ESA categories, see Appendix BB of the EIS.

Table 4-2 Natural Environmental and Ecology Constraints Categories

Constraint Category	Value
No go	Category A ESA Significant conservation area
High	EPBC species habitat area Category A ESA buffer zone Category B ESA Some Category C ESA
Moderate	EHP High Value Regrowth Category B ESA buffer zone Balance of Category C ESA Category C ESA buffer zone

4.3.1.2 Surface Water

Surface water constraints differ depending on the values potentially being impacted. For the purpose of the Project, buffer zones will be adopted for Project activities (with the exception of required creek crossings), in different areas of constraint, as defined by the Project's Constraints Mapping report (Appendix BB of the EIS).

The buffers outlined below are indicative based on the current regulatory conditions; however these may be subject to change in future. The buffers that will be implemented for the Project will be in line with the regulatory requirements at the time of implementation. Indicative buffers at this time include:

- In areas mapped as high constraint a buffer of 100 m, measured from the high bank edge, will be adopted during all phases of the Project, with a further 100 m constrained to low impact activities; and
- For areas mapped as moderate constraint, the following buffer zones, measured from the high bank edge, will be adopted during all phases of the Project:
  - a riparian buffer of 50 m width on either side of first and second order streams; and
  - a riparian buffer of 100 m width on either side of third, fourth, fifth and higher order streams.

4.3.2 Results of Preliminary Constraints Analysis

The development of the constraints framework allows for a broad, preliminary assessment of values and constraints throughout the Project area. As a result of the constraints analysis, eight maps have been produced to guide planning and development within the lease area. These maps can be found in the Constraints Mapping report (Appendix BB) of the EIS.

- Map 1: Natural environment and ecological constraints;
- Map 2: Surface water constraints;

- Map 3: Land tenure constraints;
- Map 4: Land use constraints;
- Map 5: Cultural heritage constraints;
- Map 6: Landscape amenity constraints;
- Map 7: Roads constraints; and
- Map 8: Overview of constraints.

The maps have been produced to provide an overview of the level of constraint and to address specific gas field planning issues.

4.3.3 Ongoing Constraints Analysis

The preliminary constraints analysis is based on State and Commonwealth government mapping databases and has incorporated the findings of the EIS including the results of field surveys; sensitivity analyses performed by technical specialists, and proposed mitigation measures. The constraints analysis will be updated to incorporate any findings from the SREIS, negotiations with regulatory authorities and ongoing community consultation will inform the update of the constraints mapping and environmental management controls.

The Project GIS, a live system, will be periodically updated to include updates to State and Commonwealth government GIS data, the results of ecological and preconstruction clearance surveys, and any subsequent environmental impact assessment processes.

Proposed mitigation measures are presented in the impact assessment chapters (Sections 8 to 29) and the draft EM Plan (Appendix Z) of the EIS. The measures or environmental management controls reflect the significance of potential impacts of the proposed development, and hence respond to the level of constraint posed by the environmental values. All mitigation measures from the EIS chapters and draft EM Plan are detailed as commitments in the Commitments Summary (Appendix D) of the EIS and will be incorporated in documents comprising Arrow’s HSEMS, enabling implementation of the environmental framework.

5 EPBC ASSESSMENT METHODOLOGY

5.1 EPBC Guidance

The EPBC Act Policy Statement 1.1 ‘Significant Impact Guidelines: Matters of National Environmental Significance’ (DEWHA, 2009a) provides the framework for the assessment of potential impacts upon MNES from the Project.

What is a significant impact?

> “*A ‘significant impact’ is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance”.*

When is a significant impact likely?

> *“To be ‘likely’, it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment”.*

The policy statement provides guidance on determining whether an action is likely to have a significant impact on a MNES. The following measures should be considered:

- Whether there are any matters of national environmental significance located in the area of the proposed action (noting that ‘the area of the proposed action’ is broader that the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may be potentially be impacted).
- Considering the proposed action at it broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), whether there is potential for impacts, including indirect impacts, on matters of national environmental significance?
- Whether there are any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the ‘significant impact’ threshold)?
- Whether any impacts of the proposed action on matters of national environmental significance are likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

This report assesses only whether an impact on MNES is likely to be significant or not. Impacts upon relevant MNES are assessed within the EIS and the relevant technical studies, where a detailed assessment of the likely impacts of the Project on the existing environment has been undertaken. This assessment formed the basis of whether an impact on MNES was considered to be significant or not.

Significance assessment was adopted for technical studies where an understanding of the vulnerability of the environmental asset or resource was important to the assessment. For example, an understanding of the sensitivity of ecosystems in their current state provides a sound basis for determining the severity of potential impacts. Potential impacts that arise through the management of materials and substances (e.g. waste) are more appropriately assessed using the principles of risk management. Compliance assessment was adopted for environmental aspects regulated by statutory guidelines, e.g. air quality, noise and vibration. A detailed description of the methods used to undertake the impact assessment for all environmental and social values is also provided in the Impact Assessment Method chapter (Section 6) of the EIS.

5.2 Assessment Overview

The extensive size of the Project area (approximately 8,000 km^2) and diversity of habitats precluded systematic sampling of all vegetation and habitat types, and an extensive vertebrate fauna trapping exercise. Alternatively, the following assessment approach was used:

- Detailed desktop review of literature (i.e. past and/or relevant studies) and databases to highlight known or potential sensitive values (e.g. vegetation communities and/or flora and fauna species). This included, where possible, the mapping of known habitats for MNES species based on existing records and RE mapping;
- Field verification and habitat assessment to document condition, extent and value of vegetation and habitats with particular focus on those values identified in the above stage. Field verification assisted in refining MNES species known habitat maps, highlighting those REs which are most likely to contain sensitive values, and testing the accuracy of existing vegetation mapping; and
- A risk assessment to highlight those areas or habitats that are potentially most sensitive to Project related disturbance. The assessment is based on results from both desktop and field surveys.

The above approach ensured that an increased portion of the Project area was assessed than would have otherwise been possible. Although no detailed fauna trapping was conducted as a direct result of this work, trapping records are encompassed by their inclusion in existing databases and relevant reports.

5.3 Desktop Literature and Database Review

5.3.1 Flora Methodology

Relevant available literature was reviewed and analysed. It included raw data from database searches, information held by agencies and/or individuals and interpretive reports. Database searches from state and Commonwealth agencies provided the basis for the majority of background information regarding the presence and distribution or flora species, listed under legislation or otherwise, known from or likely to be in the Project area. Table 5-1 outlines the major databases searched.

Table 5-1 Database Sources Relevant to Floristic Assessment

Source	Notes	Abbreviation
Queensland Herbarium's records system (Queensland Herbarium, 2012a)	Specimen-backed, so highly reliable. Geographic coordinates available	HERBRECS
EHPs Regional Ecosystem Description Database (Queensland Herbarium, 2012b)	Reliable vegetation descriptions based on site survey data.	REDD
EHP Wildlife Online (EHP, 2012a)	Moderately reliable observations. No geographic coordinates available. May include anomalous records that have not been confirmed with vouchered specimens.	WN
EPBC Protected Matters search tool	Predictive only and includes species restricted to habitats that occur outside the Project area.	EPBC Online
EHPs Regional Ecosystem digital data (EHP, 2012b)	Mapping of REs based on aerial photographic / satellite interpretation and limited site data. Reliability varies dependent on geographic location and accessibility for survey.	No Abbreviation
EHPs High Value Regrowth digital data (EHP, 2012c)	Mapping of regrowth vegetation based on temporal analysis of aerial photography or satellite imagery. Reliability varies dependent on geographic location and supporting field survey.	No Abbreviation
Queensland Wetland Data (EHP, 2012d)	Mapping of wetland habitat based on aerial photography / satellite image interpretation, topography and limited site data. Reliability varies dependent of reliability of RE mapping produced by DERM (EHP, 2012b)	No Abbreviation
Australia's Virtual Herbarium (http://avh.ala.org.au)	Compilation of specimen backed data from a range of sources. Generally reliable.	No Abbreviation
Other literature	Primary literature; personal communication with relevant personnel, including EHP staff; books; Biosecurity Queensland's predictive and annual pest mapping database (Biosecurity Queensland, 2008). other sources include technical and impact assessment reports relevant to the Project area including: • URS (2011a); • AECOM (2011).	References are provided where appropriate
Biodiversity Planning Assessment – Brigalow Belt North (EPA, 2008a)	A geographical information tool based on a range of data sources including expert opinion. Reliability varies dependent on RE mapping and scale of data. Some specimen backed information is presented.	BPA

The Biodiversity Planning Assessment for the Brigalow Belt (EPA, 2008b) was analysed to provide additional information relevant to biodiversity significance, essential habitat and regional wildlife corridors. Additional bioregional values were reviewed within expert panel reports for landscape (EPA, 2008b).

5.3.2 Fauna Methodology

A desktop review of ecological records, databases and literature relating to vertebrates was conducted. The area searched included the Project area and a 25 km buffer.

5.3.2.1 *Database Review*

Records from the Queensland Museum's collections database, Birds Australia Atlas, EHPs WildNet database and the Ecosmart Ecology database was inspected and compiled into a single Project-specific vertebrate database in order to gain:

- A list of all known vertebrate species from within the search area (i.e. a species list); and
- Specific locations (i.e. geographical coordinates) for MNES species records where possible.

The search included the Project area and a 25 km buffer. Aerial photography analysis was undertaken (Section 5.4) and databases searched relating to MNES includes:

- EPBC Protected Matters search tool (DSEWPaC, 2012);
- EHP WildNet;
- Biodiversity Planning Assessment Methodology;
- Queensland Museum Zoology database (Queensland Museum, 2012);
- Birds Australia Atlas (Birds Australia, 2012);
- EcoSmart Ecology database (Ecosmart Ecology and Nagel, 2010); and
- Other literature (including, primary literature, personal communications, books, technical reports and Biodiversity Queensland's predictive and annual pest mapping database).

In addition to providing a list of known MNES species, compiling the database provides an estimate of record frequency for those MNES species present. While useful, record frequency must be used cautiously as databases are biased towards obvious taxa such as birds.

It is also important to note that a species' presence in a database does not mean that the species is regularly observed in the study area. Single, unusual records may represent a transient individual that has been observed in the area. These individuals do not represent breeding populations and these records are of little value in the environmental planning process. Such records need to be carefully evaluated against the species' current known distribution and habitat requirements.

5.3.2.2 *Literature Review*

A review of ecological reports was conducted as part of the previously mentioned technical reports to provide additional information on MNES locations within the Project area. The reviewed sources included:

- AARC (2004) Mackenzie Coal Project;
- AARC (2004) Broadlea Flora and Fauna Study;
- AARC (2008) Carborough Downs Flora and Fauna Study. Prepared for McCullum Environmental;
- AARC (2009) North Goonyella flora and fauna works;
- BAAM (2010), Blackwater Power Station Project; Flora and Fauna Habitat Assessment, Prepared by Biodiversity Assessment and Management Pty Ltd;

- ESM (2010) Terrestrial Ecological Assessment; Minyango Coal Project. Prepared by Ecological Survey and Management for Hansen Bailey Pty Ltd;
- AARC (2011) Dry season terrestrial flora and fauna report; North Mackenzie Project. Prepared by AustralAsian Resource Consultants Pty Ltd for Jellinbah Group Pty Ltd;
- ESM (2011a) Bow Energy Blackwater Transmission Line; Ecological Report, Prepared by Ecological Survey and Management;
- ESM (2011b) Arrow Bowen Pipeline Terrestrial Fauna Assessment. Prepared by Ecological Survey and Management;
- Matrix Plus (2009) Millennium Coal Flora and Fauna Study. Prepared for Peabody Resources;
- RLMS (2011) Environmental Management Plan; Petroleum Lease PL 388. Prepared by RLMS for Bow Energy Ltd; and
- URS (2011b) Fauna CSG Field Survey, Report prepared for Bow Energy.

5.4 Aerial Photograph Analysis

A representative area of vegetation within the Project area was selected for detailed mapping review. This area, defined in the Terrestrial Ecology Technical Report (Appendix P of the EIS) as the ‘detailed study area’ coincided with an 800 m^2 area of sensitive vegetation to the north or Moranbah which may be subject to future well site development. A review and compilation of hard copy stereographic imagery, both recent and historical, from the NRM aerial photographic library was completed to determine the most appropriate image base for vegetation mapping and assessment purposes with the detailed study area. A list of the photographic imagery used in the assessment is provided in Table 5-2.

Historical aerial photography was extensively utilised to determine the remnant and EPBC Act status of sensitive vegetation communities as well as broadly indicating past land management practices relevant to an assessment of vegetation condition. Certified RE mapping (EHP, 2012a) was referenced during all stages of stereoscopic assessment to provide a preliminary indication of the limitations of existing mapping as well as assisting the selection of field survey site locations. There is currently no available digital photographic imagery providing comprehensive coverage of the Project area although satellite imagery from Google was consulted as deemed necessary.

Table 5-2 Stereoscopic Aerial Photographic Imagery Utilised During Study

Map Name / Film Number	Year	Scale	Run / Photograph
Harrybrandt / QAP6260	2006	1:40,000	Run 1, 165-167 Run 2, 156-163 Run 3, 128-134
Hillalong / QAP6206	2006	1:40,000	Run 7, 91-95 Run 8, 229-223 Run 9, 222-228
Wyena / QAP5841	2000	1:40,000	Run 1, 140-146 Run 2, 176-181 Run 3, 182-188

Map Name / Film Number	Year	Scale	Run / Photograph
Byerwen / QAP5816	2000	1:40,000	Run 7, 27-35 Run 8, 35-40 Run 9, 27-35
Mt Coolon / CAB 2591	1979	1:75,000	Run 4, 8431-8439 Run 5, 8528-8536 Run 6, 8466-8476 Run 7, 8407-8415
Mt Coolon / CAB 2580	1979	1:75,000	Run 8, 6540-6544

5.5 Field Survey Methodology

Results of the literature review and the aerial photographic interpretation were used to select patches of remnant and non-remnant vegetation for targeted fieldwork. These patches, which represented most REs known from the Project area, based on an initial assessment of habitat sensitivity and perceived likelihood of exposure to threatening processes. Surveyed sites were thus located within:

- Ecosystems where limited information on condition or structure within the Project area is available;
- Areas identified as possessing, or potentially possessing significant or sensitive vegetation, flora and vertebrate fauna species; and
- Areas with representative examples of remnant vegetation which provide reference condition for a number of sensitive vegetation communities or REs.

The field investigation was conducted over an initial period of 11 days (between 17 and 27 October 2011), as part of the Terrestrial Ecology Technical Report for the EIS (Section 4.4 of Appendix P of the EIS).

Conditions during the field survey were generally mild (26 - 30˚C) with overcast and windy conditions. The ground cover, particularly cover of perennial native grass species, was robust in the majority of field survey locations, a testament to the extent and duration of rainfall during the previous wet season.

A second phase of field survey subsequently was completed in May over a period of 17 days (between May 04 and May 20), to allow for seasonal variations in floristic and faunal composition of habitats and species seasonality. The latter survey period is consistent with Neldner *et al.* (2005) as the optimal window for sampling in north Australian savannahs.

For both survey periods, a survey team of two personnel undertook the flora survey and two personnel the fauna habitat assessments making for a total survey effort of 56 survey days for the flora survey and 56 survey days for the fauna habitat assessment. Field surveys were conducted as part of the EIS. Additional survey work was not carried out as part of the Arrow SREIS as development planning hasn't been refined to include detail for targeted sites at this stage of the Project development.

5.5.1 Vegetation Community Mapping

Detailed vegetation assessment was restricted to the detailed study areas selected from the literature review. In these areas mapping revision was undertaken utilising stereo-photographic images over an area approximating 800 km^2 at a spatial scale of 1:40,000. Polygons were delineated down to 0.5 ha, particularly where EPBC Act listed communities were confirmed to be present. Outside the detailed study areas, RE mapping at a scale of 1:100,000 (EHP, 2012a) was utilised as a basis for biodiversity assessment and preliminary sensitivity assessment. It is considered that from detailed assessment of mapping areas, sufficient information would be obtained to allow assumptions in regard to the utility of the existing certified ecosystem mapping to be made and management requirements identified. The sampling scale for remnant vegetation in the detailed study area equates roughly to 1:50,000.

5.5.2 Flora Survey

Flora survey methods followed Queensland Herbarium standards as identified in Neldner *et al*. (2005) using a combination of formalised secondary, tertiary and quaternary level sampling procedures, as well as informal site observation. Benchmark site data collection followed methods of the former Department of Environment and Resource Management (DERM) (2011a). Benchmark and secondary sites were chosen in habitats that presented good type examples of a particular vegetation community or RE, particularly where ground strata was particularly diverse and diagnostic (e.g. natural grasslands). Tertiary sites were undertaken to confirm the structural attributes of site vegetation in habitats that had previously been assessed by secondary method in other locations. Quaternary sites were established for the primary purpose of RE validation, often in locations where ground searches for threatened species were undertaken.

Secondary sites consisted of a 50 m x 10 m plot located along the contour with attempts made to avoid sampling across vegetation community boundaries. Crown intercept transects were extended to 100 m for the purpose of providing sufficient data for reference sites as required for map amendment procedures. Bitterlich measurements, as described in Grosenbaugh (1952), were used to record community basal area at all sites except in highly linear communities where the method proved inappropriate. Full species lists for all strata were established during the secondary sampling procedure wherein the 500 m^2 plot was intensively sampled, followed by a detailed search of the vicinity. The abundance of all species within the plot was recorded by stem counts and by a visually assessed 1-5 cover-abundance ranking using the Braun-Blanquet method. Groundcover was assessed using five 1 m x 1 m subplots placed at 10 m intervals along the transect with visual cover estimations of dominant species. Ecological and structural data together with full species lists were also recorded.

Tertiary sites were completed in a similar fashion to the secondary sampling procedure, although non-woody species were not recorded. Quaternary sites comprised a description of floristic structure, composition, and associated landform. Wherever a vegetation community was considered to be potential critical habitat for an EPBC Act listed threatened flora species, the search area was broadened and a more extensive species list was established from an extended search area. Flora species were also recorded on walking traverses, again with particular attention toward known and potential habitats of EPBC Act listed threatened flora species as well as declared weeds and locally important taxa. Botanical voucher specimens were collected throughout the field survey to verify site floristics and enable identification of those species that were problematic. Identifications were provided by Queensland Herbarium. Vouchers of all EPBC Act listed threatened flora species were sent to the Herbarium for incorporation.

Reference sites established in undisturbed or lightly disturbed vegetation communities within the Project area form a basis from which an assessment of the remnant/non-remnant status of a specific vegetation community can be made. These sites also provide a benchmark for the assessment of vegetation community condition and biodiversity values. Reference locations established in the flora study were chosen from aerial photography and on-ground scrutiny as areas representative of the best preserved or 'type' example of a given vegetation community within the Project area. Supplementary assessment of grassland condition was carried out using detailed cover measurements of all species within ten 1m x 1 m subplots placed at 10 m intervals along 50 m transects, together with full floristics and cover/abundance estimates within the plot area.

Six hundred and thirty-two floristic survey sites are recorded across the Project area comprising 102 secondary, 20 tertiary and 510 quaternary sites. A large number of these sites were collated from previous recent studies. The majority of the sites were collected from within the Project area although several sites were located outside where they provided a useful reference to a number of significant habitat types. Full benchmark site data was collected from 10 of the secondary survey sites to assist with future habitat offsetting requirements. In addition, 47 tertiary survey sites and 81 quaternary sites were recorded within the Project area in studies undertaken by URS (2011a). These sites are also considered to have contributed to the assessment. The location of floristic survey sites is shown in Figure 5-1.

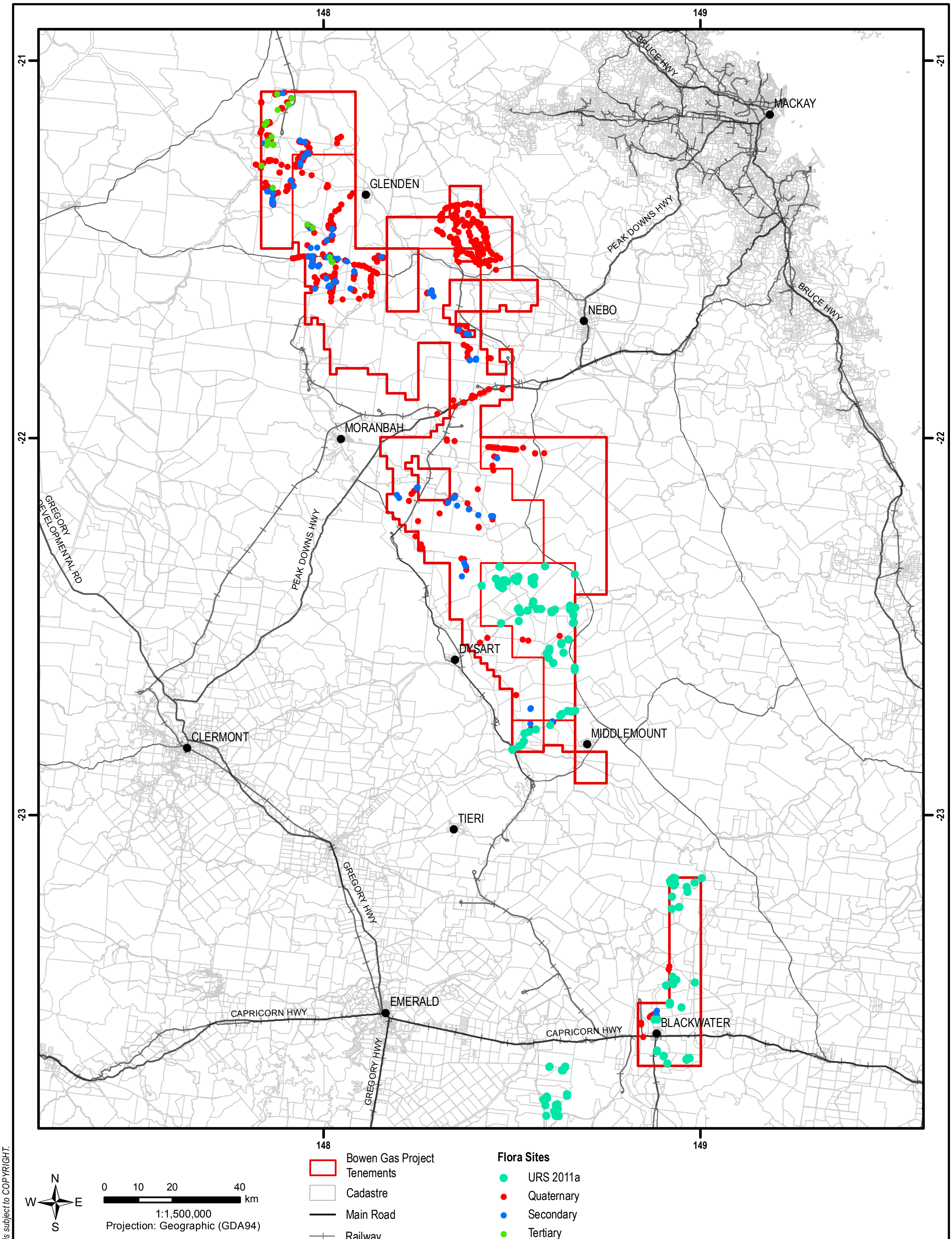
5.5.3 Fauna Habitat Survey

Assessment of faunal habitat values and species presence was undertaken in representative habitats across the Project area concurrently with the floristic survey team. At each survey location a number of non-trapping survey methods were used, and habitats were evaluated for their potential for threatened species. This data was used to refine mapping and highlight any trends between vegetation community and threatened fauna species potential. At each location, the assessments described below were undertaken.

5.5.3.1 Habitat Assessment

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including:

- Quality and type of ground cover – thick grass, woody debris, rocks, soil cracks etc;
- Abundance of hollows;
- Abundance of food resources such as fruit, flowers and seeds;
- Abundance of suitable roosting and sheltering habitat, including caves and fissures;
- Water sources or possibility for pooling surface water (e.g. gilgai);
- Canopy cover, extent and height;
- Vegetation structure, density and complexity; and
- Edge effects and other disturbance regimes.



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arrow energy go further

BOWEN GAS PROJECT SREIS

FLORA SURVEY LOCATIONS

URS

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **5-1**

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An assessment on the value of the habitat for individual EPBC Act listed threatened fauna species was made on the basis of the above observations and known threatened fauna habitat requirements.

5.5.3.2 Bird Census

Bird surveys were conducted using both aural and visual survey to determine the species present within individual REs. Habitats which might be utilised by EPBC Act listed threatened fauna species (e.g. wetlands and dams) were specifically investigated.

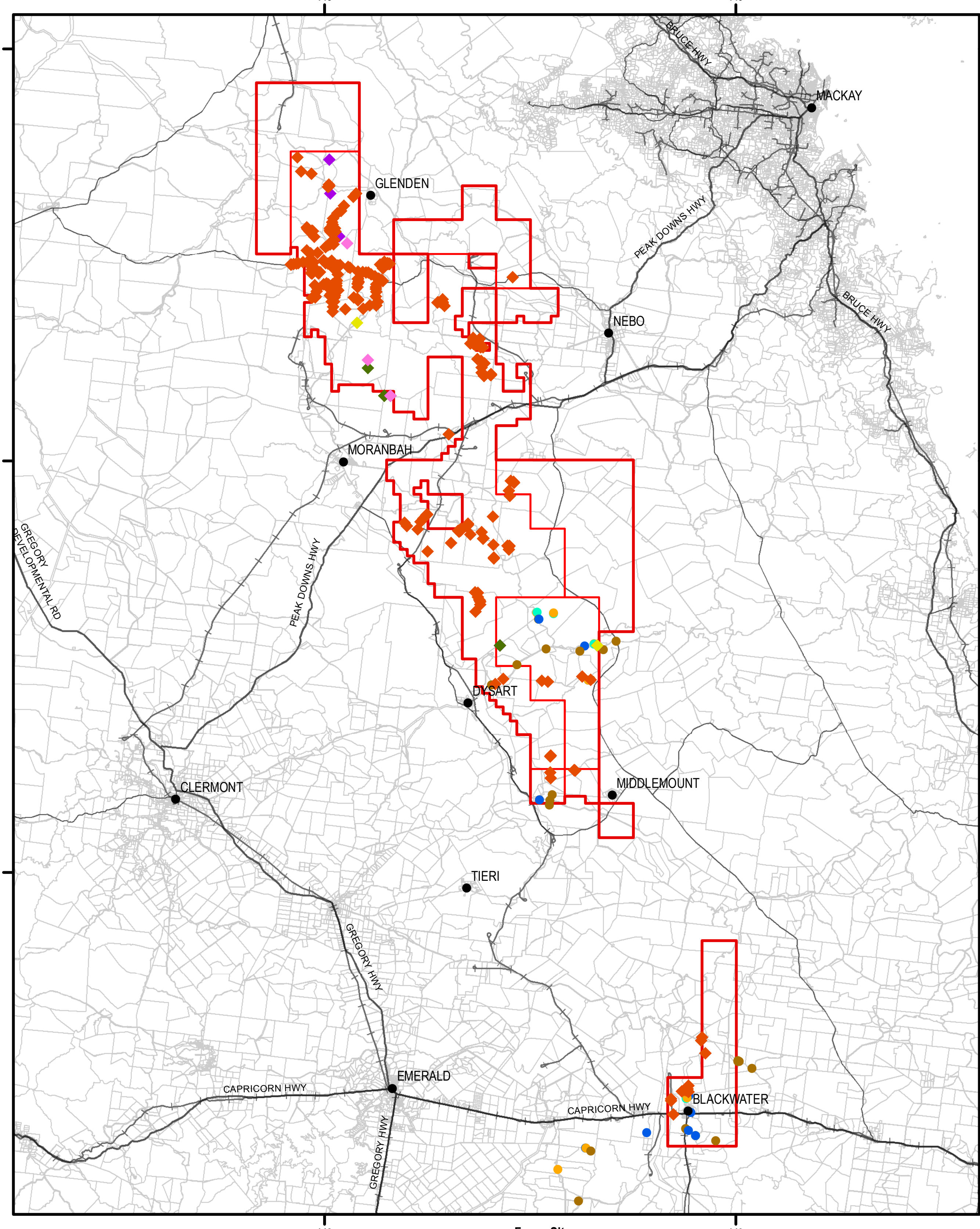
5.5.3.3 Active Search

Habitat searches for amphibians, small mammals, and reptiles included log/rock rolling, inspecting exfoliating bark and raking through leaf litter. Scats, tracks and traces, including droppings and claw marks, were recorded, this method being particularly useful for assessing the presence of koalas.

5.5.3.4 Incidental Observations

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.

A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies (ESM, 2011a and 2011b; URS, 2011). The location of fauna survey sites in the Project area are shown in Figure 5-2.



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BOWEN GAS PROJECT SREIS

FAUNA SURVEY LOCATIONS

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT Figure: **5-2**

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5.5.4 EPBC Survey Guidelines Compliance

5.5.4.1 *Threatened Ecological Communities*

There are no EPBC survey guidelines for the TECs potentially present within the Project area.

The *Commonwealth Listing Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* (TSSC, 2008a) provides key diagnostic characteristics of the TEC. These are detailed further below.

The flora survey employed methods suitable for confirming the presence of, and describing EPBC-listed TECs. These are outlined below.

Brigalow (Acacia harpophylla dominant and co-dominant)

There are no EPBC survey guidelines in place for this TEC.

The methods for the survey and mapping of REs in Queensland as identified in Neldner *et al*. (2005) are considered suitable for defining the EPBC Act-listed Brigalow TEC as REs form part of the TEC in Queensland. The following REs were sampled within the Project area; the sampling effort (in brackets) details the level of detail expended to refine the REs:

- RE 11.3.1 (5 Secondary (3 Benchmark), 3 Tertiary, 4 Quaternary);
- RE 11.4.8 (3 Secondary (1 Benchmark), 8 Quaternary);
- RE 11.4.9 (7 Secondary (2 Benchmark), 13 Quaternary);
- RE 11.5.16 (4 Secondary, 2 Tertiary, 3 Quaternary);
- RE 11.9.1 (2 Secondary); and
- RE 11.9.5 (1 Secondary, 11 Quaternary).

Natural grasslands of the Central Queensland Highlands and Northern Fitzroy Basin

The *Commonwealth Listing Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* (TSSC, 2008a) provides key diagnostic characteristics for recognising the TEC:

- Distribution;
- Tree canopy absent or sparse; and
- The ground layer is typically dominated by perennial native grasses and contains at least three of the indicator native species listed.

The methodology that is outlined within the Listing Advice was employed during assessment of grassland communities within the Project area.

The Natural grasslands of the Central Queensland Highlands and Northern Fitzroy Basin TEC was sampled in the optimal seasonal conditions with surveys completed in October 2011 and early May 2012. Methods utilised were consistent with those necessary to determine threshold condition according to the EPBC listing advice. Species were grouped into broad life-form categories with calculations of mean cover values and species richness utilised.

The REs that are analogous to the TEC were sampled within the Project area:

- RE 11.8.11 - 15 Secondary and 9 Quaternary sites were sampled; and
- RE 11.4.4 - 2 Secondary sites were sampled.

Other REs that form a component of the TEC (11.3.21, 11.4.11 and 11.9.3) were not encountered.

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

There are no EPBC survey guidelines in place for this TEC. The methods for the survey and mapping of REs in Queensland as identified in Neldner *et al.* (2005) are considered suitable for defining this TEC.

The flora field survey employed these methods in the following examples of the TEC (survey effort in brackets):

- 11.3.11 (1 Quaternary);
- 11.8.13 (2 Secondary, 4 Quaternary);
- 11.8.3 (1 Secondary, 2 Quaternary); and
- 11.9.4/11.9.4a (1 Secondary).

Weeping Myall Woodlands

Field surveys were undertaken within ‘at risk’ areas (e.g. REs 11.3.2 and 11.3.28). However no occurrence of Weeping Myall Woodland was observed. There are no EPBC Act survey guidelines in place for this TEC.

5.5.4.2 EPBC – listed Flora Species

There are no EPBC survey guidelines for threatened flora species known or likely to occur within the Project area.

Secondary, tertiary and quaternary-level assessment sites were established as an outcome of the desktop site selection process (above) in conjunction with on-ground analysis of values. Flora species were recorded as part of the vegetation community assessment methodology used in the secondary, tertiary and quaternary-level sites. Quaternary sites were often established in locations where ground searches for EPBC-listed flora species were undertaken.

Wherever a vegetation community was considered to be potential critical habitat for EPBC-listed flora species, the search area was broadened and a more extensive species list was established from an extended search area.

Flora species were also recorded on walking traverses, again with particular attention toward known and potential habitats of EPBC-listed flora species. Botanical voucher specimens were collected throughout the field survey to verify site floristics and enable identification of those species that were problematic. Identifications were provided by Queensland Herbarium.

Vouchers of all EPBC Act-listed flora species were sent to the Herbarium for incorporation into the collection.

5.5.4.3 *EPBC – listed Fauna Species*

The former Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) (subsequently DSEWPaC, now Department of the Environment) in 2010 and 2011 released a series of guidelines for surveys for threatened bats, birds, frogs, fish, mammals and reptiles. These guidelines provide a guide for stakeholders on the effort and methods considered appropriate when conducting a presence / absence survey for threatened species under the EPBC Act. The techniques and survey effort recommended are designed to detect a species if it is present, or to satisfy the argument that a species is not present or is present at very low abundance.

Targeted surveys for EPBC Act-listed fauna species to the level outlined in the threatened fauna survey guidelines were not undertaken during the field survey as they are impractical at the EIS stage of the assessment process. The field survey aimed to characterise potential fauna habitat and identify locations where faunal populations might exist as a guide to future targeted surveys. The survey methodology (as described below) was successful in meeting these aims.

Assessment of faunal habitat values and species presence was undertaken in representative habitats across the Project area concurrently with the flora survey team. At each survey location a number of non-trapping survey methods were used, and habitats were evaluated for their potential for EPBC Act-listed fauna species.

Habitat assessments were used to evaluate important ecological features that contribute to fauna values. An assessment on the value of the habitat for individual EPBC-listed fauna was made on the basis of the habitat observations and known EPBC-listed fauna habitat requirements.

Bird surveys were conducted using both aural and visual survey to determine the species present within individual REs. EPBC Act-listed birds were specifically investigated at habitats which might be utilised by these species (e.g. wetlands and dams).

Active searches included log / rock rolling, inspecting exfoliating bark and raking through leaf litter for amphibians, small mammals, and reptiles. Fauna signs such as scats, tracks and claw marks, were analysed as an effective method for assessing the presence of EPBC Act-listed fauna species such as koalas (*Phascolarctos cinereus*).

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Any locations where potentially important fauna values (including EPBC Act-listed fauna species) were recognised were geospatially recorded for later use in impact assessment and mapping.

Known Habitat for Endangered, Vulnerable and Near Threatened Fauna

Remnant habitat in the Project area that are known to host endangered, vulnerable and near threatened (EVNT) fauna (including EPBC Act-listed fauna) are shown in Figure 7-4. This mapping is produced through intersection of available records of EVNT fauna species (i.e. the desktop database supplemented by field observation) with the certified RE mapping (EHP, 2012b), highlighting individual RE polygons in which EVNT species have been recorded. This will be used as a basis for future targeted surveys for EPBC-listed fauna species where there is potential for the Project to impinge on these areas.

Constraints mapping has also been undertaken for the project that utilises known EVNT fauna and flora habitat as an ESA layer. Details are provided in the Terrestrial Ecology Technical Report (Appendix P, Section 11) of the EIS and is summarised in Section 4.3 of this report.

5.5.5 Future Assessment of MNES

It is recognised that the survey effort for EPBC Act-listed fauna for the EIS assessment does not necessarily conform to the specific guidelines for targeted fauna surveys presented within the Commonwealth guidelines for surveying for threatened fauna, as the objectives for the targeted survey guidelines differ from the objectives of the large scale surveys undertaken for the EIS to characterise the values of the Project area.

It should be noted that additional survey work will be carried out in regard to identifying EPBC Act-listed fauna species and habitat (including migratory species), as part of field development, pre-clearance and site scouting surveys.

Current known records of EPBC Act-listed species (Section 7) will be used to guide future survey work. A specific mapping product will also be developed for the SREIS to delineate the potential habitat for MNES protected species across the Project area based on a number of criteria to inform pre-clearance survey work, and provide an estimation of potential impact areas (Section 9).

5.6 Potential Habitat Mapping

Potential habitat mapping has been provided over the majority of the Project area. The purpose of the mapping is to provide an additional tool to assist in determining the most appropriate layout for gathering and processing infrastructure. The mapping has been based on best available information and should form part of the overall framework approach rather than being relied on as a single source. Potential habitat mapping has been performed for threatened species likely to be present within the Project area listed under the EPBC Act. Species that are unlikely to occur, migratory species or species that have been delisted since the EIS have not been included in the potential habitat mapping.

The primary basis for the habitat mapping is species profiles listed on the Species Profiles and Threats (SPRAT) database and the EHP species profiles. Additional information was obtained from the following sources where available: conservation plans / advice; MNES listing advice; EHP essential habitat factors database; and published articles. Habitat factors that were able to be represented on a GIS platform were combined to produce a Project wide potential habitat map.

In addition LiDAR imaging has been applied to refine potential habitat maps by analysing a number of factors at high resolution, including slope gradient, canopy density, vegetation height classes, and rocky features against species micro habitat requirements. The development of potential habitat mapping and refinement of LiDAR imagery is outlined in more detail in Section 8 of this report

5.7 Impact Assessment Method

The method of impact evaluation identifies those impacts associated with various components of the Project in the broadest sense, from Project construction, operational phases and decommissioning. It considers impacts known to be associated with the Project, or may draw from case studies associated with similar operations. The residual impact evaluation considers impacts remaining following implementation of management / mitigation procedures.

The approach used to assess impact significance considers the sensitivity of the ecological value to impact (both direct and indirect impact) as well as the predicted magnitude of the impact (see Table 5-3). The implementation of this approach aims to reduce the subjectivity of standard risk assessment procedures, which consider impact likelihood and impact consequence.

The approach adopted is conservative in nature and assumes:

- That the identified impacts will occur; and
- Proven mitigation measures will be utilised and applied successfully. Evaluation of impacts in the report uses the following matrix (as outlined in the Terrestrial Ecology Technical Report (Appendix P, Section 4.6.4) of the EIS).

Table 5-3 Matrix for the Assessment of the Significance of an Ecological Impact

		Ecological Sensitivity				
		Extremely Sensitive	**Highly Sensitive**	**Moderately Sensitive**	**Low Sensitivity**	**Not Sensitive**
Impact Magnitude	**Extremely High Magnitude**	Extremely High	Extremely High	High	Moderate	Moderate
	High Magnitude	Extremely High	High	Moderate	Moderate	Low
	Moderate Magnitude	High	Moderate	Moderate	Low	Low
	Low Magnitude	Moderate	Moderate	Low	Low	Insignificant
	Extremely Low Magnitude	Moderate	Low	Low	Insignificant	Insignificant

The sensitivity of ecological values considers a number of criteria including but not limited to:

- The legislative status (conservation status) of an ecological value;
- The intactness of an ecological value;
- The rarity of an ecological value;
- The resilience of an ecological value to cope with change;
- The ability of an ecological value to recover from an impact; and
- The potential for any losses of the ecological value to be replaced with an equivalent example.

Sensitivity definitions are provided below in Table 5-4.

Table 5-4 Impact Significance Ranking Definitions

Significance Ranking	Descriptor
Insignificant	An impact occurs to an ecological value that is of limited importance on a local or regional basis. The impact is largely reversible with degradation controlled by a range of standard mitigation and management measures that have been proven to be extremely effective.
Low Significance	An ecological value is of local importance only and impacts will be of a transient nature that will not affect the long term viability of a local population. A range of mitigation and management measures are known to ameliorate or reverse the process of degradation.
Moderate Significance	Although resilient to change, further degradation of an ecological value will occur due to the impact scale, or the activity has potential to increase the susceptibility of the ecological value to further change. Although important in the local ecological context, the value is widespread outside the area of impact and a range of management measures are known to facilitate recovery or replacement of the ecological value.
High Significance	A high magnitude impact occurs when proposed activities exacerbate or accelerate the degradation of a unique or rare ecological value. Whilst management actions are known to ameliorate impacts, a full recovery of the value to pre-impact condition is a long term process (decades) which will require rigorous active management. In these cases, avoidance is the preferred primary mitigation measure.
Extremely High Significance	An impact occurs that causes major, long term and widespread harm to a habitat or ecological value that is irreplaceable because of its uniqueness or restricted occurrence. The impact is largely irreversible and no mitigation measures have been proven to ameliorate the impact, and avoidance is considered the only effective mitigation

Information provided in this report was sourced from the EIS studies and publically available Government databases and websites during 2011, 2012 and 2013.

The reliability of Queensland Museum and Herbarium data is regarded as very high, since these represent actual specimens. The reliability of EHP Wildlife online records is regarded as moderately high, since these records have been vetted by recognised experts, even if some are observations only. The information used to produce the Wildlife online species lists is based on collated species lists and wildlife records (with a precision of 2,000 m or less).The reliability of the EPBC Protected Matters search tool for flora / fauna and ecological communities cannot be guaranteed, as the results represent indicative presence of species / communities based on potential distribution.

Queensland state RE mapping is used in part as a proxy to assess potential for habitat for some MNES. Where this is the case the reliability of RE mapping cannot be guaranteed. The Queensland Herbarium has developed a program for mapping Remnant REs, however it should be noted that there are inaccuracies inherent in RE mapping at a scale of 1:100,000, and RE maps provide an indication of what is potentially present, prior to any ground thruthing.

6 GENERAL POTENTIAL IMPACTS

This section provides a general discussion of relevant impacts and mitigation assessed in the EIS as context to help inform the detailed impact assessment undertaken for each MNES in the following sections of the report.

The common Project activities that may cause potential adverse impacts on ecological values during the construction, operation and decommissioning phases of the Project are discussed in the Terrestrial Ecology Technical Reports (Appendix P of the EIS and Appendix I of the SREIS) and summarised below.

Discussion of specific potential impacts and mitigation measures to MNES are detailed further in the report within individual MNES profiles in Section 9.

6.1 Construction

The general Project activities most likely to adversely impact on MNES values are the construction of production facilities, wells and associated low and mediumpressure gas and water gathering pipelines and the construction of high pressure gas pipelines, through:

- Vegetation 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;
- Dust generation; and
- Storage of waste.

6.2 Operations

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

- Release or spill of waste water or hazardous materials;
- Vehicle movements;
- Light and noise emissions;
- Weed encroachment from linear infrastructure;
- Ongoing vegetation clearing for easement maintenance; and
- Storage of waste.

A range of potential impacts relating to storage and handling of CSG water, including brine dams, have been identified and are outlined in the Groundwater chapter Section 14 of the EIS and Section 7 of the SREIS). These potential impacts include:

- Impact to shallow groundwater caused by seepage of brine concentrate from storage facilities; and
- Unplanned discharge of untreated CSG water and brine to the land surface leading to groundwater impact.

6.3 Decommissioning

During the decommissioning phase, general potential impacts on MNES values 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.

6.4 Habitat Fragmentation, Loss and Degradation

The Project activities will result in vegetation clearance, which if unmanaged may potentially lead to habitat loss and fragmentation. Detailed descriptions of potential habitat fragmentation impacts are provided in the Terrestrial Ecology Technical Report (Appendix P, Section 6.1.2) of the EIS. In summary habitat fragmentation and degradation may result in:

- An altered landscape mosaic (and hence habitat);
- Modification of large core unmodified habitats that may be structurally varied, have high habitat integrity and contain source populations of flora and fauna species;
- Loss of habitat for significant flora and fauna species, as listed under the EPBC Act;
- Increased movement barriers, isolating populations or reducing movement rates (forming isolated populations);
- Impacts to significant wildlife corridors, including riparian areas;
- Increased risk of some stochastic events (e.g. fire) having serious local deleterious consequences (e.g. local population extinction);
- A reduction in the likelihood of some stochastic events (e.g. fire) having broad scale impacts; and
- Increased edge effects (discussed in Section 6.5).

6.4.1 Fragmentation

Small vegetation patches usually have reduced species diversity and integrity is often low. However, some habitat patches may remain valuable, particularly if that habitat type is poorly represented within the bioregion or if the patch is within close proximity to other patches. Accordingly, small fragments of brigalow or native or derived native grasslands can host important biological values. The significance of impacts to sensitive habitats must consider the size and regional representation of the habitat type. The most common impact on the landscape matrix from the proposed activities will be fragmentation of vegetation and habitats.

Small patches of vegetation typically support fewer taxa than large intact patches and resident populations are more susceptible to extinction (MacArthur and Wilson, 1963; Rosenzweig, 1995). Species that are resident in smaller patches are typically a subset of communities found in nearby larger habitat patches (Patterson and Atmar, 1986; Cutler, 1991; Doak and Mills, 1994) and the persistence of these populations may be entirely reliant on re-colonisation and immigration. However, the creation of isolated populations is dependent on movement rates, which in turn are influenced by the:

- Presence of, and distance to, a nearby source population;
- Nature and suitability (e.g. structure) of the modified landscape matrix. The greater the modification of existing habitats, the lower the rate of movement, and
- Ability of an individual organism to migrate or disperse across the modified landscape.

Potential movement barriers created by gathering lines and associated access roads will be relatively narrow (approximately 40 m wide), and many vertebrates which are known to cross roads of similar width should not be significantly affected. In particular, mobile species such as birds, larger mammals and bats will readily cross these cuttings. However, Project-related fragmentation may be more severe for species that are rarely observed crossing open ground such as fossorial reptiles.

6.4.2 Reduced Connectivity

Clearing vegetation has the potential to impact intact corridors and stepping stones that connect the landscape (Lindenmayer and Fischer, 2006). These corridors facilitate species moving through sub-optimal habitat, thereby connecting populations, and also provide habitat for resident populations. Maintenance of corridors also ensures genetic exchange which reduces genetic drift and inbreeding depression. The effect of reduced connectivity on faunal movement rates will vary dependent on the severity of vegetation modification, sensitivity of impacted habitats and the nature of the faunal population. The impact of reduced connectivity will be magnified for species with a comparatively broad home range (e.g. birds) than for species where the home range is relatively confined (e.g. small lizards).

6.4.3 Stochastic Events

Stochastic events are random processes, such as fires, floods, disease, drought and processes relating to a species' life cycle (e.g. random variation in sex ratio, natural mortality, etc.).

Serious stochastic extinction events caused by processes such as fire could be restricted to individual vegetation patches and therefore individual species populations. Large contiguous populations are generally more resilient to deleterious stochastic events. Fire, for example, may reduce the extent of a large population but if sufficient in size the population is unlikely to be widely affected and therefore fall into local extinction. By contrast, the reduced genetic diversity in smaller populations increases the risk of extinction from disease.

6.5 Edge Effects

Edge effects refer to the changes in biological and physical conditions that occur at an ecosystem boundary (Lindenmayer and Burgman, 2005). A variety of edge effects can result from landscape modification, and may impact upon remaining ecological values:

- Ecological values can be impacted by loss of vegetation integrity along disturbed margins or within minor remnants. Canopy dieback and loss of vigour, particularly of the ground cover, may be associated with increased light, penetration, disease, altered surface water flow, dust or exotic weed invasion;
- There may be modifications to community interactions (e.g. increased competition, increased aggression, increased predation etc.); and
- Degradation of riparian and in-stream habitats through increased sedimentation and changes to hydrological regime.

These impacts are discussed further in the Terrestrial Ecology Technical Report (Appendix P, Section 6.1.3) of the EIS. A summary is given below.

6.5.1 Vegetation Integrity

Edge effect impacts may penetrate hundreds of metres into vegetation remnants, thus significantly influencing the distribution and abundance of species that inhabit these areas (Lindenmayer and Fischer, 2006). The creation of an edge alters the environmental conditions and microclimate in existing vegetation. This can affect the condition of the canopy species and, when severe, cause canopy dieback. This impact is particularly harmful as it is not immediately apparent, occurring over years after the edge-inducing event.

Some communities are particularly susceptible to this type of impact. Large brigalow trees, for example, can often be observed senescing in minor fragments. Further clearing within or even around these communities may affect the vigour of existing stands, reducing their extent.

The greater exposure to wind and surface water flow due to the loss of canopy and shrub features may increase weed propagule movement and weed spread. Weed invasion is one of the most notable and severe edge effects. Typically aggressive in growth, weeds may out-compete, or reduce the fitness of native plant species. Furthermore, some species (e.g. buffel grass) promote fire, increasing fire intensity and frequency and causing serious long-term problems in fire-sensitive vegetation (Jackson, 2005).

6.5.2 Community Interactions and Predation

Studies have shown that some fauna species avoid edges while others are common along edges or open habitats (Fletcher, 2005). Edge-dominant species are typically aggressive in nature. Noisy miners, for example, are extremely abundant in simplified habitats. They are aggressive, and scare away most other small insectivorous birds. Their abundance along edges is often at the expense of smaller native bird species (Terrestrial Ecology Technical Report (Appendix P, Section 6.1.3) of the EIS).

Another edge-associated community interaction is predation. While not universal, predation is often higher along edges than in core habitats. This is particularly apparent between strongly contrasting landscapes such as along agricultural land – woodland boundaries (Lahti, 2001), probably due to both greater predator abundance and greater predation efficiency at edges (Luch *et al*., 1999). The creation of access tracks into previously contiguous habitats may facilitate the penetration of exotic predators such as dogs, foxes and cats (Andrews, 1990). Exotic predators can have significant effects on fauna populations, including EPBC threatened species (Environment Australia, 1999) leading to listing of these predators as key threatening processes. Other exotic pest species (e.g. feral pigs) that can also negatively impact biodiversity values may also move freely along access tracks and benefit from increased water availability.

6.5.3 Dust Impacts

Deposition of dust, sand and soil may have potential impacts on vegetation if excessive levels are sustained over extended periods. When dust settles on plant foliage, it can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss. Reduction in the ability to photosynthesise due to physical effects may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health. The potential effects of dust deposition on vegetation are determined by a number of factors including:

- The characteristics of leaf surfaces, such as surface roughness, influencing the rate of dust deposition on vegetation;
- Concentration and size of dust particles in the ambient air and its associated deposition rates; and
- Local meteorological conditions and the degree of penetration of dust into vegetation.

The dominant woodland species of the vegetation communities within the Project area typically exhibit physiological qualities that are not sensitive to dust deposition. The sclerophyllous foliage of dominant *Eucalyptus* and *Corymbia* species is generally pendulous (i.e. points down), with a thick smooth cuticle that does not encourage particulate matter to remain on the surface.

6.6 Direct Mortality

6.6.1 Fauna

Direct mortality during clearing activities is difficult to avoid. While some species can quickly move from clearing activities (e.g. birds, large mammals), others are unable to (e.g. small lizards, frogs). Small terrestrial species in particular are highly susceptible to mortality during clearing (Terrestrial Ecology Technical Report (Appendix P, Section 6.1.1) of the EIS).

Furthermore, displaced individuals are less effective in competing with neighbours and their survival is also dubious. However, the degree of competition depends largely on the extent of an animal's home range that is modified and the individual's movement patterns. Minor modification within large home ranges will have less of an impact than the clearing of an individual's entire home range. Hence, higher mortality is expected for smaller, less mobile taxa (e.g. small lizards).

Clearing within habitats that are comparatively minor in extent, or within areas inhabited by species with restricted distributions, will affect a greater proportion of that area's fauna population. Hence, any clearing within rare or uncommon habitats such as native grasslands, brigalow or waterways will result in proportionally higher individual mortality and proportionally higher rates of habitat loss.

6.6.2 Flora

Direct mortality of flora species will be governed by the final impact footprint for any proposed infrastructure. Secondary impacts may also result from damage to trees on the margins of clearing resulting from tree fall or impact from operating machinery.

6.7 General Avoidance, Mitigation and Management Measures Avoidance

The change from single-well lease pads to multi-well lease pads will result in a significant reduction in the disturbance caused by the Project. By reducing the number of well pads, not only has the total area for required well pads been reduced; the number and length of gathering lines has also been significantly reduced.

Arrow's methodology for site selection includes a desktop site selection process, utilising constraints mapping developed for the EIS, followed by a detailed field-based ecological assessment to identify and map EPBC Act-listed flora, fauna and communities. Construction activities (such as clearing) will be supervised by qualified personnel to ensure that the activity is being conducted according to the standard methodology and within the approved area. Arrow adheres to the principles of avoid, minimise and mitigate and Arrow's preference is to avoid, where practicable, EPBC Act-listed TECs, EPBC Act threatened flora species and the habitat of EPBC Act-listed flora, fauna and migratory species.

The site selection process will avoid the following high constraint areas:

- Homevale National Park and Homevale Resources Reserve;
- Arthurs Bluff State Forest, contiguous with the Blackdown Tableland National Park;
- Dipperu National Park/ Scientific Reserve;
- Taunton National Park / Scientific Reserve; and
- Blackwater Brigalow Conservation Park.

National parks and forest reserves will be managed with the use of management buffers. The buffers that will be implemented for the project will be in line with the regulatory requirements at the time of implementation. Indicative buffers based on current regulatory conditions include an 800 m wide Secondary Protection Zone around a 200 m Primary Protection Zone with a total management buffer of 1,000 m (Terrestrial Ecology Technical Report (Appendix P, Section 7.4) of the EIS).

The site selection process will aim to avoid the following MNES:

- Threatened ecological communities:
  - Brigalow (*Acacia harpophylla* dominant and co-dominant);
  - Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin;
  - Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions; and

  - Weeping Myall Woodlands; and
- Habitat areas known or likely to contain EPBC Act-listed threatened species.

6.8 General Measures

The following general mitigation and management measures have been developed to address the potential impacts on MNES, including TECs, flora, fauna and migratory species. These measures have been developed in consideration of those outlined in the Terrestrial Ecology chapter (Section 17.5) of the EIS.

Environmental protection for MNES values will be primarily achieved by design and site selection that results in avoidance of high-value environmental areas. Arrow will conduct the below measures to mitigate impacts on terrestrial ecology.

6.8.1 Planning and Layout

Through the planning and design phase, areas of very high sensitivity will be avoided through implementation of the following mitigation commitments:

- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Deviate access tracks and pipelines around sensitive vegetation where practicable [B140];
- Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142];
- Avoid all disturbance within Homevale National Park (Category A ESA) [B130];
- Where possible avoid disturbance within the following areas [B131]:
  - endangered EPBC Act TECs: Brigalow Ecological Community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16); Natural Grasslands Ecological Community (RE 11.8.11); Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13); Weeping Myall Woodlands (REs 11.3.2 and 11.3.28);
  - category B ESAs;
  - category C ESAs including Arthur's Bluff State Forest and gazetted nature reserves;
  - stock routes and state or regionally significant bioregional wildlife corridors;
  - essential habitat;
  - core habitat for EVNT species;
  - state forests and resource reserves; and
  - state-listed 'of concern' REs.

6.8.2 *Construction and Operations*

During the construction phase work will be undertaken in a way that avoids and minimises impacts including through a number of mitigation commitments outlined below, including the implementation of disturbance exclusion zones (or management buffers) to be established and managed during construction and operations to effectively protect MNES values. These include the following mitigation measures:

- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Retain habitat trees as a priority [B137];
- Avoid removing riparian vegetation when directional drilling and reduction of right of ways where practical [B138];
- Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139];
- Deviate access tracks and pipelines around sensitive vegetation where practicable [B140];
- Avoid construction activities in waterbodies frequented by migratory species [B141];
- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques [B146];
- Design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat [B099];
- Use existing roads and designated access tracks, where practicable [B115];
- Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person [B149];
- Fell trees away from existing vegetation not identified for removal where practicable [B150];
- Avoid damaging trees (e.g. through scraping of tree trunk or breaking of limbs by equipment) not identified by removal where practicable [B151];
- Manage impacts to Category A, B and C ESAs through implementation of management buffers. The buffers outlined below are indicative based on current regulatory conditions, however these may be subject to change in future. Buffers that will be implemented for the Project will be in line with the regulatory requirements at the time of implementation. Indicative buffers at this time include:
  - in areas mapped as high constraint a buffer of 100 m, measured from the bank edge, will be adopted during all phases of the Project, with a further 100 m constrained to low impact activities; and

- for areas mapped as moderate constraint, the following buffer zones, measured from the bank edge, will be adopted during all phases of the Project:
  - a riparian buffer of 50 m width on either side of first and second order streams; and
  - a riparian buffer of 100 m width on either side of third, fourth, fifth and higher order streams;

- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers).

The construction and design of new dams, whether for the storage of water either prior to treatment or the resultant brine after treatment, will be in accordance with the requirements of the most recent version of *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* and constructed under the supervision of a suitably qualified and experienced person, in accordance with the relevant EHP schedule of conditions relating to dam design, construction, inspection and mandatory reporting requirements [B255].

Arrow will also apply the following hierarchy of monitoring and management options throughout the life of the Project as detailed in the Arrow CSG Water and Salt Management Strategy (Appendix AA of the EIS):

- Collect relevant geological and hydrogeological data from:
  - Existing and future production or exploration wells;
  - Monitoring of Arrow NRM and registered third-party bores;
  - Collaborative sharing information with other proponents and regulatory authorities.
- Construct, update and calibrate any geological and/or numerical groundwater models with relevant data on an ongoing basis; including:
  - Aquifer thicknesses and interfaces between formations;
  - Aquifer properties, e.g., porosity, permeability;
  - The location of sensitive areas, e.g., groundwater discharge springs; and
  - Observed responses in monitoring wells that reflect aquifer behaviour during coal seam gas extraction.
- Utilise the updated geological and numerical groundwater models (if required) to:
  - Make ongoing predictions regarding changes to groundwater levels and groundwater quality as the project develops; and
  - Improve confidence in the understanding of the sensitivity and resilience of the aquifers within the identified groundwater systems.

- Install an appropriate regional groundwater monitoring network (that satisfies Arrow's obligations as described in each Underground Water Impact Report) to:
  - Establish current groundwater level and groundwater quality conditions;
  - Assess natural variation (i.e., seasonal variations) in groundwater levels;
  - Monitor groundwater levels during the operational phase;
  - Monitor groundwater quality during the operational phase;
  - Establish suitable datum levels for each aquifer system;
  - Target sensitive areas where more frequent monitoring and investigation is required (e.g., groundwater-dependent ecosystems);
  - Monitor groundwater depressurisation as a result of CSG extraction; and
  - Monitor impacts in accordance with the Underground Water Impact Report for each tenure, Water Act and Regulations.
- Verify the preferred water management strategy by modelling effectiveness of substitution and/or injection (where conducted) in offsetting impacts of depressurization;
- Consider local biological, groundwater and surface water conditions when identifying sites for CSG water and brine storage dams;
- Install an appropriate groundwater monitoring network associated with site infrastructure that poses a significant risk to groundwater quality and satisfies the relevant Environmental Authority conditions;
- Prepare groundwater monitoring reports in accordance with the P&G Act, EP Act and Water Act; and
- Develop a structured database to host groundwater data from the project (i.e., groundwater levels and groundwater quality).

None of the identified potential impacts associated with brine storage (Section 3.2.5.1) are considered likely to have any impacts on MNES.

6.8.3 Decommissioning

Prior to commencing ground disturbance activities, a rehabilitation plan will be developed that includes the following practices to maximise the potential for meeting the proposed rehabilitation success criteria and management of potential impacts to MNES values:

- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B157];
- Undertake weed monitoring and targeted weed control measures within sensitive habitat (particularly threatened communities such as brigalow and native grasslands) [B158];
- Woody debris, logs and rocks should be retained for use in rehabilitation. Where practical, these should be piled along the edge of the cleared corridor. However, spreading these features over part or all of the corridor is preferred as it will provide

refugia for crossing fauna. Systematic removal of surface debris should be avoided and cleared timber should never be burnt [B161];

- Plant species used for rehabilitation are specific to the original ecosystem and local provenance, wherever possible unless the area has been cropped or contains improved pasture to be reinstated [B162];
- Regular inspections of pipeline and roads alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to prevent erosion from occurring or worsening [B298];
- Suitable topsoil should be re-spread directly onto rehabilitation areas where practicable. Topsoil should be spread, ameliorated (if required), treated with fertiliser and seeded in one consecutive operation to reduce topsoil loss potential to wind and water erosion. Where possible, soil ameliorants will be applied prior to topsoil stripping to ensure adequate mixing [B059];
- Implement best practice erosion and sediment control measures during decommissioning works in accordance with the requirements of the International Erosion Control Association (IECA) (2008) *Best Practice Erosion and Sediment Control* manual [B337];
- Prevent subsurface water flows and erosion along the backfilled trench by appropriate means, such as trench blocks and compaction of backfilled soils [B074].

A full description of all detailed rehabilitation and monitoring principles, objectives and monitoring requirements that will be employed for the Project in the management of potential impacts to MNES values is detailed in the Decommissioning and Rehabilitation chapter (Section 29.7) of the EIS

6.9 MNES Potential Habitat Mapping

The known occurrence of, and potential likelihood of MNES protected species within the Project area was assessed within the EIS. Specific potential mapping has been developed for this report and is currently in both mapped and tabulated format (Section 8). This potential habitat mapping has been used to further define the potential habitat for MNES species based on a number of criteria, to provide detail to allow for an estimation of potential impact areas. The development of MNES potential habitat mapping provides a refinement of information on MNES distribution and range within the Project area, compared with what appears in the EIS. The MNES species habitat mapping includes:

- Relevant specific habitat requirements for each species to establish the data layers to be utilised for distribution analysis (including relevant recovery plans, habitat data and distribution mapping);
- Species distribution analysis within the Project area based on relevant factors for each species such as associated REs, essential habitat, corridor connectivity landscape units and other known habitat requirements; and
- Expert review and species distribution refinement, based on knowledge of species specific microhabitat utilisation within the region.

6.10 Conceptual Impact Footprint and Impact Estimation

A sample conceptual impact footprint for the Project has been developed to assist in determining the potential impacts on threatened species and ecological communities. The sample conceptual impact footprint outlines in theory the location of key infrastructure elements for field development, including proposed key production facilities (FCFs and CGPFs) for phase one of the Project (see Section 3).

Due to the nature of CSG development, the entire construction footprint for the life of the Project is still unknown. A sample conceptual footprint has been designed for the Project which has been used to calculate the possible disturbance for the life of the Project. It is expected that the disturbance limits calculated and represented in Table 9-4 and Table 9-6 are a maximum disturbance and that the actual disturbance during the project will be lower than those areas shown below.

The method used for determining the entire Project disturbance is as follows:

1. Disturbance of each environmental value from the sample conceptual footprint was calculated.
2. The area of disturbance as a percentage of the total environmental value area within each sample conceptual drainage area was calculated.
3. Disturbance percentages from the sample conceptual footprint were applied to each individual environmental value within drainage areas corresponding to the same well densities as drainage areas in the sample conceptual footprint.

6.10.1 Conservativeness of Impact Estimation

A conservative approach has been taken towards calculating the potential estimated disturbance for the project. The conservative nature of the disturbance estimates is demonstrated by the following factors that have been incorporated into the potential estimated disturbance calculations:

- A disturbance calculation approach that assumes impacts to all environmental values (excluding identified no-go areas such as wetlands, and associated buffers) when reality is that infrastructure will be positioned in accordance with constraints mapping and the Framework approach.
- Linear infrastructure such as power lines and gas transmission pipelines have been calculated as individual disturbance corridors when in reality they will be co-located where possible and will use existing disturbed areas where possible.
- A 25m wide construction right of way for all pipelines, when it has been identified that a smaller right of way may be possible in places due to different construction techniques.
- The maximum disturbance footprint for each piece of infrastructure has been used when it will be possible in some situations to reduce the disturbance footprint.
- The sample conceptual footprint uses the maximum number of well pads for the life of the project.
- The mapping rules used to determine the potential habitat for environmental values are conservative in defining potential habitat areas. The rules are generally broad in scope and identify large areas of potential habitat in three categories (core habitat known, core

habitat possible and general habitat) that capture areas that whilst they may have habitat features, it is highly unlikely that all areas mapped will be suitable as habitat.

6.11 Biodiversity Offset Strategy

Queensland and Australian government policies require the provision of environmental offsets for unavoidable impacts to state significant biodiversity values (SSBVs), and unavoidable significant impacts to MNES. The Bowen Environmental Offsets Strategic Management Plan sets out Arrow's strategy for providing environmental offsets for the Project.

The aim of the Strategic Management Plan is to facilitate discussion with EHP and Department of the Environment on suitable offsets for unavoidable losses of vegetation and habitat incurred in constructing the project.

The document describes the measures taken to avoid and minimise impacts, the expected disturbance to terrestrial ecology environmental values, and evidence that there are opportunities to offset the estimated losses of remnant vegetation, species and habitat. It details Arrow's preferred approach to the provision of environmental offsets.

Potential impacts to MNES, EVNT and SSBVs are outlined within the report and identify the total expected impact for the life of the Project.

Arrow has previously developed a staged approach that accounts for actual losses. In line with the Framework approach, the staged approach manages unavoidable losses and incentivises avoidance to protect environmental values. The staged approach for the project will involve the provision of an up-front offset for the Phase 1 disturbance areas. As design and construction progresses through the other project Phases, an assessment will be carried out to determine the offset requirements as they become apparent. The steps for providing offsets using the staged approach include:

- Assess - determine the estimated area of disturbance using conceptual field development plans and detailed GIS analysis of mapped biodiversity values.
- Demonstrate - avoidance of biodiversity values through review of estimated disturbance areas against the actual disturbance which will be undertaken; and
- Acquit - source offsets to meet criteria for the specific environmental value and discharge offset.

The Bowen Environmental Offsets Strategic Management Plan has been developed in conjunction with the potential habitat mapping and Project impact calculations. It is intended that the Bowen Environmental Offsets Strategic Management Plan and this MNES report are read in tandem as they provide supporting information for each other. The MNES report provides the framework for impact assessment and habitat mapping that has been used to determine the areas to be offset as contained in the Bowen Environmental Offsets Strategic Management Plan.

In accordance with the Bowen Environmental Offsets Strategic Management Plan, a future offset implementation plan will be developed outlining the proposed methodologies and preferred locations for the provision of offsets for the Project.

6.12 Draft Environmental Management Plan

A draft EM Plan (Appendix Z) forms part of the EIS and as such, has been developed in accordance with the Project ToR, but can also be read as a standalone document. The EHP (previously DERM) *Guideline for Preparing an Environmental Management Plan for Coal Seam Gas Activities* (DERM, 2010) was also used to inform the content and structure of this plan.

The purpose of the draft EM Plan is to detail environmental values, potential impacts to these values from Project activities and environmental protection commitments for the Project to implement during planning and design, construction, operation and decommissioning, to enable protection of the identified environmental values.

The draft EM Plan will be utilised to inform a subsequent Operational EM Plan that will be prepared to support the applications for EA or amendments to existing EAs for the Project.

The key objectives of the draft EM Plan are to:

- Document acceptable environmental protection commitments to manage potential impacts on the environmental values as a result of proposed activities and, in doing so, assist the administrating authority decide on the approval conditions for the EIS; and
- Provide the community with evidence that the environmental management of the Project is appropriate.

6.12.1 Environmental Management Plan Scope

The draft EM Plan (Appendix Z) of the EIS describes Arrow's approach to the management of environmental impacts associated with Project activities, from planning and design through to decommissioning and rehabilitation. In accordance with the EP Act, the draft EM Plan contains the sections outlined in Table 6-1 below.

Table 6-1 Environmental Management Plan Sections

Section Number	Section Name	Purpose
Z.1	Introduction	• Provides a background on the Project and the proponent; • Describes the purpose and scope of the draft EM Plan; • Outlines the relevant environmental framework; • Identifies environmentally relevant activities; • Describes relevant Petroleum tenures and authorities; and • Identifies relevant stakeholders.
Z.2	Environmental Management System	Outlines HSEMS. This includes the following aspects: • Arrow's environmental policy; • Roles and responsibilities; • Inductions and training; • Monitoring and reporting; • Incidents and emergencies; • Inspections, reviews and audits;

Section Number	Section Name	Purpose
		• Continuous improvement and corrective action; • Community concerns and complaints; and • Document control and records management.
Z.3	Description of Petroleum Activities	Describes the relevant petroleum activities associated with the Project and the target resource. This section also describes the Project in terms of: • The major infrastructure components (including water treatment and storage); • Power generation facilities; and • The supporting infrastructure and logistics.
Z.4	Environmental Values, Impacts and Management Actions	Identifies the existing environment and environmental values in the Project area, and Arrow's approach to managing potential environmental impacts that are associated with Project activities. Environmental protection commitments are also identified. This section is broken down into the following environmental elements: • Section Z.4.1 – Air Quality; • Section Z.4.2 – Geology, Landform and Soils; • Section Z.4.3 – Landscape and Visual Amenity; • Section Z.4.4 – Terrestrial Ecology; • Section Z.4.5 – Aquatic Ecology; • Section Z.4.6 – Groundwater; • Section Z.4.7 – Surface Water; • Section Z.4.8 – Coal Seam Gas Water; • Section Z.4.9 – Dams; • Section Z.4.10 – Noise and Vibration; • Section Z.4.11 – Waste Management; • Section Z.4.12 – Preliminary Hazard and Risk; • Section Z.4.13 – Indigenous Cultural Heritage; • Section Z.4.14 – Non-Indigenous cultural Heritage; and • Section Z.4.15 – Roads and Transport.
Z.5	Decommissioning and Rehabilitation	This section outlines the final land use options, summarises the decommissioning and rehabilitation goals and objectives, and identified monitoring, auditing and reporting requirements.

7 OCCURRENCE OF MNES

The likelihood of a MNES being present within the Project area was assessed within the technical studies, and is based upon available records, known species range and habitat distribution, habitat suitability, availability of species ecological requirements. The following 'likelihood of occurrence' criteria for occurrence of MNES were used:

- Very Low – the Project area is outside the species normal range, habitat does not exist;
- Low – database searches indicate the species could potentially occur in the Project area, however previous records are likely to be historic or invalid, the Project area is outside the species normal range, habitat does not exist or the species is considered locally extinct;
- Moderate – habitat exists for the species; however it is either marginal or not particularly abundant. The species is known from the wider region and could potentially occur;
- High – the species is known to occur in the local area and critical habitat exists in the Project area; and
- Recorded – the species was recorded in the Project area as part of the field surveys.

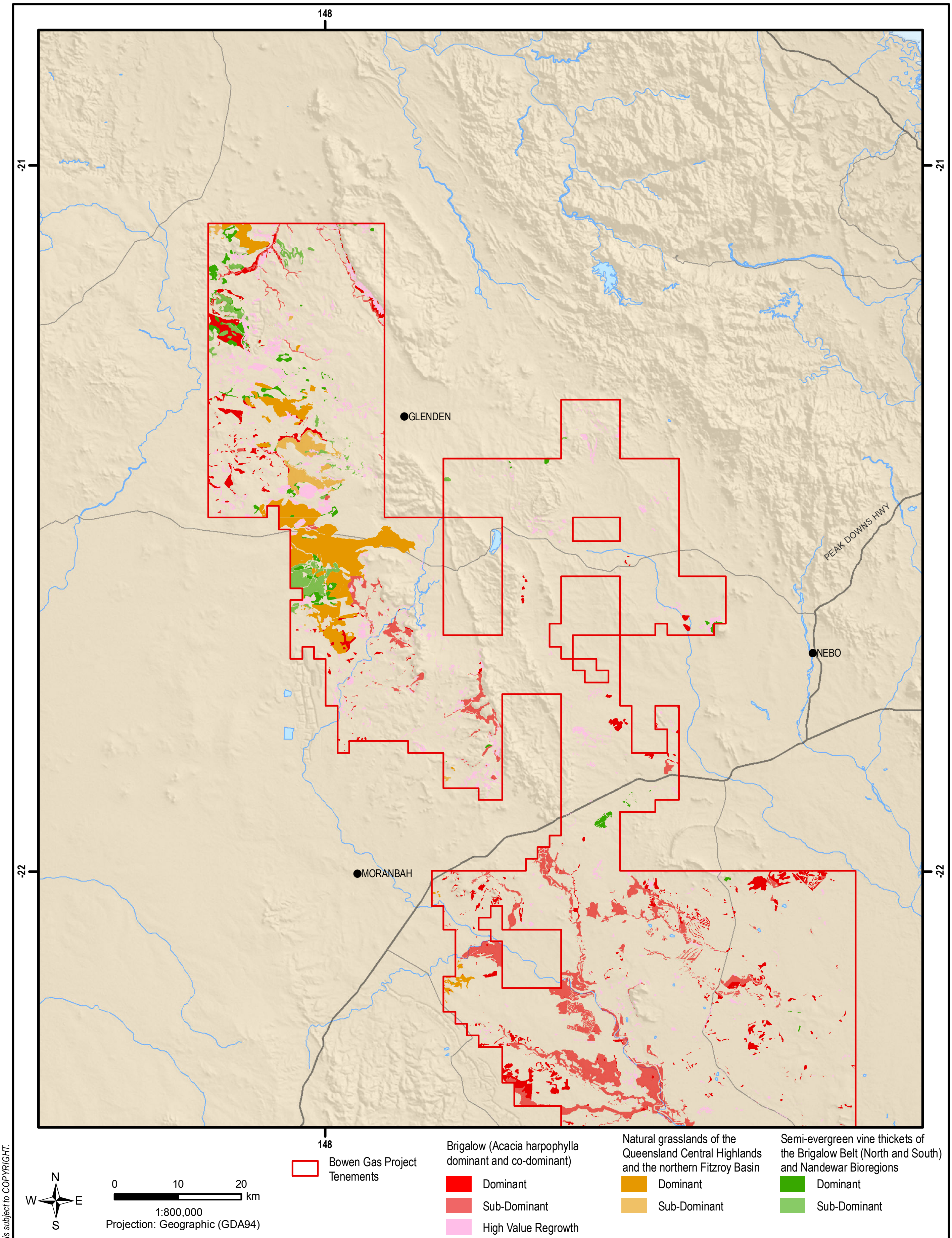
7.1 Threatened Ecological Communities

Five TECs are listed as potentially present within the Project area by the EPBC Act Protected Matters Report (DSEWPaC, 2012) (Appendix A). Table 7-1 provides a likelihood assessment of these TECs within the Project area based upon the field survey and desktop assessment. Figure 7-1presents the potential locations of TECs that are known to be recorded on site within the Project area based on EHP RE mapping (EHP, 2012b).

Table 7-1 Likelihood of Occurrence of TECs

TEC Description	EPBC Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Brigalow (*Acacia harpophylla* dominant and co-dominant) (includes remnant and HVR vegetation)	Endangered	Recorded	*Acacia harpophylla* dominant and co-dominant communities are relatively common in the study area. Based on existing mapping (EHP, 2012b), 21,799 ha of this habitat occurs in the Project area. A number of well-preserved habitats were surveyed in the Project area, associated with more extensive areas of intact remnant vegetation, although the majority of habitats exist as scattered, poorly preserved fragments.
Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Endangered	Recorded	Based on existing mapping (EHP, 2012b), 18,032 ha of this TEC occurs in the Project area. The most extensive occurrence runs in a broad east-west trending belt that occurs between Glenden and Moranbah in the north of the Project area.

TEC Description	EPBC Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Recorded	Relatively extensive areas of vine thicket habitat are mapped in certified RE mapping in the northern portion of the Project area where they are represented by REs 11.5.15, 11.8.3 and 11.8.13 (EHP, 2012b). Field examination confirmed the presence of these habitats although they are by no means as extensive as represented in the certified mapping.
Weeping Myall Woodlands	Endangered	Moderate	The distribution of the weeping myall TEC as provided by DEWHA (2009b) ranges from 100 km north of Clermont, southwards with the eastern-most limit of the ecological community coinciding roughly with the western boundary of the Project area. With the exception of a small area extending to approximately 75 km north of Blackwater. Weeping myall does not form woodland communities of sufficient size for consistent separation as a mappable ecosystem. As such, the community is not recognised as an individual ecosystem within the framework of Queensland's VM Act. Field survey within 'at risk' areas did not locate the ecological community although there is potential for it to occur as small patches within REs 11.3.2 and 11.3.28 (TSSC, 2008b). Further scrutiny of these REs, particularly RE11.3.2 which is known to occur in the Project area, is required when working within areas potentially hosting the ecological community. Given the presence of these REs on site, the likelihood of weeping Myall cannot be discounted.
Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions	Endangered	Low	This TEC was not recorded during the field surveys of the project area. The coolibah – black box woodland TEC is restricted to the Brigalow Belt South Bioregion (TSSC, 2011). This bioregion forms an extremely minor intrusion into the south-western portion of the Project area where habitats are associated with the slopes of the Blackdown Tableland. Hence, in the absence of floodplain vegetation, the coolibah – black box TEC is not expected to occur within the Project area.



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BOWEN GAS PROJECT SREIS

EPBC ACT LISTED TECs POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **7-1a**

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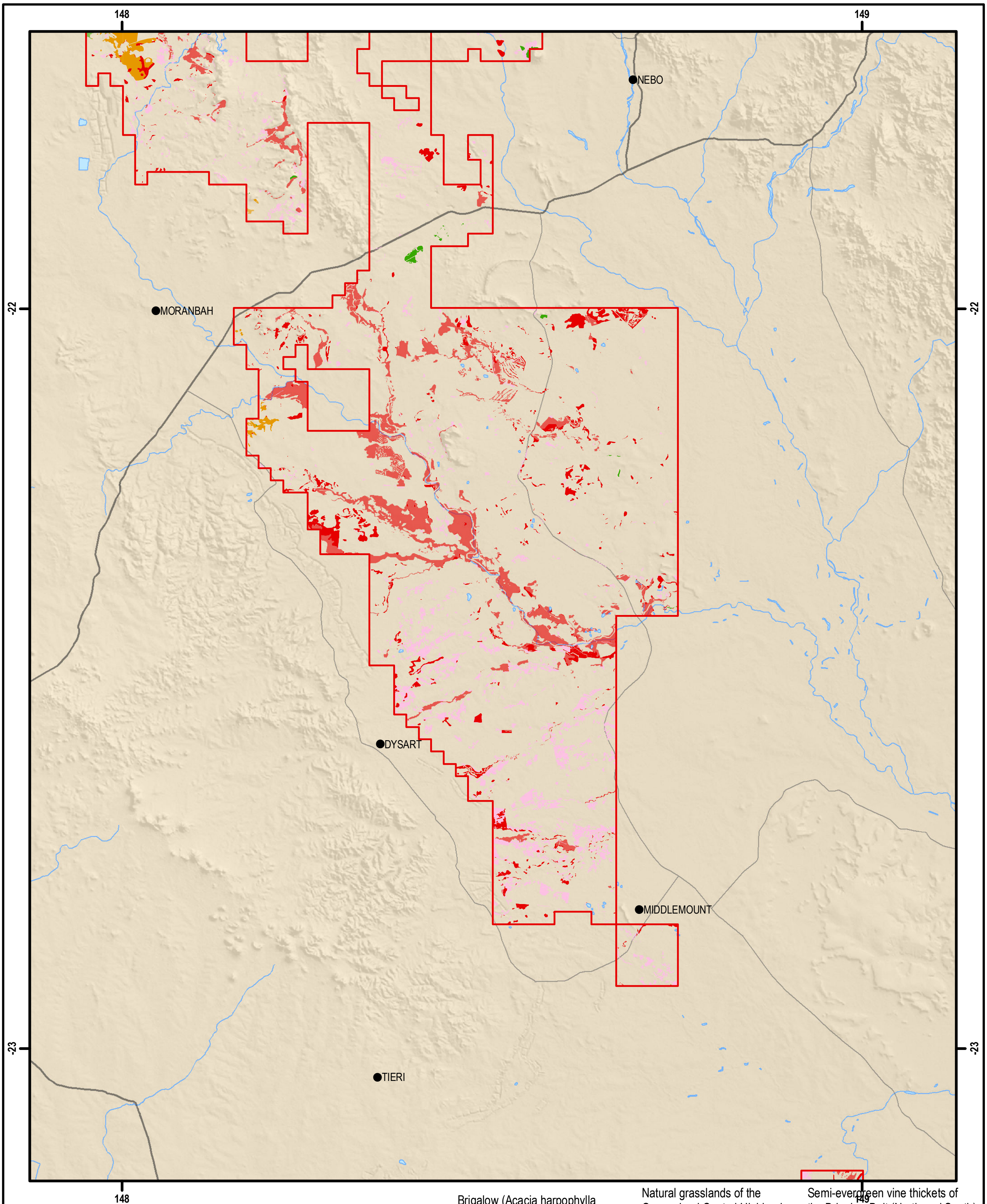

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Projection: Geographic (GDA94)

Bowen Gas Project Tenements	

Brigalow (Acacia harpophylla dominant and co-dominant)
- Dominant
- Sub-Dominant
- High Value Regrowth

Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin
- Dominant
- Sub-Dominant

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Dominant
- Sub-Dominant

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BOWEN GAS PROJECT SREIS

EPBC ACT LISTED TECs POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **7-1b**

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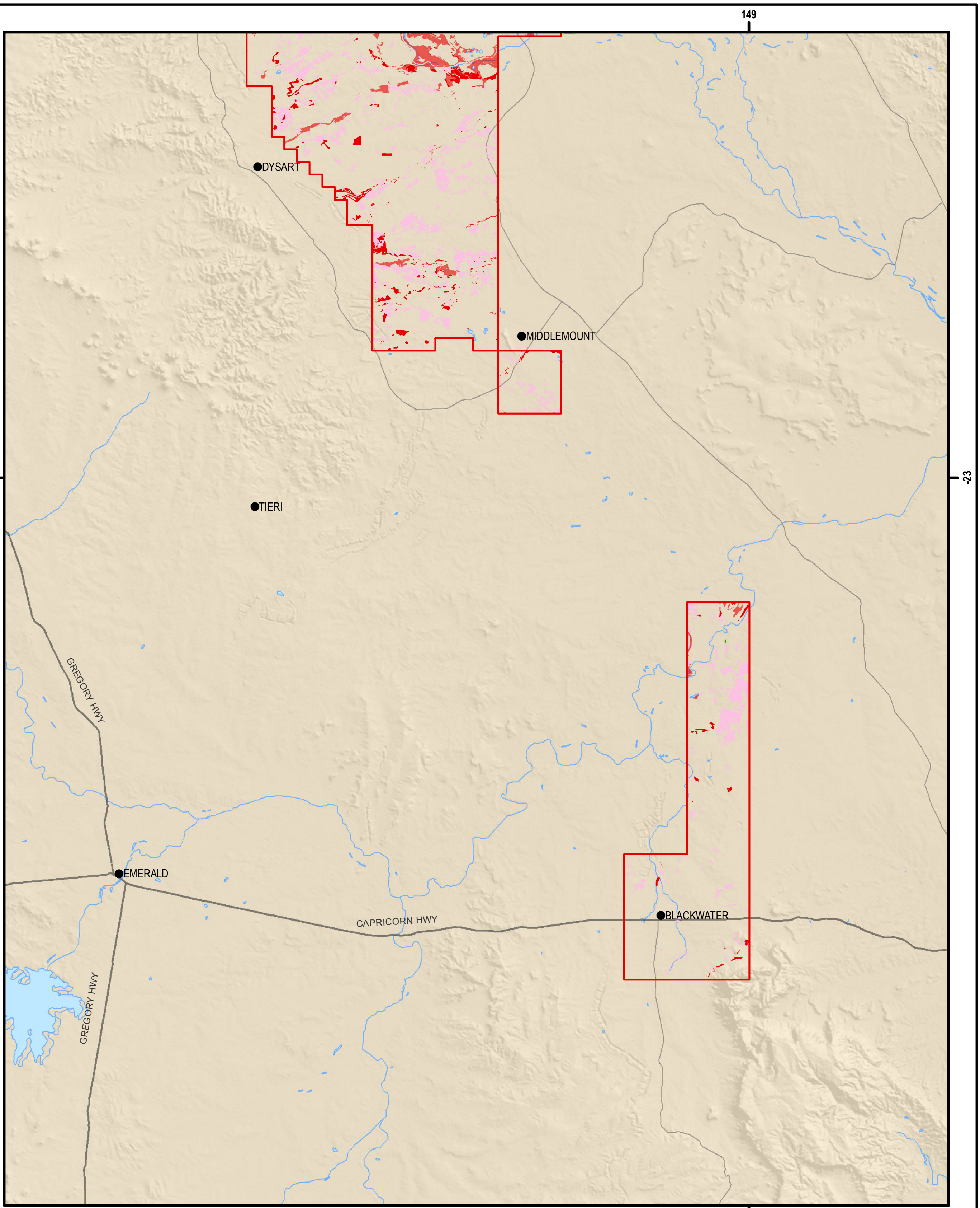

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Projection: Geographic (GDA94)

Bowen Gas Project Tenements

Brigalow (Acacia harpophylla dominant and co-dominant)
- Dominant
- Sub-Dominant
- High Value Regrowth

Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin
- Dominant
- Sub-Dominant

Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Dominant
- Sub-Dominant

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BOWEN GAS PROJECT SREIS

EPBC ACT LISTED TECs POTENTIALLY OCCURRING WITHIN THE PROJECT AREA

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **7-1c**

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7.1.1 *Groundwater Dependant Ecosystems*

Groundwater dependant ecosystems (GDEs) are ecosystems that have their species composition and natural ecological processes determined in part by groundwater. The groundwater parameters that sustain GDEs are flow rate, level, and quality, with dependence potentially being a function of one or all of these factors.

The TEC associated with GDEs is the endangered “Community of native species dependent on natural discharge of groundwater from the Great Artesian Basin”. The native species that comprise this TEC are flora and fauna taxa associated with, and dependent on, the springs and wetland areas located at points where Great Artesian Basin (GAB) groundwater is discharged naturally. The species assemblage for this TEC includes flora and fauna that are endemic to one or more springs / wetlands and species that also occur more widely in the GAB (Threatened Species Scientific Committee, 2001).

There is no known presence or likely potential for presence of this TEC in the Project area, and this community is not listed for the Project area in the EPBC Act Protected Matters Report (DSEWPaC, 2012) (Appendix A).

The locations of all springs in the Bowen Basin were investigated within the groundwater study for the EIS and a list of all registered springs in the region was obtained from the Queensland Herbarium (Fensham and Fairfax, 2005). No springs were listed within the Project area, which is consistent with the observation from the EIS that groundwater is either unconfined or sub-artesian.

Seventeen springs occur outside the Project area, some 10 to 40 km south and southeast of Blackwater, on a sandstone plateau comprised of Clematis Sandstone and known as the Blackdown Tableland National Park (~320 km^2). The sandstone plateau is situated within the Mimosa Management Area of the GAB, adjacent to, and few isolated overlaps with, Project tenement ATP 1025. The springs are known as the ‘Blackdown Tableland Spring Complex’ and are situated on top of the plateau, up to 650 m above the plains. Two of the recorded springs are located on the western base of the plateau and are likely to be fed by groundwater flowing down through the sandstone plateau.

In a regional context, such springs are common along the eastern recharge zones of the GAB and are termed ‘recharge springs’ or ‘recharge reject springs’. At the local scale, these springs form because the sandstone can absorb significant amounts of rainwater but then may discharge some of this groundwater through rock fractures and topographic discontinuities. The actual details of each spring are site-specific, and in general terms, the springs on the Blackdown Tableland National Park are considered to be the product of recent recharge-discharge that occurs on the plateau (Figure 7-2).

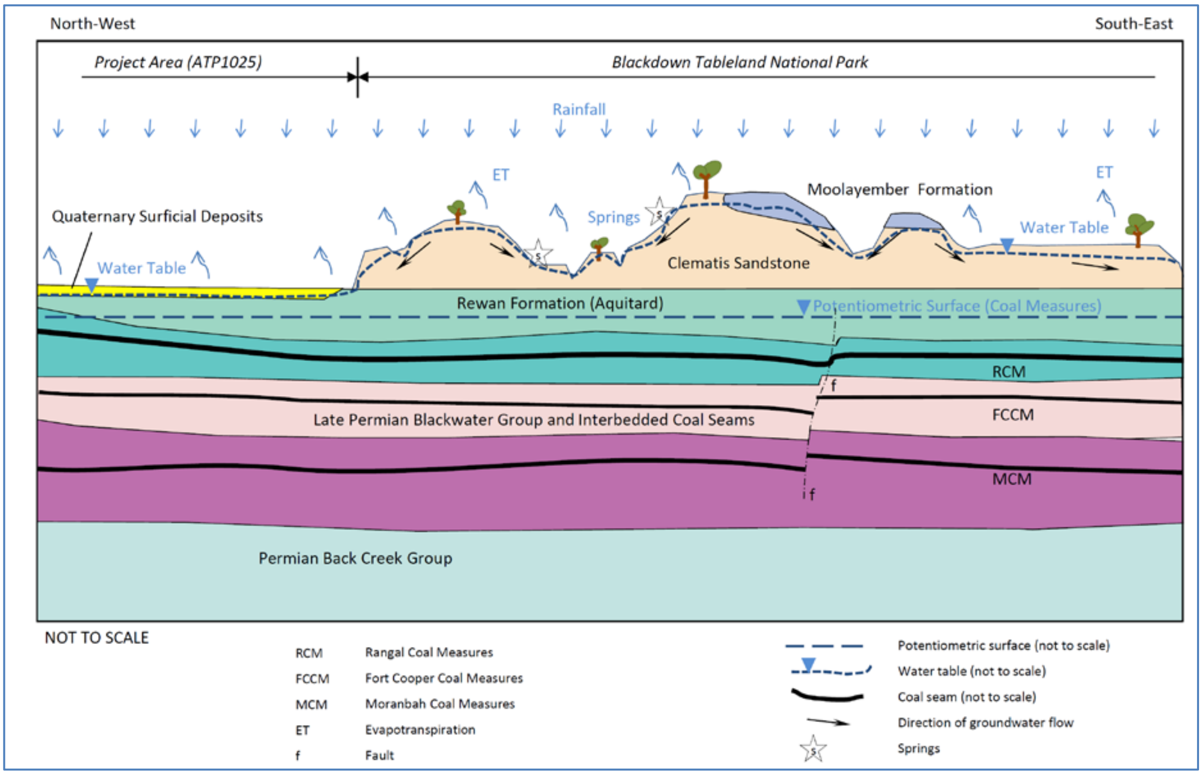
Geology maps (1:250,000) of the area indicate that the Clematis Sandstone is underlain by the Rewan Formation and the conceptual hydrogeological model of the plateau suggests that the Rewan Formation and Blackwater Group interburden (aquitards) will contain the impacts of CSG depressurisation. The springs are fed by recent rainfall on the plateau and are contiguous with perched groundwater in the plateau. Hence potential impacts on the plateau groundwater and associated springs are not considered lieky to occur because:

- The groundwater system is perched above the plains of the Bowen Basin; and
- The Rewan Formation (aquitard) is confining the groundwater from below.

Consequently no drawdown impact is considered as likely to occur for the Blackdown Tableland spring complex.

Discussion of potential imapcts to GDE's outside of the Project area from potential groundwater drawdown is outlined further below in the Water Resources chapter (Section 13.3.4) of this Report.

Figure 7-2 Basic Conceptual Model of Spring Flow in the Blackdown Tableland National Park



7.2 MNES Listed Protected Species

7.2.1 Flora Species

Nineteen EPBC Act-listed threatened flora species were identified within the desktop assessment as possibly occurring within the Project area (DSEWPaC, 2012; Queensland Herbarium, 2012a). The Terrestrial Ecology Technical Reports (Appendix P of the EIS and Appendix I of the SREIS) assessed the threatened species' likelihood of occurrence within the Project area as:

- Two Recorded;
- Two High;
- Two Moderate;
- Seven Very Low; and
- Six no longer listed under the EPBC Act due to status revisions since the original EIS was submitted.

The location of threatened flora species derived from the HERBRECS database (Queensland Herbarium, 2012a), field survey, and a number of independent sources (Appendix P of the EIS and Appendix I of the SREIS) is provided in Figure 7-3. Broad scale habitat mapping for threatened flora species is also provided in Figure 7-3. The tabulated results of likelihood of occurrence assessment are provided in Table 7-2. Further habitat mapping is discussed in Section 8.

Six conservation significant flora species that were listed in the EIS are no longer listed as conservation significant species: *Acacia ramiflora, Croton magneticus, Digitaria porrecta, Leucopogon cuspidatus*, *Taeniophyllum muelleri* and *Trigonostemon inopinatus*. For consistency between the EIS and SREIS, these species are still included in the likelihood of occurrence table, but will not be counted when determining impacts to MNES.

Table 7-2 Threatened Flora Species Likelihood of Occurrence

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
No common name	*Acacia ramiflora*	This species is no longer listed under EPBC Act. Since the inclusion of this species in the EIS assessment it has undergone a status update.	Very Low	This species grows in woodland on sandstone hills (Pedley, 1978 and 1987; Orchard and Wilson, 2001a in DSEWPaC, 2013a). A collection from Hughenden is from pebbly red earth in low open woodland of *Eucalyptus whitei* and *Triodia* sp. (Pedley, 1981 in DSEWPaC, 2013a). This species is restricted to hills of the Great Dividing Range in Qld (Pedley, 1978, 1987 in DSEWPaC, 2013), in the Torrens Creek-Pentland area, and also in the Robertson R. area, near the headwaters of the Gilbert R., Qld (Pedley, 1978, 1987; Orchard and Wilson, 2001a in DSEWPaC, 2013a). *Acacia ramiflora* was not detected during EIS field surveys. Primarily, there is unsuitable habitat and no records of its range within the Project area preclude its presence and therefore it has a Very Low likelihood of occurrence.
No common name	*Aristida annua*	Vulnerable	Moderate	*Aristida annua* is a poorly known species known from 7 collection records with the main population existing between Emerald and Springsure, 50 to 100 km west of the south-western corner of the Project development area. The nearest record is an individual (single) 1999 collection 25 km west of Dysart adjacent to Cotherstone Road near the Peak Range National Park (AVH, 2013). This collection lies 30 km west of the Project development area boundaries and is separated from the main population (of 6 records) by a distance of over 100 km *Aristida annua* was not detected during EIS field surveys. The species possibly occurs within the Project area. A buffered search area retrieved one HERBRECS record (Queensland Herbarium 2012a) located approximately 30 km west of the Project area boundary. The species was not recorded during field surveys of the Project area however suitable habitat in the form of black soil plains occur within the study area.
ooline	*Cadellia pentastylis*	Vulnerable	Very Low	Ooline grows in dry rainforest, semi-evergreen vine thickets (SEVT) and sclerophyll ecological communities, often locally dominant or as an emergent (TSSC, 2008c). Ooline occurs on the western edge of the NSW north-west slopes, from Mt Black Jack near Gunnedah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton (Harden *et al*., 2006). Ooline was not detected during EIS field surveys While suitable SEVT habitat is present within the Project area, all records for the known range of this species are located outside of the Project area to the south of Blackwater. The species is considered to have a Very Low likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
No common name	*Croton magneticus*	This species is no longer listed under EPBC Act. Since the inclusion of this species in the EIS assemsent it has undergone a status update.	Moderate	*Croton magneticus* occurs in deciduous vine thickets on skeletal granite limestone or sandstone soils, including rocky seashores or acid agglomerate substrates (Forster, 2003). It grows in association with numerous vine thicket plant species including *Croton arnhemicus* and *Croton phebalioides*. Separate isolated populations are known between Magnetic Island and Greenvale in the north to Collinsville in the south (Lokkers et al., 2005). This species occurs within the Burdekin (Queensland) Natural Resource Management Region. *Croton magneticus* was not detected during EIS field surveys The species has been previously recorded in vine thicket habitats on basalt to the north of the Project area and therefore it has a Moderate likelihood of occurrence.
Marlborough blue	*Cycas ophiolitica*	Endangered	Very Low	*Cycas ophiolitica* is endemic to Queensland, occurring from Marlborough to Rockhampton in central-eastern Queensland (Hill, 1998a in DSEWPaC, 2013ax), occurring in woodland or open eucalypt woodlands (Queensland Herbarium 2007 in DSEWPaC, 2013ax). The Project area is situated outside the species known extent with the closest record occurring approximately 70 km east of the Project area. Other known occurrences of the species occur further east near Marlborough (120 km east) and Rockhampton (150 km east). Within its range, suitable habitat for *Cycas ophiolitica* includes hills and slopes in sparse, grassy open forest at altitude ranges from 80–400 m above sea level (DSEWPaC, 2013ax). *Cycas ophiolitica* was not detected during field surveys undertaken as part of the EIS. Given the Project area occurs west of the known distribution for this species and that no western records occur in close proximity to the Project area, *Cycas ophiolitica* has a Very Low likelihood of occurrence.
No common name	*Daviesia discolor*	Vulnerable	Very Low	*D. discolor* is known from three widely disjunct localities in Queensland, near Blackwater on the Blackdown Tableland, in the Mount Walsh area near Biggenden (Crisp, 1991) and north of Mount Playfair within Carnarvon National Park (Queensland Herbarium specimen records). On the Blackdown Tableland, *Daviesia discolor* occurs on sandy soil derived from sandstone and on lateritic clay, at altitudes of 600 to 900 m, in open eucalypt forest dominated by species such as Blackdown Stringybark (*Eucalyptus sphaerocarpa*) and Black Stringybark (*Eucalyptus nigra*) (Crisp, 1991).

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
				Daviesia discolor was not detected during the field survey. Suitable habitat is not present within the Project area. All records of this species known range are located to the east of the Project area. The species has a Very Low likelihood of occurrence.
king blue-grass	*Dichanthium queenslandicum*	Endangered	Recorded	King blue-grass was detected during the field survey The species occurs on heavy clay soils, typically vertic in nature, derived from a range of sources including alluvium and basalt. The species is associated with native grasslands, grassy woodlands although may occur in disturbed or non-remnant habitats. The species is endemic to Queensland, and is known from the Brigalow Belt North and South Bioregions with records from the northern Darling Downs, Burnett, Leichhardt, South Kennedy and Mitchell Pastoral Districts. Fensham (1999) considers the taxon restricted to the Central Highlands following its extinction from southern Queensland (in Fensham, 1998). More recently, the species has been found near Jondaryan (R.G. Silcock, unpublished data) and near Roma (Scattini, unpublished data in Silcock *et al*., 2007). The species is known to occur in the Project area. A targeted survey in the late wet season (May 2012) within suitable native grassland habitats identified a robust population of the species in the Lancewood and Wards Well properties. Within these properties, the species is associated with *Dichanthium sericeum* dominant native grassland habitats and associated woodlands (RE11.8.11, RE11.8.5). A single herbarium collection (Queensland Herbarium, 2012a) also exists in the north of the Project area near Newlands Coal Mine. In the vicinity of the Project area, the species is known from scattered collections near Nebo.
blue-grass	*Dichanthium setosum*	Vulnerable	High	Blue-grass is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil (Ayers *et al*., 1996; DEC, 2005a; TSSC, 2008d) and is located in moderately disturbed areas, including cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture (DEC, 2005a). In Queensland it has been reported from the Leichhardt, Moreton, North Kennedy and Port Curtis regions (Henderson, 1997). This species occurs in the Mistake Range, in Main Range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (QDNR, 2001). Blue-grass was not detected during the field survey. Blue-grass is known to occur in the Project area. It has been recorded from six HERBRECS records (Queensland Herbarium, 2012a).

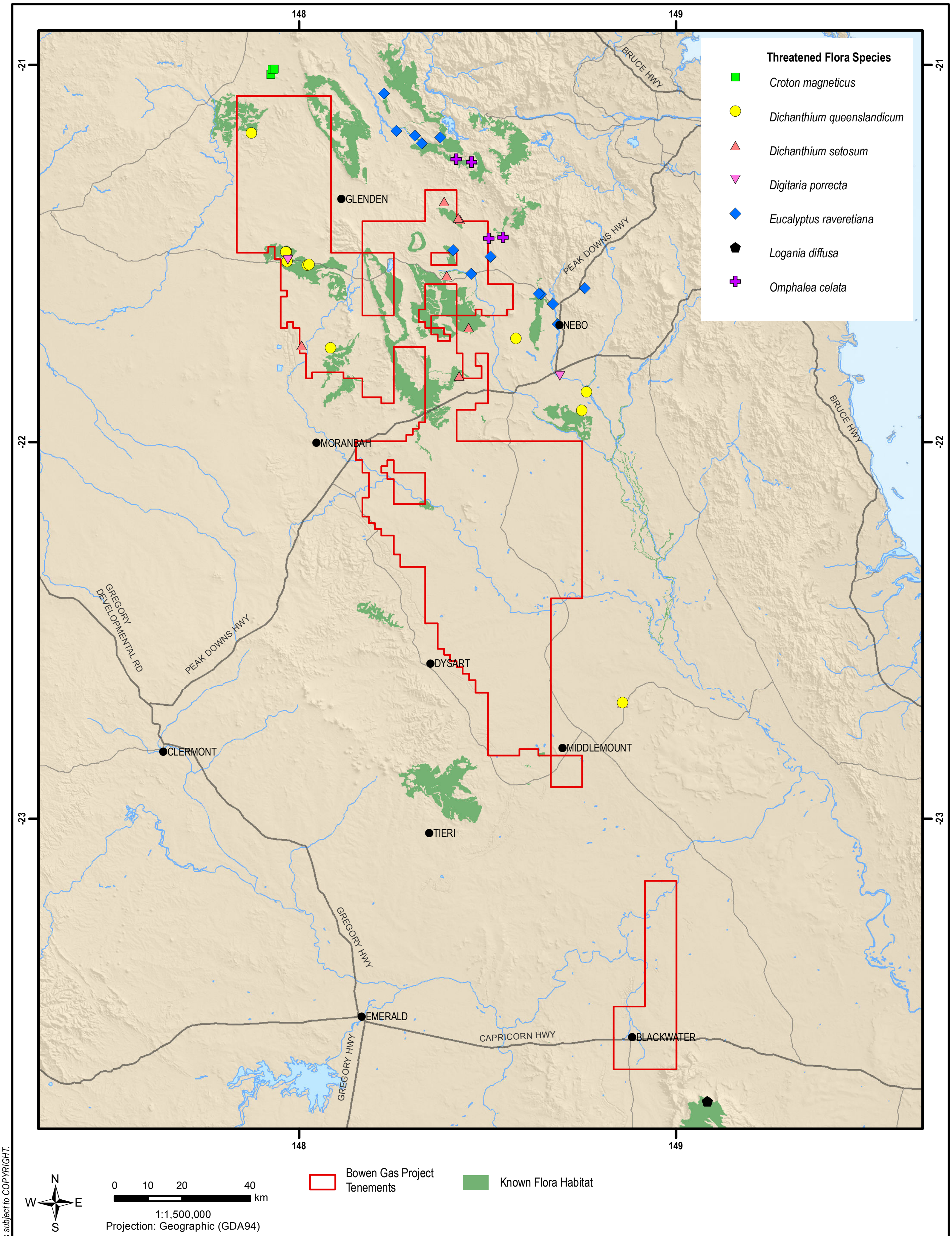
Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
finger panic grass	*Digitaria porrecta*	This species is no longer listed under EPBC Act. Since the inclusion of this species in the EIS assessment it has undergone a status update.	High	Finger panic grass occurs in grasslands, woodlands and open forests associated with basaltic plains and in underlying woodland and open forest with underlying basaltic geology (TSSC, 2008e). In Queensland, habitat is usually formed by woodland of *Eucalyptus orgadophila* (RE 11.8.5) although may also occur in floodplain woodland with associated *Eucalyptus populnea* or *Eucalyptus tereticornis* (TSSC, 2008e). This includes REs 11.3.2 and 11.3.4. It is associated with woodland with a grassy under-storey on heavier black soil plains of the Darling Downs, and lighter textured soils to the west (Goodland, 2000, Halford, 1995; Fensham, 1997). The species is not necessarily restricted to high quality native grasslands, having potential to occur in highly disturbed sites (Goodland, 2000). Its Queensland distribution includes the scattered records in the Nebo district, the Central Highlands between Springsure and Rolleston and from Jandowae south to Warwick. Finger panic grass was not detected during the field survey. The species is known to occur in the Project area. It is recorded as a single roadside record (Queensland Herbarium, 2012a) in the Wards Well property within remnant grassland on cracking clay soils derived from basalt (RE 11.8.11).
black ironbox	*Eucalyptus raveretiana*	Vulnerable	Recorded	Black ironbox is endemic to central coastal and sub-coastal Queensland. It has a strictly riparian habitat and It typically occurs in riparian habitat along rivers and streams where it may grow in association with Queensland blue gum (*Eucalyptus tereticornis*), river red gum *(E. camaldulensis*), Moreton Bay ash (*Corymbia tessellaris*), river oak (*Casuarina cuninghamiana*) and weeping paperbark (*Melaleuca fluviatilis*), or in coastal habitats as an emergent to rainforest on alluvium. Its distribution is scattered and disjunct, being known from the tributaries of the Fitzroy River (Mackenzie, Isaac and Connors Rivers), the Suttor River and its upper tributaries; the Bowen, Burdekin, Don, Bogie, Broughton, Haughton, O'Connell, and Andromache Rivers. Black ironbox was detected during the field survey. The species is known from the Project area and was recorded during field survey from a number of watercourses including Bee Creek, Blenheim Creek and Hail Creek. These habitats are all in the north–east of the Project area.
No common name	*Graptophyllum ilicifoleum*	Vulnerable	Very Low	This species is endemic to central coastal Queensland from the Mackay area with a disjunct population at Miriam Vale, The EPBC Act Species Profiles and Threats (SPRAT) database notes that it grows in tall to very tall mixed notophyll forest. This is a coastal rainforest community and does not exist within the project area. The most current confirmed records of the species have been obtained from the Queensland

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
				Herbarium (2 April 2014) and in discussions with the Herbarium staff to ascertain the correct range of distribution for this species. These records confirm that all specimens are located in coastal and subcoastal rainforest and vine thicket communities that are found further to the east of the Project area. No records of this species are within or are in proximity to the Project Development area, with the closest record over 50 km away to the north east of ATP749 where suitable rainforest community habitat exists in a more suitable less dry microclimate. The Terrestrial Ecology Technical Report (Appendix P, Table 11) of the EIS notes the presence of *Graptophyllum illicifolium* as Unlikely. As tall to very tall mixed notophyll forest is not present in the Project development area, the likelihood of occurrence for this species has been retained as Very Low.
Three-veined hakea	*Hakea trineura*	Vulnerable	Very Low	This species is confined to soils derived from serpentinite rocks mostly on gravelly ridges and slopes (Queensland Herbarium, 1997 in DSEWPaC, 2013b). It grows in open eucalypt forest over hummock grassland (Queensland Herbarium, 1997; Barker *et al*., 1999 in DSEWPaC, 2013b). This species is restricted to the Marlborough and Rockhampton area of central coastal Qld (Queensland Herbarium, 1997; Barker *et al*., 1999 in DSEWPaC, 2013b). *Hakea trineura* was not detected during the field survey. As suitable habitat is not present within the Project area, and all records of the species known range are located to the east of the Project area, the species has a Very Low likelihood of occurrence.
No common name	*Leucopogon cuspidatus*	This species no longer listed under EPBC Act. Since the inclusion of this species in the EIS assessment it has undergone a status update.	Very Low	*L. cuspidatus* collections have been made from open forest, woodland and heath on rocky slopes with granitic or serpentinite substrates (TSSC, 2008f). *L. cuspidatus* occurs in eastern Queensland from Blackdown Tableland in the south to the Mount Stewart area near Homestead Township in the north. Most populations occur in coastal districts and islands, but collections have been made as far west as Blackdown Tableland (TSSC, 2008f). *Leucopogon cuspidatus* was not detected during the field survey. Suitable habitat is not present within the Project area. All records of the species known range are located to the east of the Project area. The species has a Very Low likelihood of occurrence.
No common name	*Logania diffusa*	Vulnerable	Very Low	At Blackdown Tableland, *Logania diffusa* occurs on the top of the plateau escarpment in heathland dominated by *Banksia oblongifolia* and *Leptospermum* spp. and in open forest with *Eucalyptus* spp. and Forest Sheoak (*Allocasuarina torulosa*) in shallow,

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
				sandy, often stony soil overlying sandstone (Conn & Brown, 1996 in TSSC, 2008g). *Logania diffusa* is known from the Blackdown Tableland, central-eastern Queensland (TSSC, 2008g). *Logania diffusa* was not detected during the field survey. As there are no records from the Project (all records are located in Blackdown Tableland NP on sandstones) and suitable habitat within the Project area is not present, the species has a Very Low likelihood of occurrence.
cycad	*Macrozamia platyrhachis*	Endangered	Very Low	*M. platyrhachis* is restricted to the Blackdown Tableland / Planet Downs area of the Dawson Range in central Queensland, in eucalypt woodland or open forest on sandy soil (Queensland Herbarium, 2007). *Macrozamia platyrhachis* was not detected during the field survey. As there are no records of the species known range for the Project area (all records are located in Blackdown Tableland / Planet Downs area of the Dawson Range) and suitable habitat within the Project area is not present, the species has a Very Low likelihood of occurrence.
No common name	*Omphalea celata*	Vulnerable	Low	*Omphalea celata* is known from three sites in central east Queensland. Locations include Hazlewood Gorge, near Eungella; Gloucester Island, near Bowen; and Cooper Creek in the Homevale Station area, north-west of Nebo (TSSC, 2008h). At Hazlewood Gorge, *Omphalea celata* grows in fragmented semi-evergreen vine thicket along a watercourse on weathered metamorphics in a steep-sided gorge at an altitude of 560 m (Forster, 1995). At Cooper Creek, plants grow in the creek bed and adjacent bank (TSSC, 2008h). Prime potential habitat is present east of the Project development area in the Hazelwood Gorge area which features rocky riparian open forests supporting vine thicket communities Additional to the above, the distribution of *Omphalea celata* is not known to overlap with any EPBC TEC community. *Omphalea celata* was not detected during flora field surveys undertaken as part of the EIS The closest records are located outside the north eastern margin of the Project area (300 m) within Homevale National Park. It is considered that potential exists for this species to occur further along Cooper Creek within the Project area. However this part of the creek is confined to Homevale National Parkwhich is a “no go” constraint area for the Project. Despite the proximity of this record, the preferred habitat for the species is uncommon across the Project development area. As such, the remainder of the Project area

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
				(outside Homevale National Park) is considered Unlikely to support this species. *Omphalea celata* is considered a Low occurrence within the Project area. This species has a low likelihood of occurrence within the Project area (excluding Homevale National Park where it's a moderate occurrence along Cooper Creek) no further impact assessment or habitat mapping has been undertaken.
quassia	*Samadera bidwillii (syn. Quassia bidwillii)*	Vulnerable	Very Low	Quassia commonly occurs in lowland rainforest or on rainforest margins (Hewson, 1985 in DSEWPaC, 2013c), but it can also be found in other forest types, such as open forest and woodland (QDNR, 2001 in DSEWPaC, 2013c). Quassia is commonly found in areas adjacent to both temporary and permanent watercourses (Belleng Pty Ltd, 2004 in DSEWPaC, 2013c) in locations up to 510 m altitude. The species occurs on lithosols, skeletal soils, loam soils, sands, silts and sands with clay subsoils (Stanley & Ross, 1983 in DSEWPaC, 2013c). Quassia is endemic to Queensland and is currently known to occur in several localities between Scawfell Island, near Mackay, and Goomboorian, north of Gympie (QDNR, 2001 in DSEWPaC, 2013c). *Samadera bidwillii* was not detected during flora field surveys undertaken as part of the EIS Suitable habitat is not present in the Project area. A HERBRECS record of a *Samadera* sp. from Burton Range is confirmed as an undescribed separate regionally significant taxon. The species has a Very Low likelihood of occurrence.
minute orchid, ribbon-root orchid	*Taeniophyllum muelleri*	This species is no longer listed under EPBC Act. Since the inclusion of this species in the EIS assessment it has undergone a status update.	Very Low	Occurs in rainforests, sheltered areas of open forests, humid gullies and streamside vegetation where it grows on trees and shrubs. Plants in the southerly regions are usually single but in the tropics they are often linked to form clonal colonies, reproducing by proliferation from root tips (ATRO, 2010). Occurs in Queensland from Cape York Peninsula, south to the Wilson River, west of Wauchope in New South Wales at altitudes of 50-1200 m (ATRO, 2010). *Taeniophyllum muelleri* was not detected during flora field surveys undertaken as part of the EIS. Suitable habitat is not present in the Project area. All records of the species range are located to the east of the Project area. The species has a Very Low likelihood of occurrence.
No common name	*Trigonostemon inopinatus*	This species is no longer listed under EPBC Act. Since the inclusion of this species in the EIS assesment it has undergone a status update.	Very Low	Collections of this species have been made in Araucarian microphyll and notophyll vineforest on alluvium along rocky creek banks; complex notophyll vineforest on a granite ridge crest; and mixed notophyll vineforest on granite derived soils, at altitudes of 80–820 m (BRI collection details, n.d. in TSSC, 2008i). It is known from a small area between Mackay and Proserpine in Queensland (Airy

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
				Shaw, 1980 in TSSC, 2008i). *Trigonostemon inopinatus* was not detected during flora field surveys undertaken as part of the EIS Suitable habitat is not present within the Project area. All records located in well-developed rainforest habitats located to the east of the Project area. This species has a Very Low likelihood of occurrence within the Project area.



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arrowenergy go further

BOWEN GAS PROJECT SREIS

LOCATION OF THREATENED FLORA SPECIES

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **7-3**

File No: **42627140-g-2085.mxd** Drawn: **RG** Approved: **DS** Date: **05-03-2014** Rev. **A** A4

7.2.2 *Fauna Species*

Twenty-nine EPBC Act-listed threatened fauna species were identified within the desktop assessment as possibly occurring within the Project area (DSEWPaC, 2012; Queensland Museum, 2012). The Terrestrial Ecology Technical Report (Appendix P) of the EIS has assessed the threatened species' likelihood of occurrence within the Project area as:

- Two recorded;
- Two high;
- Six moderate;
- Two low;
- Fifteen very low; and
- Two no longer listed under the EPBC Act due to status revisions since the original EIS was submitted.

The tabulated results of likelihood of occurrence assessment are provided below in Table 7-3.

Potential habitats in the Project area for threatened fauna that are likely to be present within the Project area are described in Section 8. This mapping was produced through intersection of available records of threatened fauna species (i.e. database results supplemented by field observation) with certified RE mapping (EHP, 2012b), highlighting individual RE polygons in which threatened fauna species have been recorded. These locations have been identified in Figure 7-4.

Table 7-3 Threatened Fauna Species' Likelihood of Occurrence

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
Birds				
paradise parrot	*Psephotus pulcherrimus*	Extinct	Very Low	The paradise parrot mainly inhabited undulating river valleys, lightly timbered with eucalypt woodlands or open forests, often dominated by ironbarks and bloodwoods, with an understorey of annual and perennial native grasses; these areas were often dotted with termitaria (termite mounds) (Chisholm 1922a; Forshaw & Cooper 2002; Higgins 1999; Kiernan 1993 in DSEWPaC, 2013d). Bird surveys were undertaken during EIS field surveys. During these surveys the paradise parrot was not detected. As the species is classed as extinct, it has a Very Low likelihood of occurrence within the Project area.
star finch (eastern)	*Neochmia ruficauda ruficauda*	Endangered	Very Low	The star finch (eastern) population is thought to number less than 50 individuals and could possibly be extinct (Garnett *et al*. 2011). No recent records of the star finch (eastern) occur within central Queensland with the last confirmed sighting in 1994 (Curtis *et al*., 2012). Given that this species has not been confirmed since 1994, the distribution of the star finch (eastern) is very poorly known, with historical records indicating that the star finch (eastern) occured only in central Queensland. Based on the small number of accepted records, the historical distribution of the Star Finch (eastern) is believed to extend north to Bowen, west to beyond Winton and, based on recent records, south to near Wowan (Holmes, 1996, 1998 in DSEWPaC, 2013e). Within the historical distribution, suitable habitat for the star finch (eastern) comprise grasslands and grassy woodlands located within close proximity to bodies of fresh water (Garnett, 1993; Gould, 1865; Holmes, 1996 in DSEWPaC, 2013e) Within the Project area, suitable habitat (grasslands and grassy woodlands) is mapped as occurring. However, Given the absence of relevant recent records and that this species is regarded as possibly extinct, the star finch (eastern) is considered to have a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
black-throated finch	*Poephila cincta cincta*	Endangered	Very Low	The black-throated finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by Eucalyptus, *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands or other habitats (DSEWPaC, 2013f). The black-throated finch (southern) occurs at two general locations: in the Townsville region, where it is considered to be locally common at a few sites around Townsville and Charters Towers (BTF Recovery Team 2004; Garnett & Crowley 2000 in DSEWPaC, 2013f); and at scattered sites in central-eastern Queensland (between Aramac and Great Basalt Wall National Park) (BAAM, 2010; BTF Recovery Team 2004, in DSEWPaC, 2013f). Bird surveys were undertaken during EIS field surveys. During these surveys the black-throated finch was not detected. Given that the project area is outside of the species' habitat and range, the black-throated finch is unlikely to be present and is considered to have a very Low likelihood of occurrence within the Project area.
swift parrot	*Lathamus discolor*	Endangered	Very Low	The swift parrot inhabits dry sclerophyll eucalypt forests and woodlands (DSEWPaC, 2013g). The swift parrot is endemic to south-eastern Australia. It breeds only in Tasmania, and migrates to mainland Australia in autumn (Higgins 1999; Swift Parrot Recovery Team 2001 in DSEWPaC, 2013g). This species is semi-nomadic during winter, foraging in dry woodlands mainly in Victoria and New South Wales. It has been recorded regularly in south-eastern Queensland. Recent records from southern Queensland have come from the Gold Coast, Noosa, Toowoomba, Warwick and Lockyer Valley areas (Swift Parrot Recovery Team, 2001 in DSEWPaC, 2013g). Bird surveys were undertaken during EIS field surveys. During these surveys the swift parrot was not detected. The Project area is located outside of the species range and therefore the swift parrot has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
squatter pigeon	*Geophaps scripta scripta*	Vulnerable	Recorded	The squatter pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts (EPA, 2006; Frith, 1982; Leach, 1988 in DSEWPaC, 2013h). It has also been recorded in disturbed habitats (i.e. around stockyards, along roads and railways, and around settlements) (Longmore, 1976; Lord, 1956 in DSEWPaC, 2013h). The species is commonly observed in habitats that are located close to bodies of water (EPA, 2006; North, 1913-14 in DSEWPaC, 2013h). The squatter pigeon occurs on the inland slopes of the Great Dividing Range. Its distribution extends from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Port Curtis (near Gladstone), and south to scattered sites throughout south-eastern Queensland (Frith, 1982; Higgins & Davies, 1996; Schodde & Mason, 1997; Storr, 1984 in DSEWPaC, 2013h). The squatter pigeon was recorded during field surveys undertaken for the EIS. The squatter pigeon is common and widespread throughout the Project area and has a High likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
red goshawk	*Erythrotriorchis radiatus*	Vulnerable	Moderate	The red goshawk is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley Division (north of 19°S) to north-eastern NSW (north of 33°), and occasionally on continental islands (Aumann & Baker-Gabb, 1991; Marchant & Higgins, 1993 in DSEWPaC, 2013i). Within Queensland, the records for the red goshawk indicate that it has primarily been recorded within the Great Dividing Range. Records west of the Great Dividing Range in Central Australia occur however, these are thought to most likely be dispersive individuals (DSEWPaC, 2013i). The red goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia (Marchant & Higgins, 1993 in DSEWPaC, 2013i). Nesting habitat for this species consists of tall stands of trees invariably within 1 km of permanent water, often adjacent to rivers or clearings. Foraging habitat for resident red goshawk pairs include intact, extensive woodlands and forests with a mosaic of vegetation types that are open enough for fast manoeuvring flight. Favoured areas typically contain permanent water and support large populations of birds to forage upon. Historical records in close proximity to the Fitzroy River and Mackenzie River occur outside the Project area (50 km south east). The most recent of these records was taken in 1914. Field surveys for the red goshawk undertaken during EIS studies include general bird surveys. During this study the red goshawk was not detected. Habitat for this species within the Project area is marginal. Suitable nesting and foraging habitat such as extensive woodlands within range of permanent water are largely absent within the Project area. Typically, watercourses within the Project area do not support permanent water and adjacent vegetation or riparian zones have been extensively disturbed during historical grazing practices. The absence of recent records and restricted amount of permanent water and extensive woodland habitat for nesting and foraging within the Project area suggest this species is an unlikely resident. Potential exists for dispersive individuals to move through the Project area. Given this and that the species occurs in low densities even in optimal habitat, the red goshawk is regarded as having a moderate likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
plains-wanderer	*Pedionomus torquatus*	Vulnerable	Very Low	The plains-wanderer inhabits sparse, treeless, lowland native grasslands (Baker-Gabb, 1987b, 1990b, 2002; Harrington *et al*., 1988 in DSEWPaC, 2013j). In Queensland, more than 80% of records have been made in the channel country in the far west of the state (Baker-Gabb, 1990a, 2002; Bennett, 1983 in DSEWPaC, 2013j). These records are concentrated in the northern reaches of Astrebla Downs National Park (which was formerly part of Davenport Downs Station), the southern reaches of Diamantina Lakes National Park, and on Sandringham Station (Baker-Gabb, 1990a, 2002b in DSEWPaC, 2013j). Astrebla Downs National Park is approximately 800 km west of the Project bounds. Bird surveys were undertaken during EIS field surveys. During these surveys the plains-wander was not detected. Given that the Project area occurs outside the known QLD distribution of the species and that suitable habitat is largely absent within the Project area, the plains-wanderer has a very Low likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
Australian painted snipe	*Rostratula australis*	Endangered	Moderate	The Australian painted snipe has been recorded at wetlands in all states of Australia (Barrett et al., 2003; Blakers et al., 1984; Hall, 1910b in DSEWPaC, 2013k).Within Queensland, the Australian painted snipe has been recorded largely throughout northern areas of the state (Cape York) (DSEWPaC, 2013k). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (Marchant & Higgins, 1993 in DSEWPaC, 2013k). Wetlands suitable to this species are mapped within the Project area. Despite the occurrence of wetlands, few known records near the Project area suggest that it is not a regular inhabitant. General bird surveys within wetlands across the Project area were undertaken as part of the fauna field survey program. During these surveys the Australian painted snipe was not detected during field surveys. The Australian painted snipe is regarded as having a Moderate likelihood of occurance given the species is known from the wider area and that suitable habitat such as freshwater wetlands are mapped within the area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
black-breasted button-quail	*Turnix melanogaster*	Vulnerable	Very Low	The black-breasted button-quail is restricted to rainforests and forests, mostly in areas with 770-1200 mm rainfall per annum (Bennett, 1985; Hughes & Hughes, 1991; Marchant & Higgins, 1993 in DSEWPaC, 2013l). They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest (Bennett, 1985; Hughes & Hughes, 1991; Marchant & Higgins, 1993; Milledge, 2000; Smyth *et al*., 2001 in DSEWPaC, 2013l). The black-breasted button-quail is endemic to eastern Australia. It is restricted to coastal and near-coastal regions of south-eastern Queensland and north-eastern New South Wales. The main populations occur within south-east Queensland. General bird surveys were undertaken during EIS field surveys. This species was not detected during these surveys. No records of this species occur within 60 km of the Project area, with most records occurring north of the Sunshine Coast down to northern NSW. Habitat for this species within the Project area is minimal. The Project area occurs north of the known distribution areas. Given this the black-breasted button-quail has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
Mammals				
northern quoll	*Dasyurus hallucatus*	Endangered	Moderate	The northern quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert (Threatened Species Scientific Committee 2005aq in DSEWPaC, 2013m). The northern quoll now occurs in five regional populations across Queensland, the Northern Territory and Western Australia both on the mainland and on offshore islands (DSEWPaC, 2013m). Records of the species within the Project area and surrounding area are known, though few records exist. The most recent records in proximity to the Project area include individuals in Dipperu National Park (1971), Mt. Hess (2002) and within Homevale National Park (2003). Northern quoll are most likely to be associated with the Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland and therefore has a Moderate likelihood of occurrence.
northern bettong	*Bettongia tropica*	Endangered	Very Low	The preferred habitat of the northern bettong is tall and medium open eucalypt forest with grassy understorey (Harrington & Sanderson, 1994; Maxwell *et al*., 1996 in DSEWPaC, 2013n). These habitat types occur as a narrow fragmented strip along the western edge of wet tropical rainforests. Historically, the northern bettong occurred in Queensland, from Rockhampton to the present northern distribution near Cairns (Laurance 1997; Wakefield 1967 in DSEWPaC, 2013n). This species is no longer present within the local area or region and therefore it has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
bridled nail-tail wallaby	*Onychogalea fraenata*	Endangered	Very Low	The bridled nail-tail wallaby previously occupied *Acacia* shrubland and grassy woodland in semi-arid regions of eastern Australia. The only known significant population occurs in Taunton National Park (Scientific), located near the town of Dingo (Davidson, 1991; Lundie-Jenkins, 2001 in DSEWPaC, 2013o). Taunton National Park is situated approximately 25 km east of the Project with no contiguous vegetation between the park and the Project area. The population is outside the Project area. High levels of disturbance and fragmentation make it unlikely that it would have traversed to the Project area. Therefore, it has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
brush-tailed rock-wallaby	*Petrogale penicillata*	Vulnerable	Very Low	Populations of the brush-tailed rock wallaby within Queensland occurs, or did occur, throughout the Great Dividing Range from the NSW border to Nanango, Queensland (approximately 100 km northwest of Brisbane) (DSEWPaC, 2013p). Nanango, Queensland is located 400 km south of the Project area. Suitable habitat in which the brush-tailed wallaby occurs comprises of rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks (Murray, et al., 2008; Short, 1982 in DSEWPaC, 2013p). The Project area occurs outside the known distribution of this species, and museum records for this species do not occur within the Project area, records for this species are present within 100 km of the Project area, with the closest occurring near Blackdown Tableland National Park (60 km south east of the Project area). These records are considered historical (sampled 1929) and overlap with matching records (duplicate location and date) for Herbert's rock wallaby (*Petrogale penicillata herberti*). Analysis of museum records within Australia, suggest core populations and habitat for this species occur along the Great Dividing Range within habitat south of Nanango, Queensland. Fauna surveys were undertaken during the EIS. During these surveys, the brush-tailed rock wallaby was not detected. Given that the Project area occurs outside of the current distribution (Nanango being the northern extent) and that no records occur within the Project area, the brush-tailed rock-wallaby is considered a Very Low likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
koala[1]	*Phascolarctos cinereus*	Vulnerable	High	Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus* (Martin & Handasyde, 1999 in DSEWPaC, 2013q). The distribution of koalas is also affected by altitude (limited to <800mASL), temperature and, at the western and northern ends of the range, leaf moisture (Munks *et al*., 1996 in DSEWPaC, 2013q). Within central Queensland, koalas have been studied at Tambo (Mitchell Grass Downs bioregion), Springsure and Blair Athol (both in Brigalow Belt North bioregion). Koalas in this region typically occur in low densities and have large home ranges (Ellis *et al*., 2002 in DSEWPaC, 2013q). Fauna surveys undertaken during the EIS did not detect this species. The koala is sparsely distributed within the Project area and therefore has a High likelihood of occurrence.
south-eastern long-eared bat[2]	*Nyctophilus corbeni*	Vulnerable	Moderate	The south-eastern long-eared bat occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands (DSEWPaC, 2013r). Most records are from large tracts of vegetation of approximately 5,000+ ha (e.g. Southwood National Park) (EPA, 2008c), although the species can be recorded from smaller tracts of 600 ha (e.g. Erringibba National Park; M. Sanders pers obs). The distribution of this species approximates the Murray-Darling Basin, south from near Taroom in central Queensland through inland NSW into northern Victoria and the corner of South Australia (Danggali Conservation Park) around the Murray River (Churchill, 2008; van Dyck and Strahan, 2008; Parnaby, 2009). The species' stronghold appears to be within the Pilliga forests of central NSW (Turbill and Ellis, 2006). Most of the Project area is outside the known range of this species. However several individuals have been recorded in the south near the Blackdown Tableland and Dawson Range State Forest. The species may occur only in the southern portions of the Project area. It has a Moderate likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
large-eared pied bat	*Chalinolobus dwyeri*	Vulnerable	Moderate	Habitat of importance to the large-eared pied bat include sandstone cliffs and fertile woodland valley habitat within close proximity of each other (NSW DECC, 2007d in DSEWPaC, 2013s). Records from south-east Queensland suggest that rainforest and moist eucalypt forest habitats on other geological substrates (rhyolite, trachyte and basalt) at high elevation are of similar importance to the species (Gynther, 2011 pers. comm. cited in DERM, 2011; Mathieson, 2011 pers. comm. cited in DERM, 2011 in DSEWPaC, 2013s). In Queensland, records are known from sandstone escarpments in the Carnarvon, Expedition Ranges and Blackdown Tablelands. It is likely that these areas support a high proportion of the Queensland populations of the large-eared pied bat, although estimates of the number of individuals present and their distribution in these areas has not been established (DSEWPaC, 2013s). The species has the potential to be present within the Project area and therefore has a Moderate likelihood of occurrence.
spectacled flying-fox	*Pteropus conspicillatus*	Vulnerable	Very Low	The spectacled flying-fox is associated primarily with rainforest and sometimes with mangroves containing black flying-foxes (Hall & Richards, 2000; Richards, 1990 in DSEWPaC, 2013t). Roosts are always found within six km of rainforest (Richards, 1990 in DSEWPaC, 2013t). The Mabi Forest (Complex Notophyll Vine Forest 5b) is considered a key habitat for the Spectacled Flying-fox (WWF, 2003 in DSEWPaC, 2013t). The spectacled flying-fox occurs in north-eastern Queensland, north of Cardwell with past records from Brisbane and Chillagoe (Hall & Richards, 2000; Richards, 1990 in DSEWPaC, 2013t). It is restricted to tropical rainforest areas (Webb & Tidemann, 1996 in DSEWPaC, 2013t), most specifically, the species occurs between Ingham and Cooktown, and between the McIlwraith and Iron Ranges of Cape York. Fauna surveys undertaken during the EIS did not detect this species. The Project area is outside the known range of the spectacled flying-fox and lacks suitable roosting habitat such as rainforest. As such it has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
grey-headed flying-fox	*Pteropus poliocephalus*	Vulnerable	Low	The grey-headed flying-fox is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas (DSEWPaC, 2013u). The grey-headed flying-fox occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (Tidemann, 1998 in DSEWPaC, 2013u). However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years. Fauna surveys undertaken during the EIS did not detect this species. Habitat for this species within the Project area is marginal. Only two known records suggest it is not a regular inhabitant of the area. Core habitat for the grey-headed flying-fox occurs within the coastal lowlands and slopes of south-eastern Australia with its northerly extent occurring at Rockhampton, Qld. Whilst, the grey-headed flying fox is wide ranging, the Project area is considered to occur outside the western and northern extent of the species range. As such, the species is considered to be a Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
Reptiles				
Allan's lerista, Retro slider	*Lerista allanae*	Endangered	Very Low	The Retro slider is known only from black soil downs (undulating plains formed on basalt, shale, sandstone and unconsolidated sediments) of the Oxford land system in the Brigalow Belt South Biogeographic Region. The Retro slider's range is believed to occur within the area bound by coordinates: 21°00'–24°00' S and 147°00'–149°00' E (Brigalow Belt Reptiles Workshop 2010 in DSEWPaC, 2013v). This area is within the Brigalow Belt North Bioregion (Interim Biogeographic Regionalisation of Australia) in eastern central Queensland. The restricted distribution of the Retro slider is severely fragmented across the landscape as a result of clearing, mostly for agriculture. Populations are known to occur on freehold lands and in road reserves (Brigalow Belt Reptiles Workshop 2010 in DSEWPaC, 2013v). General fauna observational surveys undertaken during the EIS did not detect this species. The distribution of for *L. allanae* occurs outside of the Project area and therefore it has a Very Low likelihood of occurrence within the Project area.
Mount Cooper striped lerista	*Lerista vittata*	Vulnerable	Very Low	In the Mount Cooper area, south-west of Charters Towers, the species has been found in a variety of habitats. These include REs 11.5.9, 9.12.1a, 11.5.15 and spinifex communities (Brigalow Belt Reptiles Workshop, 2010; Cogger *et al*., 1993; Wilson & Knowles, 1988 in DSEWPaC, 2013w). *Lerista vittata* was first described at Mount Cooper Station, approximately 80 km south-east of Charters Towers, Queensland. A second population has been tentatively identified approximately 100–200 km NNW of Hughenden on the Chudleigh Plateau (DSEWPaC, 2013w). General fauna surveys undertaken during the EIS did not detect this species. The known distribution of this species is outside of the region and therefore it has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
ornamental snake	*Denisonia maculata*	Vulnerable	Recorded	Ornamental snake habitat is likely to be found in Brigalow (*Acacia harpophylla*), Gidgee (*Acacia cambagei*), Blackwood (*Acacia argyrodendron*) or Coolibah (*Eucalyptus coolabah*)-dominated vegetation communities, or pure grassland associated with gilgais (Brigalow Belt Reptiles Workshop, 2010 in DSEWPaC, 2013x). The species is known only from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions. The core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson Rivers (McDonald *et al*., 1991; Cogger *et al*., 1993 in DSEWPaC, 2013x). During the EIS field survey the ornamental snake was found in woodland of *Eucalyptus coolabah* with scattered *Casuarina cristata* palustrine wetland with shallow gilgai development and groundcover dominated by *Eleocharis pallens*. Its occurrence is therefore ‘recorded’.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
brigalow scaly-foot	*Paradelma orientalis*	No longer listed under EPBC Act. Since the inclusion of this species in the EIS assessment it has undergone a status update	High	The brigalow scaly-foot's core habitat occurs mostly within the Brigalow Belt South bioregion. The species is found in a wide variety of remnant and non-remnant open forest to woodland habitats. The species is known to persist in highly disturbed vegetation types (DSEWPaC, 2013y) The known distribution of the brigalow scaly-foot extends from Nebo in the north, Boyne Island in the east, Wyaga in the south and Ulcanbah Station and Idalia National Park (NP) in the west (Kutt *et al*., 2003, Tremul, 2000; TSN, 2008b in DSEWPaC, 2013y). The species occurs in the Brigalow Belt North and South bioregions (Cogger *et al*., 1993 in DSEWPaC, 2013y), the southern parts of the Desert Uplands bioregion and the Mulga Lands bioregion (TSN, 2008b in DSEWPaC, 2013y). Important brigalow scaly-foot populations occur in large contiguous areas of remnant vegetation that are suitable for the species, such as the central Queensland sandstone rises, the Blackwater/Blackdown Tablelands region, the Moura/Theodore region and the Boyne Island area. Such areas of remnant vegetation are considered important strongholds for the species. Any populations found in such habitats are, therefore, important (Brigalow Belt Reptiles Workshop 2010 in DSEWPaC, 2013y). The brigalow scaly-foot was not recorded during EIS fauna surveys. However, the brigalow scaly-foot is known to be present within the Project area and as such has a High likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
stripe-tailed delma	*Delma labialis*	No longer listed under EPBC Act. Since the inclusion of this species in the EIS assessment it has undergone a status update	Moderate	The striped-tailed delma has been found in a variety of habitats, including low and tall open forests and open woodland (all with grassy understory), wet sclerophyll forest, coastal microphyll/notophyll vine forests/thickets, eucalypt forest and woodland with dense *Xanthorrhoea* and *Acacia* mid-storey to understory, spinifex, and seasonally dry tea-tree (*Melaleuca viridiflora*) swamp (Brigalow Belt Reptiles Workshop, 2010; Queensland Museum, 2009; Woodcock, 2008 in DSEWPaC, 2013z). The striped-tailed delma has been found in the coastal region of central North Queensland from Paluma (north of Townsville) south as far as Keswick Island (off Mackay). The species is known to occur on Magnetic, South Molle, Shaw and the Whitsunday Islands. The species is currently known to occur between 0–800 m above sea level (Brigalow Belt Reptiles Workshop, 2010; Lloyd, 2005; DERM, 2010; Queensland Museum, 2009 in DSEWPaC, 2013z). Within the Bowen Basin, this species is rare. It is represented within the Project development area by a single road kill record from near Lake Elphinstone. The stripe-tailed delma was not detected during EIS field surveys. The striped-tailed delma is known from a single record within the Project development area. The individual was located near Burton Gorge Dam, and associated populations are likely to be restricted to remnant vegetation associated with the Kerlong Range. As such it has a Moderate likelihood of occurrence.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
collared delma	*Delma torquata*	Vulnerable	Very Low	The collared delma normally inhabits eucalypt-dominated woodlands and open-forests in Queensland RE land zones 3 (Alluvium (river and creek flats)), 9 (Undulating country on fine-grained sedimentary rocks) and 10 (Sandstone Ranges) (Brigalow Belt Reptiles Workshop, 2010 in DSEWPaC, 2013aa) The species has been recorded at the following sites (Davidson, 1993; Peck & Hobson, 2007 in DSEWPaC, 2013aa): • the Bunya Mountains (approximately 200 km north-west of Brisbane); • Blackdown Tablelands National Park (approximately 200 km west of Rockhampton); • Expedition National Park (Central Queensland); • Western Creek, near Millmerran (approximately 200 km south-west of Brisbane); and • the Toowoomba Range. General fauna surveys undertaken during the EIS, including habitat searches for reptiles, did not detect this species. The Project area is situated north of the known distribution of this species. The Blackdown Tablelands National Park is the most proximate area in which this species is known to occur (15 km south east of the southern Project gas field). Habitat suitable to the collared delma is considered absent from the southern Project gas field. The northern Project gas field is considered outside the species distribution. Given this, the collared delma is not likely to be present. As such it has a Very Low likelihood of occurrence within the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
yakka skink	*Egernia rugosa*	Vulnerable	Moderate	The known distribution of the yakka skink extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt (North and South) (Brigalow Belt Reptiles Workshop, 2010; Cogger, 2000; Wilson & Knowles, 1988 in DSEWPaC, 2013ab). The yakka skink is known to occur in open dry sclerophyll forest, woodland and scrub (Brigalow Belt Reptiles Workshop, 2010; Cogger, 2000; Wilson & Knowles, 1988 in DSEWPaC, 2013ab). The core habitat of this species is within the Mulga Lands and Brigalow Belt South Bioregions (TSN, 2008b in DSEWPaC, 2013ab). Within the above habitat types, microhabitat preferential to the yakka skink include rocks, logs or tree stumps, root cavities and abandoned animal burrows (Brigalow Belt Reptiles Workshop, 2010; TSN 2008b in DSEWPaC, 2013ab). No records of the yakka skink occur within or close proximity to the northern Project gas field. Two records occur in proximity to the southern Project gasfield at 3 km and 16 km to the west of the boundary. It is considered that marginal habitat may exist in the southern Project gas field. The yakka skink was not detected during field surveys in this area. The northern gas field has been included in the habitat mapping as a precaution. Given the above, the yakka skink is a Moderate likelihood of occurrence within the Project area.

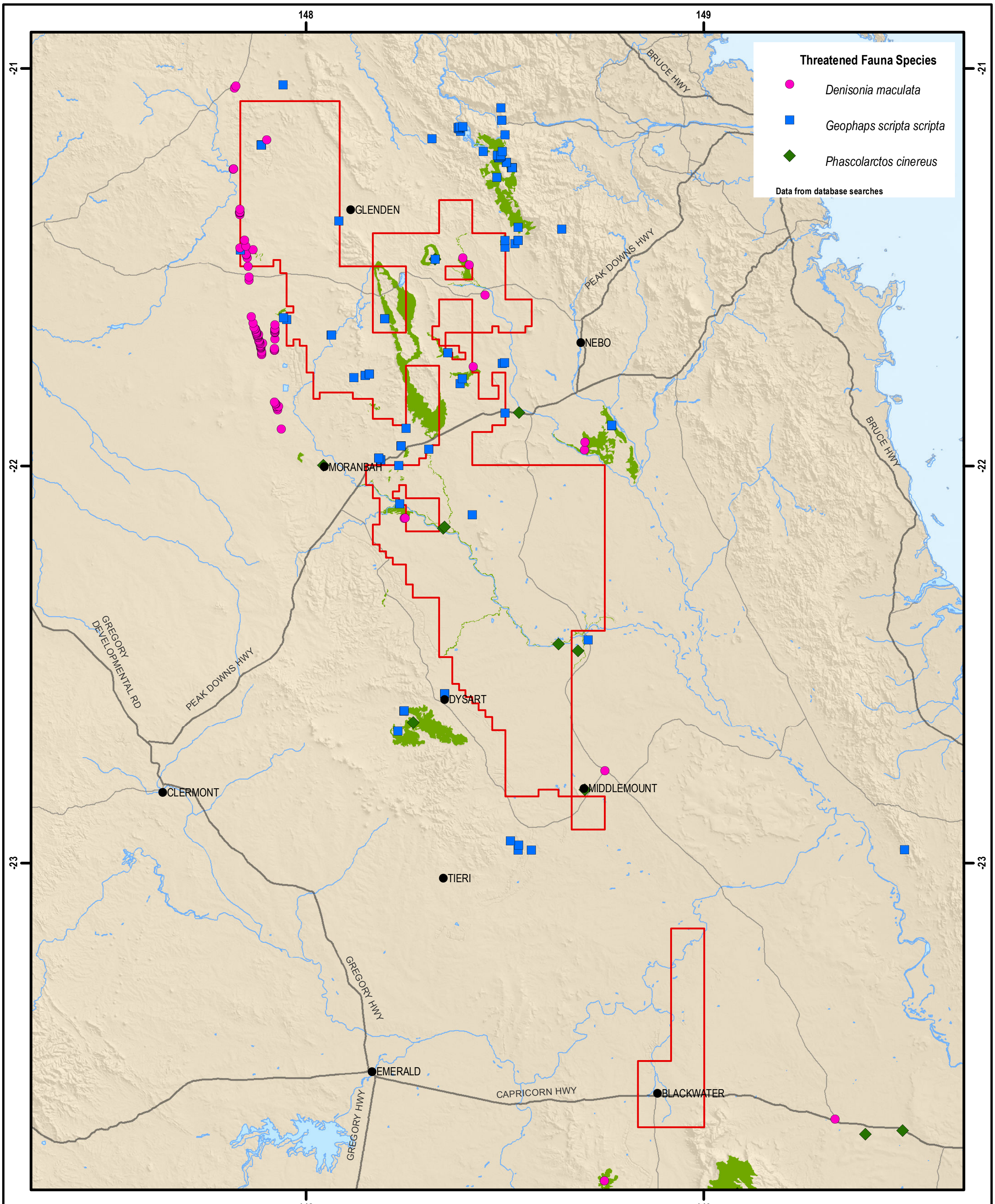
Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	***Scientific Name***			
Fitzroy River turtle	*Rheodytes leukops*	Vulnerable	Low[3]	The Fitzroy River turtle is found in rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles. Preferred areas have high water clarity, and are often associated with Ribbonweed (*Vallisneria* sp.) beds (Cogger *et al*., 1993 in DSEWPaC, 2013ac). Common riparian vegetation associated with the Fitzroy River turtle includes Blue Gums (*Eucalyptus tereticornis*), River Oaks (*Casuarina cunninghamiana*), Weeping Bottlebrushes (*Callistemon viminalis*) and Paperbarks (*Melaleuca linariifolia*) (Tucker *et al*., 2001 in DSEWPaC, 2013ac). The Fitzroy River turtle is only found in the drainage system of the Fitzroy River, Queensland. It is estimated that this species occurs in a total area of less than 10,000 km² (Cogger *et al*., 1993; McDonald *et al*., 1991 in DSEWPaC, 2013ac). Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek, and Gogango (J. Cann cited in Cogger *et al*., 1993; Covacevich *et al*., 1996a; Tucker *et al*., 2001; Venz, 2002 in DSEWPaC, 2013ac). General fauna surveys did not detect this species during EIS field surveys. The core habitat for this species is found to the south-east of the Project area. Even though it has been rated as having a Low likelihood of occurrence, it is being included in the assessment on a precautionary basis.
Dunmall's snake	*Furina dunmalli*	Vulnerable	Very Low	Dunmall's snake has been found in a broad range of habitats including forests and woodlands on black alluvial cracking clay and clay loams and various spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), white cypress pine (*Callitris glaucophylla*) and bulloak open forest and woodland associations on sandstone derived soils (Brigalow Belt Reptiles Workshop, 2010; Stephenson & Schmida, 2008, Threatened Species Network, 2008 in DSEWPaC, 2013ad). Dunmall's snake occurs primarily in the Brigalow Belt region in the south-eastern interior of Queensland. Records indicate sites at elevations between 200–500 m above sea level. The snake is very rare or secretive with limited records existing. It has been recorded at Archokoora, Oakey, Miles, Glenmorgan, Wallaville, Gladstone, Lake Broadwater, Mount Archer, Exhibition Range National Park, roadside reserves between

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
				Inglewood and Texas, Rosedale, Yeppoon and Lake Broadwater Conservation Park (Cogger *et al*., 1993; Covacevich *et al*., 1988; Covacevich *et al*., 1996a; McDonald *et al*., 1991 in DSEWPaC, 2013ad). The Dunmall's snake was not detected during EIS field surveys. The Project area is outside the species' known range and therefore it has a Very Low likelihood of occurrence within the Project area.
Amphibians				
Eungella day frog	*Taudactylus eungellensis*	Endangered	Very Low	The Eungella day frog is restricted to the ranges west of Mackay, mid-eastern Queensland, from Clarke Range in the north to Finch Hatton Gorge and Crediton in the south at altitudes between 200 and 1000 m (Covacevich & McDonald, 1993; Ingram, 1980 in DSEWPaC, 2013ae). The known distribution of the Eungella day frog is situated outside the Project area boundary. Within its range, the Eungella day frog occurs along small creeks in rainforest as well as wet sclerophyll forest (Liem & Hosmer, 1973 in DSEWPaC, 2013ae). Wet sclerophyll forest and rainforest is absent from the Project area. Fauna surveys undertaken during the EIS did not detect the Eungella day frog. As detailed above, the known distribution of the Eungella day frog is well outside the Project area. Suitable habitat for the species is absent form the Project area. Given this, the Eungella day frog has a Very Low likelihood of occurrence within the Project area

1. combined populations of Qld, NSW and the ACT

2. Taxonomic revision of *Nyctophilus timoriensis* has revealed four geographically separated forms (Parnaby, 2009). The south-eastern form has been called *Nyctophilus corbeni* (south-eastern long-eared bat) and is protected under the NC Act as *N. timoriensis* (south-eastern form).

3. The core habitat for this species is found to the south-east of the Project area. It is being included in the assessment on a precautionary basis.



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Bowen Gas Project Tenements

Known Fauna Habitat

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Figure: 7-4

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7.3 Protected Migratory Species

Thirteen EPBC Act-listed migratory bird species were identified within the desktop assessment as possibly occurring within the Project area (DSEWPaC, 2012; Queensland Museum 2012). The Terrestrial Ecology Technical Report (Appendix P) of the EIS has assessed the migratory species' likelihood of occurrence within the Project area as:

- Three Recorded;
- Nine Moderate; and
- One Low.

The tabulated results of likelihood of occurrence assessment are provided below in Table 7-4.

7.3.1 Non-avian

The Estuarine crocodile (*Crocodylus porosus*) is listed in the EPBC Act protected matters report as species or species habitat likely to occur within area (Appendix A of this report). Estuarine crocodiles were not seen during the ecological survey and they are not expected to inhabit in the Project area as it is outside their normal range.

Table 7-4 Migratory Species Identified as being Potentially Present

Species: Common Name	Species: Scientific Name	EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Migratory Wetland Species				
Latham's snipe, Japanese snipe	*Gallinago hardwickii*	Migratory (Terrestrial, Wetland)	Moderate	Latham's snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia. It occurs in permanent and ephemeral wetlands up to 2000 m above sea-level (DSEWPaC, 2013af). It has been previously Recorded in the area but was not detected during the field survey.
eastern great egret	*Ardea modesta* (syn. *Ardea alba)*	Migratory (Marine, Wetland)	Recorded	Eastern great egrets are widespread in Australia and utilise a wide range of wetland habitats (DSEWPaC, 2013ag). It was Recorded during the survey and is expected to use suitable habitat throughout the Project area.
cattle egret	*Ardea ibis*	Migratory (Marine, Wetland)	Recorded	The cattle egret is widespread and common according to migration movements and breeding localities surveys. The cattle egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures (DSEWPaC, 2013ah). It was Recorded during the survey and is expected to use suitable habitat throughout the Project area.
Australian painted snipe	*Rostratula australis* (syn. *Rostratula benghalensis* s. lat.)	Migratory (Wetland)	Moderate	The Australian painted snipe has been recorded at wetlands in all states of Australia and generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (DSEWPaC, 2013k). As there are few records near the Project development area it is not considered a likely regular inhabitant of the area. Included as a Moderate likelihood of occurrence as a Vulnerable species.
Migratory Woodland Species				
rainbow bee-eater	*Merops ornatus*	Migratory (Terrestrial)	Recorded	The rainbow bee-eater is distributed across much of mainland Australia. It occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (DSEWPaC, 2013ai). It was Recorded during the survey and is expected to be found throughout the Project development area where insect prey is abundant.
black-faced monarch	*Monarcha melanopsis*	Migratory (Terrestrial)	Moderate	Uses rainforest, mangroves, eucalypt forest and woodland. Forages in denser parts of mid-level forest (Morcombe, 2004). Was not detected during the field survey but is expected to use suitable habitat (e.g. semi-evergreen vine thicket, denser gullies and riparian areas) throughout the Project area.

Species Common Name	Species Scientific Name	EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
spectacled monarch	*Symposiachrus trivirgatus* (syn. *Monarcha trivirgatus)*	Migratory (Terrestrial)	Moderate	Usually in rainforest, mangroves, moist gloomy gullies of dense eucalypt forest (Morcombe, 2004). Was not detected during the field survey but is expected to use suitable habitat (e.g. semi-evergreen vine thicket, denser gullies and riparian areas) throughout the Project area.
satin flycatcher	*Myiagra cyanoleuca*	Migratory (Terrestrial)	Moderate	The satin flycatcher is widespread in eastern Australia and vagrant to New Zealand. Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DSEWPaC, 2013aj). Was not detected during the field survey but is expected to use suitable habitat (e.g. semi-evergreen vine thicket, denser gullies and riparian areas) throughout the Project area.
rufous fantail	*Rhipidura rufifrons*	Migratory (Terrestrial)	Moderate	The rufous fantail occurs in coastal and near coastal districts of northern and eastern Australia. It mainly inhabits wet sclerophyll forests, often in gullies. When on passage, they are sometimes recorded in drier sclerophyll forests and woodlands (DSEWPaC, 2013ak). Was not detected during the field survey but is expected to use suitable habitat (e.g. semi-evergreen vine thicket, denser gullies and riparian areas) throughout the Project area.
Migratory Aerial Species				
fork-tailed swift	*Apus pacificus*	Migratory (Marine)	Moderate	Aerial species, widespread distribution mostly over inland plains but sometimes above foothills or in coastal areas. Non-breeding visitor from Siberia (DSEWPaC, 2013al). Was not detected during the field survey but likely to feed occasionally in airspace over the Project area.
barn swallow	*Hirundo rustica*	Migratory (Terrestrial)	Low	The barn swallow usually occurs in northern Australia, and is recorded in open country in coastal lowlands, often near water, towns and cities (DSEWPaC, 2013am). Was not detected during the field survey and is not expected to utilise habitat within the Project area.
white-throated needletail	*Hirundapus caudacutus*	Migratory (Terrestrial)	Moderate	The white-throated needletail is widespread in eastern and south-eastern Australia. It is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. The white-throated needletail is almost exclusively aerial (DSEWPaC, 2013an). Was not detected during the field survey but likely to feed occasionally in airspace over the Project area.

Species		EPBC Act Status	Likelihood of Occurrence	Notes on Habitat, Distribution and Presence
Common Name	*Scientific Name*			
Raptor				
white-bellied sea-eagle	*Haliaeetus leucogaster*	Migratory (Terrestrial)	Moderate	The white-bellied sea-eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea) (DSEWPaC, 2013ao). Was not detected during the field survey but likely to utilise habitat at the larger lakes, rivers and wetlands in the Project area.

8 POTENTIAL HABITAT MAPPING

This section provides details on the habitat mapping methodology and refinement used to determine the potential habitat maps for MNES species and communities. These potential habitat maps have been used to determine the potential impacts to MNES.

Potential habitat mapping was produced for the EIS stage to identify known occurrences of MNES. Mapping was limited to known occurrences of MNES due to the following restrictions:

- Field investigation associated with the floristic survey indicates that the accuracy of the existing EHP digital dataset (EHP, 2012a) was limited, narrowing its use to all but the broadest ecological analysis;
- A significant proportion of existing MNES species records are located within non-remnant habitats; and
- Many MNES species records are not accompanied by accurate location coordinates (e.g. WildNet records).

Since the EIS, further work has been performed to identify and refine potential habitat areas of MNES species and communities, including the use of LiDAR data to analyse species specific habitat features.

The aim of mapping potential habitat is to identify MNES potential habitat across the entire Project. The maps of potential habitat will be used as a planning tool during the design and construction stage of the Project to assist in the placement of infrastructure. Where possible, areas of mapped potential habitat will be avoided during the design stage of the Project and changes to designs will be made with consideration given to the potential habitat mapping. The mapping will also be used to determine the potential impact of the project on MNES. Where applicable, it is also used to estimate the offset requirements for the Project.

MNES identified in Section 7 as having a likelihood of presence of ‘moderate’, ‘high’ or ‘recorded’ have been subjected to potential habitat mapping and are addressed in this section.

8.1 Development of Maps

Where available, information from the SPRAT database was used as a basis to develop the mapping rules for individual species and communities. Additionally relevant species recovery plans (where available), referral guidelines, approved conservation advice, management plans and peer-reviewed journal articles were used to further develop the potential habitat mapping rules.

Mapping rules for each MNES are the specific criteria by which different potential habitat maps are constructed for individual MNES from the various relevant data sources available. Mapping rules for each MNES are presented in Appendix B.

Each habitat map was developed with up to four habitat categories, as outlined below.

8.1.1 Habitat Categories

The habitat categories reflect those used in the Surat Gas Project EIS and presented in Table 8-1 below:

Table 8-1 Potential Habitat Category Definitions

Potential Habitat Category	Definition
Core Habitat Known	Known recent records (since 1980) or confirmed sightings, generally buffered by a 1km radius. May also include remnant or regrowth vegetation contiguous with areas where known sightings have occurred.
Core Habitat Possible	Areas of potential habitat with a number of features or values known to contribute to, or be important for the occupation of the species.
General Habitat	Areas of potential habitat with some features of values known to contribute to, or be important for the occupation of the species. Includes areas for species requiring specific micro-habitat features that are unable to be determined at a large scale. Includes areas for species that have little information known about habitat characteristics.
Absence suspected	Areas unlikely to be utilised by the species. Includes areas that are not suitable as habitat (e.g. roads and areas likely to be avoided by the species). The area may be traversed in transit between habitat areas, but is unlikely to support the species for prolonged periods.

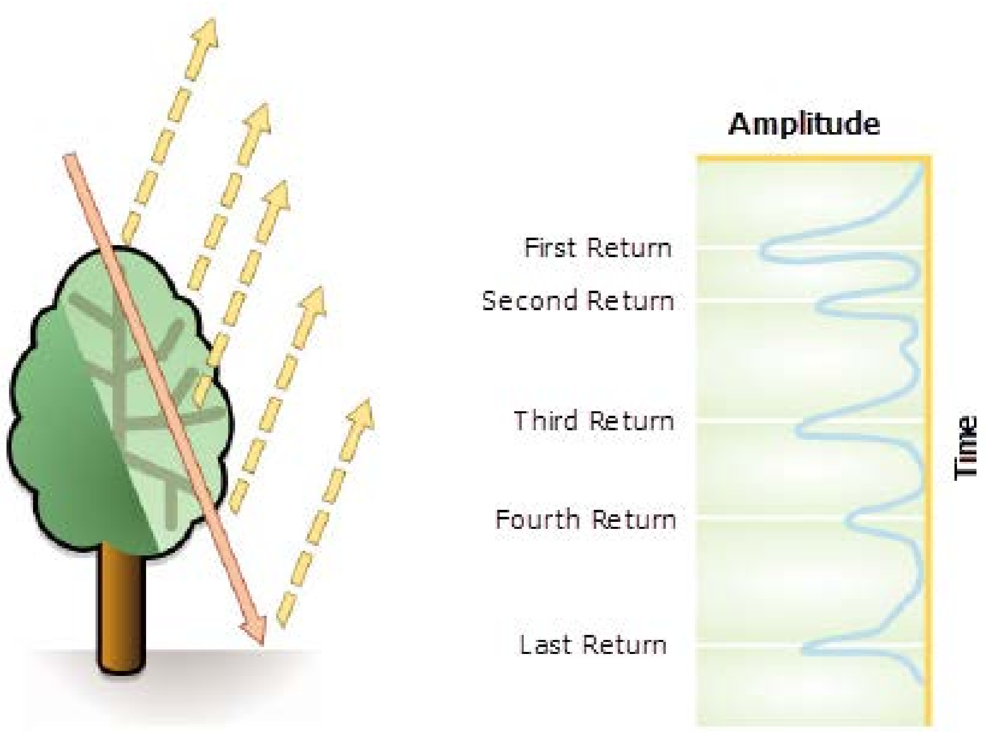
8.2 LiDAR

Arrow has incorporated light detection and ranging (LiDAR) to refine and improve potential habitat mapping across the project area.

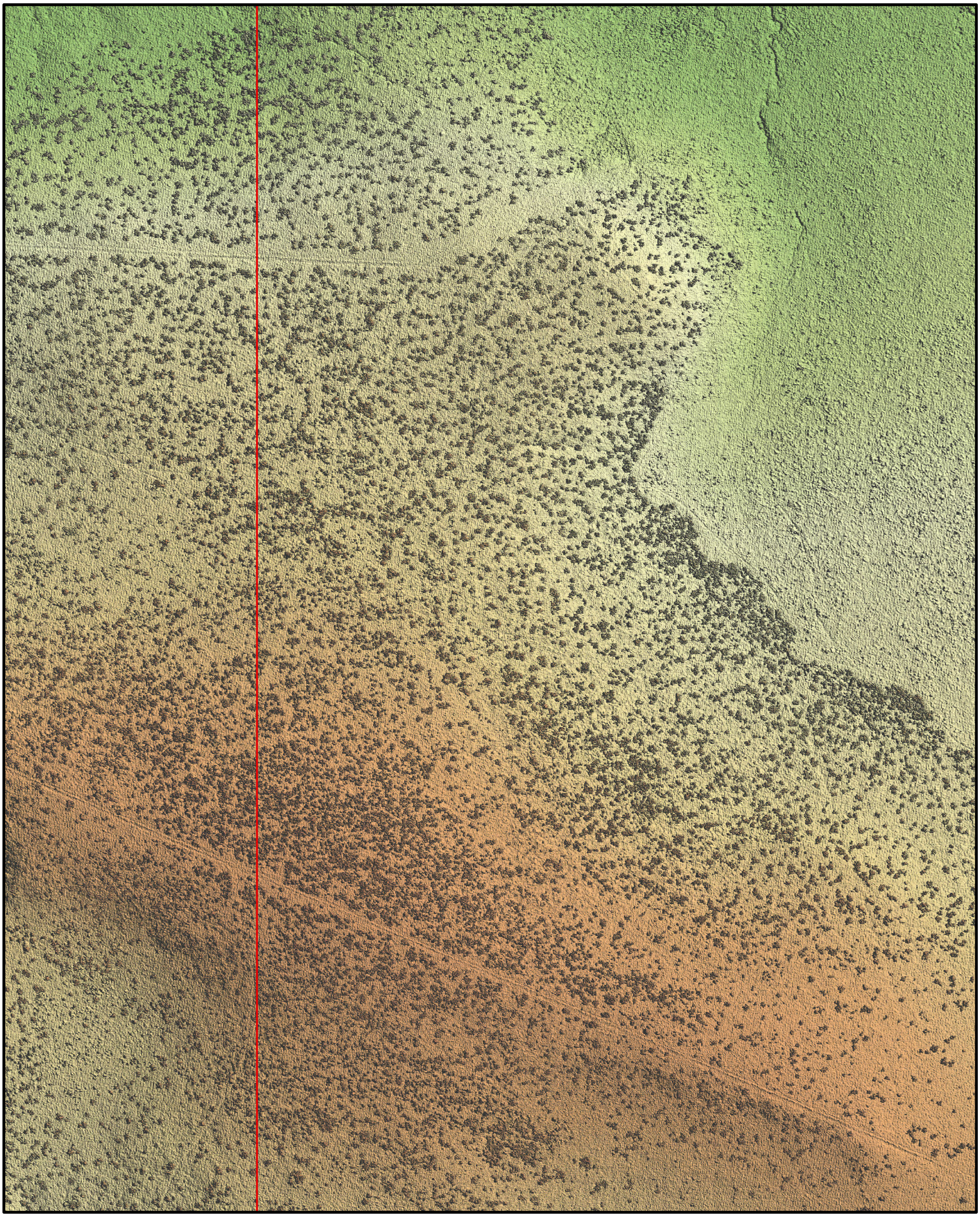
LiDAR is a remote sensing technique that uses laser light to sample at a high density, producing highly accurate x, y and z coordinates (ArcGIS, 2013). LiDAR fires a beam of laser light towards a target and captures the reflection in a sensor to determine the distance between the sensor and the target. When combined with Global Positioning System (GPS) information, these measurements can be used to create a three dimensional representation of the target object or area (ArcGIS, 2013).

A single laser pulse may reflect off a number of surfaces on its way to the ground, thus providing a number of points of data from a single pulse (see Figure 8-1).

Figure 8-1 Multiple Returns from a Single LiDAR pulse (ArcGIS, 2013)



Continued pulses allow for millions of data points over an area to create a three dimensional picture of the target area (see Figure 8-2).



Bowen Gas Project Tenements

N
W E
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0 50 100 200 300 m

1:10,000

Projection: Geographic (GDA94)

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EXAMPLE OF THREE DIMENSIONAL POINT DATA RETURN PLOT

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Figure: **8-2**

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Returned points are classified into classifications determined by international standards. These points are highlighted in Table 8-2 below. Of particular relevance to this Project are classifications 2, 3, 4, 5, 6 and 9.

Table 8-2 International LIiAR Classifications

Classification value	Meaning
0	Never classified
1	Unassigned
2	Ground
3	Low vegetation
4	Medium vegetation
5	High vegetation
6	Building
7	Noise
8	Model key
9	Water

LiDAR data was collected for the Project area. Once collected, the data was separated into layers of the classification values corresponding with ground, low vegetation, medium vegetation, and high vegetation, allowing a visual representation of each classification value. These classification layers were then able to be interrogated by GIS software to provide the following information:

- Canopy density of individual canopy height classes;
- Analysis of slope gradient;
- Identification and delineation of watercourse banks; and
- Identification of ground layer habitat features.

The information obtained from the LiDAR data was incorporated into the species potential habitat mapping, where appropriate. The relevant species and how the LiDAR data was incorporated into the potential habitat mapping is outlined in Section 8.3.

8.3 MNES Potential Habitat Mapping Rules

Potential habitat maps were developed incorporating LiDAR data. The rules used to develop the potential habitat maps are located in Appendix B.

9 ASSESSMENT AGAINST MNES SIGNIFICANCE CRITERIA - POTENTIAL IMPACTS

This section provides detailed profiles for MNES identified in Section 7. MNES profiles include potential habitat mapsfor each MNES and an assessment of potential impacts specific to TECs (Section 9.1), protected fauna (Section 9.2), protected flora (Section 9.3) and protected migratory species (Section 9.4). Potential Impacts are discussed in relation to guidance within the policy statement on those subject areas.

Specific avoidance, mitigation and managment measures specific to each MNES are detailed in Section 10. Recovery and threat abatement plans are also discussed in Section 10. It should be noted that additional survey work will be carried out in regard to identifying EPBC Act listed fauna species and habitat, as part of field development, pre-clearance surveys outlined in the mitigation commitment sections in the following species profiles.

Current known records of MNES species and potential habitat mapping will be used to guide future survey work.

9.1 Threatened Ecological Communities

As detailed in Section 7.1 and summarised in Table 9-1 below, three TECs are known to occur within the Project area, whilst one TEC is considered a moderate occurrence given the presence of analagous RE communities. Details of these TECs including an assessment of the significant impact criteria are provided in the profiles below.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community;
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- Adversely affect habitat critical to the survival of an ecological community;
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning of flora or fauna harvesting;
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - Assisting invasive species, that are harmful to the listed ecological community, to become established; or
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community;
- Interfere with the recovery of an ecological community.

Table 9-1 TECs with a Moderate, High or Recorded Likelihood of Occurence within the Project Area

TEC Description	EPBC Status	Likelihood of Occurrence
Brigalow (*Acacia harpophylla* dominant and co-dominant) (includes remnant and HVR vegetation)	Endangered	Recorded
Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	Endangered	Recorded
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Recorded
Weeping Myall Woodlands	Endangered	Moderate

9.1.1 Brigalow (Acacia harpophylla dominant and co-dominant)

Status: EPBC: Endangered **NC Act:** N/A **VM Act** Endangered	
Recovery Plan: Recovery plan required	

The brigalow TEC is characterised by the presence of brigalow (*Acacia harpophylla*) as one of the three most abundant tree species. Brigalow is usually either dominant in the tree layer or co-dominant with other species such as belah (*Casuarina cristata*). The structure of the vegetation ranges from open forest to open woodland. The height of the tree layer varies from approximately 9 m in low rainfall areas to approximately 25 m in higher rainfall areas. (DSEWPaC, 2013ap)

Within Queensland, the brigalow TEC comprises the following 16 REs:

- RE 6.4.2 - *Casuarina cristata* +/- *Acacia harpophylla* open forest on clay plains;
- RE 11.3.1 - *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains;
- RE 11.4.3 - *Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains;
- RE 11.4.7 - Open forest of *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* on Cainozoic clay plains;
- RE 11.4.8 - *Eucalyptus cambageana* open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains;
- RE 11.4.9 - *Acacia harpophylla* shrubby open forest with *Terminalia oblongata* on Cainozoic clay plains;
- RE 11.4.10 - *Eucalyptus populnea* or *E. pilligaensis*, *Acacia harpophylla*, *Casuarina cristata* open forest on margins of Cainozoic clay plains;
- RE 11.5.16 - *Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces;
- RE 11.9.1 - *Acacia harpophylla-Eucalyptus cambageana* open forest on Cainozoic fine-grained sedimentary rocks;

- RE 11.9.5 - *Acacia harpophylla* and/or *Casuarina cristata* open forest on Cainozoic fine-grained sedimentary rocks;
- RE 11.9.6 - *Acacia melvillei* ± *A. harpophylla* open forest on Cainozoic fine-grained sedimentary rocks;
- RE 11.11.14 - *Acacia harpophylla* open forest on deformed and metamorphosed sediments and interbedded volcanics;
- RE 11.12.21 - *Acacia harpophylla* open forest on igneous rocks; colluvial lower slopes;
- RE 12.8.23 - *Acacia harpophylla* open forest on Cainozoic igneous rocks;
- RE 12.9-10.6 - *Acacia harpophylla* open forest on sedimentary rocks; and
- RE 12.12.26 - *Acacia harpophylla* open forest on Mesozoic to Proterozoic igneous rocks.

9.1.1.1 Distribution and Habitat

In Queensland, about 85% of the brigalow TEC remnants occur on flat to gently undulating Cainozoic clay plains that are not associated with current alluvium, and on gently undulating landscapes on more or less horizontally bedded fine grained sedimentary rocks. About 10% of remnants are associated with river and creek flats, and the remainder with old loamy and sandy plains, basalt plains and hills, or hills and lowlands on metamorphic or granitic rocks. (DSEWPaC, 2013ap).

The brigalow TEC extends from south of Charters Towers in Queensland, in a broad swathe east of Blackall, Charleville and Cunnamulla, south to northern New South Wales near Narrabri and Bourke (DSEWPaC, 2013ap).

In Queensland, the TEC occurs predominantly within the Brigalow Belt North, Brigalow Belt South, Darling Riverine Plains and Southeast Queensland bioregions, with smaller amounts in the Mitchell Grass Downs, Mulga Lands and Einasleigh Uplands bioregions (DSEWPaC, 2013ap).

The brigalow TEC is relatively common in the Project area. Based on existing mapping (EHP, 2012a), 57,846.81 ha of this habitat occurs in the Project area (Figure 9-1). The ecological community is represented in the Project area by REs 11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16, 11.9.1, and 11.9.5. A number of well-preserved habitats were surveyed in the Project area, associated with more extensive areas of intact remnant vegetation, although the majority of habitats exist as scattered, poorly preserved fragments. The habitat also includes advanced brigalow regrowth communities determined as being older than 15 years old as per guidelines of Environment Australia (2001). Survey methods and data are outlined above in Section 5, and presented in Section 4.4 of the Terrestrial Ecology Technical Report (Appendix P) in the EIS.

9.1.1.2 Key Threats

Current key threats identified to the TEC (DSEWPaC, 2013ap) include clearing vegetation (controlled and uncontrolled), fire, pest plants, pest animals and lack of knowledge (including knowledge on suitable restoration techniques, pest species impacts and impacts of climate change).

9.1.1.3 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Direct impacts due to vegetation clearing associated with placement of facilities or infrastructure (e.g. gathering lines for water and gas, road widening and road maintenance); and
- Edge effects associated with increased habitat and landscape fragmentation including loss of native ground covers, exotic species invasion, changes to surface water flow and sedimentation that affect ecosystem function.

9.1.1.4 *Significant Impact Criteria*

1. Reduce the extent of an ecological community.

   Within the Project area the brigalow TEC is represented by REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16. The constraints analysis mapping within the Environmental Framework chapter (Section 7.2) of the EIS identifies these six REs as constrained areas (based upon their classification as endangered REs). As a result of this constraints analysis Arrow will seek to preferentially avoid these areas during the planning and design phase as outlined in the mitigation commitments listed below in this TEC profile.

   Where brigalow TEC cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

   As discussed in Section 3 the lack of certainty about the preferred location of infrastructure at this stage of the Project means that an exact extent of brigalow TEC to be cleared cannot be determined for the EIS.

   A conceptual field development plan and estimates of maximum clearing extents of TECs have been developed for the Project to provide a maxiumum disturbance estimate for these values. These maxiumum disturbance estimates for environmental values are presented in the SREIS Offsets Strategic Management Plan (Appendix P).

   Given the proposed management measures for this TEC, including constraints mapping, pre-clearance surveys and the mitigation commitments outlined below, the Project activities are not expected to significantly reduce the extent of the ecological community.

2. Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.

   The following mitigation measures will be implemented to avoid fragmentation of this ecological community:

a) Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
b) Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
c) Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
d) Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
e) Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
f) Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B156]; and
g) Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167].

3. Adversely affect habitat critical to the survival of an ecological community.

   As discussed above the proposed mitigation measures and environmental framework approach means that the Project is unlikely to adversely affect habitat critical to the survival of this ecological community.

4. Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.

   The Project is not considered likely to affect abiotic factors necessary for the ecological communities' survival. Details of land management, soil management, groundwater and surface water mitigation measures are provided in Sections 19, 12, Z.4.6 and Z.4.7 of the EIS respectively.

5. Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning of flora or fauna harvesting.

   The Project activities are not expected to include flora and fauna harvesting or regular burning, and therefore are not expected to cause a substantial change in species composition.
6. Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established, or; causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological

community.

Invasive species known to have the potential to impact the brigalow TEC include pasture grasses, prickly pear (*Opuntia stricta*), tree pear (*Opuntia tomentosa*), and harrisia cactus (*Eriocereus martinii*). Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project which will minimise impacts to the ecological community. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

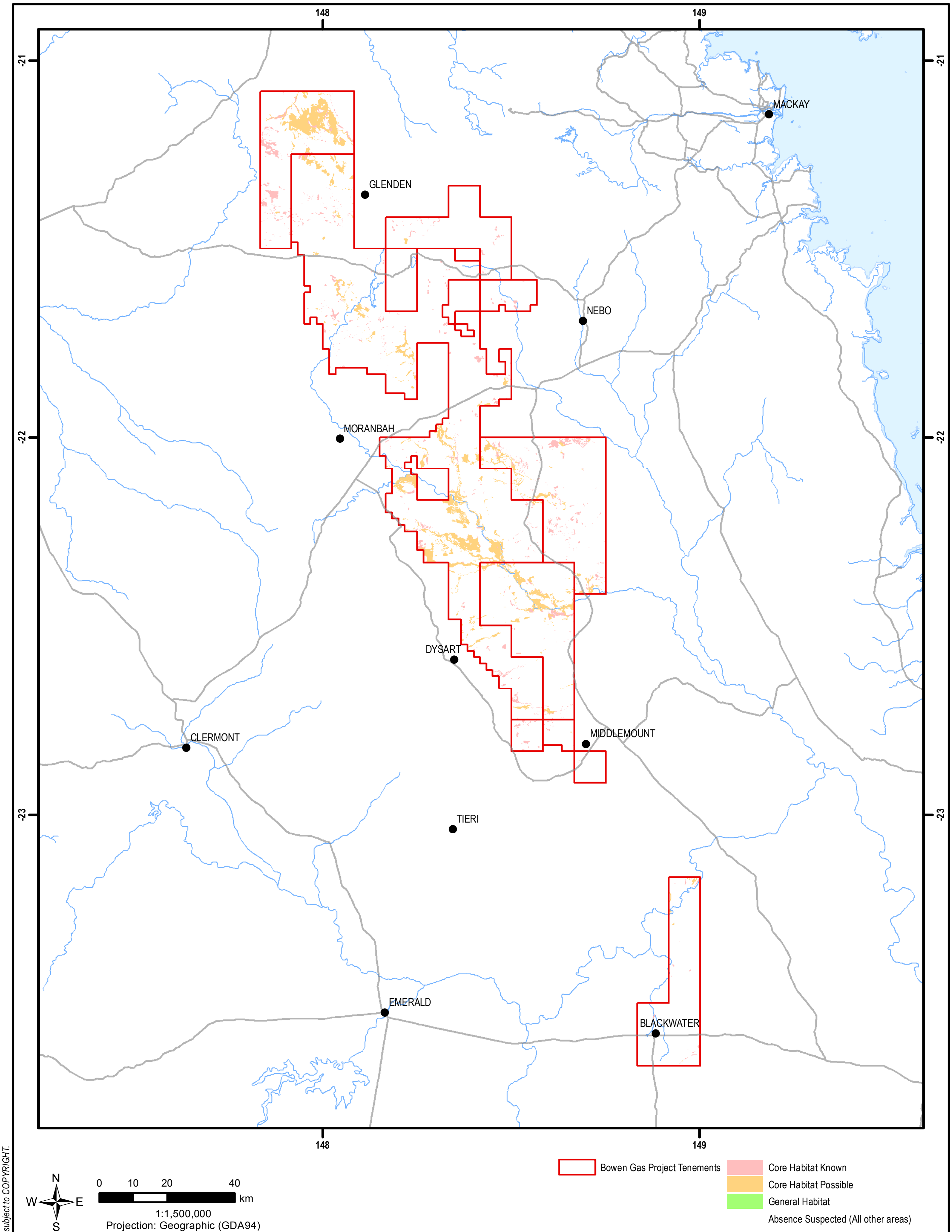
The Project activities are considered unlikely to cause any impacts to the ecological community through the release of fertilisers, herbicides or other chemicals or pollutants.

7. Interfere with the recovery of an ecological community.

Threats identified within the draft recovery plan (Butler, 2007a) include clearing, fire, pest plants, pest animals and lack of knowledge (including knowledge on suitable restoration techniques, pest species impacts and impacts of climate change).

The Project is considered unlikely to compound these issues and therefore recovery of the TEC is not likely to be impeded as a result of the Project.

Mitigation measures outlined in Section 10.1.1.2 will minimise potential impacts on this TEC.



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POTENTIAL HABITAT AREAS FOR BRIGALOW (ACACIA HARPOPHYLLA) TEC WITHIN THE PROJECT AREA

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Figure: **9-1**

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9.1.2 TEC Profile: Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin

Status: EPBC: Endangered	**NC Act:** N/A
Recovery Plan: Recovery plan required	

The natural grasslands TEC are native grasslands typically composed of perennial native grasses. They are found on soils that are fine textured (often cracking clays) derived from either basalt or fine-grained sedimentary rocks, on flat or gently undulating rises. These grasslands occur in areas with relatively high summer rainfall and a tree canopy usually absent, but when present projective crown cover is no more than 10% (TSSC, 2008a).

The natural grasslands TEC may be recognised by the following diagnostic features (as defined by TSSC, 2008a):

- Distribution: It occurs within the Brigalow Belt North and South subregions, which are largely within the Central Highlands and northern Fitzroy River Basin regions of Queensland;
- Tree canopy absent or sparse (less than 10% projective crown cover). If it can be demonstrated, beyond reasonable doubt, that the grassland was derived from cleared woodland then it is not part of the national ecological community; and
- The ground layer is typically dominated by perennial native grasses and contains at least three of the indicator native species listed below:
  - feather-top wiregrass (*Aristida latifolia*);
  - white speargrass (*Aristida leptopoda*);
  - hoop Mitchell grass (*Astrebla elymoides*);
  - curly Mitchell grass (*Astrebla lappacea*);
  - bull Mitchell grass (*Astrebla squarrosa*);
  - satin-top grass (*Bothriochloa erianthoides*);
  - king bluegrass (*Dichanthium queenslandicum*);
  - Queensland bluegrass (*Dichanthium sericeum*);
  - cup grass (*Eriochloa crebra*);
  - native millet (*Panicum decompositum*);
  - yabila grass (*Panicum queenslandicum*);
  - shot grass (*Paspalidium globoideum*); and
  - coolibah grass (*Thellungia advena*).

9.1.2.1 *Distribution and Habitat*

The ecological community occurs entirely within Queensland. It extends from Collinsville in the north to Carnarvon National Park in the south. This ecological community occurs within the Brigalow Belt North and Brigalow Belt South Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and within the Fitzroy Basin, Burdekin, South West Qld, Border Rivers Maranoa-Balonne and Desert Channels Natural Resource Management regions (TSSC, 2008a)

The natural grasslands TEC usually occurs on flat ground or gently undulating rises. It occurs on soils that have formed either in situ on the fresh basalt, or on fine-grained sedimentary rocks, or where this material has been transported to form extensive alluvial plains along ancient and flood-prone watercourses. The soils are fine textured vertosols (cracking clay), often deep and dark in colour (Fensham, 1999 in TSSC, 2008a), although soils may be shallower on ridges or sloping land. The soils are cracking or self-mulching, that is, they expand when wet and contract when dry. The development of deep cracks may tear tap roots and is a possible reason why trees and woody shrubs are lacking in these grasslands (Beadle, 1981; Fensham, 2003; Whalley, pers. comm., 2007 in TSSC, 2008a). Other factors, such as fire, frost, and soil chemistry (particularly low sodicity) can also be important for tree exclusion (Fensham, 2003 in DSEWPaC, 2013). The high water-holding capacity of the clay soil also inhibits deep penetration during most rainfall events.

The natural grasslands TEC is relatively common in the Project area. Based on existing mapping (EHP, 2012b) 29,246.19 ha of this habitat occurs in the Project area (Figure 9-2). The ecological community is represented in the Project area by REs 11.3.21, 11.4.4, 11.4.11, 11.8.11 and 11.9.3. The most extensive occurrence runs in a broad east-west trending belt that occurs between Glenden and Moranbah in the north of the Project area although fragmented remnants persist throughout the landscape in the broader Project area. As per TSSC (2008a), the habitat can be described within two conditions classes; ‘best quality’ and ‘good quality’, with ‘best quality’ habitats being relatively common in the less fragmented occurrences that were subject to field investigation.

9.1.2.2 *Key Threats*

Current key threats identified to the TEC (TSSC, 2008a) include: grazing, cropping, and pasture improvement; weeds and pest animals; mining activities; and construction of roads and other infrastructure.

9.1.2.3 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Direct impacts due to vegetation clearing associated with placing facilities or infrastructure (e.g. gathering lines for water and gas, road widening and road maintenance);
- Fragmentation of large undisturbed tracts of remnant vegetation during placement of access tracks, wells and other petroleum related infrastructure;
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers, exotic species invasion,

changes to surface water flow and sedimentation including localised erosion along access tracks that affect ecosystem function;

- Trampling of grass and compaction of soil in the vicinity of well facilities due to uncontrolled access and poorly defined working areas (e.g vehicles turning outside of defined work area); and
- Salt scalding through saline groundwater discharge from production well heads.

A draft recovery plan for the natural grasslands TEC was prepared in 2007 (Butler, 2007b). Specific objectives proposed for the recovery plan (Butler, 2007b) are to:

- Maintain the remnant areas of the bluegrass grassland TEC in subregions in which its extent is 30 percent or less of its pre-clearing extent and, in other subregions, maintain the remnant areas of the bluegrass grassland TEC that are either known habitat for threatened species, are infrequently grazed, or are larger than 50 ha in area;
- Improve the condition of bluegrass grasslands across the Brigalow Belt;
- Maintain or enhance populations and knowledge of threatened flora and fauna from bluegrass grasslands, such as grazing sensitive plants; and
- Improve knowledge of key ecosystem components, such as perennial grasses and legumes, and identify appropriate management practices that will contribute to item two above.

9.1.2.4 *Significant Impact Criteria*

1. Reduce the extent of an ecological community.

   Within the Project area the natural grasslands TEC is represented by REs 11.3.21, 11.4.4, 11.4.11, 11.8.11 and 11.9.3. The constraints analysis mapping within the Environmental Framework chapter (Section 7.2) of the EIS identifies four of these five REs as constrained areas (based upon their classification as of concern or endangered REs). As a result of this constraints analysis Arrow will seek to preferentially avoid these areas during the planning and design phase as outlined in the mitigation commitments listed below in this TEC profile.

   Where natural grasslands TEC cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

   As discussed in Section 3, the lack of certainty about the preferred location of infrastructure at this stage of the Project means that an exact extent of natural grassland TEC to be cleared cannot be determined for the EIS. A conceptual field development plan and estimates of clearing extents of TEC's have been developed for the SREIS (refer to Section 6.8).

   Given the constraints mapping, environmental framework approach and proposed pre-clearance surveys and mitigation, the Project activities are not expected to significantly reduce the extent of the ecological community.

2. Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.

   The following mitigation measures will be implemented to avoid fragmentation of this ecological community:

   a) Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
   b) Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
   c) Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
   d) Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
   e) Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
   f) Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B156]; and
   g) Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167].

3. Adversely affect habitat critical to the survival of an ecological community.

   As discussed above the proposed mitigation measures and environmental framework approach means that the Project is unlikely to adversely affect habitat critical to the survival of this ecological community.

4. Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.

   The Project is not considered likely to affect abiotic factors necessary for the ecological communities' survival. Details of land use, soil management, groundwater and surface water mitigation measures are provided in Sections 19, 12, Z.4.6 and Z.4.7 of the EIS respectively.

5. Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning of flora or fauna harvesting.

   The Project activities are not expected to include regular burning and therefore are not expected to cause a substantial change in species composition.

6. Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established, or; causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.

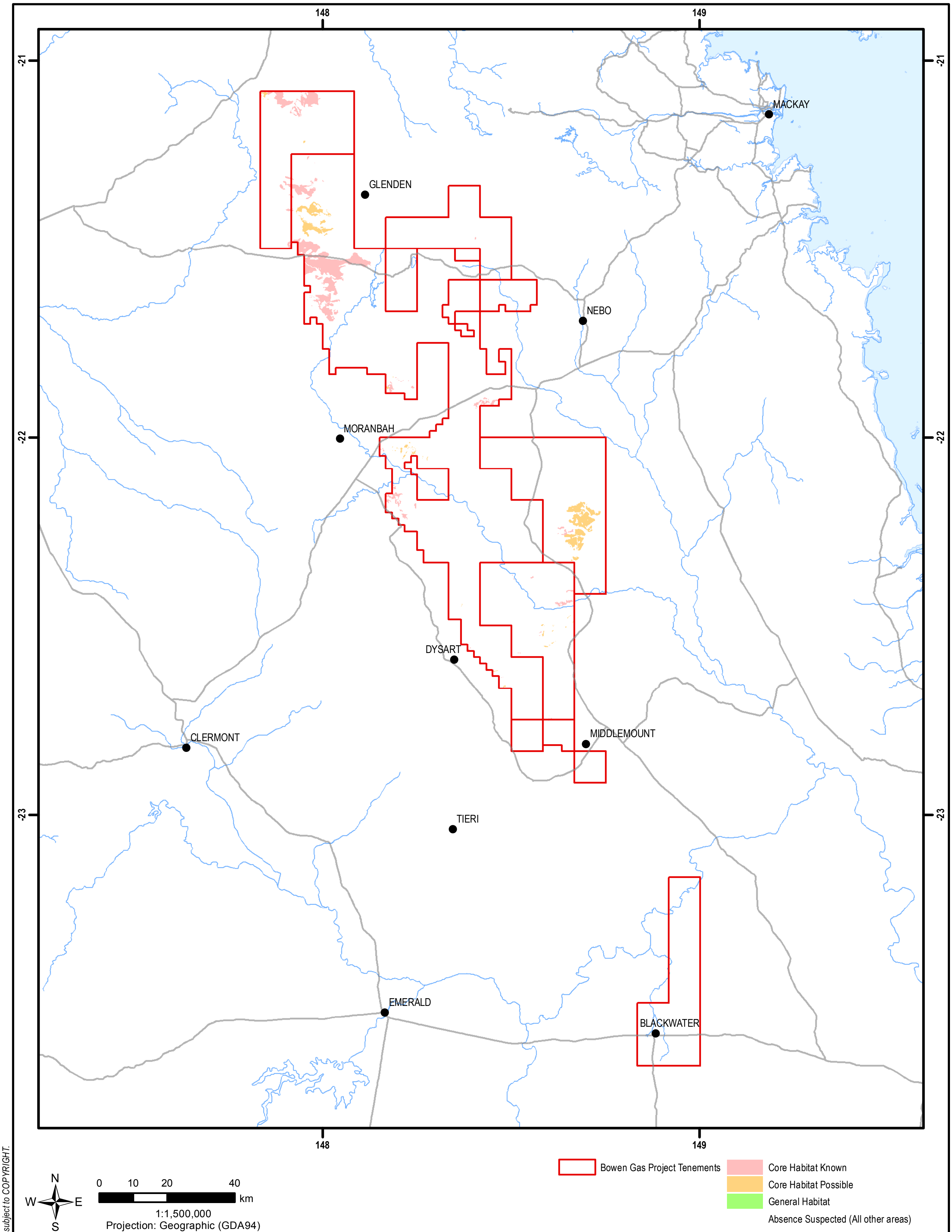
   Invasive species known to have the potential to impact the natural grasslands TEC include parthenium (*Parthenium hysterophorus*), parkinsonia (*Parkinsonia aculeata*), prickly acacia (*Acacia nilotica* subsp. *indica*) and buffel grass (*Pennisetum ciliare*). Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project which will minimise impacts to the ecological community. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

   The Project activities are considered unlikely to cause any impacts to the ecological community through the release of fertilisers, herbicides or other chemicals or pollutants.

7. Interfere with the recovery of an ecological community.

   Threats identified within the recovery plan (Butler, 2007b) include: expansion of exotic pastures and tree crops; expansion of mining activities; expansion of cultivation for cropping; persistent heavy grazing; invasive species; construction of roads and other infrastructure; and lack of knowledge.

   The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.1.2.2 and therefore recovery of the TEC is not likely to be impeded as a result of the Project.



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POTENTIAL HABITAT AREAS FOR NATURAL GRASSLANDS TEC WITHIN THE PROJECT AREA

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **9-2**

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9.1.3 TEC Profile: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

Status: EPBC: Endangered	**NC Act:** N/A
Recovery Plan: National recovery plan for the Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ecological community.	

The SEVT TEC comprises semi-evergreen vine thickets in eastern Queensland and northern New South Wales (DSEWPaC, 2013aq).

SEVT is considered an extreme form of dry seasonal subtropical rainforest (McDonald 1996 in DSEWPaC, 2013aq). It is generally characterised by the prominence of trees with microphyll sized leaves (i.e. leaves usually 2.5–7.6 cm long), the presence of bottle trees (*Brachychiton* spp.) as emergents from the vegetation, and the thickets occurring in areas with a subtropical, seasonally dry climate on soils of high to medium fertility (DSEWPaC, 2013aq).

In Queensland, SEVT TEC comprises the following 10 REs within the Brigalow Belt Bioregion (DSEWPaC, 2013aq):

- RE 11.2.3-Microphyll vine forest on sandy beach ridges;
- RE 11.3.11-Semi-evergreen vine thicket on alluvial plains;
- RE 11.4.1-Semi-evergreen vine thicket ± Casuarina cristata on Cainozoic clay plains;
- RE 11.5.15-Semi-evergreen vine thicket on Cainozoic sand plains/remnant surfaces;
- RE 11.8.3-Semi-evergreen vine thicket on Cainozoic igneous rocks;
- RE 11.8.6-*Macropteranthes leichhardtii* thicket on Cainozoic igneous rocks;
- RE 11.8.13-Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks;
- RE 11.9.4-Semi-evergreen vine thicket on Cainozoic fine-grained sedimentary rocks;
- RE 11.9.8-*Macropteranthes leichhardtii* thicket on Cainozoic fine-grained sedimentary rocks; and
- RE 11.11.18-Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding.

9.1.3.1 *Distribution and Habitat*

The SEVT TEC extends from the Townsville area in Queensland to northern New South Wales. It is mostly located within the Brigalow Belt Bioregion. In Queensland the remnant vine thicket patches are mostly scattered from coastal dunes and river deltas in the vicinity of Townsville and Ayr through the northern and central parts of the Brigalow Belt Bioregion to its south-eastern parts between Jandowae and Killarney on the

Queensland / New South Wales border (Queensland Herbarium, 2002a in DSEWPAC, 2013aq).

The TEC occurs in the Brigalow Belt North, Brigalow Belt South and Nandewar bioregions. In Queensland, more than 50% of remnants occur in the Arcadia, Buckland Basalts, Claude River Downs, Dawson River Downs, Northern Bowen Basin and Southern Downs subregions (McDonald, 2007).

Relatively extensive areas (total area of 5,212.53 ha) of SEVT TEC habitat are mapped in certified RE mapping in the northern portion of the Project area where they are represented by REs 11.5.15, 11.8.3, 11.8.13 and 11.9.4a (see Figure 9-3) (EHP, 2012b). Field examination confirmed the presence of these habitats although they are by no means as extensive as represented in the certified mapping. A considerable portion of habitat currently represented as RE11.8.13 (EHP, 2012b)) was found to occupy lateritic escarpments and be consistent with RE11.7.1x, a non-EPBC Act significant community. Furthermore, revised mapping in the detailed Project area where EHP (2012b) identifies 429 ha of the vine thicket RE11.5.15 failed to recognise any mappable occurrences of this habitat with its true extent calculated to be <1 ha. Despite this, good quality examples of vine thicket were surveyed on basaltic terrains north of Newlands Mine consistent with RE11.8.3. It should be noted that the vine thicket ecological community also includes brigalow habitat where they occur on basaltic landforms, consistent with the description of RE11.8.13. Survey methods are outlined above in Section 5, and data is detailed in Section 4.4 of the Terrestrial Ecology Technical Report (Appendix P) in the EIS.

9.1.3.2 *Key Threats*

Current key threats identified to the TEC (DSEWPaC, 2013aq) include: clearing; coastal development; fire; grazing by domestic stock, native herbivores and pigs; and weeds.

9.1.3.3 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Direct impacts due to vegetation clearing. Major threats are associated with field development related activities (e.g. drill pad, access tracks); and
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.

A recovery plan for the SEVT TEC was prepared in 2007 (McDonald, 2007). Overall objectives proposed within the recovery plan are to maintain and conserve the environmental values of the semi-evergreen vine thicket ecological community over the long term, by minimising the loss of both remnant and regrowth SEVT and improving their condition and management (McDonald, 2007).

9.1.3.4 Significant Impact Criteria

1. Reduce the extent of an ecological community.

   Within the Project area the SEVT TEC is represented by REs 11.5.15, 11.8.3 and 11.8.13. The constraints analysis mapping within the the Environmental Framework chapter (Section 7.2) of the EIS identifies these three REs as constrained areas (based upon their classification as of concern or endangered REs) and Arrow will seek to preferentially avoid these areas during the planning and design phase as outlined in the mitigation commitments listed below in this TEC profile.

   Where SEVT TEC cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

   As discussed in Section 3 the lack of certainty about the preferred location of infrastructure at this stage of the Project means that an exact extent of SEVT TEC to be cleared cannot be determined for the EIS. A conceptual field development plan and estimates of clearing extents of TEC's have been developed for the SREIS (Section 6.8).

   Given the constraints mapping, environmental framework approach and proposed pre-clearance surveys and mitigation, the Project activities are not expected to significantly reduce the extent of the ecological community.

2. Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.

   The following mitigation measures will be implemented to avoid fragmentation of this ecological community:

   a) Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
   b) Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
   c) Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
   d) Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
   e) Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
   f) Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B156]; and
   g) Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167].

3. Adversely affect habitat critical to the survival of an ecological community.

   As discussed above the proposed mitigation measures and environmental framework approach means that the Project is unlikely to adversely affect habitat critical to the survival of this ecological community.

4. Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.

   The Project is not considered likely to affect abiotic factors necessary for the ecological communities' survival. Details of land use, soil management, groundwater and surface water mitigation measures are provided in the Land Use and Tenure chapter (Section 19) Soils chapter (Section 12) and draft EM Plan (Appendix Z, Sections Z.4.6 and Z.4.7) of the EIS respectively.

5. Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning of flora or fauna harvesting.

   The Project activities are not expected to include regular burning and therefore are not expected to cause a substantial change in species composition.

6. Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established, or; causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.

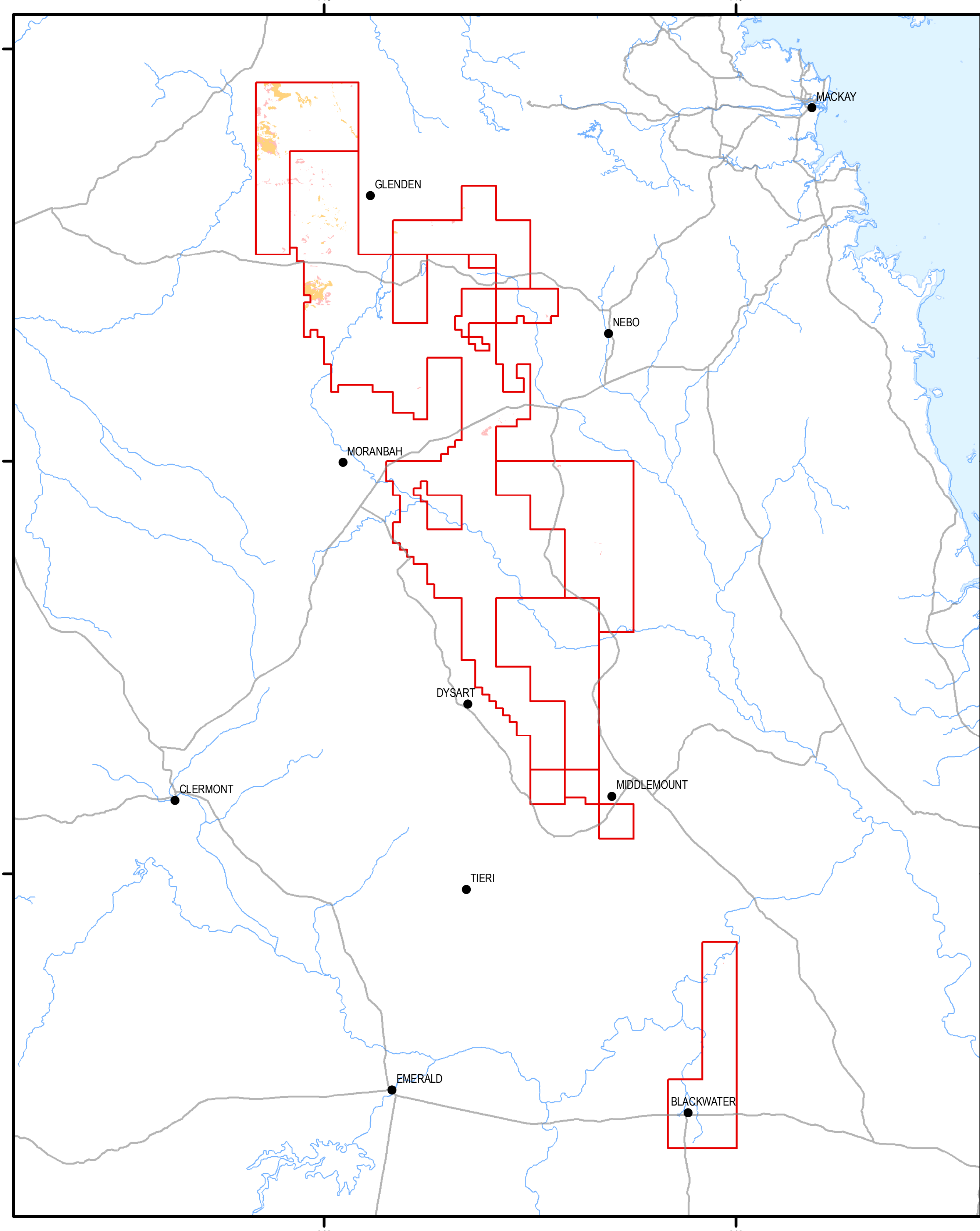
   Invasive species known to have the potential to impact the SEVT TEC include parthenium (*Parthenium hysterophorus*), green panic (*Megathyrsus maximus*) and buffel grass (*Pennisetum ciliare*). Arrow has committed to a pest management plan (draft EM Plan (Section Z.4.4.5) of the EIS) for the Project which will minimise impacts to the ecological community. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

   The Project activities are considered unlikely to cause any impacts to the ecological community through the release of fertilisers, herbicides or other chemicals or pollutants.

7. Interfere with the recovery of an ecological community.

Threats identified within the recovery plan include (McDonald, 2007): clearing; fire; weeds; grazing; vertebrate pests; and coastal development.

The Project will manage these threats where relevant. A detailed outline of specific Avoidance measures mitigation commitments detailed in Section 10.1.3.2 and therefore recovery of the TEC is not likely to be impeded as a result of the Project.



N
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0 10 20 40 km

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Projection: Geographic (GDA94)

Bowen Gas Project Tenements

Core Habitat Known

Core Habitat Possible

General Habitat

Absence Suspected (All other areas)

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POTENTIAL HABITAT AREAS FOR SEVT TEC WITHIN THE PROJECT AREA

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **9-3**

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9.1.4 *TEC Profile: Weeping Myall Woodlands*

Status: EPBC: Endangered	**NC Act:** N/A
Recovery Plan: Recovery plan required.	

The Weeping Myall Woodlands TEC occur in a range from open woodlands to woodlands, generally 4-12 m high, in which weeping myall (*Acacia pendula*) trees are the sole or dominant overstorey species (TSSC, 2008b).

Although the species weeping myall (*Acacia pendula*) occurs widely in Queensland, the Weeping Myall Woodlands ecological community is restricted to small patches that occur within two REs in Queensland (TSSC, 2008b). These are:

- RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains; and
- RE 11.3.28 *Casuarina cristata* ± *Eucalyptus coolabah* open woodland on alluvial plains.

9.1.4.1 *Distribution and Habitat*

The weeping myall TEC occurs on the inland alluvial plains west of the Great Dividing Range in NSW and Queensland, with one small outlying patch in northern Victoria. It occurs in the Riverina, NSW South Western Slopes, Darling Riverine Plains, Brigalow Belt South, Brigalow Belt North, Murray-Darling Depression, Nandewar and Cobar Peneplain IBRA Bioregions (TSSC, 2008b).

The weeping myall TEC generally occurs on flat areas, shallow depressions or gilgais on raised (relict) alluvial plains. These areas are not associated with active drainage channels and are rarely if ever flooded (White *et al.* 2002; Keith, 2004 in TSSC, 2008b). The ecological community occurs on black, brown, red-brown or grey clay or clay loam soils (TSSC, 2008b).

No occurrence of the weeping myall TEC was observed during the field survey of the Project area. The distribution of the weeping myall TEC as provided by DEWHA (2009b) ranges from 100 km north of Clermont, southwards with the eastern-most limit of the ecological community coinciding roughly with the western boundary of the Project area. With the exception of a small area extending to approximately 75 km north of Blackwater, the TEC is not expected to occur within the Project area. Weeping myall does not form woodland communities of sufficient size for consistent separation as a mappable ecosystem. As such, the community is not recognised as an individual ecosystem within the framework of Queensland's VM Act. The patchy nature of the community also makes community delineation difficult; hence the community is relatively easily overlooked. Field survey within 'at risk' areas did not locate the ecological community although it there is potential for it to occur as small patches within REs 11.3.2 and 11.3.28 (TSSC, 2008b). These areas of potential habitat are shown in Figure 9-4. Further scrutiny of these REs, particularly RE11.3.2 which is known to occur in the Project area, is required when working within areas potentially hosting the ecological community. Survey methods are outlined above in Section 5, and data are presented in Section 4.4 of the Terrestrial Ecology Technical Report (Appendix P) of the EIS.

9.1.4.2 Key Threats

Key threats to the TEC are clearing and ongoing degradation. Weeping myall TEC occurs on highly fertile and arable soils where there is significant pressure to clear for cropping. Other threats include overgrazing, weed invasion and herbivory by caterpillars of the bag-shelter moth (TSSC, 2008b).

9.1.4.3 Potential Impacts

Potential impacts associated with the proposed Project activities include:

- Direct impacts due to vegetation clearing. No occurrences of the TEC have been recorded in field surveys and the TEC is considered to possibly occur within the Project area. Major threats are associated with field development related activities (e.g. drill pad, access tracks); and
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.

9.1.4.4 Significant Impact Criteria

1. Reduce the extent of an ecological community.

   Within the Project area the weeping myall TEC is potentially represented by REs 11.3.2 and 11.3.28. The constraints analysis mapping within the Environmental Framework chapter (Section 7.2) of the EIS identifies these two REs as constrained areas (based upon their classification as of concern REs). As a result of this constraints analysis Arrow will seek to preferentially avoid these areas during the planning and design phase as outlined in the mitigation commitments listed below in this TEC profile.

   Where weeping myall TEC cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken. Following the pre-clearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

   As discussed in Section 3 the lack of certainty about the preferred location of infrastructure at this stage of the Project means that an exact extent of weeping myall TEC to be cleared cannot be determined for the EIS. A conceptual field development plan and estimates of clearing extents of TECs have been developed for the SREIS (refer to Section 6.8).

   Given the constraints mapping, environmental framework approach and proposed pre-clearance surveys and mitigation measures, the Project activities are not expected to significantly reduce the extent of the ecological community.

2. Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.

   The following mitigation measures will be implemented to avoid fragmentation of this ecological community:

   a) Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
   b) Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
   c) Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
   d) Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
   e) Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
   f) Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B156]; and
   g) Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167].

3. Adversely affect habitat critical to the survival of an ecological community.

   As discussed above the proposed mitigation measures and environmental framework approach means that the Project is unlikely to adversely affect habitat critical to the survival of this ecological community.

4. Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community’s survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.

   The Project is not considered likely to affect abiotic factors necessary for the ecological communities’ survival. Details of land use, soil management, groundwater and surface water mitigation measures are provided in the Land Use chapter (Section 19), Soils chapter (Section 12) and draft EM Plan (Appendix Z, Sections Z.4.6 and Z.4.7) of the EIS respectively.

5. Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning of flora or fauna harvesting.

   The Project activities are not expected to include regular burning and therefore are not expected to cause a substantial change in species composition.

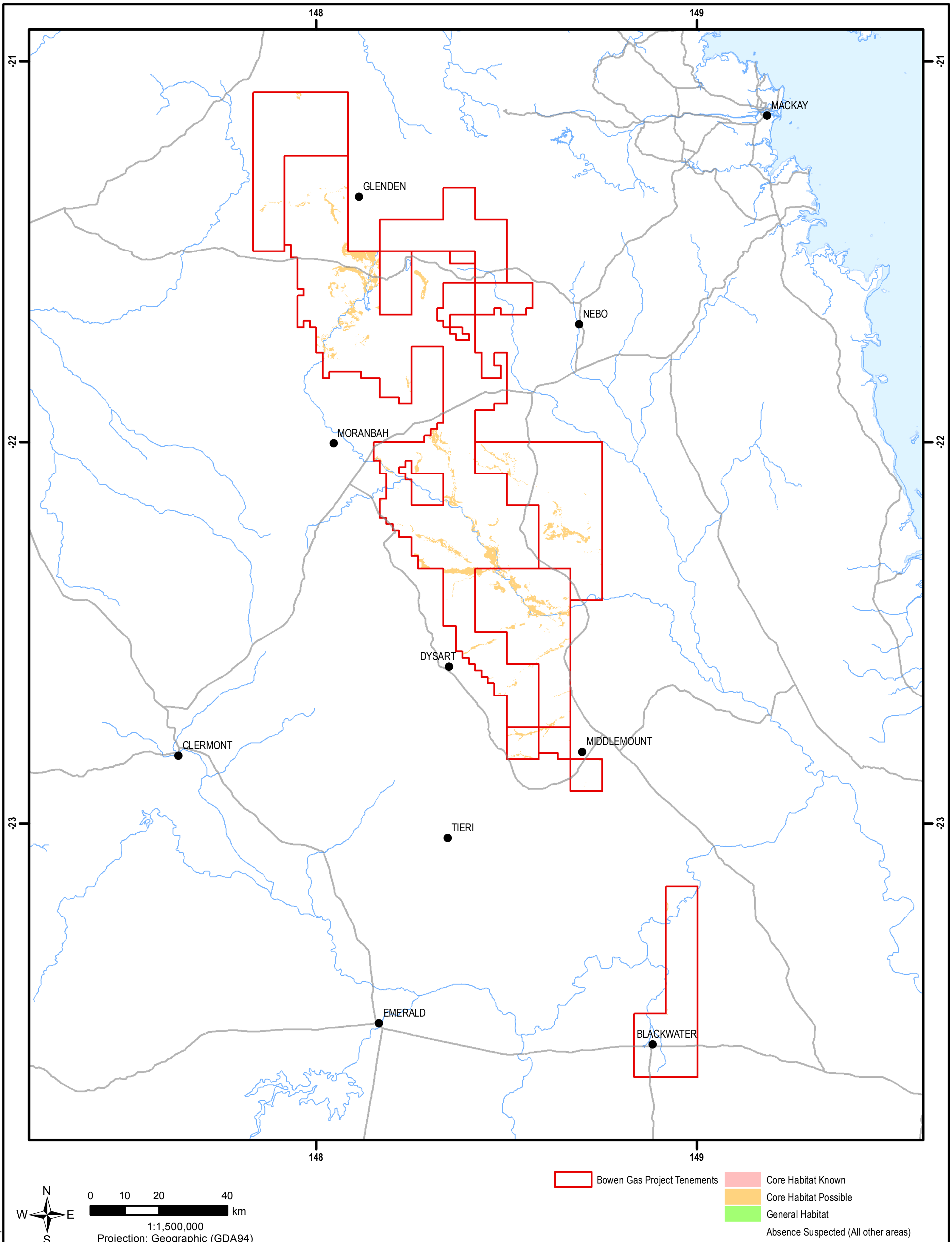
6. Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established, or; causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.

   Arrow has committed to a pest management plan (refer to the draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project which will minimise impacts to the ecological community. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

   The Project activities are considered unlikely to cause any impacts to the ecological community through the release of fertilisers, herbicides or other chemicals or pollutants.

7. Interfere with the recovery of an ecological community.

   No recovery plan is in place for the Weeping Myall Woodlands ecological community. The Project will manage impacts to this TEC as detailed in the mitigation commitments detailed below in Section 10.1.4.2 and therefore any recovery of the existing weeping myall TEC is unlikely to be impeded as a result of the Project.



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POTENTIAL HABITAT AREAS FOR WEEPING MYALL WOODLANDS TEC WITHIN THE PROJECT AREA

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT Figure: **9-4**

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9.1.5 TEC Potential Areas

The Areas potential TEC's within the Project area and the calculated disturbance from the sample conceptual footprint are detailed below in Table 9-2 below.

Table 9-2 Potential impact areas of TECs within the Project area

TEC	EPBC Act Status	NC Act Status	Area of TEC Within Project Area (ha)	Area of TEC Within Project Disturbance Footprint (ha)	Offset Assessment Method
Brigalow (*Acacia harpophylla* dominant and co-dominant)	E	-	57,846.81	781.16	EPBC Act Offsets assessment guide
Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin	E	-	29,246.19	871.10	EPBC Act Offsets assessment guide
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	E	-	5,212.53	107.42	EPBC Act Offsets assessment guide
Weeping Myall Woodlands	E	-	29,164.14	198.48	EPBC Act Offsets assessment guide

9.2 Protected Terrestrial Fauna Species

Nine terrestrial fauna species have been identified as having a moderate, high or recorded occurrence within the Project area (Table 9-3). The Fitzroy River turtle was identified as a low likelihood of occurrence within the Project given that records suggest the core habitat for this species occurs outside the Project area. However, as a precaution, this species has been included in habitat mapping and subsequent potential impact assessment.

Profiles for all ten species are outlined below in Section 9.2 including a summary of the extents of their potential habitat within the Project area based on potential habitat mapping, and an assessment against *MNES: Signficant Impact Guidelines 1.1* (2013). Specific avoidance, mitigation and management measures for each species are detailed below in Section 10.2.

Protected terrestrial fauna and flora identified as having a likelihood of occurrence of moderate, high or recorded were assessed against the significant impact criteria provided in the Department of the Environment's *MNES: Signficant Impact Guidelines 1.1* (2013).

Within this guideline, an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

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

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

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

Table 9-3 MNES Fauna with a Moderate, High or Recorded Likelihood of Occurence within the Project Area

Species		EPBC Act Status	Liklihood of Occurrence
Common Name	*Scientific Name*		
northern quoll	*Dasyurus hallucatus*	Endangered	Moderate
ornamental snake	*Denisonia maculata*	Vulnerable	Recorded
Fitzroy River turtle	*Rheodytes leukops*	Vulnerable	Low[1]
squatter pigeon	*Geophaps scripta scripta*	Vulnerable	Recorded
koala	*Phascolarctos cinereus*	Vulnerable	High
south-eastern long-eared bat	*Nyctophilus corbeni*	Vulnerable	Moderate
large-eared pied bat	*Chalinolobus dwyeri*	Vulnerable	Moderate
Australian painted snipe	*Rostratula australis*	Endangered	Moderate
red goshawk	*Erythrotriorchis radiatus*	Vulnerable	Moderate
yakka skink	*Egernia rugosa*	Vulnerable	Moderate

[1] The core habitat for this species is found to the south-east of the Project area. It is being included in the assessment as a precaution

9.2.1 *Species Profile: Northern Quoll (Dasyurus hallucatus)*

Status: EPBC: Endangered **NC Act:** not listed
Recovery Plan: National Recovery Plan For the Northern Quoll *Dasyurus hallucatus*
Identified Relevant Threat Abatement Plans: Threat Abatement Plan for Predation by the European Red Fox. Threat Abatement Plan for Predation by Feral Cats.

The northern quoll (*Dasyurus hallucatus*) is solitary, arboreal and the smallest of the quoll species (Menkhorst and Knight, 2004). An omnivorous species, northern quolls feed on a diversity of invertebrates as well as mammals, birds, amphibians, reptiles and native fruits (van Dyck and Strahan, 2008). Northern quolls are generally nocturnal, denning in tree hollows, termite mounds, fallen logs and rock crevices. Individuals will use a number of dens across their territory (van Dyck and Strahan, 2008). Males are larger than females and perish after their first year of mating. Females are also short lived generally only surviving one breeding season. Females average seven offspring born between June and September of which 2 to 3 surviving offspring are weaned at six months of age (van Dyck and Strahan, 2008).

9.2.1.1 *Distribution and Habitat*

The northern quoll was formerly distributed across northern Australia, occurring commonly from the Pilbara in Western Australia across to south-eastern Queensland. It is now largely confined to small areas within its former range, areas often dominated by rocky escarpment country. Although found in a variety of habitats, it is most common in rocky eucalypt woodland and open forest within 200 km of the coast including areas such as Eungella, Cooktown, Mareeba, The Kimberley, The Pilbara and the Top End (Menkhorst and Knight, 2004). Records of the species within the Project area and surrounding area are known, though few records exist. The most recent records in proximity to the Project area include individuals in Dipperu National Park (1971), Mt. Hess (2002) and within Homevale National Park (2003).

The northern quoll was not detected during the field surveys of the Project area. Survey methods are outlined above in Section 5, and data are presented in Section 4 of the Terrestrial Ecology Technical Report (Appendix P) of the EIS.

9.2.1.2 Potential Habitat Extent within the Project Area

Potential habitat within the Project area includes Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland. It is considered to be uncommon and perhaps restricted to the rocky hills and ranges listed above.

Figure 9-5 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species. Because of the limited information available on this species, the only habitat available to be mapped is ‘General habitat’.

9.2.1.3 Key Threats

Key threats listed for the species on the SPRAT database (DSEWPaC, 2013m) and in the recovery plan for the species (Hill and Ward, 2010) include:

- habitat loss;
- weed invasion;
- inappropriate fire regimes;
- habitat degradation and destruction;
- weeds;
- disease;
- predation by feral predators; and
- death by ingestion of the toxic cane toad.

9.2.1.4 Potential Impacts

The lack of populations within the Project area dilutes the Project related impacts, which could include:

- The loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure;
- Death or injury of individuals during construction;
- Increased risk of vehicle strike;
- Increased fire frequency related to increased human presence;

- Increased mortality through predation and cane toad ingestion; and
- Increased competition with introduced predators (e.g. cats).

A National Recovery Plan has been developed for the northern quoll (Hill and Ward, 2010). The recovery plan details the following relevant key recovery actions:

- Determine which factors affect survival and recovery of northern quolls in areas with cane toads;
- Collect baseline data on population densities and monitor trends of quolls at a series of key sites not currently occupied by cane toads;
- Identify the effect of pastoral land management practices on northern quoll persistence;
- Interim fire management at potential key quoll populations;
- Refine models of the current and expected distribution of cane toads and northern quolls, incorporating predictions of climate change;
- Continue research into the susceptibility of quolls to cane toad poisoning;
- Test the efficacy of control measures for cane toads and whether they allow local persistence of quoll populations;
- Protection of key secure populations through protection of habitat in National Parks and Conservation Agreements;
- Increase knowledge and monitoring for disease in northern quoll populations;
- Assess the impacts of feral predators on populations of northern quolls;
- Implement efforts to protect key northern quoll populations from the impacts of feral predators; and
- Implement a broader public education and awareness campaign on quolls and feral species (particularly cane toads and cats).

9.2.1.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of a population.

   The northern quoll was not identified in surveys. Suitable habitat within the Project area is limited due to historical fragmentation of habitat with the species potentially restricted to rocky hills and ranges such as Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland. These areas have been identified in the Constraints Mapping report (Appendix BB, Section BB.2.1, Figure 1) of the EIS as areas of High constraint. Additionally the Blackdown Tableland is largely outside of the Project area. As identified in Section 7.2.2 of this report, the nothern quoll is considered to be uncommon within the Project Area.
   Production facilities are excluded from High constraint areas. Project activities in High constraint areas are restricted to minimise potential impacts to MNES values by the sensitive location of wells and gathering lines. Further detail on the sensitive management of values in High constraint areas is outlined in the Constraints Mapping report (Appendix BB, Section BB.2) of the EIS.

2. Reduce the area of occupancy of the species.

   As noted above, the northern quoll is uncommon within the Project area. In addition, Project activities will be managed to minimise any potential impacts to potential habitat. Therefore, a reduction in the area of occupancy of an important population will be unlikely as a result of the Project.

   A detailed habitat mapping process for the northern quoll has been undertaken by Arrow for the Project SREIS, which further refined the knowledge of potential habitat for this species within the Project area. Further detail of the proposed habitat mapping is provided in Section 8.

3. Fragment an existing important population into two or more populations.

   Northern quolls are uncommon within the Project area and are most likely to be associated with the Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland. These areas have been identified in Constraints Mapping report (Appendix BB, Section BB.2.1, Figure 1) of the EIS as areas of High constraint, and as such will be minimally impacted by the Project.
   Production facilities are excluded from High constraint areas. Project activities in High constraint areas are restricted to minimise potential impacts to MNES values by sensitive location of wells and gathering lines. Further detail on the sensitive management of values in High constraint areas is outlined in the Constraints Mapping report (Appendix BB, Section BB.2) of the EIS.
   The development of the Project will be strictly managed within or adjacent to these areas through the management measures proposed, and as such, it is considered that there will be no fragmentation of important populations resulting from Project activities.

4. Adversely affect habitat critical to the survival of a species.

   Northern quolls are an active species often associated with rocky outcrops and breakaways, with the potential to move large distances over modified land. However, Northern quolls are very uncommon within the Project area and are most likely to be associated with the Kerlong Range, Carborough Range, Redcliffe Tableland and Blackdown Tableland. These areas have been identified as areas of High constraint (Constraints Mapping report (Appendix BB, Section BB.2.1, Figure 1) of the EIS). Additionally the Blackdown Tableland is largely outside of the Project area, and only a relatively small area overlaps with the Project area (within the south of ATP 1025).
   Production facilities are excluded from High constraint areas. Project activities in High constraint areas are restricted to minimise potential impacts to MNES values by sensitive location of wells and gathering lines. Further detail on the sensitive management of values in High constraint areas is outlined in the Constraints Mapping report (Appendix BB, Section BB.2) of the EIS. These activities are unlikely to adversely affect critical habitat for the species.

5. Disrupt the breeding cycle of a population.

   As no populations are expected to be impacted, disruption to breeding cycles critical to the survival of the species is unlikely to result from the proposed Project activities.

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

   As noted in (4) above, any suitable habitat is restricted to rocky hills and ranges where Project activities will be constrained. While there may be minimal indirect impacts to potential habitat, these will be no greater than ambient disturbance from existing activities and will not modify habitat to the point where the species will decline.

7. Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species habitat.

   Invasive flora and fauna species have been identified as a key threat to the species (DSEWPaC, 2013m, Hill and Ward, 2010). Arrow has committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

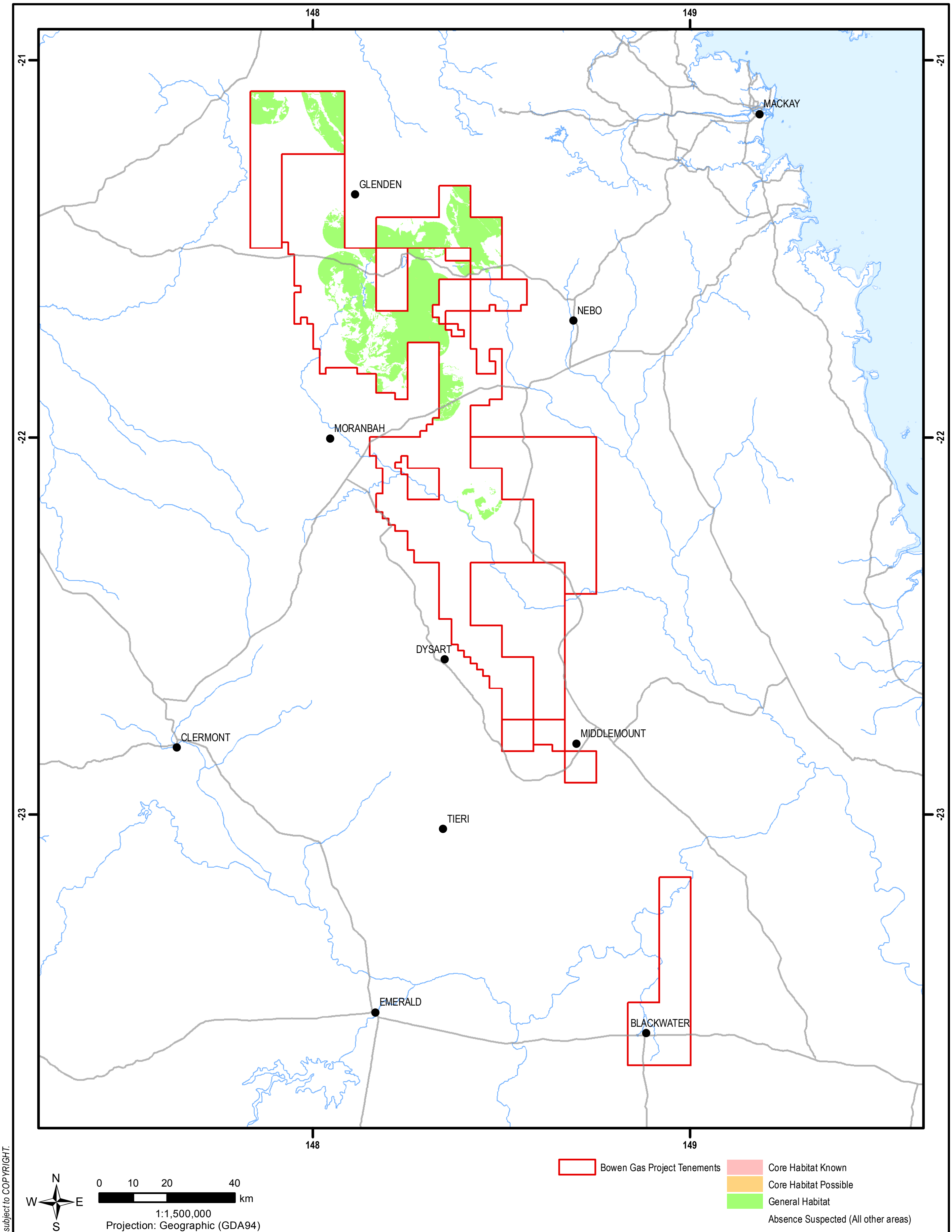
8. Introduce disease that may cause the species to decline.

   Hill and Ward (2010) identify disease as a potential threat to the northern quoll. Population crashes among dasyurids in central Queensland may be attributable to disease (Finlayson, 1934 in Hill and Ward, 2010). Abbott (2006 in Hill and Ward, 2010) proposes that an exotic epizootic disease triggered faunal collapse sequentially across Western Australia, particularly from the 1880s to 1920s. However, given that the pest management plan for the Project will detail the measures to prevent the introduction and spread of disease, it is not expected that the Project will cause the species to decline form this source.

9. Interfere with the recovery of the species.

   The Project will not result in threatening processes identified in the recovery plan (Hill and Ward, 2010) for the species. Pest management plans and control of invasive weeds within the Project area will support measures to reduce the decline in the species.

The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.2.1.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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NORTHERN QUOLL (DASYURUS HALLUCATUS) POTENTIAL HABITAT MAPPING

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Figure: 9-5

File No: 42627140-g-2013b.mxd | Drawn: RG | Approved: DS | Date: 16-04-2014 | Rev. B | A4

9.2.2 Species Profile: Ornamental Snake (*Denisonia maculata*)

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery plan required	
Identified Relevant Threat Abatement Plans: Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs. Threat Abatement Plan for Predation by the European Red Fox. Threat Abatement Plan for Predation by Feral Cats.	

Ornamental snake (*Denisonia maculata*) is a small, robust, viviparous (live-bearing) elapid (front-fanged snake), giving birth to 3-11 babies. Sexual maturity is reached at approximately 24.7 cm for females and 23.0 cm for males (Shine, 1983). A nocturnal species, ornamental snakes predominantly eat amphibians and high numbers of individuals can be found when metamorph amphibians are in abundance (M. Sanders pers obs.; E. Vanderduys pers. com.). During the day individuals will retreat under fallen debris (e.g. logs, rocks, leaf litter) or down soil cracks. During dry periods individuals are infrequently active and difficult to locate. Rain and the filling of ephemeral pools provide suitable conditions for amphibian reproduction increasing prey availability and activity levels in ornamental snakes. Ornamental snakes are more likely to be active as temperatures and rainfall increase (e.g. summer months).

9.2.2.1 *Distribution and Habitat*

The ornamental snake is currently known only from the Brigalow Belt bioregion with core distribution within the drainage system of the Fitzroy and Dawson Rivers (McDonald *et al*., 1991; Cogger *et al*., 1993 in DSEWPaC, 2013x) where they are found in open-forests to woodlands associated with gilgai formations and wetlands. These are commonly mapped as REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9 and 11.5.16 or mapped as cleared but where the above REs formerly occurred (DSEWPaC, 2013x).

The ornamental snake was recorded at one location to the south-east of Moranbah during the field surveys. This specimen was located within *Eucalyptus coolaba*h woodland with shallow gilgai development and groundcover dominated by *Eleocharis pallens*. This individual was recorded under a dead log on moist heavy clay soil. Survey methods are outlined above in Section 5, and data are presented in the Terrestrial Ecology Technical Report (Appendix P, Section 4.4) of the EIS. The SPRAT database notes that the core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson Rivers, and within this area important populations occur on, or surrounding, gilgai mounds and depressions (DSEWPaC, 2013x). The draft Referral Guidelines for the Brigalow Belt Reptiles (DSEWPaC, 2011b) notes that known important habitat for the ornamental snake includes gilgai depressions and mounds and that habitat connectivity between gilgais and other suitable habitats is important. The draft referral guidelines also note that "…given that the listed Brigalow Belt reptiles are difficult to detect and population information is limited, the department (DSEWPaC) regards important habitat as a surrogate for important populations in the assessment of whether an action is likely to have a significant impact on one or more of these species".

9.2.2.2 *Potential Habitat Extent within the Project Area*

Ornamental snakes utilise habitats that maintain water for extended periods including gilgai (melon-hole) mounds and depressions (Burgess, 2007) and wetlands. The moisture maintained in these regions allows for extended periods of amphibian reproduction, providing ornamental snakes with increased prey abundance. Deep-cracking soils with high clay content and a high abundance of logs / woody debris on the ground provide shelter and refuge during dry cool periods.

Figure 9-6 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-6). Based upon this mapping approximately 61,470.08 ha of potential mapping is present within the Project area including 1,988.37 ha of 'core habitat known', 59,481.71 ha of 'core habitat possible'.

9.2.2.3 *Key Threats*

Key threats listed for the species on the SPRAT database (DSEWPaC, 2013x) include:

- Habitat loss through clearing (roads, ploughing, railways, mining-related activities, pipeline constructions);
- Habitat fragmentation;
- Habitat degradation by overgrazing by stock, especially cattle, or grazing of gilgais during the wet season leads to soil compaction and compromising of soil structure;
- Alteration of landscape hydrology in and around gilgai environments;
- Alteration of water quality through chemical and sediment pollution of wet areas;
- Contact with the Cane Toad;
- Predation by feral species; and
- Invasive weeds.

Of the above threats, the Project has the potential to contribute to habitat loss, habitat fragmentation, alteration of landscape hydrology and water quality and introduction or spread of invasive weeds.

9.2.2.4 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Possible death or injury of individual during vegetation clearing. It is possible, depending on the extent of the clearing, that displaced animals forced into nearby or adjacent habitats may be unlikely to persist due to increased competition in these areas.
- As the species is known to cross artificial corridors, it is highly probable that individuals could become trapped and perish in open trenches;

- The species is susceptible to changes in soil structure and hydrology resulting from construction activities such as soil compaction and short-term loss of soil structure development (i.e. cracking), however the species has also been observed in disturbed soils (such as graded road verges and spoil piles) which suggests that the species can tolerate some soil degradation;
- Edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for the species. Although the species is known to utilise buffel grass-dominated pasture, the impacts from other weeds such as parthenium is unclear. Therefore weed invasion resulting from clearing has the potential to alter large areas of potential or known habitat, possibly reducing the abundance or extent of the species; and
- Individuals may become entrapped and perish in plastic-lined surface ponds.

9.2.2.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   The ornamental snake favours areas of cracking clays for shelter and seeks prey in gilgai formations. These features are situated widely throughout the study area, and observations suggests the density of ornamental snakes within these areas is low (M. Sanders pers obs). It is considered unlikely that the proposed works will impact enough of the suitable habitat to cause a decrease in the size of an important population. In addition, the ornamental snake is known to utilise disturbed areas such as non-remnant grassland, thereby indicating it is not reliant solely on remnant habitat and further reducing the opportunity for impacts on the species and its habitat.

   As the draft Referral Guidelines for the Brigalow Belt Reptiles (DSEWPaC, 2011b) notes that known important habitat is a surrogate for important populations for the ornamental snake, there is the potential for impacts to the ornamental snake from Project activities to result in a long-term decrease in the size of an important population of this species. The actual extent of habitat needs to be determined during pre-clearing surveys prior to construction as detailed below.

2. Reduce the area of occupancy of an important population.

   Removal of vegetation and habitat for the Project may reduce the extent of habitat available for the species; however the extent of habitat loss as a proportion of the habitat available within the region is small. Due to the snake's ability to use a variety of habitat types, and the widespread nature of its habitat, it would be expected that the reduction of area of occupancy would be minimal. However, given that known important habitat is a surrogate for important populations for the ornamental snake, the Project does have the potential to reduce the area of occupancy of an important population.

   A detailed habitat mapping process for the ornamental snake has been undertaken by Arrow for the SREIS. This will further refine the knowledge of the occurrence of suitable habitats for this species within the study area. Further detail of the proposed habitat mapping is provided in Section 8

3. Fragment an existing important population into two or more populations.

   The ornamental snake is typically found in disjunct populations throughout the Brigalow Belt. Therefore, it is highly unlikely that an existing important population will be fragmented into two or more populations. However, given that known important habitat is a surrogate for important populations for the ornamental snake, the Project does have the potential to fragment an existing important population into two or more populations. The disruption of connectivity between potential ornamental snake habitat (such as areas featuring gilgai and brigalow) also has the potential to fragment populations.

   The mitigation commitments outlined below, including the detection of potential habitat during preclearance surveys will enable the identification of opportunities for relocation of infrastructure to avoid such habitat and thus avoid fragmentation of populations.

4. Adversely affect habitat critical to the survival of a species.

   As noted above, the ornamental snake possesses a widespread distribution. There is a very low risk that the Project activities will be placed such that habitat critical to the survival of a species will be impacted to the detriment of the species.

5. Disrupt the breeding cycle of an important population.

   As no habitat critical to the survival and breeding success of the species as a whole will be impacted, disruption to breeding cycles critical to the survival of the species will not result from the proposed Project activities. However, given that known important habitat is a surrogate for important populations for the ornamental snake, the Project does have the potential to disrupt the breeding cycle of an important population.

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

   As much of the study area has been impacted by agricultural and pastoral activities, and as ornamental snakes are known to utilise disturbed habitat, Project activities are unlikely to further modify the quality of habitat to the detriment of the species in the long term.

7. Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.
   Invasive species such as the cane toad in particular and feral predators in general have been identified as key threats to the species (DSEWPaC, 2013x).

   Invasive flora and fauna species have been identified as a key threat to the species (DSEWPaC, 2013x). Arrow has committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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.

Given the successful implementation of a Project pest management plan, the development of the Project activities will not result in the establishment of invasive species that have the potential to harm the ornamental snake. The feral predators of the ornamental snake (e.g. red fox, feral cat, wild dog) are already well established in the region and the Project will not exacerbate predation or poisoning on the ornamental snake.

8. Introduce disease that may cause the species to decline.

Disease has not been identified as a key threat to ornamental snakes. The pest management plan to be developed for the Project will detail the measures to prevent the introduction and spread of disease.

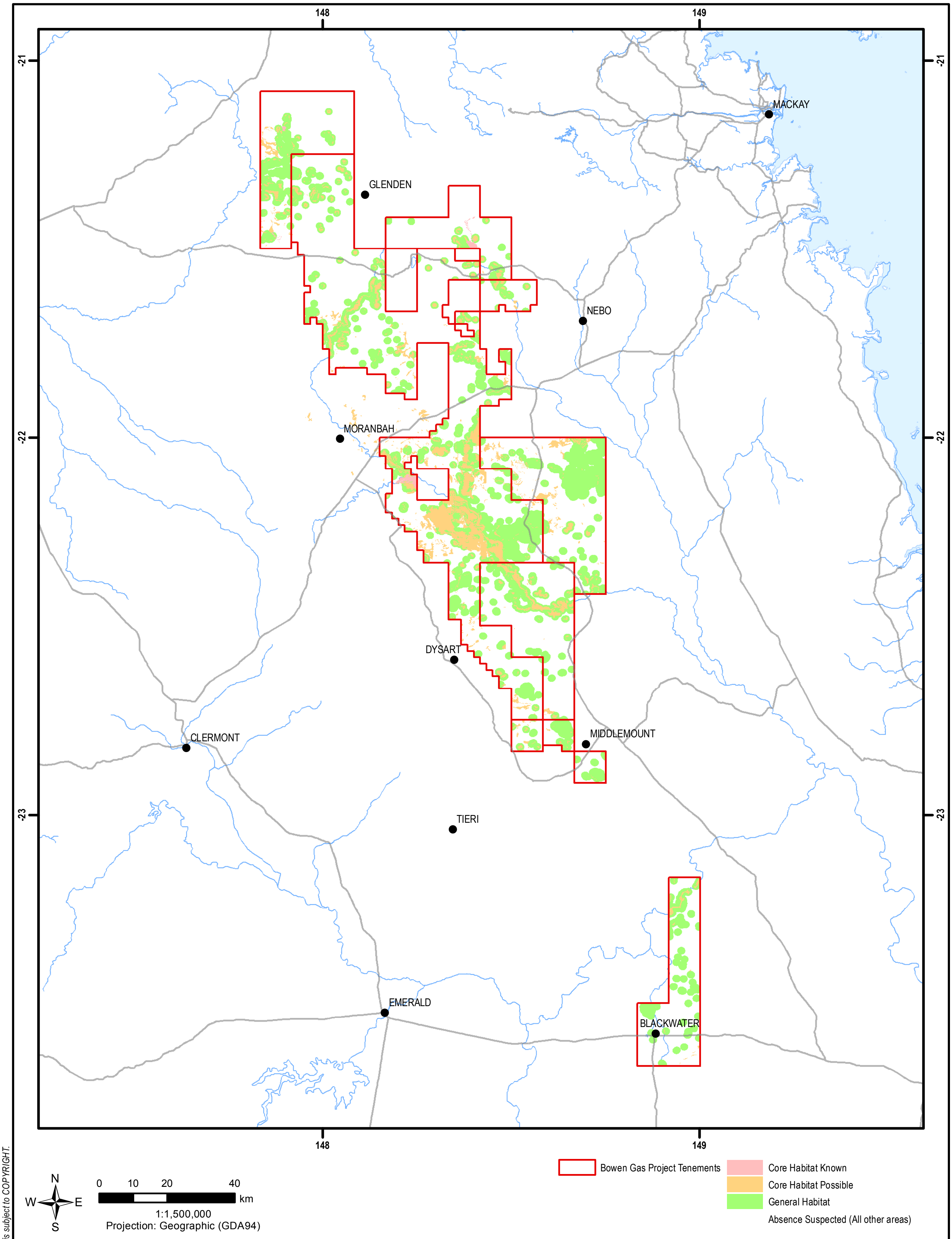
9. Interfere substantially with the recovery of the species.

The draft recovery plan for the Queensland Brigalow Belt Reptiles (Richardson, 2006) notes that impediments to the recovery of the Brigalow Belt reptiles include:

- Inadequate knowledge of species distribution and habitat;
- Inadequate knowledge of species biology and ecology;
- Community perception and stakeholder involvement;
- Climate change; and
- Availability of resources.

The Project will not compound any of these issues and therefore recovery of the ornamental snake is not likely to be impeded as a result of the Project. Studies conducted for this and similar Projects may actually improve overall knowledge which may benefit the species in the long-term.

The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.2.2.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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ORNAMENTAL SNAKE (DENISONIA MACULATA) POTENTIAL HABITAT MAPPING

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Figure: 9-6

File No: 42627140-g-2014c.mxd Drawn: RG Approved: DS Date: 16-04-2014 Rev. C A4

9.2.3 *Species Profile: Fitzroy River Turtle (Rheodytes leukops)*

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery plan not required, included on the Not Commenced List	
Identified Relevant Threat Abatement Plans: nil	

The Fitzroy River turtle is a medium to dark brown turtle growing to 25 cm (shell length) with scattered darker spots and blotches on the upper shell surface. It has a pale yellow or cream belly and dull olive-grey exposed fleshy parts. The shell is broadly oval and the neck is covered with large, pointed conical tubercles (Cogger, 2000 in DSEWPaC, 2013ac). The back edge of the shell on hatchlings is serrated (Cogger, 2000; Latta and Latta, 2005; Wilson and Swan, 2003 in DSEWPaC, 2013ac). The Fitzroy River turtle andhas distinctive eyes with black pupils surrounded by a narrow white inner ring (adults) or a metallic silvery-blue iris (hatchlings) (Cogger, 2000; Limpus, 2007 in DSEWPaC, 2013ac). The Fitzroy River turtle has relatively long forelimbs with five long claws and a large cloacal bursae which has a respiratory function (Cogger, 2000; Wilson and Swan, 2003 in DSEWPaC, 2013ac).

9.2.3.1 *Distribution and Habitat*

Occurring exclusively in the drainage system of the Fitzroy River, Queensland, it is estimated that the species' habitat is confined to a total area of less than 10,000 km^2.

Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek, and Gogango (J. Cann cited in Cogger *et al.*, 1993; Covacevich *et al.,* 1996a; Tucker *et al*., 2001; Venz 2002 in DSEWPaC, 2013ac).

9.2.3.2 *Potential Habitat Extent within the Project Area*

It is thought that the Fitzroy River turtle has an affinity for well-oxygenated riffle zones, moving into deeper pools as the riffle zones cease to flow (Tucker *et al.*, 2001 in DSEWPaC, 2013ac). However, recent studies have captured several turtles from deep pools (Gordos *et al.*, 2003; 2003a; 2004 in DSEWPaC, 2013ac).

General surveys were undertaken for a range of turtles as part of the aquatic survey program. Although targeted surveys for the Fitzroy River turtle were not included due to the specialised and highly intensive methods required, standard turtle trapping techniques occasionally result in captures. No captures or incidental records for this species were obtained.

Figure 9-7 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-7). Based upon this mapping approximately 535.29 ha of potential habitat is present within the Project area all of which is 'core habitat possible'.

9.2.3.3 Key Threats

The Fitzroy River turtle is primarily threatened by egg predation by foxes, feral pigs, wild dogs, goannas and water rats. At some monitored sites, nest predation has resulted in 100% loss of eggs. Other threats listed for the species outlined on the SPRAT database (DSEWPaC, 2013ac) include:

Feral animals and nest destruction: Nesting sites may be threatened by unseasonable flooding or trampling by stock (Limpus, 2007 in DSEWPaC, 2013ac). The species is also vulnerable to predation by foxes (*Vulpes vulpes*), feral pigs (*Sus scrofa*) and wild dogs (*Canus lupus familiaris*) if forced to move over land due to artificial barriers (Venz, 2002 in DSEWPaC, 2013ac).

Water pollution and weed infestation: Increasing turbidity and pollution in rivers due to agriculture and mining operations can affect food resource abundance and availability and respiratory function (Cann, 1998; Cogger *et al.*, 1993 in DSEWPaC, 2013ac) leading to population decline. Weed infestations in riparian zones restrict access of the species to preferred nesting sites (Limpus, 2007 in DSEWPaC, 2013ac).

Flow regulation: Construction of dams and weirs potentially impacts on dietary ecology or respiratory physiology (Tucker *et al.*, 2001 in DSEWPaC, 2013ac), in addition to acting as a physical barrier restricting access to feeding or nesting areas (Venz, 2002 in DSEWPaC, 2013ac).

9.2.3.4 Potential Impacts

Potential impacts associated with the Project include:

- Loss of habitat from construction activities;
- Loss of movement opportunities from construction activities;
- Reduction in water quality;
- Sediment deposition in habitat areas; and
- Spread of riparian weeds.

Rivers within the Fitzroy River turtle's range have experienced increases in turbidity since the species' discovery (Venz, 2002 in DSEWPaC, 2013ac). Increasing turbidity and sedimentation may affect food resources and cloacal respiration, and have been observed to coincide with some population declines (Cann, 1998 in DSEWPaC, 2013ac). Pollution of water and soil by surrounding land uses, such as agriculture and mining operations, may also pose a threat to populations (Cann, 1998; Cogger *et al.*, 1993 in DSEWPaC, 2013ac).The Aquatic Ecology chapter (Section 16.4.5) of the EIS notes that impacts from track and easement construction and maintenance are generally likely to be quite localised and of short duration. Impacts on aquatic ecosystems as a result of these activities are largely associated with the construction phase, when freshly denuded and/or disturbed soils are most at risk of erosion. Track construction can also lead to sediment transport. There is potential for the contamination of waterways as a result of fuel, oil or chemical spills, use of herbicides during track maintenance, and increased public access (litter).

The removal of riparian or aquatic vegetation, or terrestrial vegetation in close proximity to watercourses, may result in short-term exposure of soil to erosion and sediment transport processes, particularly if sodic soils are disturbed or denuded. This may impact on aquatic ecosystems through the creation of poor water quality or smothering of benthic habitat with sediment.

There is the potential for these activities, if unmitigated, to impact on downstream habitat for the Fitzroy River turtle.

9.2.3.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   The Fitzroy River turtle is restricted to aquatic ecosystems, with the majority of records to the south-east outside of the Project area (Atlas of Living Australia, 2013). Aquatic field studies undertaken for the Project did not record this species on site. However, as the Project area is located largely within the Fitzroy River catchment, there is the possibility that some habitat may overlap with Project area.

   Given that the majority of the waterways in the Project area are ephemeral, and populations appear to be concentrated to the south-east outside of the Project area, it is considered unlikely that Project activities will lead to a long-term decrease in the size of an important population of the species.

2. Reduce the area of occupancy of an important population.

   As discussed above, important populations appear to be restricted to the south-east of the Project area. Whilst there is a possibility of the species utilising habitat within the Project area, based on available records, this appears of low likelihood. The Project is unlikely to reduce the area of occupancy of an important population.

3. Fragment an existing important population into two or more populations.

   As important populations are not known from the Project area, the Project activities are unlikely to cause fragmentation of an important population.

4. Adversely affect habitat critical to the survival of a species.

   The Project is primarily within the Fitzroy River catchment. The Fitzroy River turtle is restricted to this catchment. Therefore any impacts to waterways or drainage systems from the Project have the potential to affect downstream receiving environments that may support the turtle. Although the Project itself is unlikely to cause minimal direct damage to aquatic ecosystems, cumulative impacts from all land uses in the catchment may impact on critical habitat. Cumulative impacts are further discussed in Section 11.

   Given the distance of Project activities from Fitzroy River turtle habitat, and the implementation of mitigation actions as detailed below in this species profile, it is unlikely that the Project will directly affect critical habitat for the species.

5. Disrupt the breeding cycle of an important population.

   The distance of the Project activities from important populations, and the proposed mitigation of downstream impacts, means that Project activities are unlikely to affect breeding cycles of the turtle.

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

   The distance of the Project from important populations, and proposed mitigation of downstream impacts, means that Project activities are unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. In addition, the implementation of mitigation actions as detailed below will further minimise the opportunity for habitat modification or destruction.

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

   Feral animals such as foxes, feral pigs and wild dogs are a known threat to the Fitzroy River turtle (DSEWPaC, 2013ac). These species are already well established within the Project area and core Fitzroy River turtle habitat.

   Arrow has committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a threat to the Fitzroy River turtle. The pest management plan for the Project will detail the measures to prevent the introduction and spread of disease.

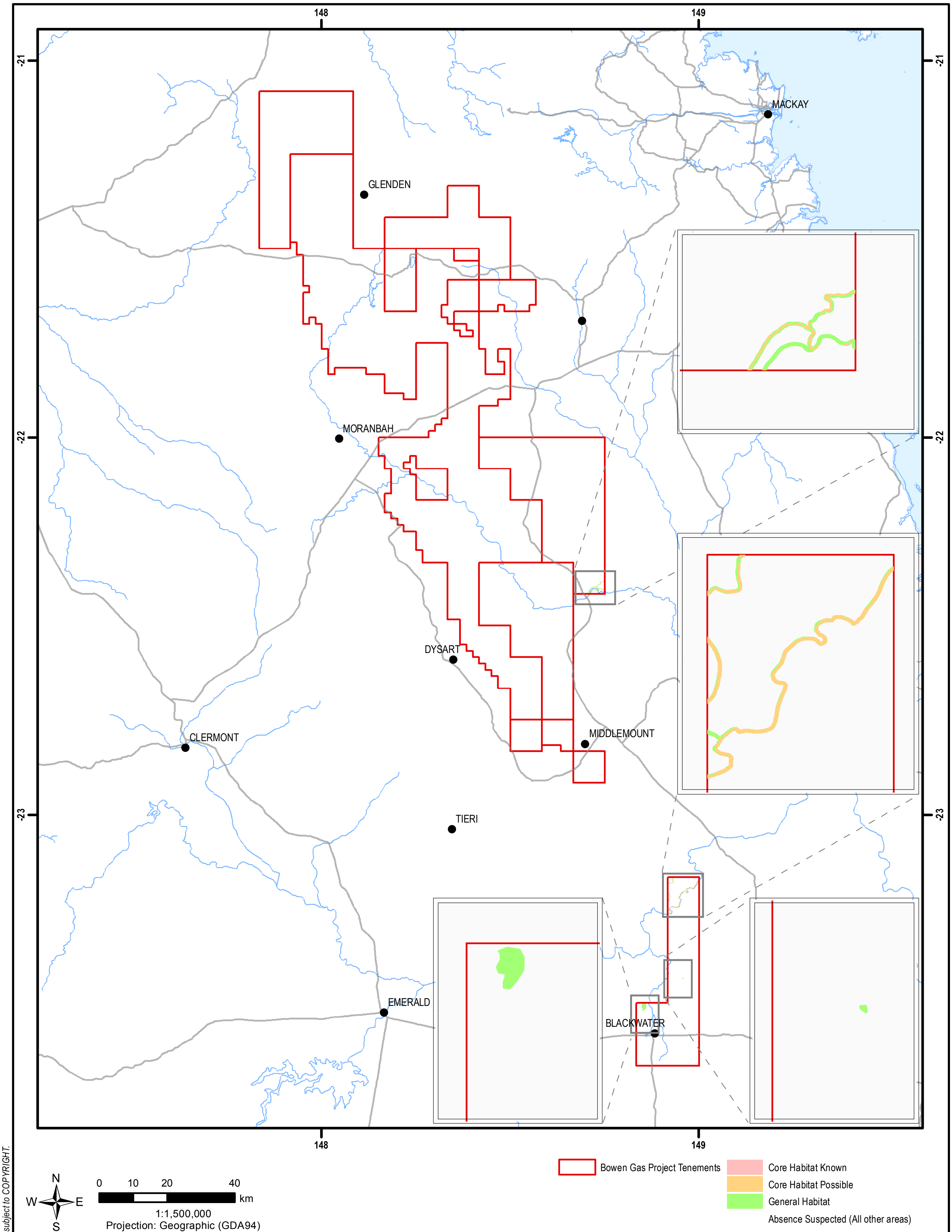
9. Interfere substantially with the recovery of the species.

   There is no recovery plan in place for this species. However, the following recovery actions are recommended (EPA, 2007):

   – maintain nesting banks used by the turtles and protect turtle nests from predation and disturbance;
   – improve recruitment of hatchlings into the population;
   – maintain stream flow and connectivity of turtle populations between impoundments;

- improve water quality in the lower Fitzroy River catchment; and
- boat owners should look out for turtles floating at the surface and 'go slow for those below' to give turtles time to get out of the way of oncoming boats.

The Project will not interfere with any of these recovery actions. Mitigation measures for the Fitzroy River turtle are detailed in Section 10.2.3.2



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FITZROY RIVER TURTLE (RHEODYTES LEUKOPS) POTENTIAL HABITAT MAPPING

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Figure: **9-7**

File No: **42627140-g-2010b.mxd** Drawn: **RG** Approved: **DS** Date: **05-03-2014** Rev. **B** A4

9.2.4 Species Profile: Squatter pigeon (Geophaps scripta scripta)

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery plan not required, included on the Not Commenced List	
Identified Relevant Threat Abatement Plans: Threat Abatement Plan for Predation by the European Red Fox. Threat Abatement Plan for Predation by Feral Cats.	

The squatter pigeon (southern) is a medium-sized, ground-dwelling pigeon that measures approximately 30 cm in length and weighs about 190 to 250 g. The adults are predominantly grey-brown, but have black and white stripes on the face and throat, blue-grey skin around the eyes, dark brown (and some patches of iridescent green or violet) on the upper surfaces of the wings, blue-grey on the lower breast and belly, white on the lower region and flanks of the belly and extending onto the under surfaces of the wings, and a blackish-brown band along the trailing edge of the tail. They have black bills, dark brown irises, and dull purple legs and feet. The sexes are similar in appearance (Higgins and Davies, 1996 in DSEWPaC, 2013h).

Juvenile squatter pigeons can be distinguished from the adults by their duller colouring, the patchy and less distinctive appearance of the black and white facial stripes, and the paler colouring (buff to pale yellow) of the facial skin (Higgins and Davies, 1996 in DSEWPaC, 2013h).

The squatter pigeon is usually seen in pairs of small groups of up to 20 or more birds (EPA, 2006; North, 1913-14; G. Porter, 2006, pers. comm in DSEWPaC, 2013h). It usually breeds in solitary pairs (G. Porter, 2006, pers. comm in DSEWPaC, 2013h).

9.2.4.1 *Distribution and Habitat*

Records of squatter pigeons occur along the inland slopes of the Great Dividing Range west to Longreach and Charleville. Historically, it was found as far south as the Dubbo region, NSW, and extended north to the base of Cape York Peninsula (Garnett and Crowley, 2000; Pizzey and Knight, 2003 in DSEWPaC, 2013h). The southern subspecies (*Geophaps scripta scripta*) inhabits the southern portion of this range, interbreeding with *G.* s. *peninsulae* around the Burdekin-Lynd Divide (Ford, 1986 in DSEWPaC, 2013h). The species has declined dramatically in the south, and no confirmed records have been recorded from NSW since the 1970s (Garnett and Crowley, 2000 in DSEWPaC, 2013h).

While the subspecies may still be commonly seen round the Bowen Basin and north of Injune (M. Sanders pers. obs.), it has largely disappeared from the regions of Inglewood, Leyburn, Chinchilla and the Lockyer Valley (EPA, 2008c).

9.2.4.2 *Potential Habitat Extent within the Project area*

Recently, squatter pigeon has been reported on Arrow exploration sites north of Chinchilla (D. Fleming, pers. comm). Squatter pigeons occur in open dry sclerophyll woodland with grassy understorey, nearly always near permanent water (Pizzey and Knight, 2003; Higgins and Davies, 1996 in DSEWPaC, 2013h). Birds may occasionally feed in sown grasslands and pastures. These habitat sites occur throughout the Project area, and as such the species is highly likely to occur.

Figure 9-8 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-8). Based upon this mapping approximately 105,807.71 ha of potential mapping is present within the Project area including 4,324.72 ha of 'core habitat known', 101,482.89 ha of 'core habitat possible'.

9.2.4.3 *Key Threats*

Large areas of historical habitat for the squatter pigeons have been lost due to clearing for agricultural purposes. Habitat clearing is ongoing due to continued agricultural and industrial demands. The SPRAT database (DSEWPaC, 2013h) also outlines other key threats to the species, including:

Degradation of habitat by grazing herbivores: Ongoing overstocking of habitats with livestock and subsequent overgrazing.

Weed invasion: Particularly by exotic grass species that are established as treeless pastures, which provide minimal food for the species and are therefore generally avoided.

Feral animals: the squatter pigeon is vulnerable to predation by a number of species, predominantly foxes (*Vulpes vulpes*) and cats (*Felis catus*).

9.2.4.4 *Potential Impacts*

The dispersal and movement patterns of the squatter pigeon are unlikely to be affected by Project activities due to the highly mobile nature of the species and large areas of suitable habitat. Project related impacts are therefore mainly restricted to:

- The loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure;
- Decreased habitat quality due to invading exotic grasses associated with unsuitable revegetation practices or surface soil disturbance; and
- Increased surface water flows and resultant decrease in separation distance between permanent water and foraging habitats, enabling access to these areas for other less mobile species. Due to the mobility of the species, this benefit is likely to be minor or negligible.

9.2.4.5 Significant Impact Criteria

1. Lead to a long-term decrease in the size of an important population of a species.

   Suitable habitat for the species has been identified within the Project area. While the quality, extent and connectivity of existing available habitat has been severely affected by clearing for agricultural purposes, grazing and altered fire regimes, there appears to be abundant habitat throughout the region. As a result, there is no single important population of the squatter pigeon present within the Project area alone.

   Homevale Resources Reserve and Taunton National Park, identified habitats of the species, occur within the Project area and are likely to act as preferred habitat due to lower levels of disturbance. These areas are both protected estate and are likely to have a buffering capacity against any impact on the species within the Project area.
   The poor condition of much of the existing habitat, the identification of similar habitat in areas adjacent to the Project area and the mobile nature of the species indicate that it is unlikely that the Project will result in a long-term decrease in the size of an important population.

2. Reduce the area of occupancy of an important population.

   Removal of vegetation and habitat for the Project may reduce the extent of habitat available for the species; however the extent of habitat loss as a proportion of the habitat available within the region is small. In addition, the species is known to utilise a wide range of different habitats, minimising the impact of habitat clearing on the species.

3. Fragment an existing important population into two or more populations.

   The Project area does not contain an identified important population; no populations are listed on the SPRAT database (DSEWPaC, 2013h) as being especially important to the long-term survival or recovery of the species. Therefore Project activities will not result in the fragmentation of important populations.

4. Adversely affect habitat critical to the survival of a species.

   No areas of critical habitat were identified on the SPRAT database (DSEWPaC, 2013h). While individuals were observed in the Project area, and suitable habitat identified, the habitat is not deemed critical to the survival of the species. Identified habitat supporting known populations in protected reserves (Homevale Resources Reserve and Taunton National Park) within the Project area will mitigate any impact from unavoidable habitat disruption during the Project life cycle.

5. Disrupt the breeding cycle of an important population.

   Project related impacts such as removal of vegetation may impact on local breeding cycles or individual pairs. However, it is likely that breeding occurs in the more extensive habitat in protected estates within the Project area and in surrounding areas. As such, it is unlikely that the Project will significantly disrupt the breeding cycle of the population as a whole.

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

   Ongoing disturbance to the pastoral landscape (including remnant vegetation) is occurring throughout the Project area. While there may be some impacts to potential habitat as a result of the Project, these will generally be no greater than the levels of disturbance from existing activities and will not modify habitat to the point where the species will decline.

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

   Invasive flora and fauna species have been identified as a key threat to the species (DSEWPaC, 2013).

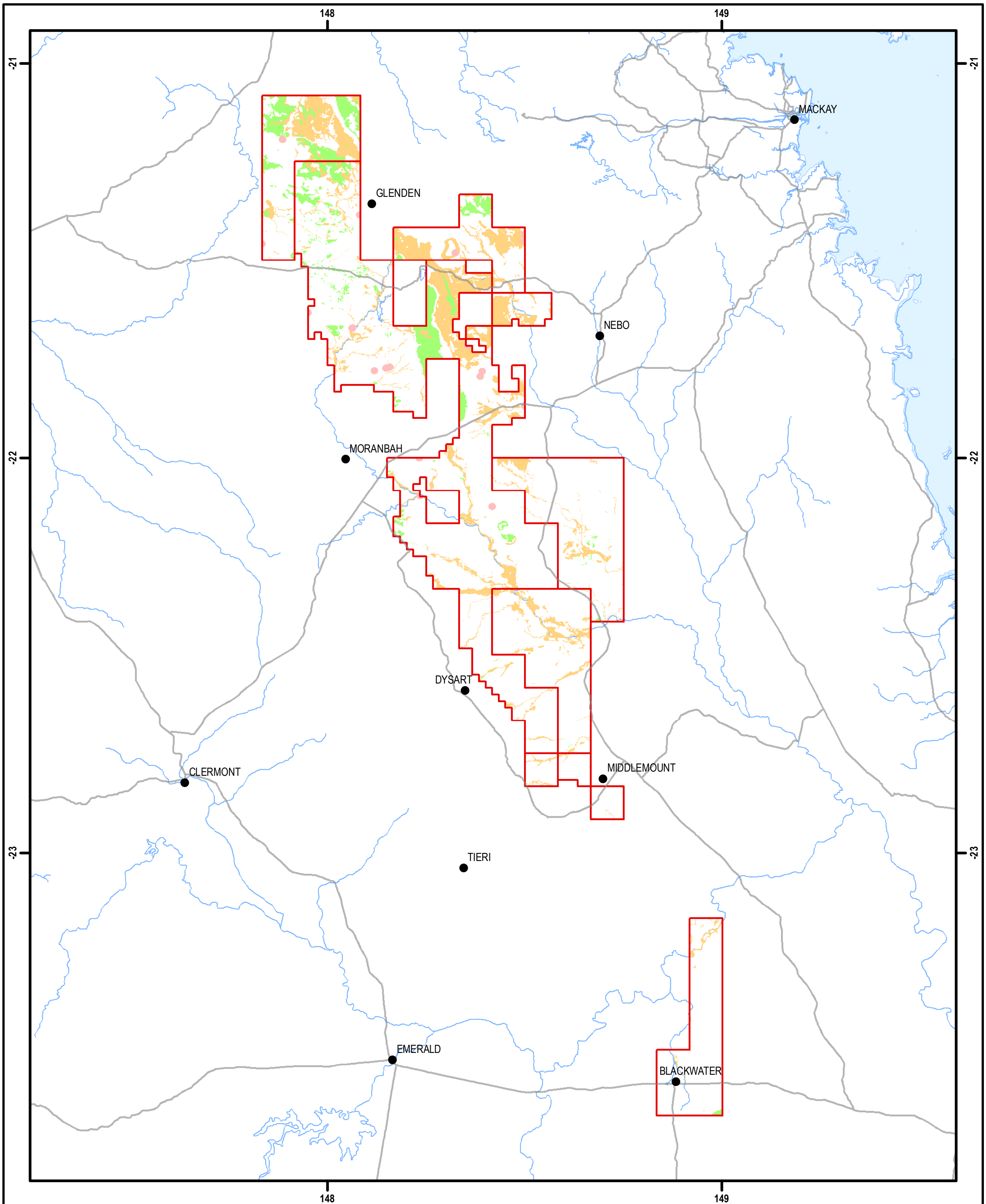
   Arrow has committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to the species. The pest management plan for the Project will detail the measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be impacted by the Project and some clearing of habitat may occur, protected estate within and adjacent to the Project area provide suitable replacement habitat. Proposed mitigation measures (Section 10.2.4.2) are designed to minimise habitat loss and ensure that replacement habitat is established during Project closure.



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Projection: Geographic (GDA94)

Bowen Gas Project Tenements
Core Habitat Known
Core Habitat Possible
General Habitat
Absence Suspected (All other areas)

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SQUATTER PIGEON (GEOPHAPS SCRIPTA SCRIPTA) POTENTIAL HABITAT MAPPING

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Figure: **9-8**

File No: **42627140-g-2016b.mxd** Drawn: **RG** Approved: **DS** Date: **16-04-2014** Rev. **B** A4

9.2.5 *Species Profile: Koala (Phascolarctos cinereus)*

Status: EPBC: Vulnerable	**NC Act:** least concern
Recovery Plan: Recovery Plan required, a recovery plan for the Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) will be developed and is to commence following the expiration of the National Koala Conservation and Management Strategy in 2014.	
Identified Relevant Threat Abatement Plans: nil	

The Koala is a tree-dwelling, medium-sized marsupial with a stocky body, large rounded ears, sharp claws and variable but predominantly grey-coloured fur. Males generally are larger than females and there is a gradient in body weight from north to south across their range, with larger individuals in the south and smaller individuals in the north. The average weight of males is 6.5 kg in Queensland, compared with 12 kg in Victoria. In the north of its range, the Koala tends to have shorter, silver-grey fur, whereas in the south it has longer, thicker, brown-grey fur (Martin and Handasyde, 1999 in DSEWPaC, 2013q).

9.2.5.1 *Distribution and Habitat*

Endemic to Eastern Australia, the koala is a solitary species that is widespread across coastal and inland areas from Cooktown, Queensland to the Mt. Lofty ranges, South Australia (Menkhorst & Knight, 2004). Restricted to altitudes below 800 m ASL (Munks *et al*., 1996 in DSEWPaC, 2013q). The range extends over 22° of latitude and 18° of longitude, or about one million square kilometres (Martin and Handasyde 1999 in DSEWPaC, 2013q). The Koala's distribution is not continuous across this range and it occurs in a number of populations that are separated by cleared land or unsuitable habitat (Martin and Handasyde 1999; NSW DECC 2008 in DSEWPaC, 2013q).

There are no identified important populations (DSEWPaC, 2013q).

9.2.5.2 *Potential Habitat Extent within the Project area*

Koalas occur in a diversity of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities, and sclerophyll forest, on foothills, plains and in coastal areas (Martin and Handasyde, 1999, Menkhorst & Knight, 2004; van Dyck & Strahan, 2008 in DSEWPaC, 2013q). Koalas on the western side of the Great Dividing Range are often associated with water courses, although are not restricted to them (Melzer *et al*., 2000; Sullivan *et al*., 2003 in DSEWPaC, 2013q). The koala has been located in nine biogeographic regions of Queensland, including the Brigalow Belt (North).

Figure 9-9 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-9). Based upon this mapping approximately 166,741.28 ha of potential mapping is present within the Project area including 3,883.81 ha of 'core habitat known', 162,857.47 ha of 'core habitat possible'.

9.2.5.3 *Key Threats*

Koala population density is low within the Project area and the wider Bowen Basin and threats specific to this area have not been well studied. In general, threats will be similar to those identified for the population in south-east Queensland, as outlined on the SPRAT database (DSEWPaC, 2013q), which include:

Habitat loss, fragmentation and degradation: Large scale land clearing for agricultural purposes has effectively ceased. However, in many cases the remaining vegetation is of poor quality and is isolated and intervening spaces display relative hostility for dispersing or roaming koalas (Cogger *et al*., 2003; Tilman et al., 1994 in DSEWPaC, 2013q).

Drought and extreme weather events: Increasing temperatures inland and reduced water availability due to climate change are expected to force the koala's range to contract eastwards (Adams-Hosking *et al*., 2011 in DSEWPaC, 2013q). Increasing drought duration is inversely related to the recovery ability of the population. Additionally, drought and heat related stress potentially increases the susceptibility of the species to disease (McDonnell, 2010 in DSEWPaC, 2013q).

Feral animals: The Koala is vulnerable to predation by dogs (*Canis lupus familiaris*) and cats (*Felis catus*).

Other potential threats, possibly of lower impact, include vehicle strike, wildfire, disease, over population and low genetic variability.

9.2.5.4 *Potential Impacts*

While koalas are slow moving, they readily cross short distances through unsuitable landscapes (i.e. cleared land). The isolation of existing populations is therefore unlikely to be a consequence of Project-related activities in an already fragmented landscape. Potential impacts associated with the Project will include:

- The loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure;
- Invasive species altering ground cover density influencing the ability of the species to move within the environment;
- Death or injury of individuals during clearing;
- Increased mortality due to capture of individuals in open trenches passing through or adjacent to existing habitats; and
- Increased fire frequency and intensity due to increased human presence and modified vegetation composition (i.e. weed invasion).

9.2.5.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   The koala population density is low within the Project area and the wider Bowen Basin. Due to the solitary nature of the species, the low density in the region and the distributed nature of the Project, it is unlikely that the Project will result in a long-term decrease in an important population of the koala.

Impact mitigation strategies as detailed below will reduce the potential for important habitat to be impacted.

2. Reduce the area of occupancy of an important population.

   As described above, the current densities in the region are low and therefore it is highly unlikely that the area of occupancy of an important population will be reduced by the Project.

3. Fragment an existing important population into two or more populations.

   No important populations have been identified within the Project area. Whilst the Project activities may contribute to fragmentation or isolation of habitat, this is more likely to affect koala dispersal than fragment a population. Mitigation strategies such as rehabilitation and placement of infrastructure to avoid fragmentation, as detailed below, will reduce the risk of impacts to the koala.

4. Adversely affect habitat critical to the survival of a species.

   Whilst habitat within the Project area may support a low density of koalas, none of the habitat potentially affected is expected to be critical to the survival of the species as a whole.

5. Disrupt the breeding cycle of an important population.

   The Project area would support a very low density of koalas. There may be impacts associated with Project activities that may affect individual koalas. However, given the mitigation actions as detailed below, impacts to koalas will not constitute disruption of breeding cycles of an important population.

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

   The Project has the potential to modify, destroy, remove or isolate vegetation that may act as habitat for the koala. It is likely that with the probable low density of koalas in the region, the impacts to the species as a whole will not result in the decline of the species.

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

   Invasive fauna species have been identified as a key threat to the species (DSEWPaC, 2013q).

Arrow has committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

Feral predators of the koala such as the wild dog are already present in the Project area. The Project will not result in an increase of the number of wild dogs.

8. Introduce disease that may cause the species to decline.

   Koalas can be affected by a number of diseases, including chlamydia (clinical symptoms are known as chlamydiosis) and koala retrovirus (DSEWPaC, 2013q). There is circumstantial evidence that chlamydiosis might increase in response to environmental stresses such as overcrowding and poor nutrition (Melzer *et al*. 2000 in DSEWPaC, 2013q). It is highly unlikely that the current low densities in the Project area would be subject to stress from overcrowding. However, natural stochastic events such as fire, droughts and floods may contribute to poor nutrition.

   Koala retrovirus was recently identified and is thought to be responsible for a range of conditions, including leukaemia (Tarlinton, *et al.* 2005 in DSEWPaC, 2013q) and an immunodeficiency syndrome. This is generally transmitted genetically (Hanger *et al,*2000) and its spread will not be influenced by Project activities.

   The pest management plan for the Project will detail the measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   The Conservation Advice for the Koala (TSSC, 2012) notes that the status of, and threats to, individual koala populations vary over their range, and that a range of management prescriptions have been applied to varying circumstances. The advice identifies threat abatement actions that would support the recovery of the koala in Queensland, NSW and the ACT, including:

   – Develop and implement a development planning protocol to be used in areas of koala populations to prevent loss of important habitat, koala populations or connectivity options;

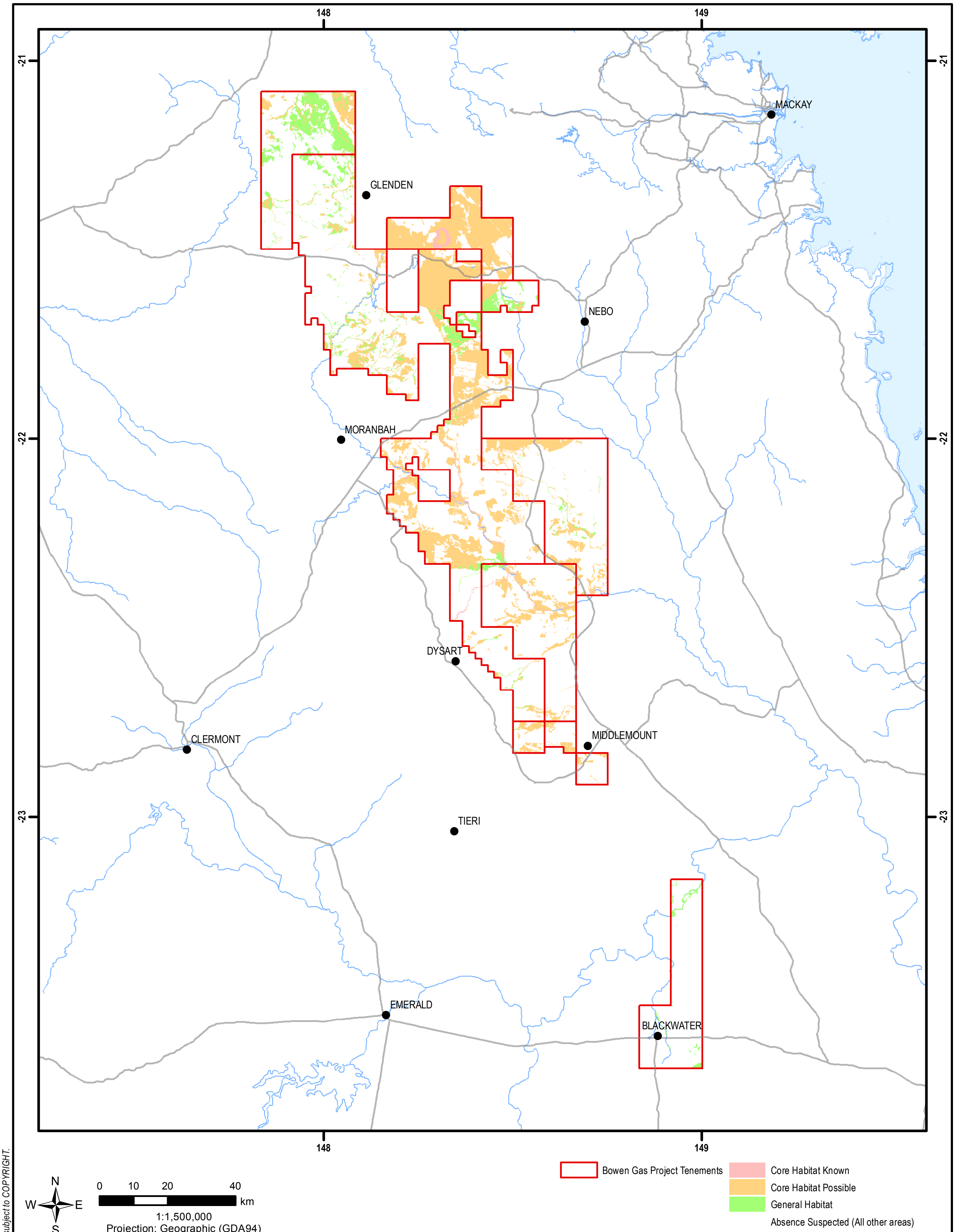
   – Development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, koala habitat;

   – Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary;

   – Identify populations of high conservation priority;

- Investigate formal conservation arrangements, management agreements and covenants on private land, and for Crown and private land investigate and/or secure inclusion in reserve tenure if possible;
- Manage any other known, potential or emerging threats such as bell miner (Manorina melanophrys) Associated Dieback or eucalyptus rust;
- Develop and implement options of vegetation recovery and re-connection in regions containing fragmented koala populations, including inland regions in which koala populations were diminished by drought and coastal regions where development pressures have isolated koala populations;
- Develop and implement a management plan to control the adverse impacts of predation on koalas by dogs in urban, peri-urban and rural environments; and
- Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.

Given the low density of koalas within the Project area, and taking into account the mitigation strategies detailed in Section 10.2.5.2, the Project should not interfere substantially with the recovery of the koala.



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KOALA (PHASCOLARCTOS CINEREUS) POTENTIAL HABITAT MAPPING

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Figure: 9-9

File No: 42627140-g-2011c.mxd Drawn: RG Approved: DS Date: 16-04-2014 Rev. C A4

9.2.6 Species Profile: South-Eastern Long-Eared Bat (*Nyctophilus corbeni*)

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery plan required, included on the Commenced List	
Identified Relevant Threat Abatement Plans: Nil	

The south-eastern long-eared bat has a head and body length of around 50-75 mm and a tail length of 35-50 mm. The weight varies between genders with females (14-21 g) being heavier than males (11-15 g). The south-eastern long-eared bat is distinguishable from other long-eared bats by its larger size as well as a broader skull and jaw. It is also geographically separated from other long-eared bats (van Dyck and Strahan, 2008 in DSEWPaC, 2013r).

Little is known about the biology or social structure of these bats. It is likely, however, that they roost solitarily under exfoliated bark and in the crevices on trees. During maternity, females are believed to form roosting colonies in larger tree cavities. They have a unique flight pattern, similar to a butterfly and probably forage within one kilometre of their roosting site (van Dyck and Strahan, 2008 in DSEWPaC, 2013r).

9.2.6.1 *Distribution and Habitat*

The distribution of this species approximates the Murray-Darling Basin, south from near Taroom in central Queensland through inland NSW into northern Victoria and the corner of South Australia (Danggali Conservation Park) around the Murray River (Churchill, 2008; van Dyck & Strahan, 2008; Parnaby, 2009 in DSEWPaC, 2013r). Most records are from large tracts of vegetation of approximately 5000+ ha (e.g. Southwood National Park) (EPA, 2008), although the species can be recorded from smaller tracts of 600 ha (e.g. Erringibba National Park) (M. Sanders pers. obs.). Most of the Project area is outside the known range of this species. However several individuals have been recorded in the south near the Blackdown Tablelands and Dawson Range State Forest. The species was not detected during field surveys. Survey methods are outlined above in Section 5, and data are presented in the Terrestrial Ecology Technical Report (Appendix P, Section 4.4) of the EIS.

The SPRAT database (DSEWPaC, 2013r) does not identify core habitat or important populations of the species.

9.2.6.2 *Potential Habitat Extent within the Project Area*

The species' stronghold appears to be within the Pilliga forests of central NSW (Turbill and Ellis, 2006 in DSEWPaC, 2013r). It inhabits dry forest and woodland vegetation types including mallee, brigalow, bulloak, box and belah dominated communities. South-eastern long-eared bats appear to be more common in woodlands dominated by box/ironbark and bulloak/cypress on sandy soils (Turbill and Ellis, 2006; Churchill, 2008; van Dyck & Strahan, 2008 in DSEWPaC, 2013r). However, they have also been recorded from semi-evergreen vine thicket and inland dry sclerophyll forests with *Corymbia citriodora*, mixed eucalypt forest, poplar box open forest and brigalow / belah vegetation (Churchill, 2008 in DSEWPaC, 2013r). The species may occur only in the southern portions of the Project area.

Figure 9-10 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-10). Based upon this mapping approximately 295,648.22 ha of potential mapping is present within the Project area including 0 ha of ‘core habitat known’, 295,648.22 ha of ‘core habitat possible’.

9.2.6.3 *Key Threats*

The south-eastern long-eared bat is primarily threatened by habitat loss and fragmentation. Survey data suggests that large, intact remnants of suitable habitat are required to support populations (Turbill and Ellis, 2006; van Dyck and Strahan, 2008 in DSEWPaC, 2013r). With more than 75% of habitat cleared in some parts of its range, land clearing and fragmentation continues to threaten this species (Duncan *et al*., 1999 in DSEWPaC, 2013r). Other threats listed for the species outlined on the SPRAT database (DSEWPaC, 2013r) include:

Fire and forestry practices: Due to the small population size, fire poses a major threat to the species, causing direct fatalities and reduction in roosting sites. Similarly, forestry practices including the removal of deadwood and hollow trees / branches results in a significant reduction in available roosting sites.

Overgrazing: the species is believed to forage on low ground and shrubs. High density grazing in habitat or foraging regions destroys shrubs and limits habitat regeneration. Overgrazing by feral species such as the rabbit may also pose a threat.

Feral animals: The south-eastern long-eared bat is expected to be vulnerable to predation; however, the extent of the impact is unknown.

Tree hollow competition, exposure to agricultural chemicals and climate change have also been identified as potential threats to the species.

9.2.6.4 *Potential Impacts*

Evidence suggests that this species is absent from small patches of vegetation, occurring most often in patches approximating Southwood National Park in extent (approximately 5,000 ha) (EPA, 2008c). However, the effect of fragmentation and disturbance associated with the construction of tracks and linear clearing is uncertain. Possible Project-related impacts include:

- Potential death or injury of roosting bats caused by diurnal clearing of roosts;
- The loss of foraging and roosting habitat due to the construction of infrastructure;
- Fragmentation of existing large, intact and contiguous habitats. The species does occur in large forests that are traversed by management tracks, suggesting that they could be tolerant of some disturbance;
- Increased fire frequency associated with increased human activity and machinery; and

- Decreased wildfire extent due to fire breaks along gas gathering lines in otherwise continuous vegetation.

9.2.6.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   Important populations of the south-eastern long-eared bat have not been identified within the Project area. Survey data suggests that large, intact remnants of suitable habitat are required to support populations (Turbill and Ellis, 2006; van Dyck and Strahan, 2008 in DSEWPaC, 2013r). The remaining large tracts of habitat are primarily restricted to the sandstone ranges, much of which in the region is within protected estate (e.g. Blackdown Tablelands NP; Expedition NP; Carnarvon NP). The Project will not impact on these areas and therefore important populations (if present) will not be affected.

2. Reduce the area of occupancy of an important population.

   As discussed above, important populations, if present, will most likely be within protected estate such as Blackdown Tablelands, Expedition or Carnarvon national parks (and others). As the Project will not impact on these areas, there will not be a reduction to the area of occupancy of an important population of the south-eastern long-eared bat.

3. Fragment an existing important population into two or more populations.

   Important populations, if present, will are likely to be within protected estate such as Blackdown Tablelands, Expedition or Carnarvon national parks (and others). As the Project will not impact on these areas, there will be no fragmentation of an important population of the south-eastern long-eared bat.

4. Adversely affect habitat critical to the survival of a species.

   The south-eastern long-eared bat may forage within remnant and regrowth vegetation outside of its preferred habitat areas. These fragmented areas currently exist within the Project area. Whilst the Project activities have the potential to impact habitat such as this, such disturbance will not affect habitat critical to the survival of the species. Impact mitigation strategies as outlined below will assist in reducing impacts to habitat for the species.

5. Disrupt the breeding cycle of an important population.

   Important populations, if present, will likely be within protected estate such as Blackdown Tablelands, Expedition or Carnarvon national parks (and others). As the Project will not impact on these areas, there will be no disruption to breeding cycles of an important population of the south-eastern long-eared bat.

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

   The avoidance of disturbance to preferred habitat types (e.g. large tracts of undisturbed vegetation within areas such as Blackdown Tablelands, Expedition or Carnarvon national parks) will mean that the species is unlikely to decline through habitat modification or removal. Some foraging habitat might be impacted by the Project; however this will not contribute to a decline in the south-eastern long-eared bat.

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

   Invasive fauna species have been identified as a threat to the species (DSEWPaC, 2013r). However, given the species' feeding and roosting habits it would more likely be pursued by native predators (owls, raptors, snakes) than feral animals. Nevertheless it has been noted to forage on the ground (Lumsden and Bennett, 2000; van Dyck and Strahan, 2008 in DSEWPaC, 2013r) and it may be prone to occasional predation by the feral cat in particular.

   Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to the species. The pest management plan for the Project will detail the measures to prevent the introduction and spread of disease.

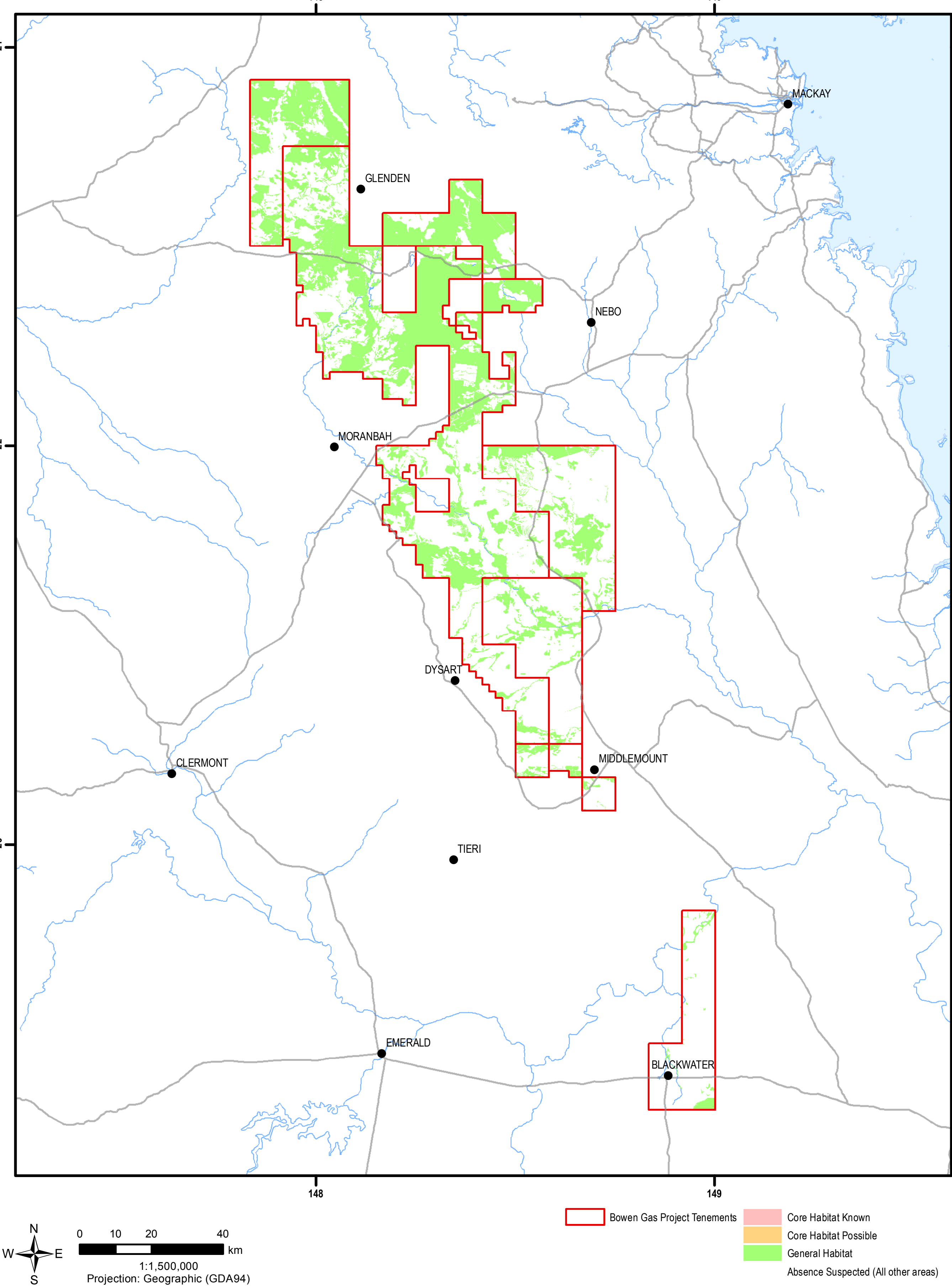
9. Interfere substantially with the recovery of the species.

   Curtis *et al.* (2012) note the following recovery efforts are required for the species:

   – Prevent native vegetation clearing;
   – Encourage the protection and enhancement of understorey vegetation;
   – Reduce grazing pressure in native forests;
   – Promote the protection of native vegetation and hollow bearing trees on private lands;
   – Retain hollow-bearing trees during logging and timber removal operations;
   – Review fire management practices to retain hollow bearing trees;
   – Develop and promote state-wide bat awareness programs;

- Restore degraded habitat; and
- Install escape nets in water tanks so that bats falling in while drinking can climb out again.

The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.2.6.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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SOUTH-EASTERN LONG EARED BAT (NYCTOPHILUS CORBENI) POTENTIAL HABITAT MAPPING

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Figure: 9-10

File No: 42627140-g-2015b.mxd | Drawn: RG | Approved: DS | Date: 16-04-2014 | Rev. B | A4

9.2.7 Species Profile: Large-eared Pied Bat (Chalinolobus dwyeri)

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: National recovery plan for the large-eared pied bat *Chalinolobus dwyeri*	
Identified Relevant Threat Abatement Plans: Nil	

The Large-eared pied bat is a medium-sized insectivorous bat measuring a total length of approximately 100 mm and weighing 7–12 g. It has shiny, black fur on the body with a white stripe on the ventral side of the torso where it adjoins the wings and tail. The ears are large, and lobes of skin adorn the lower lip and between the corner of the mouth and the bottom of the ear (Hoye and Dwyer, 1995; Ryan, 1966 in DSEWPaC, 2013s). Its relatively short, broad wings suggest it flies slowly and with considerable manoeuvrability (DERM, 2011 in DSEWPaC, 2013s).

Large-eared pied bats are fast and highly manoeuvrable flyers. Insects, predominantly moths, are taken from under the canopy (van Dyck and Strahan, 2008 in DSEWPaC, 2013s). Individuals are thought to undergo torpor during the coldest months (van Dyck and Strahan, 2008 in DSEWPaC, 2013s). Mating occurs during winter and females are able to give birth at one year of age; young are born in November-December (Dwyer, 1966; Menkhorst and Knight, 2004; van Dyck and Strahan, 2008 in DSEWPaC, 2013s).

9.2.7.1 *Distribution and Habitat*

Large-eared pied bats occur from the Blackdown Tableland south to Wollongong and inland to Carnarvon Gorge. The species is often observed along ecotones on rainforest edges or in association with sandstone escarpments. Although the species occurs across a broad area, *C. dwyeri* appears to selectively use only a subset of available habitats within its range (DSEWPaC, 2013s). Many populations are thought to be isolated from each other due intervening distances (DSEWPaC, 2013s).

9.2.7.2 *Potential Habitat Extent within the Project Area*

Within the Project development area, *C. dwyeri* may occur in the south in habitats connected to or within close proximity to the Blackdown Tableland. Individuals in other locations are unlikely.

Important populations supporting higher numbers of individuals include those present in the sandstone escarpments of the Carnarvon and Expedition Ranges, and Blackdown Tableland in Queensland (DSEWPaC, 2013s).

Figure 9-11 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-11). Based upon this mapping approximately 176,459.61 ha of potential mapping is present within the Project area, which is comprised entirely of ‘core habitat possible’.

9.2.7.3 Key Threats

The only confirmed threat is disturbance and damage to nursery sites, primarily by goats and humans. Flooding and disturbance by macropods have also caused abandonment of nursery sites.

Potential threats include clearing or timber harvesting in or around roosts, closing or filling disused mine shafts, subsidence stemming from longwall coal mining and predation by feral animals (particularly foxes) (DSEWPaC, 2013s).

9.2.7.4 Potential Impacts

Large-eared pied bats are highly mobile and are known to use tracks and canopy openings as hunting grounds. Impacts to dispersal and movement patters are unlikely. Project related impacts are likely to be limited, but could include the loss of roosts if activities affect rock outcrops and jump-ups in proximity to the Blackdown Tableland. Loss of habitat in southern tenements may also reduce foraging habitat, although these impacts are not likely to be significant if roosts are unaffected.

9.2.7.5 Significant Impact Criteria

1. Lead to a long-term decrease in the size of an important population of a species.

   Important populations supporting higher numbers of individuals include those present in the sandstone escarpments of the Carnarvon and Expedition Ranges, and Blackdown Tableland in Queensland (DSEWPaC, 2013s).

   The Project will not impact on these areas and therefore important populations (if present) will not be affected.

2. Reduce the area of occupancy of an important population.

   As discussed above, important populations, if present, will most likely be within protected estate such as the Blackdown Tableland, Expedition or Carnarvon national parks (and others). As the Project will not impact on these areas, there will not be a reduction to the area of occupancy of an important population of the large-eared pied bat.

3. Fragment an existing important population into two or more populations.

   Important populations, if present, are likely to be within protected estate such as Blackdown Tablelands, Expedition or Carnarvon national parks (and others). As the Project will not impact on these areas, there will be no fragmentation of an important population of the large-eared pied bat.

4. Adversely affect habitat critical to the survival of a species.

   The large-eared pied bat may forage within remnant and regrowth vegetation outside of its preferred habitat areas. These fragmented areas currently exist within the Project area. Whilst the Project activities have the potential to impact habitat such as this, such disturbance will not affect habitat critical to the survival of the species. Impact mitigation strategies as outlined below will assist in reducing impacts to habitat for the species.

5. Disrupt the breeding cycle of an important population.

   Important populations, if present, will likely be within protected estate such as Blackdown Tablelands, Expedition or Carnarvon national parks (and others). As the Project will not impact on these areas, there will be no disruption to breeding cycles of an important population of the large-eared pied bat.

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

   The avoidance of disturbance to preferred habitat types (e.g. large tracts of undisturbed vegetation within areas such as Blackdown Tablelands, Expedition or Carnarvon national parks) will mean that the species is unlikely to decline through habitat modification or removal. Some foraging habitat might be impacted by the Project; however this will not contribute to a decline in the large-eared pied bat.

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

   Invasive fauna species have been identified as a threat to the species (DSEWPaC, 2013s).

   Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to the species. The pest management plan for the Project will detail the measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

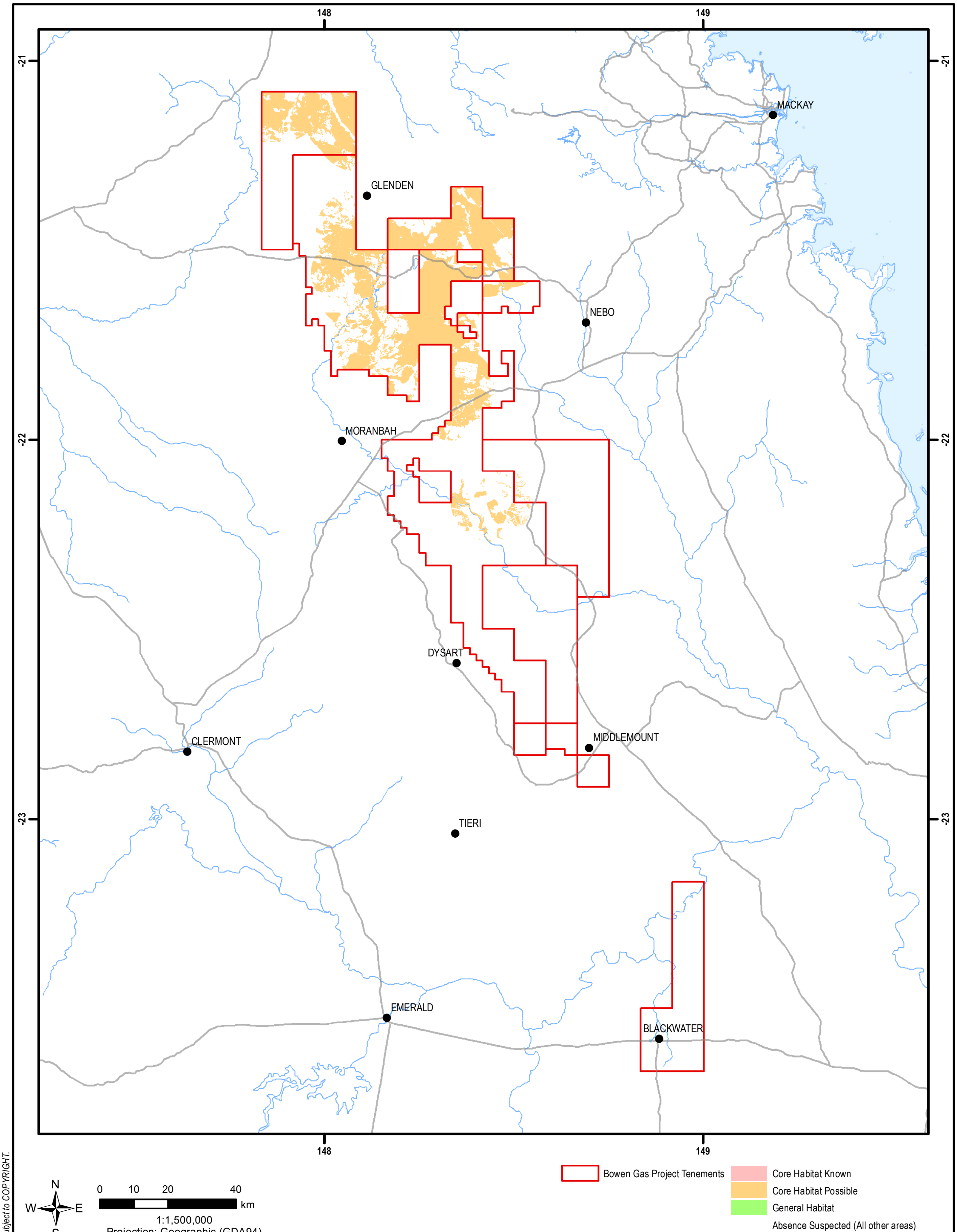
   Curtis *et al*. (2012) note the following recovery efforts are required for the species:

   - Protect known and potential roost sites and/or manage the impacts of mining and recreational caving;
   - Exclude feral goats from overhang roost sites along cliff faces;
   - Identify the maternity roost requirements and protect known maternity sites; and

– Protect, manage and/or rehabilitate native vegetation around known roost sites.

Whilst the Project may result in impacts to native vegetation, it is unlikely that the Project will interfere substantially with the recovery of large-eared pied bat as preferred habitat in the region will not be affected.

The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.2.7.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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LARGE-EARED PIED BAT (CHALINOLOBUS DWYERI) POTENTIAL HABITAT MAPPING

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File No: 42627140-g-2012c.mxd Drawn: RG Approved: DS Date: 16-04-2014 Rev. C A4

9.2.8 Species Profile: Australian Painted Snipe (Rostratula australis)

Status: EPBC: Endangered	**NC Act:** Vulnerable
Recovery Plan: Recovery Plan required, stopping the decline and supporting the recovery of this species is complex and involves a highly adaptive management process and the requirement for a high level of: planning to abate the threats; cross-jurisdictional co-ordination; co-ordination between managers; support by key stakeholders; and prioritisation of actions	
Identified Relevant Threat Abatement Plans: Nil	

The Australian painted snipe is a stocky wading bird around 220 to 250 mm in length with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye and a white crown stripe, and metallic green back and wings, barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down its upper back. The adult male is similar to the female, but is smaller and duller with buff spots on the wings and without any chestnut colouring on the head, nape or throat (D. Ingewersen, 2007 pers. comm.; NSW NPWS, 2006 in DSEWPaC, 2013k).

The species is generally seen singly or in pairs, or less often in small flocks (Marchant & Higgins, 1993 in DSEWPaC, 2013k). Flocking occurs during the breeding season, when adults sometimes form loose gatherings around a group of nests. Flocks can also form after the breeding season, and at some locations small groups regularly occur. Groups comprising of a male and up to six offspring have been observed (D. Ingwersen, 2007 pers. comm.; Marchant & Higgins, 1993 in DSEWPaC, 2013k).

9.2.8.1 *Distribution and Habitat*

The Australian painted snipe has been recorded at wetlands in all states of Australia; however, it occurs predominantly in eastern Australia, where it has been most frequently recorded at scattered locations in Queensland, New South Wales and Victoria (Barrett *et al*., 2003; Blakers *et al*., 1984; Hall, 1910b in DSEWPaC, 2013k). The extent of occurrence of the snipe is estimated to be up to 4,500,000 km^2, however, the area of occupancy is estimated to be as low as 1000 km^2 (Garnett & Crowley, 2000 in DSEWPaC, 2013k). The species is usually found in shallow, inland, freshwater (occasionally brackish) wetlands, utilising small islands as nesting sites. The species also utilises inundated or waterlogged grassland, dams and bore drains. Loose colonies have been observed; however, small polyandrous groups or breeding pairs are favoured.

9.2.8.2 *Potential Habitat Extent within the Project area*

Given the nomadic nature and extensive range of occurrence of the species, it is difficult to maintain an understanding of the current extent of the population. The species is recorded at scattered sites throughout Australia, and is recorded only infrequently at most sites. Therefore, it is difficult to determine if the presence or absence of the species from a given site is a temporary or permanent change to its distribution.

Figure 9-12 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-12). Based upon this mapping approximately 856.67 ha of potential mapping is present within the Project area including 658.8 ha of 'core habitat known', and 197.9 ha of 'core habitat possible'.

9.2.8.3 Key Threats

The primary threat to the Australian painted snipe population is loss and degradation of wetland habitats. Data indicates that approximately 50% of Australian wetlands have been destroyed or altered to be no longer suitable as habitat since European settlement, predominantly due to drainage of wetlands or diversion of water resources for the purpose of agriculture (DSEWPaC, 2013k). Secondary effects of these processes include a decline in water quality, proliferation of dense reeds or invasion of noxious weeds that impact on the suitability of the habitat for the species and reduced flooding frequency (DSEWPaC, 2013k).

The SPRAT database (DSEWPaC, 2013k) also lists predation by foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) as a potential significant threat to the species however, the exact extent of the impact is unknown.

9.2.8.4 Potential Impacts

The Project area includes identified wetlands and a recognised 'important wetland', Lake Elphinstone, that is not located within the Project area but within an enclave that the Project area surrounds. Therefore, the loss of wetland habitat or disturbance to nesting sites is considered a potential impact of Project activities. Additional potential Project related impacts include:

- Potential death or injury of snipes traversing the Project area during movement between habitats; and
- Project facilitated spread of invasive pest flora and fauna species, and subsequent loss or degradation of habitat or increased predation.

9.2.8.5 Significant Impact Criteria

1. Lead to a long-term decrease in the size of an important population of a species.

   The SPRAT database (DSEWPaC, 2013k) indicates that the species is predominantly found in south-eastern Queensland and in proximity to the Murray-Darling river system. Curtis *et al*. (2013) depict a number of records within central Queensland. The species was not recorded in the Project area during field surveys for the Project; however freshwater wetlands (RE 11.5.17) were identified in and adjacent to the Project area, including Lake Elphinstone and wetlands associated with the river systems of the Isaac and Mackenzie Rivers. These features may support the species at times. Survey methods are outlined above in Section 5, and data are presented in Section 4.4 of Appendix P in the EIS.

   However, there is no recognised important population of the species present within the Project area. As such the Project is unlikely to impact an important population of the Australian painted snipe.

2. Reduce the area of occupancy of an important population.

   As discussed above, there is unlikely to be an important population of the Australian painted snipe within or adjacent to the Project area. Furthermore, identified wetland habitat within the Project area will be avoided. As such, it is unlikely that Project activities will result in a reduction of the area of occupancy of the species.

3. Fragment an existing important population into two or more populations.

   Important habitat for the Australian painted snipe has not been identified within the Project area. Therefore, Project activities will not result in the fragmentation of an existing important population of the species into two or more populations

4. Adversely affect habitat critical to the survival of a species.

   The species was not recorded during the field survey in the Project area or in adjacent areas including identified wetland habitat and patchy grassland habitat for the species. Furthermore, sensitive areas within the Project area, such as wetland habitat, will be avoided where practical.

   Additionally, mitigation commitments with the aim of minimising impact on aquatic values from edge effects will be implemented. These commitments are detailed below. Given this, Project activities will not adversely affect habitat critical to the survival of a species.

5. Disrupt the breeding cycle of an important population.

   As no important populations have been identified in the Project area, disruption to breeding cycles critical to the survival of the species is unlikely to result from the proposed Project activities.
6. Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Construction activities in waterbodies frequented by migratory species will be avoided. The Australian painted snipe is a migratory bird that has not been recorded within or adjacent to the Project area, however e suitable wetland habitat has been identified on the Project area.

   Given that construction activities in waterbodies frequented by migratory species will be avoided and additional management buffers will be in place (as outlined in the mitigation commitments below), while there may be minimal impacts to potential habitat, these will be no greater than ambient disturbance from existing activities and will not modify habitat to the point where the species will decline.

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

   Invasive flora and fauna species have been identified as a key threat to the species (DSEWPaC, 2013k, Hill and Ward, 2010). Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

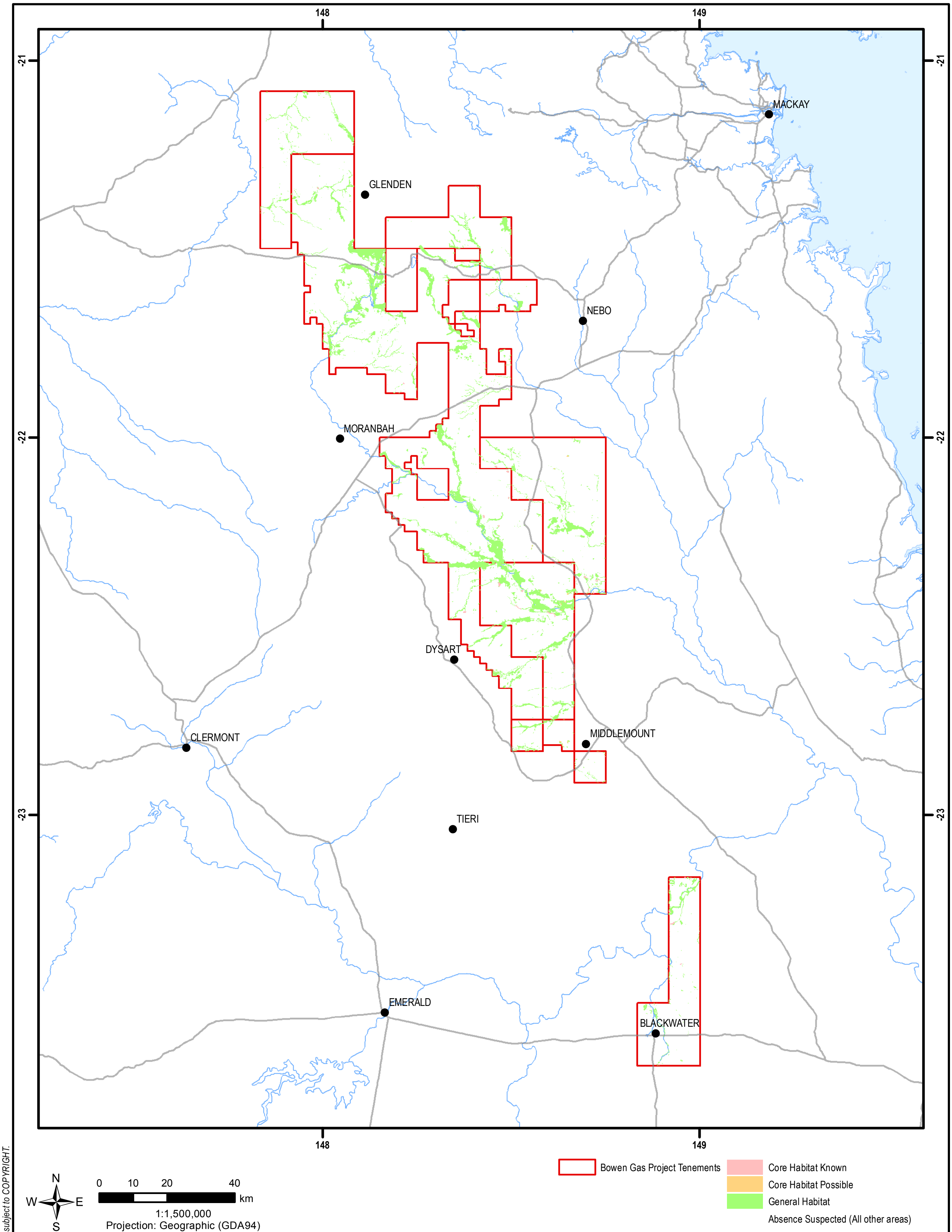
8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to the species. The pest management plan for the Project will detail measures to be undertaken throughout the life of the Project to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   There is no specific recovery plan in place for this species. The species has not been identified within the Project area and wetland habitat is to be avoided as a priority during the Project. Project activities will not adversely affect habitat critical to the survival of the species and therefore will not interfere with the recovery of the species.

   The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.2.8.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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AUSTRALIAN PAINTED SNIPE (ROSTRATULA AUSTRALIS) POTENTIAL HABITAT MAPPING

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Figure: **9-12**

File No: **42627140-g-2008b.mxd** Drawn: **RG** Approved: **DS** Date: **16-04-2014** Rev. **B** A4

9.2.9 Species Profile: Red Goshawk (Erythrotriorchis radiatus)

Status: EPBC: Vulnerable	**NC Act:** Endangered
Recovery Plan: National recovery plan for the red goshawk (*Erythrotriorchis radiatus*)	
Identified Relevant Threat Abatement Plans: nil.	

The red goshawk (*Erythrotriorchis radiatus*) is a large, swift and powerful rufous-brown hawk. Adult male and juvenile red goshawks have rich rufous underparts, whereas adult females are much paler and heavily streaked below. Adults with their grey, darkly-streaked heads can be distinguished in the field from juveniles which have rufous heads (DERM, 2012).

The red goshawk is a solitary and secretive bird that is generally silent. Even when nesting, red goshawks are inconspicuous; they do not usually reveal themselves by flying off in alarm when approached (Aumann and Baker-Gabb 1991 in DERM, 2012). Despite the differences between red goshawks and other raptors being well documented (e.g. Debus and Czechura 1988a in DERM, 2012), they are difficult to identify and many erroneous reports have to be discounted (Debus and Czechura 1988b, Debus 1993, Czechura 1996 in DERM, 2012).

9.2.9.1 *Distribution and Habitat*

The red goshawk is very sparsely dispersed across approximately 15 percent of primarily coastal and near-coastal Australia from the Kimberley in Western Australia to north-eastern New South Wales (Blakers et al. 1984, Aumann and Baker-Gabb 1991, Barrett et al. 2003 in DERM, 2012). Very low numbers, perhaps transient birds, have also been recorded along major rivers in central Australia (Garnett and Crowley 2000, Aumann 2001 in DERM, 2012). While this broad geographic distribution (Figure 1) has changed little since European settlement (Blakers et al. 1984, Barrett et al. 2003 in DERM, 2012), there have been some marked coastal contractions in large parts of the bird's range.

Habitat critical for red goshawk survival needs to contain all known sites for nesting, food resources, water, shelter, essential travel routes, dispersal, buffer areas, and sites needed for the future recovery as defined by the EPBC Act. Much of the remaining feeding and nesting habitat in eastern Queensland is on public reserves and state forests (Czechura 1996, Czechura and Hobson 2000 in DERM, 2012), whereas in Cape York, the Top End and Kimberley the red goshawk's habitat is subject to a greater range of ownership and management practices, including public reserves, land under Indigenous ownership, and pastoral leases.

Nesting habitat is a subset of foraging habitat, with a tall stand of trees invariably selected as the nest location (Aumann and Baker-Gabb 1991 in DERM, 2012). All identified nest trees have been within 1 km of permanent water, often adjacent to rivers or clearings, and usually the tallest (mean height = 31 m) and most massive trees (Aumann and Baker-Gabb 1991, Czechura 2001 in DERM, 2012). Such situations provide mature trees for both the substantial nests the birds construct and foraging advantages where prey is concentrated. In flat to rolling country where there may be few breaks in the tree canopy, nest trees are sometimes selected alongside roadways or other clearings, but still within 1 km of permanent water (Aumann and Baker-Gabb 1991, Czechura 2001 in DERM, 2012). Such positions allow ready access to the nest site, an advantage for large, long-winged birds, and are useful for male red goshawks carrying sticks up to 2 m long onto the nest platform (Aumann and Baker-Gabb 1991 in DERM, 2012).

For foraging, resident pairs of red goshawks prefer intact, extensive woodlands and forests with a mosaic of vegetation types that are open enough for fast manoeuvring flight (Marchant and Higgins 1993 in DERM, 2012). These favoured areas contain permanent water, are relatively fertile and biologically rich with large populations of birds. In northern Queensland, red goshawks are mainly associated with extensive, uncleared, mosaics of native vegetation, especially riparian vegetation, open forest and woodland (Czechura and Hobson 2000 in DERM, 2012) that contain a mix of eucalypt, ironbark and bloodwood species. In southern and northern Queensland, red goshawks frequent a number of regional ecosystems that have been extensively cleared and are considered to be 'Of concern' or 'Endangered' under the Queensland Vegetation Management Act 1999 (Czechura 1996, Czechura and Hobson 2000 in DERM, 2012).

9.2.9.2 Potential Habitat Extent within the Project Area

A thorough review of habitat, distribution and historical data suggests suitable nesting and feeding habitat is minimal within the Project area. However, the Project area is situated in close proximity to large tracts of vegetation.

Given the above, large tracts of native vegetation, especially riparian and open woodlands, that occur within 1 km of permanent water sources have potential to support this species. Given nesting and foraging requirments above, open woodland and riparian communities within close proximity to permanent water will be preferentially selected should they support tall trees suitable to nest building.

Figure 9-13 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-13). Based upon this mapping approximately 27,001.92 ha of potential mapping is present within the Project area which consists entirely of ‘core habitat known’,

9.2.9.3 Key Threats

The main cause of the decline of the red goshawk in north-east New South Wales and eastern Queensland has been widespread clearance of native forests and woodlands for agriculture.(Hollands 1984, Debus and Czechura 1988b, Aumann and Baker-Gabb 1991, Debus 1993, Czechura 1996, Czechura and Hobson 2000 in DERM, 2012).

For a widespread but sparse species such as the red goshawk, most developments are only likely to affect one or two pairs. However, the cumulative threat of many small developments and their associated impact on vegetation fragmentation is much harder to quantify and accommodate within recovery planning and impact assessment for this species.

Given that the presence of permanent fresh water is an essential component of red goshawk habitat, the degradation of rivers and wetlands utilised by potential prey species of the red goshawk may reduce prey availability (Czechura 1996, Czechura and Hobson 2000 in DERM, 2012). Burning and heavy grazing may have altered the prey base and prey availability (Aumann and Baker-Gabb 1991 in DERM, 2012), but these impacts are difficult to identify and harder to quantify. In tropical northern Australia, Franklin et al. (2005) in DERM (2012) found that grazing intensity was the greatest single human-induced cause of declines in the distribution and abundance of granivorous birds. However, it is not possible to determine whether the impacts on the bird fauna were a direct effect of grazing on seed abundance or due to indirect impacts of pastoral settlement, including alterations to fire regimes.

9.2.9.4 *Potential Impacts*

Within the Project area, the loss of potentially suitable foraging and nesting habitat may impact this species. Potential impact on the species may also occur where avifauna species richness is reduced from habitat fragmentation.

9.2.9.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   No populations or important populations of the red goshawk occur within the Project area. Additionaly, potential habitat for this species is minimal with the species most likely to occur at low densities if present. Given the lack of potential habitat, the low density of occurrence within the region and the distributed nature of the Project, it is unlikely that the Project will result in a long-term decrease in an important population of the red goshawk.

   Impact mitigation strategies as detailed below will reduce the potential for important habitat to be impacted.

2. Reduce the area of occupancy of an important population

   As described above, current densities of this species in the region are very low and therefore it is highly unlikely that the area of occupancy of an important population will be reduced by the Project.

3. Fragment an existing important population into two or more populations.

   No important populations have been identified within the Project area. Impact mitigation strategies as detailed below will reduce the potential for important habitat to be impacted.

4. Adversely affect habitat critical to the survival of a species

   Whilst there is potential for habitat identified within the Project area to support this species, the habitat is not considered critical to the survival of the species as a whole.

5. Disrupt the breeding cycle of an important population.

   As detailed above, no known important populations of the red goshawk occur within the Project area. Additionally, should a population or pair of red goshawk be discovered within the Project area, mitigation measures identified within this report will minimise the likelihood of Project activities disrupting breeding periods.

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

   Given that the Project area supports minimal potential habitat for the species largely due to the absence of permanent water throughout the Project area, it is considered unlikely that any impact on this habitat will modify, destroy, remove or isolate vegetation that may act as habitat.

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

   Invasive species have not been identified as a threat for the red goshawk. Arrow have committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

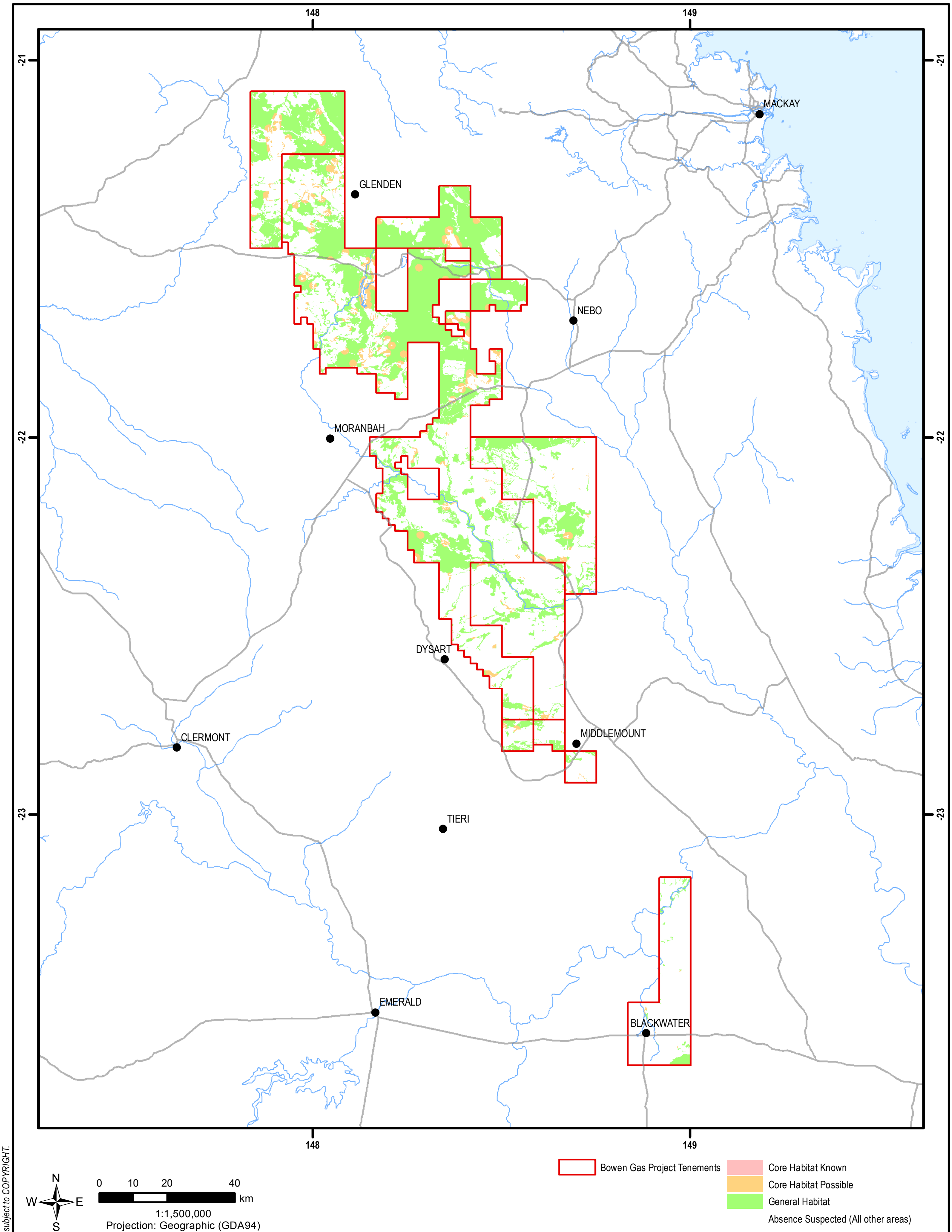
8. Introduce disease that may cause the species to decline.

   Disease is not a known threat to this species. However, the pest management plan for the Project will detail the measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   Whilst the Project may result in the clearing vegetation, it is not likely that the Project will interfere substantially with the recovery of the species as core habitat in the region will not be affected.

   The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.2.9.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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RED GOSHAWK (ERYTHROTRIORCHIS RADIATUS) POTENTIAL HABITAT MAPPING

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Figure: **9-13**

File No: **42627140-g-2112.mxd** Drawn: **RG** Approved: **DS** Date: **16-04-2014** Rev. **A** A4

9.2.10 Species Profile: Yakka Skink (Egernia rugosa)

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery Plan required, included on the Commenced List Queensland Brigalow Belt Reptile Recovery Plan (Richardson, 2006)	
Identified Relevant Threat Abatement Plans: Threat Abatement Plan for Predation by the European Red Fox Threat Abatement Plan for Predation by Feral Cats	

The yakka skink (*Egernia rugosa*) is a pale fawn reptile growing to 40 cm. It has a broad dark brown to black stripe from nape to tail bordered on either side by a narrow, pale fawn back/side stripe. Dark brown to pale brown to reddish-brown scales on the flanks form a faintly variegated orange-brown pattern. The throat is cream-yellow in colour, with blackish flecks/spots, and the chest and abdomen are yellow-orange (Cogger 2000 in DSEWPaC, 2014). This skink is often described as robust and around the same size as a blue tongue lizard (*Tiliqua scincoides*) making it one of the largest skinks in sub-humid to semi-arid eastern Queensland (TSN 2008a in DSEWPaC, 2014).

Yakka skinks live in communal burrow systems, often under timber and in deep rock crevices. The species also uses abandoned rabbit (*Oryctolagus cuniculus*) warrens and shelters in hollow logs. Burrows may be under buildings and other solid structures, such as concrete slabs and piles of felled timber (Ehmann 1992; Wilson 2005). Yakka skinks can occur in highly degraded sites especially where there are heaps of dead timber and rabbit warrens. The species may be more common than previously thought (EPA 2003). Yakka skinks eat soft plant material, invertebrates and small vertebrates and foraging occurs by day and on warm nights (Ehmann 1992). However, no detailed study on the distribution and ecology of this species has been published. They are secretive animals, retreating to their burrows when disturbed. Their presence is often indicated by their defecation sites (Eddie 2012).

9.2.10.1 *Distribution and Habitat*

The known distribution of the yakka skink extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt (North and South), Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula Biogeographical Regions. Locations range from the Queensland/New South Wales border to Mungkan Kandju National Park (NP) on Cape York Peninsula, and from Bundaberg and the region west of Gympie to Mariala NP west of Charleville (Brigalow Belt Reptiles Workshop 2010; Cogger 2000; Wilson & Knowles 1988 in DSEWPaC, 2014).

The yakka skink's distribution is highly fragmented as a large proportion of potential habitat for the species has been cleared throughout the species' range (Brigalow Belt Reptiles Workshop 2010; Queensland DERM 2010 in DSEWPaC, 2014).

The yakka skink is known to occur in open dry sclerophyll forest, woodland and scrub (Brigalow Belt Reptiles Workshop 2010; Cogger 2000; Wilson & Knowles 1988 in DSEWPaC, 2014). The core habitat of this species is within the Mulga Lands and Brigalow Belt South Bioregions (TSN 2008b in DSEWPaC, 2014).

The species occurs in land zones 3, 4, 5, 7, 9 and 10, and possibly in land zone 8, though the latter is not considered to be representative of core habitat. Within these land zones it occurs in a wide variety of habitat types, particularly woodland and open forest dominated by brigalow (*Acacia harpophylla*), mulga (*A. aneura*), bendee (*A. catenulata*), lancewood (*A. shirleyi*), belah (*Casuarina cristata*), poplar box (*Eucalyptus populnea*), ironbark (Eucalyptus spp.), and white cypress pine (*Callitris glaucophylla*). Yakka skinks usually occur on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Ehmann 1992; Cogger 2000; Wilson 2005; Richardson 2006; Brigalow Belt Reptiles Workshop 2010) but are also found on loam and clay soils (Eddie 2012). The core habitat of yakka skink is within the Mulga Lands and Brigalow Belt South bioregions (TSN 2008).

9.2.10.2 *Potential Habitat Extent within the Project Area*

No known records exist within the Project area for the yakka skink. However, two records occur at 3 km and 16 km respectively to the west of the southern Project gas field. It is considered that the northern gas field is situated outside the known range of this species. However, potential habitat has been mapped within both gas fields as a precaution.

9.2.10.3 *Key Threats*

The main threat to the yakka skink is the loss of habitat and habitat degradation. Other threats to the species include:

- Predation by foxes (*Vulpes vulpes*) and cats (*Felis catus*) (Drury 2001; Richardson 2006; TSN 2008);
- Trampling of burrows by livestock;
- Pasture improvement activities such as ploughing;
- Inappropriate fire regimes (Drury 2001);
- Ripping of rabbit warrens (TSN 2008);
- Removal of fallen timber and rocks;
- Inappropriate roadside management (Richardson 2006; TSN 2008);
- Mortality by being struck by vehicles (Drury 2001); and
- Potential project-related impacts: Impacts associated with the proposed.

9.2.10.4 *Potential Impacts*

Potential project related impacts on the yakka skink include:

- Loss of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals;
- Wide infrastructure corridors with little cover may inhibit movement, leading to increased fragmentation of existing populations;
- Individuals may become trapped in open trenches, resulting in mortality;
- Creation and maintenance of gas gathering lines and access tracks may increase access to habitats for feral predators;
- Edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for this species. Considering the small extent of some populations, even small weed infestations could have significant impacts; and
- Drowning or other mortality in steep-sided, plastic-lined dams.

9.2.10.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species

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

   There is no known record of this species from the Project area. Given this and that minimal habitat is present within the southern gas field, it is unlikely that Project activities will lead to a long-term decrease in the size of an important population. Whilst suitable habitat is present within the northern gas field, it is considered to be situated outside the known distribution for the species. As such Project activities are unlikely to lead to a long-term decrease in the size of an important population.

   Preclearance surveys undertaken prior to clearing and other mitigation measures identified below will reduce potential impacts on this species.

2. Reduce the area of occupancy of an important population

   Given that no important populations are known to occur as outlined above, it is unlikely that the Project will reduce the area of occupancy of an important population.

3. Fragment an existing important population into two or more populations.

   Given that no important populations are known to occur as outlined above, it is unlikely that the Project will fragment an existing important population.

4. Adversely affect habitat critical to the survival of a species

   Given the information above detailing the absence of any known important populations, it is unlikely that the Project will result in a significant impact on the population. The southern gas field is considered the most likely area within the Project to support this species (as opposed to the northern gas field). However, this gas field supports minimal remnant vegetation and associated potential yakka skink habitat. As such any disturbance within this area is considered unlikely to critically affect the survival of the species.

5. Disrupt the breeding cycle of an important population.

   Given the information above, it is unlikely that the Project will disrupt the breeding cyle of an important population.

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

   The southern gas field is considered the most likely area within the Project to support this species (as opposed to the northern gas field). However, this gas field supports minimal remnant vegetation and associated potential yakka skink habitat. As such any disturbance within this area is considered unlikely that the Project will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

   Invasive fauna species have been identified as a threat to the species (DSEWPaC, 2014).

   Arrow has committed to a pest management plan (draft EM Plan (Appendix Z, Section Z.4.4.5) of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

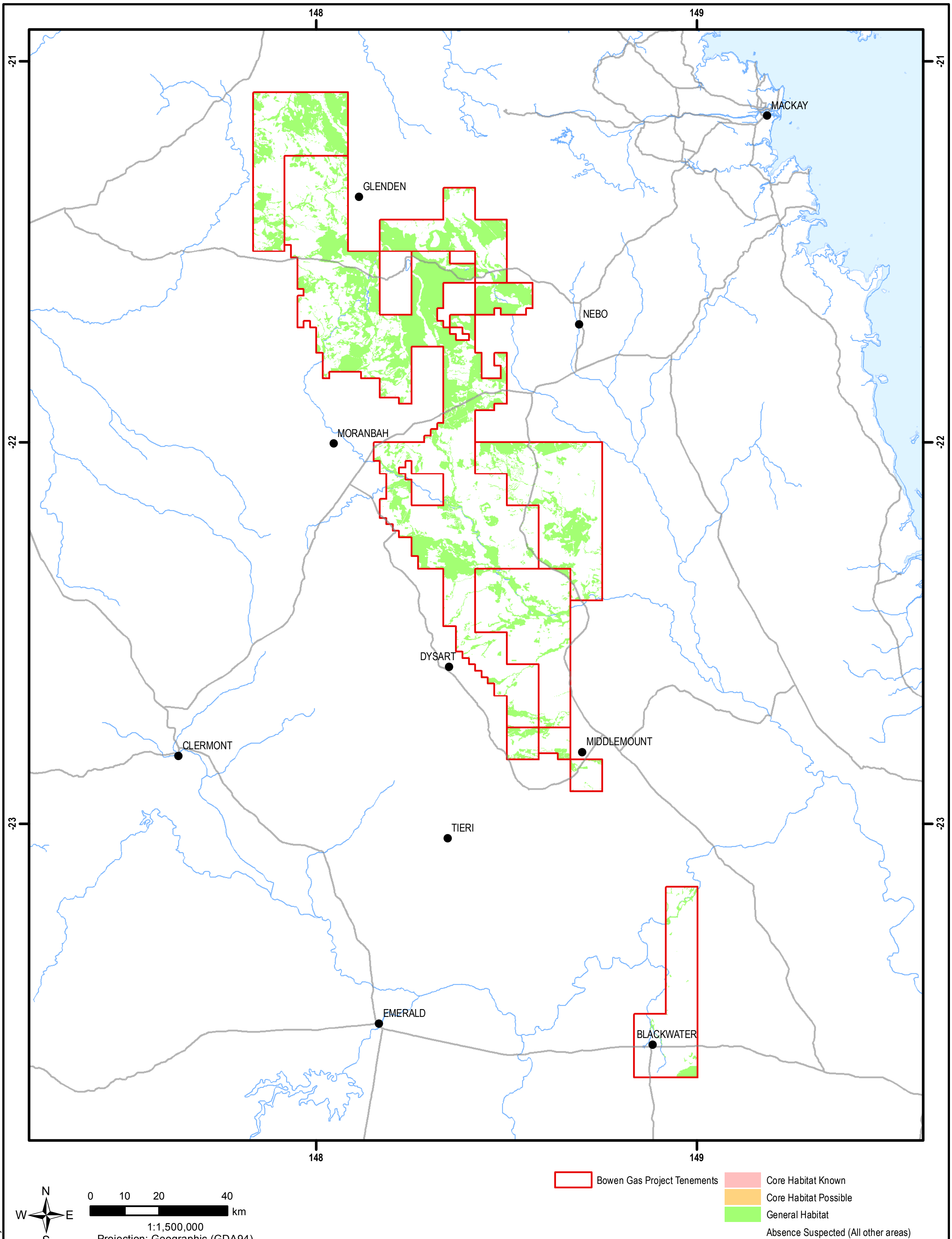
   Feral predators of the yakka skink such as the wild cat are already present in the Project area. The Project will not result in an increase of the number of wild cats.

8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a threat to this species. However, the pest management plan for the Project will detail measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   Given the mitigation measures proposed in Section 10.2.10.2, the Project is considered unlikely to interfere with the recovery of the species.



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YAKKA SKINK (EGERNIA RUGOSA) POTENTIAL HABITAT MAPPING

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Figure: **9-14**

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9.2.11 *Terrestrial Fauna Potential Habitat Impact Areas*

The potential habitat for MNES fauna within the Project area and the calculated disturbance from the sample conceptual footprint are detailed below in Table 9-4 below.

Table 9-4 Threatened Fauna Species Potential Habitat Areas

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Project Area - Core Habitat Known (ha)	Project Disturbance Footprint - Core Habitat Known (ha)	Project Area - Core Habitat Possible (ha)	Project Disturbance Footprint - Core Habitat Possible (ha)
Dasyurus hallucatus	northern quoll	E	-	0	0	58.93	1.54
Denisonia maculata	ornamental snake	V	V	1,988.37	2.9	59,481.71	1,027.41
Rheodytes leukops	Fitzroy River turtle	V	V	0	0	535.29	0.87
Geophaps scripta scripta	squatter pigeon	V	V	4,324.72	74	101,482.89	1,341.22
Phascolarctos cinereus	koala	V	-	3,883.81	3.06	162,857.47	2,462.98
Nyctophilus corbeni	south-eastern long-eared bat	V	-	0	0	295,648.22	2,282.57
Chalinolobus dwyeri	large-eared pied bat	V	V	0	0	176,459.61	1,451.44
Rostratula australis	Australian painted snipe	E	V	658.8	5.14	197.9	0.55
Erythrotriorchis radiatus	red goshawk	V	E	0	0	27,001.92	187.14
Egernia rugosa	yakka skink	V	V	0	0	0	0

9.3 Protected Terrestrial Flora Species

Four terrestrial flora species have been identified as having a moderate, high or recorded occurrence within the Project area (Table 9-5). Two of these four species were recorded within the Project area as part of the field surveys.

Profiles for all four species and a summary of the extents of their potential habitat within the Project area based on potential habitat mapping is discussed below. Significant impact criteria (outlined below) for each species as outlined above in Section 9.2 are also addresed.

Protected terrestrial fauna and flora identified as having a likelihood of moderate, high or recorded were assessed against the significant impact criteria provided in the Department of the Environment's *MNES: Signficant Impact Guidelines 1.1* (2013).

Within this guideline, an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

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

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

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

- Introduce disease that may cause the species to decline; and
- Interfere substantially with the recovery of the species.

Table 9-5 MNES Flora with a Moderate, High or Recorded Likelihood of Occurence within the Project Area

Common Name	Species *Scientific Name*	EPBC Act Status	Likelihood of Occurrence
black ironbox	*Eucalyptus raveretiana*	Vulnerable	Recorded
blue-grass	*Dichanthium setosum*	Vulnerable	High
king blue-grass	*Dichanthium queenslandicum*	Endangered	Recorded
No common name	*Aristida annua*	Vulnerable	Moderate

9.3.1 *Species Profile: Black Ironbox (Eucalyptus raveretiana)*

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery Plan not required, included on the Not Commenced List.	
Identified Relevant Threat Abatement Plans: Nil	

Black ironbox (*Eucalyptus raveretiana*) is a medium sized to large tree growing to 15-30 m in height. It has rough grey bark on the trunk and largest branches with smooth, white to grey or pale blue branches. Buds are diamond-shaped and fruit hemispherical. Black ironbox has the smallest fruit of any eucalypt (Brooker and Kleinig, 2004; Hall *et al.*, 1970 in DSEWPaC, 2013ar).

9.3.1.1 *Distribution and Habitat*

Black ironbox is endemic to central coastal and sub-coastal Queensland. The species typically occurs in riparian habitat along rivers and streams where it may grow in association with Queensland blue gum (*Eucalyptus tereticornis*), river red gum (*E. camaldulensis*), Moreton Bay ash (*Corymbia tessellaris*), river oak (*Casuarina cunninghamiana*) and weeping paperbark (*Melaleuca fluviatilis*), or in coastal habitats as an emergent to rainforest on alluvium. Suitable REs include RE 9.3.1, 11.3.25 and 8.3.3. The species is said to be highly salt tolerant (Dunn *et al.*, 1994 in DSEWPaC, 2013ar) and grows in soils from sand through to heavy clay types (Halford, 1997c in DSEWPaC, 2013ar).

The SPRAT database (DSEWPaC, 2013ar) does not identify any specific geographical areas as supporting important populations for the species. The species distribution is scattered and disjunct, being known from the tributaries of the Fitzroy River (Mackenzie, Isaac and Connors Rivers), the Suttor River and its upper tributaries; the Bowen, Burdekin, Don, Bogie, Broughton, Haughton, O'Connell, and Andromache Rivers. It is conserved in Dipperu, Eungella, Goodedulla and Homevale National Parks, as well as being present in State Forest 652 and State Forest 658 (Halford, 1997c in DSEWPaC, 2013ar). It occurs on Funnel, Boothill, Nebo, and Denison Creeks, and on the lower Fitzroy near Rockhampton. It is know from riparian riverbanks of the Burdekin River and along Oakey Creek in RE 9.3.1.

The Project area forms only a small portion of the known distribution of the species, being the broader Fitzroy Catchment. Survey methods are outlined above in Section 5, and data are presented in Section 4.4 of Appendix P in the EIS.

9.3.1.2 *Potential Habitat Extent within the Project area*

The species is known from the Project area and was recorded during the field surveys from a number of watercourses including Bee Creek, Blenheim Creek and Hail Creek. These habitats are all in the north–east of the Project area.

Table 9-6 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-15). Based upon this mapping approximately 18,749 ha of potential habitat is present within the Project area including 18,479 ha of 'core habitat possible'.

9.3.1.3 *Key Threats*

Key threats identified to the species (DSEWPaC, 2013ar) include invasive weeds, water resource developments and timber harvesting. Invasive weeds that occupy the same habitat e.g. rubber vine (*Cryptostegia grandiflora*) can smother mature eucalypt trees (Calvert *et al.*, 2005; Halford, 1997c in DSEWPaC, 2013ar). Other weeds such as lantana, bellyache bush, and chinee apple together with robust invasive grasses such as *Megathyrsus maximus* typically inhabit creek bank habitat and hinder seedling regeneration. The latter can increase fire frequency and intensity (Calvert *et al*., 2005 in DSEWPaC, 2013ar).

Historically, water resource developments have caused habitat loss and degradation, thereby affecting black ironbox populations. Local populations may be impacted by linear infrastructure development such as power transmission lines, water and gas pipelines and associated access across watercourses.

9.3.1.4 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Direct loss of individuals during habitat clearing for infrastructure (mostly linear) and watercourse diversions;
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks; and
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

There is no recovery plan for the species.

9.3.1.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   Within the Project area black ironbox is largely restricted to riparian habitats and generally within RE 11.3.25. The constraints analysis mapping within the EIS

(Section 7.2 of the EIS) identifies RE 11.3.25 and waterways as constrained areas. As a result of this constraints analysis Arrow will seek to preferentially avoid these areas during the planning and design phase as outlined in the mitigation commitments listed below in this species profile.

Where potential habitat cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken for black ironbox. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

Given the restricted distribution of the species within the Project area and the proposed mitigation commitments the project activities are not expected to lead to a long-term decrease in the size of an important population of the species.

2. Reduce the area of occupancy of an important population.

   The restriction of black ironbox as scattered individuals within riparian areas and the proposed mitigation commitments mean that the proposed actions are unlikely to reduce the area of occupancy of an important population.

   A detailed process for producing habitat mapping across the Project area for black ironbox is to be undertaken by Arrow for the Bowen Supplementary Report to the EIS. This will further refine the knowledge of this species within the Project area and inform pre-clearance survey work. Further detail of the proposed habitat mapping is provided in Section 8.

3. Fragment an existing important population into two or more populations.

   The restriction of black ironbox as scattered individuals within riparian areas and the proposed mitigation commitments mean that the proposed actions are unlikely to fragment an important population.

4. Adversely affect habitat critical to the survival of a species.

   As noted above the proposed mitigation commitments mean that the proposed activities are unlikely to affect habitat critical to the survival of the species. Habitat utilised by this species within the Project area is described above under the habitat and distribution section.

5. Disrupt the breeding cycle of an important population.

   As no habitat critical to the survival and breeding success of the species is expected to be impacted, disruption to breeding cycles critical to the survival of the species is unlikely to result from the proposed Project activities.

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

   The Project has the potential to facilitate the spread of weed species which could potentially reduce the quality of habitat available to the species (e.g. through the spread of rubber vine). A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152] (Section Z.4.4.5 of the EIS).

   The Project activities are considered unlikely to decrease habitat availability given the Project area forms only a small portion of the known distribution of the species, being the broader Fitzroy Catchment, and that potential habitat will be managed through the proposed mitigation commitments.

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

   Invasive flora has been identified as a key threat to the species (DSEWPaC, 2013ar) with species known to impact black ironbox including rubber vine (*Cryptostegia grandiflora*) which can smother mature trees and robust invasive grasses such as *Megathyrsus maximus* which can hinder seedling regeneration.

   Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

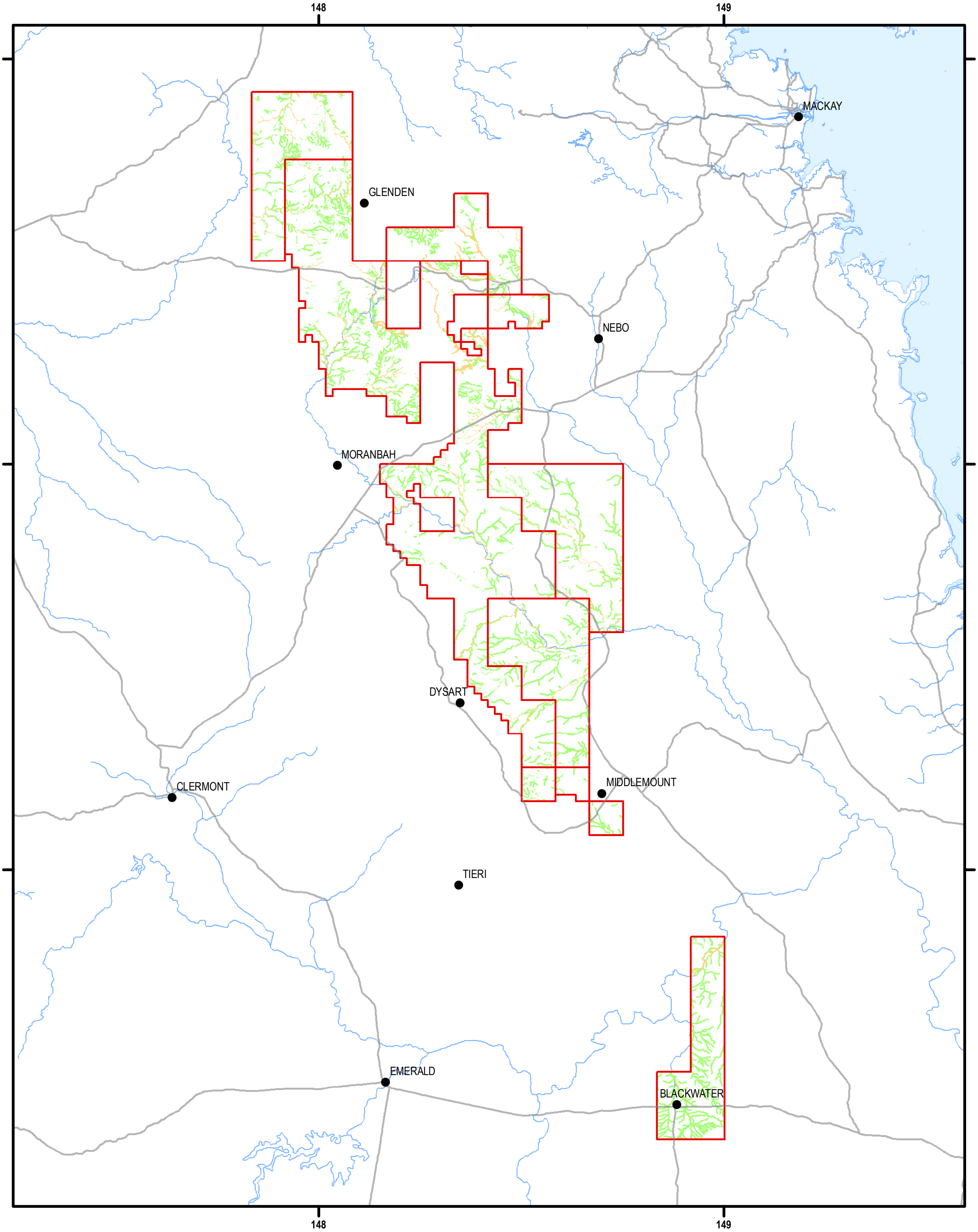
8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a key threat to the black ironbox. The pest management plan to be developed for the Project (Section Z.4.4.5 of the EIS) will detail measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation will be cleared for the Project, any potential loss of habitat for this species is not considered critical to the species' foothold in the region.

   The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.3.1.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



Bowen Gas Project Tenements
Core Habitat Known
Core Habitat Possible
General Habitat
Absence Suspected (All other areas)

N S W E

0 10 20 40 km

1:1,500,000

Projection: Geographic (GDA94)

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EUCALYPTUS RAVERETIANA POTENTIAL HABITAT MAPPING

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: **9-15**

File No: **42627140-g-2007.mxd** Drawn: **RG** Approved: **DS** Date: **05-03-2014** Rev. **A** A4

9.3.2 *Species Profile: Bluegrass (Dichanthium setosum)*

Status: EPBC: Vulnerable	**NC Act:** Not listed
Recovery Plan: Recovery Plan not required, included on the Not Commenced List.	
Identified Relevant Threat Abatement Plans: Nil	

Dichanthium setosum is an upright perennial grass 30 cm to 70 cm in height, 2 to 4-noded with mid-culm nodes bearded. Inflorescence is solid or digitate, a rame, with ramose branches. It has mostly hairless leaves approximately 2-3 mm in width (Sharp *et al.*, 2002). The flowers are densely hairy and clustered along a stalk in a cylinder shape and occur mostly in summer (DEC, 2005a).

9.3.2.1 *Distribution and Habitat*

Dichanthium setosum is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil (Ayers *et al*., 1996; DEC, 2005a in TSSC, 2008d) and is located in moderately disturbed areas, including cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture (DEC, 2005a). The species occurrence overlaps with and occurs within the TEC 'Native Grasslands of the Central Queensland Highlands and Northern Bowen Basin'.

The SPRAT database does not identify any specific geographical areas as supporting important populations for the species. *Dichanthium setosum* occurs on the northern tablelands of NSW and on the north-western slopes, central western slopes and north-western plains of NSW extending to Narrabri (Ayers *et al*., 1996 in TSSC, 2008d). In Queensland it is known from the Leichhardt, Morton, North Kennedy and Port Curtis regions (Bostock and Holland, 2010 in TSSC, 2008d).

9.3.2.2 *Potential Habitat Extent within the Project area*

The species is known to occur in the Project area. It has been recorded from six HERBRECS records (Qld Museum, 2012). The habitats from which the species is recorded are open woodland of *Eucalyptus crebra, E. orgadophila, Corymbia erythrophloia* including open woodland of *Eucalyptus orgadophila* on black soils, grasslands on flat plains of sandy clay loam, and grassy *Eucalyptus crebra, Eucalyptus populnea* woodland on dark brown cracking clays on basalt. Records from outside the Project area are from grassland and open woodland on clay plains and alluvium. Potential habitat includes non-remnant grazed grasslands.

Table 9-6 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-16). Based upon this mapping approximately 52,917.41 ha of potential mapping is present within the Project area including 19.41 ha of 'core habitat known', and 52,898 ha of 'core habitat possible'.

9.3.2.3 *Key Threats*

Key threats identified to the species (DSEWPaC, 2013as) include heavy grazing by domestic stock, loss of habitat through clearing for pasture improvement and cropping, frequent fires (particularly regular burning for agricultural purposes), invasion by introduced grasses (including Coolatai grass, lippia, and African lovegrass) and road widening.

9.3.2.4 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Direct loss of individuals during habitat clearing;
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks; and
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

There is no recovery plan for the species.

9.3.2.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   A process for detailed habitat mapping for *Dichanthium setosum* is to be undertaken by Arrow for the Bowen Supplementary Report to the EIS. This will further refine the knowledge of this species within the Project area. Further detail of the proposed habitat mapping is provided in Section 8.

   Where potential habitat cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken for *Dichanthium setosum*. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

   Given that the proposed Project mitigation controls have the capacity to minimise impacts to the species the Project activities are not expected to lead to a long-term decrease in the size of an important population of the species.

2. Reduce the area of occupancy of an important population.

   Given that the proposed Project mitigation controls have the capacity to minimise impacts to the species the Project activities are unlikely to reduce the area of occupancy of an important population.

3. Fragment an existing important population into two or more populations.

   Given that the proposed Project mitigation controls have the capacity to minimise impacts to the species the Project activities are unlikely to fragment an important population.

4. Adversely affect habitat critical to the survival of a species.

   As noted above implementation the proposed mitigation commitments means that the proposed activities are unlikely to affect habitat critical to the survival of the species. Habitat utilised by this species within the Project area is described above under the habitat and distribution section.

5. Disrupt the breeding cycle of an important population.

   As no habitat critical to the survival and breeding success of the species is expected to be impacted, disruption to breeding cycles critical to the survival of the species is unlikely to result from the proposed Project activities.

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

   The Project has the potential to facilitate the spread of weed species which could potentially reduce the quality of habitat available to the species. A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152] (Section Z.4.4.5 of the EIS).

   The Project activities are considered unlikely to decrease habitat availability given the Project area forms only a small portion of the known distribution of the species and that impact will be managed through the proposed mitigation commitments.

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

   Invasive flora has been identified as a key threat to the species (DSEWPaC, 2013as) with species known to impact *Dichanthium setosum* including invasive grasses such as such as coolatai grass (*Hyparrhenia hirta*), lippia (*Phyla canescens*) and African lovegrass (*Eragrostis curvula*).

   Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

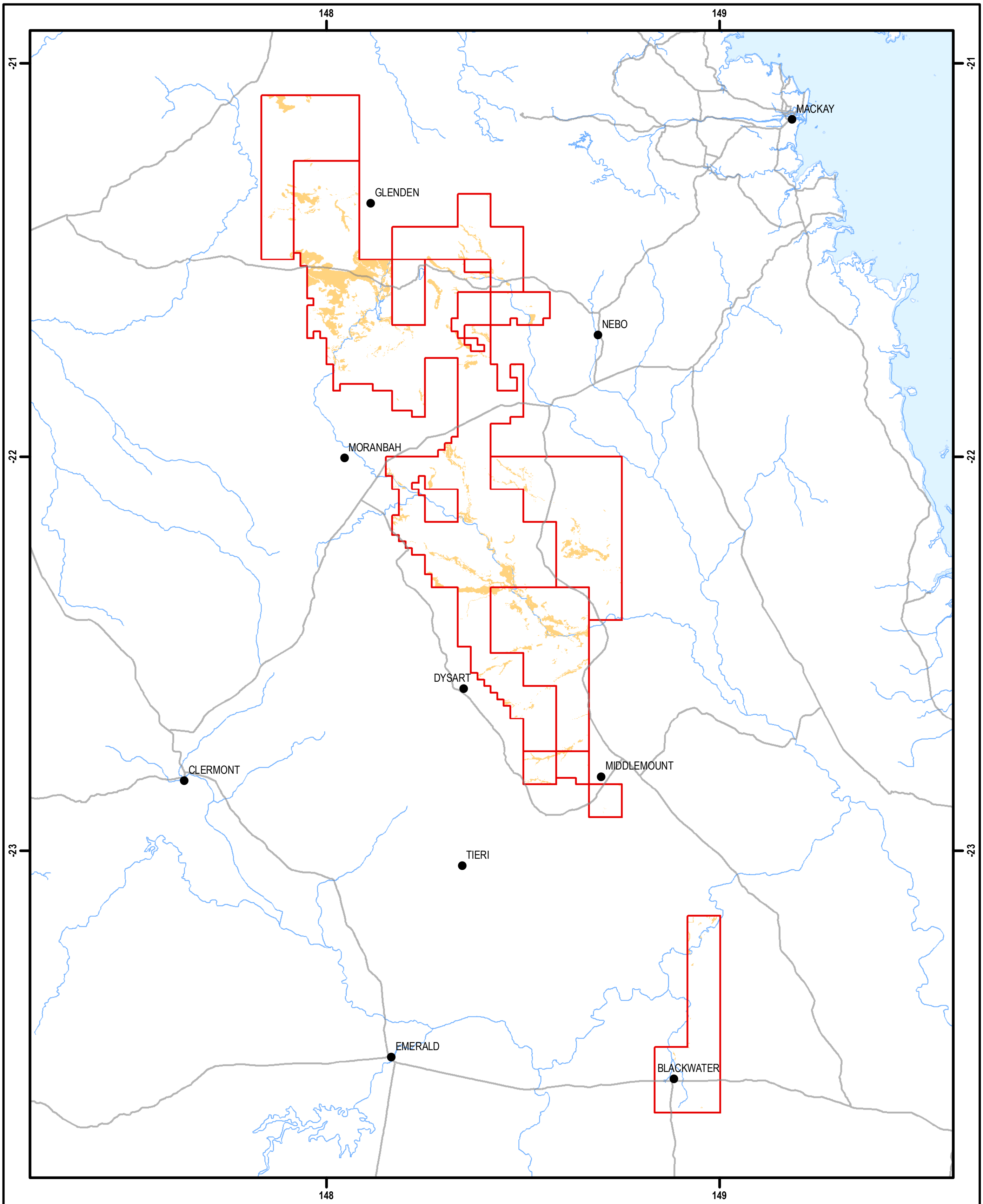
8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a key threat to *Dichanthium setosum*. The pest management plan to be developed for the Project (Section Z.4.4.5 of the EIS) will detail relevant measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation will be cleared for the Project, any potential loss of habitat for this species is not considered critical to the species' foothold in the region.

   The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.3.2.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



Bowen Gas Project Tenements

Core Habitat Known

Core Habitat Possible

General Habitat

Absence Suspected (All other areas)

N W E S

0 10 20 40 km

1:1,500,000

Projection: Geographic (GDA94)

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BLUEGRASS (DICHANTHIUM SETOSUM) POTENTIAL HABITAT MAPPING

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Figure: 9-16

File No: 42627140-g-2005.mxd Drawn: RG Approved: DS Date: 05-03-2014 Rev. A A4

9.3.3 Species Profile: King Bluegrass (Dichanthium queenslandicum)

Status: EPBC: Endangered	**NC Act:** Vulnerable
Recovery Plan: Recovery Plan required, at this time the recovery of the species is complex and likely to need a high level of planning, prioritisation and coordination to prevent further decline and support recovery.	
Identified Relevant Threat Abatement Plans: Nil	

King blue-grass is an erect perennial grass of 40-80cm in height. The plant is 4-5-noded with mid-culms bearded and hairy leaf-sheaths. The inflorescence is solid or sub-digitate, a rame, with ramose branches (Sharp and Simon, 2002).

9.3.3.1 *Distribution and Habitat*

King blue-grass occurs on heavy clay soils, typically vertic in nature, derived from a range of sources including alluvium and basalt. The species is associated with native grasslands and grassy woodlands although it may occur in disturbed or non-remnant habitats.

The SPRAT database (DSEWPaC, 2013at) does not identify any specific geographical areas as supporting important populations for the species. The species is endemic to Queensland, and is known from the Brigalow Belt North and South Bioregions with records from the northern Darling Downs, Burnett, Leichhardt, South Kennedy and Mitchell Pastoral Districts. Fensham (1999) considers the taxon restricted to the Central Highlands following its extinction from southern Queensland (in Fensham, 1998) and Hill (2000 in Silcock *et al*., 2007) also considers it extinct on the Darling Downs. More recently, the species has been found near Jondaryan (R.G. Silcock, unpublished data) and near Roma (W.J. Scattini, unpublished data in Silcock *et al*., 2007).

Survey methods are outlined above in Section 5, and data are presented in Section 4.4 of Appendix P in the EIS.

9.3.3.2 *Potential Habitat Extent within the Project area*

The species is known to occur in the Project area. Targeted surveys in the late wet season (May 2012) within suitable native grassland habitats identified a robust population of the species in the Lancewood and Wards Well properties. Within these properties, the species is associated with king blue-grass dominant native grassland habitats and associated woodlands (RE 11.8.11, RE 11.8.5). A single herbarium collection (Qld Herbarium, 2012) also exists in the north of the Project area near Newlands Coal Mine. In the vicinity of the Project area, the species is known from scattered collections near Nebo.

Table 9-6 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-17). Based upon this mapping approximately 36,216.43 ha of potential mapping is present within the Project area including 329.82 ha of ‘core habitat known’ and 35,886.61 ha of ‘core habitat possible’.

9.3.3.3 Key Threats

DSEWPaC (2013at) do not identify any key threats to the species. General threats to the species include clearing for agriculture or conversion to improved pastures which has heavily fragmented the species' native grassland habitat. Remaining habitat is threatened by degradation from mechanical disturbance, invasive weeds and unsustainable grazing regimes. The species is considered highly palatable to stock and its habitat may be subject to over-grazing.

9.3.3.4 Potential Impacts

Potential impacts associated with the proposed Project activities include:

- Direct loss of individuals during habitat clearing for wells and access tracks;
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks; and
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

There is no recovery plan for the species.

9.3.3.5 Significant Impact Criteria

1. Lead to a long-term decrease in the size of an important population of a species.

   A detailed process for producing habitat mapping across the Project area for king blue-grass is to be undertaken by Arrow for the Bowen Supplementary Report to the EIS. This will further refine the knowledge of this species within the Project area and inform pre-clearance survey work. Further detail of the proposed habitat mapping is provided in Section 8.

   Within the Project area king blue-grass is predominantly expected to occur within REs 11.8.11 and 11.8.5. The constraints analysis mapping within the EIS (Section 7.2 of the EIS) identifies RE 11.8.11 as a constrained area. As a result of this constraints analysis Arrow will seek to preferentially avoid these areas (including the robust population identified on the Lancewood and Wards Well properties) during the planning and design phase as outlined in the mitigation commitments listed below in this species profile

   Where potential habitat cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken for king blue-grass. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below.

   Given the proposed Project mitigation controls have the capacity to minimise impacts to the species the Project activities are not expected to lead to a long-term decrease in the size of an important populations of the species.

2. Reduce the area of occupancy of an important population.

   Given that the proposed Project mitigation controls have the capacity to minimise impacts to the species the Project activities are unlikely to reduce the area of occupancy of an important population.

3. Fragment an existing important population into two or more populations.

   Given that the proposed Project mitigation controls have the capacity to minimise impacts to the species the Project activities are unlikely to fragment an important population.

4. Adversely affect habitat critical to the survival of a species.

   Habitat critical to the survival of the species is not known to be present within the Project area. As noted above the proposed mitigation commitments mean that the proposed activities are unlikely to affect habitat critical to the survival of the species. Habitat utilised by this species within the Project area is described above under the habitat and distribution section.

5. Disrupt the breeding cycle of an important population.

   As no habitat critical to the survival and breeding success of the species is expected to be impacted, disruption to breeding cycles critical to the survival of the species is unlikely to result from the proposed Project activities.

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

   The Project has the potential to facilitate the spread of weeds which could potentially reduce the quality of habitat available to the species. A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species (Section Z.4.4.5 of the EIS).

   The Project activities are considered unlikely to decrease habitat availability given the proposed mitigation commitments.

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

   Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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.

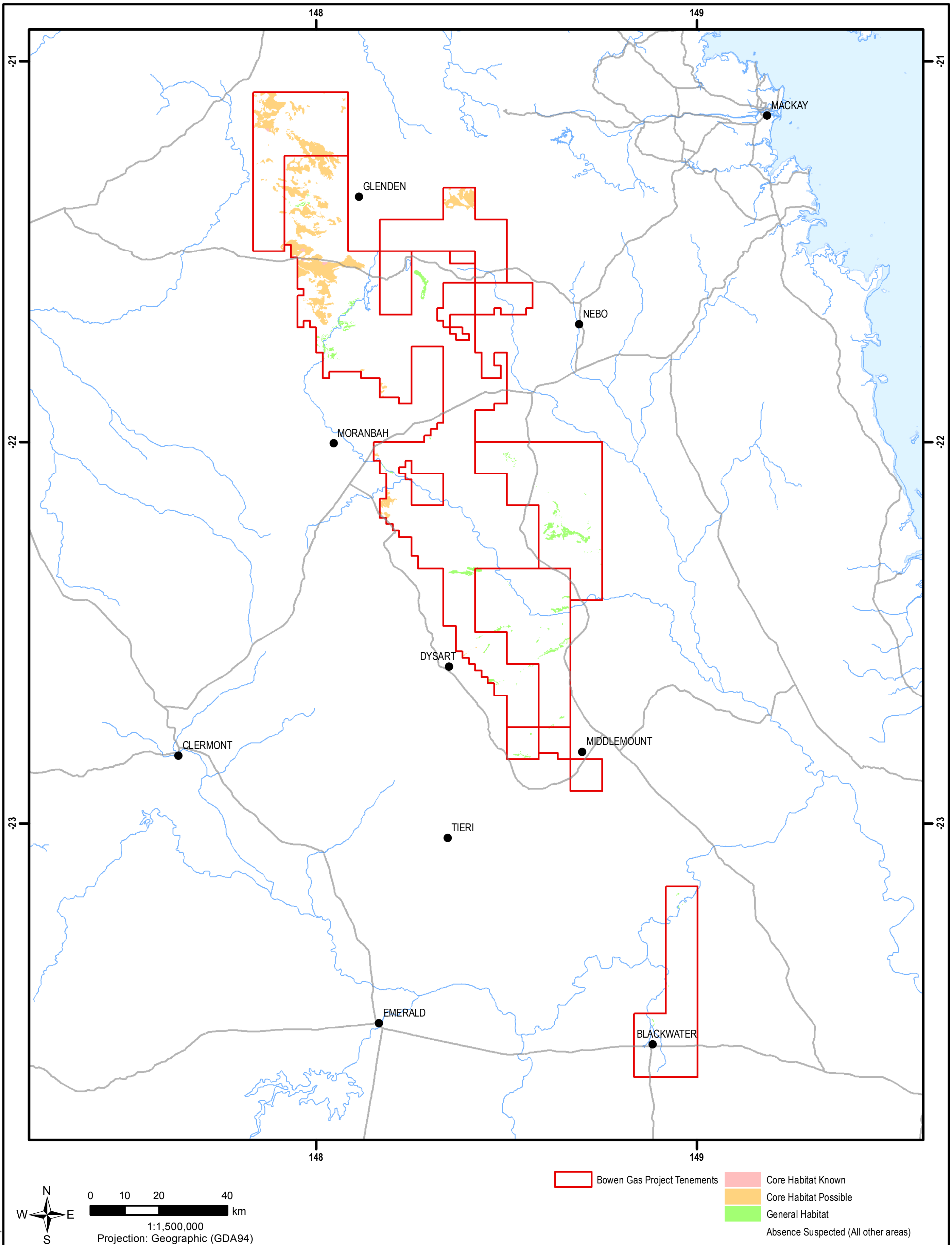
8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a key threat to *Dichanthium queenslandicum*. The pest management plan to be developed for the Project (Section Z.4.4.5 of the EIS) will detail measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation will be cleared for the Project, any potential loss of habitat for this species is not considered critical to the species' foothold in the region.

The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.3.3.2 and therefore recovery of this species is not likely to be impeded as a result of the Project.



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KING BLUEGRASS (DICHANTHIUM QUEENSLANDICUM) POTENTIAL HABITAT MAPPING

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT Figure: **9-17**

File No: **42627140-g-2004.mxd** Drawn: **RG** Approved: **DS** Date: **05-03-2014** Rev. **A** A4

9.3.4 Species Profile: *Aristida annua*

Status: EPBC: Vulnerable	**NC Act:** Vulnerable
Recovery Plan: Recovery Plan required, included on the Commenced List.	
Identified Relevant Threat Abatement Plans: Nil	

Aristida annua is an annual loosely tufted grass with a flowering stem growing to approximately 50 cm in height. It has smooth 25–50 cm long culms (stems) with culm-internodes that are distally glabrous. The species has sparse lateral branches and leaf-blades that have pubescent surfaces, are hairy adaxially and grow between 7–15 cm long and 1–1.5 mm wide. The species flowers between March and June. (DSEWPaC, 2013au).

9.3.4.1 *Distribution and Habitat*

Aristida annua occurs in eucalypt woodland. It is restricted to black clay soils, basalt soils and possibly disturbed sites. The species occurs in the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community (DSEWPaC, 2013au).

The SPRAT database does not identify any specific geographical areas as supporting important populations for the species. *Aristida annua* is restricted to central Queensland in Emerald and Springsure districts (BRI collection records n.d.; Simon 1984, 1992b in DSEWPaC, 2013au). The species is very poorly understood and there appears to be no survey data (DSEWPaC, 2013au).

There are no known *Aristida annua* populations within the reserve system. However, Albinia Downs National Park conserves 5,300 ha of the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community, and *Aristida annua* is associated with this community (Qld DERM, 2011 in DSEWPaC, 2013au). This park is adjacent to the Rolleston Coal Mine, which has also been identified as potential habitat for the species (DSEWPaC, 2013au).

Survey methods are outlined above in Section 5, and data are presented in Section 4.4 of Appendix P in the EIS.

9.3.4.2 *Potential Habitat Extent within the Project area*

The species possibly occurs within the Project area. A buffered search area retrieved one HERBRECS records (Qld Herbarium, 2012) located approximately 30 km west of the Project area boundary. The species was not recorded during field surveys of the Project area however suitable habitat in the form of black soil plains occur within the study area (e.g. RE 11.8.11).

Table 9-6 presents the extents of potential habitat within the Project area based upon potential habitat mapping for the species (Figure 9-18). Based upon this mapping there is no potential habitat present within the Project area.

9.3.4.3 *Key Threats*

Key threats identified to the species (DSEWPaC, 2013au) include loss of habitat for agriculture, overgrazing and for mining.

9.3.4.4 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Direct loss of individuals or minor populations during habitat clearing;
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks; and
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

There is no recovery plan for the species.

9.3.4.5 *Significant Impact Criteria*

1. Lead to a long-term decrease in the size of an important population of a species.

   A detailed process for producing habitat mapping across the Project area for *Aristida annua* is to be undertaken by Arrow for the Bowen Supplementary Report to the EIS. This will further refine the knowledge of this species within the Project area and inform pre-clearance survey work. Further detail of the proposed habitat mapping is provided in Section 8.

   Where potential habitat cannot be avoided through the planning and design phase, pre-clearance surveys will be undertaken for *Aristida annua*. Following the preclearance surveys disturbance will be minimised in identified areas of core habitat as detailed by the mitigation commitments outlined below

   Given the proposed mitigation commitments and that there are no records of the species within the Project area, the Project activities are not expected to lead to a long-term decrease in the size of an important population of the species.

2. Reduce the area of occupancy of an important population.

   Given the proposed mitigation commitments and that there are no records of the species within the Project area, the Project activities are unlikely to reduce the area of occupancy of an important population.

3. Fragment an existing important population into two or more populations.

   Given the proposed mitigation commitments and that there are no records of the species within the Project area, the Project activities are unlikely to fragment an important population.

4. Adversely affect habitat critical to the survival of a species.

   As noted above the proposed mitigation commitments mean that the proposed activities are unlikely to affect habitat critical to the survival of the species. Habitat utilised by this species within the Project area is described above under the habitat and distribution section.

5. Disrupt the breeding cycle of an important population.

   As no habitat critical to the survival and breeding success of the species is expected to be impacted, disruption to breeding cycles critical to the survival of the species is unlikely to result from the proposed Project activities.

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

   The Project has the potential to facilitate the spread of weed species which could potentially reduce the quality of habitat available to the species. A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152] (Section Z.4.4.5 of the EIS).

   The Project activities are considered unlikely to decrease habitat availability given the proposed mitigation commitments and that the Project area occurs outside of the species known range.

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

   Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the *Petroleum Industry – Pest Spread Minimisation Advisory Guide* (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass and lippia). Weed control efforts will be increased 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 [B191].

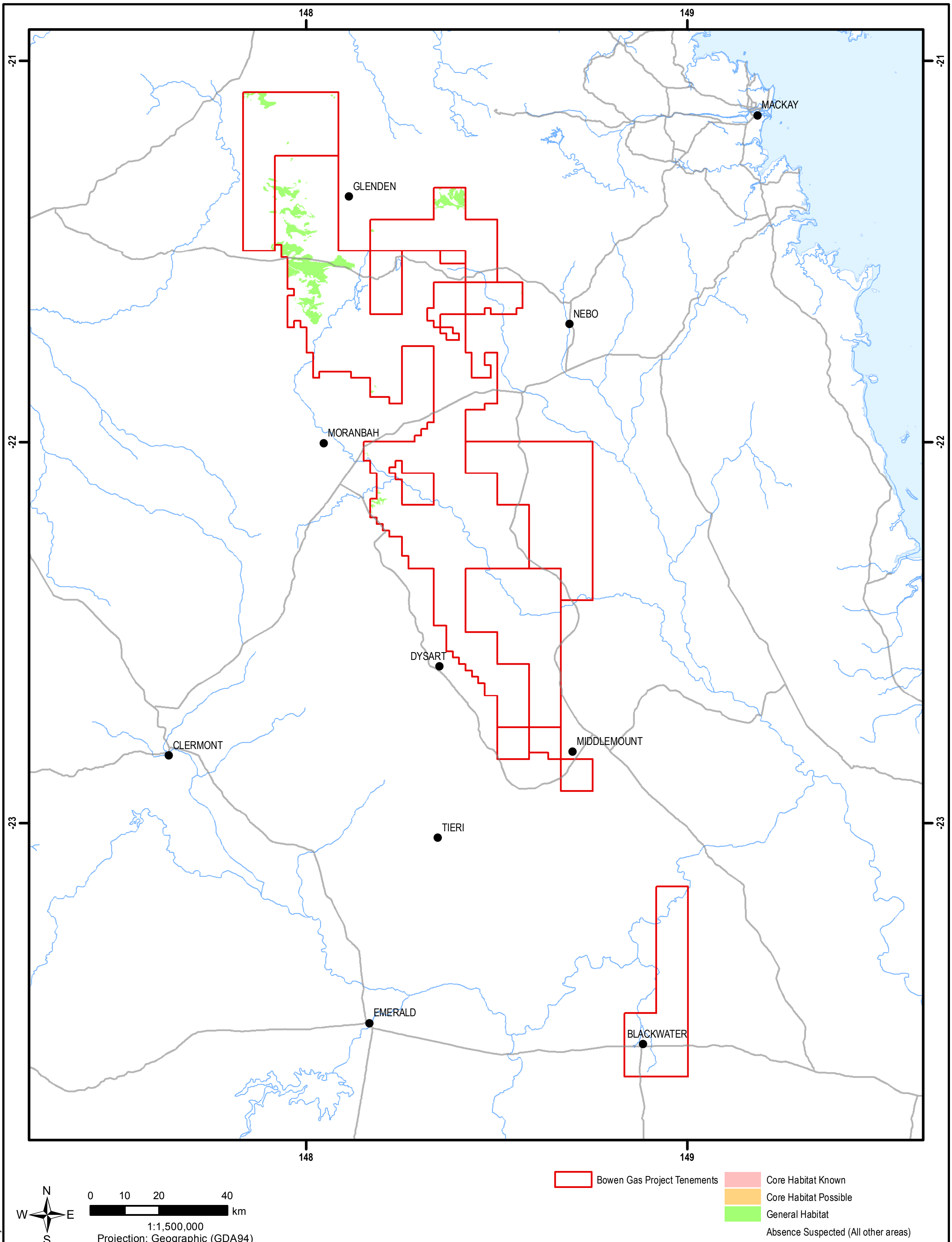
8. Introduce disease that may cause the species to decline.

   Disease has not been identified as a key threat to *Aristida annua*. The pest management plan to be developed for the Project (Section Z.4.4.5 of the EIS) will detail the measures to prevent the introduction and spread of disease.

9. Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation will be cleared for the Project, any potential loss of habitat for this species is not considered critical to the species' foothold in the region.

   The Project will manage these threats where relevant as detailed in the mitigation commitments detailed in Section 10.3.4.2



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ARISTIDA ANNUA POTENTIAL HABITAT MAPPING

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MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Figure: 9-18

File No: 42627140-g-2002b.mxd Drawn: RG Approved: DS Date: 16-04-2014 Rev. B A4

9.3.5 Terrestrial Flora Potential Habitat Areas

The potential habitat for MNES flora within the Project area and the calculated disturbance from the sample conceptual footprint are detailed below in Table 9-6 below

Table 9-6 Threatened Flora Species Potential Habitat Areas

	Common Name	EPBC Act Status	NC Act Status	Project Area - Core Habitat Known (ha)	Project Disturbance Footprint - Core Habitat Known (ha)	Project Area - Core Habitat Possible (ha)	Project Disturbance Footprint - Core Habitat Possible (ha)	Offset Assessment Method
Eucalyptus raveretiana	black ironbox	V	V	0	0	18,749	258.32	EPBC Act Offsets assessment guide
Dichanthium setosum	blue-grass	V	-	19.41	0	52,898.2	809.59	EPBC Act Offsets assessment guide
Dichanthium queenslandicum	king blue-grass	E	V	329.82	27.20	35,886.6	1,134.03	EPBC Act Offsets assessment guide
Aristida annua	-	V	V	0	0	0	0	EPBC Act Offsets assessment guide

9.4 Migratory Birds

Eleven migratory bird species (as listed under the EPBC Act 1999) identified in database searches were assessed, after further desktop review and field survey, as possibly occurring within the Project area (Table 9-7). Survey methods are outlined above in Section 5, and data are presented in Section 4 of Appendix P in the EIS.

Table 9-7 MNES Migratory Species with a Moderate, High or Recorded Likelihood of Occurence within the Project Area

Species		EPBC Act Status
Common Name	*Scientific Name*	
Migratory Wetland Species		
Latham's snipe, Japanese snipe	*Gallinago hardwickii*	Migratory (Terrestrial, Wetland)
eastern great egret	*Ardea modesta* (syn. *Ardea alba)*	Migratory (Marine, Wetland)
cattle egret	*Ardea ibis*	Migratory (Marine, Wetland)
Migratory Woodland Species		
rainbow bee-eater	*Merops ornatus*	Migratory (Terrestrial)
black-faced monarch	*Monarcha melanopsis*	Migratory (Terrestrial)
spectacled monarch	*Symposiachrus trivirgatus* (syn. *Monarcha trivirgatus)*	Migratory (Terrestrial)
satin flycatcher	*Myiagra cyanoleuca*	Migratory (Terrestrial)
rufous fantail	*Rhipidura rufifrons*	Migratory (Terrestrial)
Migratory Aerial Species		
fork-tailed swift	*Apus pacificus*	Migratory (Marine)
white-throated needletail	*Hirundapus caudacutus*	Migratory (Terrestrial)
Raptor		
white-bellied sea-eagle	*Haliaeetus leucogaster*	Migratory (Terrestrial)

Significant impact criteria for migratory bird species are defined as:

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

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

9.4.1 Profile: Migratory Wetland Species

Three migratory bird species predominately associated with wetland habitats were observed within the Project area or are considered a possible occurrence. These include:

- Latham's snipe (*Gallinago hardwickii*);
- great egret (*Ardea modesta*); and
- cattle egret (*Ardea ibis*).

The great egret and cattle egret were confirmed present within the Project area during field assessment.

9.4.1.1 *Distribution and Habitat*

Great egret and cattle egret inhabit permanent and ephemeral wetlands throughout the majority of Australia. Latham's snipe is mainly confined to eastern Australia. These species utilise habitat which includes freshwater wetlands with dense vegetation such as swamps, flooded grasslands or heathlands. The great egret and cattle egret are known to inhabit broader habitat range which include disturbed habitat such as farm dams, agricultural lands and sewage treatment ponds.

9.4.1.2 *Latham's Snipe Migration Pattern*

Latham's snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia (Higgins & Davies, 1996 in DSEWPaC, 2013af). This species typically arrives in northern Australia from July to November (Frith *et al.*, 1977; Higgins & Davies, 1996 in DSEWPaC, 2013af) before continuing south and arriving in south-eastern Australia between August and January (Higgins & Davies, 1996; Lane, 1987; Naarding, 1982, 1983 in DSEWPaC, 2013af). Most snipe have departed south-eastern Australia by late February or early March (Frith *et al*., 1977; Naarding, 1982, 1983 in DSEWPaC, 2013af).

9.4.1.3 *Key Threats*

Key threats identified to the species (DSEWPaC, 2013af, 2013ag, 2013ah) include:

- loss and/or degradation of foraging and breeding habitat;
- drainage and/or clearing of wetlands for development;
- burning of wetland vegetation used for nesting;
- salinization of wetlands; and
- invasion by exotic flora and fauna.

9.4.1.4 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Habitat loss and habitat degradation. Depending on the extent and location of clearing, foraging and breeding habitat utilised by these species may be impacted. Where habitat is retained, degradation from adjacent works may result in a loss of habitat quality through secondary impacts such as sedimentation.
- Edge effects such as the introduction of pest and weed species may result in the degradation of habitat. Additionally, other effects such as noise and light may result in the displacement of individuals.

Migratory wetland species are known to utilise Lake Elphinstone amongst other waterbodies in the region. Although outside the immediate Project area, Lake Elphinstone could be subject to a range of indirect impacts if unmitigated, including:

- Altered flow regimes resulting from infrastructure development;
- Increased sedimentation from exposed soil surfaces following rainfall;
- Deleterious impacts on water quality from CSG water (e.g. increased salinity);
- Increased weed incursion and outbreak from propagules transported from upstream infestations; and
- Dam overtopping / dam breaks in the catchment of Lake Elphinstone impacting on its habitat value for migratory species.

Given the mitigation commitments detailed below for the management of potential impacts to migratory species, it is considered any residual impact on the habitat provided by Lake Elphinstone will not represent any significant impact on habitat for migratory wetland species.

There is no recovery plan for these species.

9.4.1.5 *Significant Impact Criteria*

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Important habitat for the Latham's snipe has been defined as those sites:

   – that support at least 18 individuals of the species; and
   – that have the following characteristics: a naturally occurring freshwater wetland with vegetation cover nearby (for example tussock grasslands, sedges, lignum and reeds) (DEWHA, 2009c).

   Whilst the Project area may feature habitat with the characteristics identified in the second point above, there are no records of wetlands in the region supporting such a high density (18+) of Latham's snipe.

Nonetheless, Arrow aim to avoid disturbance within Category B and Category C ESAs, referable wetlands and wetland habitat prescribed under the Ramsar convention which may act as habitat for any of the species. Preclearance surveys will be undertaken prior to construction activities to identify additional wetland habitat in which migratory wetland bird species inhabit. Identified habitat will be avoided where possible.

Therefore, it is unlikely that important habitat for a migratory species will be substantially modified.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   Invasive flora and fauna species have been identified as a key threat to the species (DSEWPaC, 2013af). Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   As above, Arrow aim to avoid disturbance within Category B and Category C ESAs, referable wetlands and wetland habitat prescribed under the Ramsar convention. Preclearance surveys will be undertaken prior to construction activities to identify additional wetland habitat in which migratory wetland bird species inhabit. Identified habitat will be avoided where possible as outlined in the detailed mitigation commitments below.

   Given the above, it is considered unlikely that the lifecycle of an ecologically significant proportion of the population of identified migratory wetland species will be disrupted from Project related activities.

   Mitigation measures for migratory wetland species are outline in Section 10.4.1.2.

9.4.2 Profile: Migratory Woodland Species

Five migratory bird species predominately associated with Eucalypt woodland, riparian and vine-thicket habitats which were observed within the Project area or considered a possible occurrence include the:

- rainbow bee-eater (*Merops ornatus*);
- black-faced monarch (*Monarcha melanopsis*);
- spectacled monarch (*Symposiachrus trivirgatus* (syn. *Monarcha trivirgatus*));
- satin flycatcher (*Myiagra cyanoleuca*); and
- rufous fantail (*Rhipidura rufifrons*).

The rainbow bee-eater was confirmed present within the Project area during field assessment.

9.4.2.1 *Distribution and Habitat*

These species tend to seasonally migrate throughout the country or region, and/or are locally nomadic. Populations of these species tend to be resident in the north whilst migrating to southern areas of their distributions during summer months (Morcombe, 2004).

The rainbow bee-eater is distributed across much of Australia (excluding Tasmania) and is known to exhibit a broad habitat preference which includes open Eucalypt woodland, riparian, floodplain and wetland vegetation, open farmland and roadside vegetation (Badman, 1979; Boekel, 1976; Fry, 1984; Roberts, 1979; Storr, 1984a, 1984b, 1985a in DSEWPaC, 2013ai). The rainbow bee-eater also occurs within vine-thicket and mangrove communities. The rainbow bee-eater is often recorded in communities which are proximate to water.

The remaining migratory woodland species share similar distributions and habitat preferences. These species occur along much of eastern Australia. Unlike the rainbow bee-eater, the remaining woodland species prefer habitat types which exhibit a high structural complexity including heavily vegetated gullies, riparian vegetation, vine thickets and mangrove communities (Blakers *et al*., 1984; Emison *et al*., 1987; Officer, 1969 in DSEWPaC, 2013aj, 2013ak; Morcombe, 2004). During migration, more open communities are utilised.

9.4.2.2 *Key Threats*

Key threats identified to the species (DSEWPaC, 2013ai, 2013aj, 2013ak, 2013av, 2013aw) include:

- Habitat loss and fragmentation; and
- Invasive pest species.

9.4.2.3 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Habitat loss and habitat degradation. Depending on the extent and location of clearing, foraging and breeding habitat utilised by these species may be impacted; and
- Edge effects such as the introduction of pest and weed species may result in the degradation of habitat. Additionally, other effects such as noise and light may result in the displacement of individuals.

There are no recovery plans for these species.

9.4.2.4 *Significant Impact Criteria*

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Arrow aim to avoid disturbance within Category B and Category C ESAs, including endangered and of concern habitat. Where practical, avoidance of these areas will preserve areas of high structural complexity such as semi-evergreen vine thicket and riparian communities. Additionally, preclearance surveys will be undertaken prior to construction activities to identify the presence of habitat for this species. Identified habitat will be avoided where possible as outlined in the detailed mitigation commitments below.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   Invasive flora and fauna species have been identified as a key threat to the species (2013ai, 2013aj, 2013ak, 2013av, 2013aw). Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the Project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   As detailed above, Arrow aim to avoid disturbance within Category B and Category C ESAs, including endangered and of concern habitat. Where practical, avoidance of these areas will preserve areas of high structural complexity such as semi-evergreen vine thicket and riparian communities. Additionally, preclearance surveys will be undertaken prior to construction activities to identify the presence of habitat for this species. Identified habitat will be avoided where possible as outlined in the detailed mitigation commitments below.

   Given the above, it is considered unlikely that the lifecycle of an ecologically significant proportion of the population of identified migratory wetland species will be disrupted from Project related activities.

   Mitigation measures for migratory woodland species are outlined in Section 10.4.2.2.

9.4.3 Profile: Migratory Aerial Species

Two migratory aerial bird species considered as possible occurring include the:

- Fork-tailed swift (*Apus pacificus*); and
- White-throated needletail (*Hirundapus caudacutus*).

9.4.3.1 *Distribution and Habitat*

The fork-tailed swift and white-throated needletail are almost exclusively aerial, flying from less than 1 m to greater than 300 m (DSEWPaC, 2013al, 2013an). The white-throated needletail is widespread in eastern and south-eastern Australia (Barrett *et al*., 2003; Blakers *et al*., 1984; Higgins, 1999 in DSEWPaC, 2013al) whereas the fork-tailed swift occurs over much of mainland Australia. Both species are non-breeding migrants, generally arriving in October and departing by the end of April.

Both species occur over most habitat types including grasslands, however, are most often recorded flying over wooded areas, including open forest and rainforest (Higgins, 1999 in DSEWPaC, 2013al, 2013an).

9.4.3.2 *Key Threats*

No significant threats are known to these species within Australia.

9.4.3.3 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

Dust impacts. Excessive dust may result in individuals above dispersing to areas away from the dust source.

There is no recovery plan for these species.

9.4.3.4 *Significant Impact Criteria*

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Given these species are almost exclusively aerial it is considered unlikely that Project activities will have an impact on important habitat for this species. It is recognised that this species is commonly recorded over vegetated areas. Given this, the detailed mitigation commitments as detailed below will further minimise any impact on potential or important habitat.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   Given these species are exclusively aerial, the presence / absence of invasive species are unlikely to influence this species.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   Given these species are exclusively aerial it is considered unlikely that Project activities will seriously disrupt the lifecycle of a significant proportion of the population of these species. However, detailed mitigation commitments as detailed in Section 10.4.3.2 will further minimise impact on these species.

9.4.4 Profile: White-Bellied Sea-Eagle (*Haliaeetus leucogaster*)

Desktop review identified the white-bellied sea-eagle (*Haliaeetus leucogaster*) as a possible occurrence within the Project area. Unlike the previous migratory species, this species is a defined as a raptor and has been assessed individually due to the utilisation of different habitat types and requirements (particularly nesting habitat) and its associated population threats.

9.4.4.1 *Distribution*

The white-bellied sea-eagle is distributed along the coastline (including offshore islands) of mainland Australia and also extends inland along some of the larger waterways, especially in eastern Australia (Barrett *et al*., 2003; Bilney & Emison, 1983; Blakers *et al*., 1984; Marchant & Higgins, 1993 in DSEWPaC, 2013ao).

Terrestrial habitats in which the white-bellied sea-eagle inhabits are characterised by the presence of large areas of open water, including rivers, swamps, lakes and coastal waters (DSEWPaC, 2013ao). Breeding territories of the white-bellied sea-eagle are located close to water and mainly occur within tall open woodland (Emison & Bilney, 1982; Marchant & Higgins, 1993 in DSEWPaC, 2013ao), although nests can be located in other habitats such as rainforest, closed scrub or remnant trees within cleared land (Rhodes, 1959; Emison & Bilney, 1982 in DSEWPaC, 2013ao).

9.4.4.2 *Key Threats*

Key threats identified to the species (DSEWPaC, 2013ao) include:

- Habitat loss and fragmentation (specifically nesting habitat). the inland distribution of the species is limited to vegetated sites that occur in the vicinity of major waterways or waterbodies;
- Disturbance of nesting pairs from human activity;
- Water quality degradation from increased sediment input;
- The drainage of waterbodies for agriculture; and
- Poisoning (dingo baiting).

9.4.4.3 *Potential Impacts*

Potential impacts associated with the proposed Project activities include:

- Habitat loss and habitat degradation. Depending on the extent and location of clearing, foraging and breeding habitat utilised by this species may be impacted. As detailed above, this species requires remnant vegetation within close proximity to major watercourses. Therefore, the loss of riparian communities may locally impact on the breeding success of this species.
- Edge effects such as disturbance of nesting pairs from human activity. It is not uncommon for adult sea-eagles to abandon a nest if disturbed (especially early on into the breeding season) (Clunie, 1994; Hollands, 2003; Mooney & Brothers,

1986; Stokes, 1996 in DSEWPaC, 2013ao). The disturbance of nesting pairs may potentially lower breeding success.

There is no recovery plan for this species applicable within Queensland.

9.4.4.4 *Significant Impact Criteria*

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Arrow aim to avoid disturbance within Category B and Category C ESAs, including endangered and of concern riparian habitat. Where practical, avoidance of these areas will preserve nesting and foraging habitat for this species. Additionally, preclearance surveys will be undertaken prior to construction activities to identify the presence of suitable habitat for this species and/or the presence of white-bellied sea-eagle nests.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   Invasive flora and fauna species have been identified as a key threat to the species (DSEWPaC, 2013ao). Arrow has committed to a pest management plan (Section Z.4.4.5 of the EIS) for the project. Weed and pest management plans will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   As above, Arrow aim to avoid disturbance within Category B and Category C ESAs, including endangered and of concern riparian habitat. Where practical, avoidance of these areas will preserve nesting and foraging habitat for this species. Additionally, preclearance surveys will be undertaken prior to construction activities to identify the presence of suitable habitat for this species and/or the presence of white-bellied sea-eagle nests.

   Given the large territories in which this species occupies, disruption to a single nest or nesting pair is unlikely to impact the local population or total population of this species. In addition Arrow will develop specific threatened species management procedures when Project activities are identified as likely to impact upon individuals, such as potential impacts to identified active breeding pairs.

   Mitigation measures for this species are outlined in Section 10.4.4.2.

10 SPECIFIC AVOIDANCE, MITIGATION AND MANAGEMENT MEASURES

Specific avoidance, mitigation and management measures commited by Arrow which will minimise the potential impact on MNES from the Project are detailed below. Where available, the conservation advice, threat abatement and recovery plans associated with each MNES species or community is discussed and the potential for the Project to hinder recovery objectives is addressed.

Cumulative impacts for each MNES are also discussed.

10.1 Threatened Ecological Communities

10.1.1 Brigalow (Acacia harpophylla dominant and co-dominant)

10.1.1.1 Conservation Advice, Threat Abatement and Recovery Plans

The conservation advice for the brigalow TEC was approved by the Delegate of the Minister on 17 December 2013. The conservation advice identifies key diagnostic features and REs analogous to the brigalow TEC as well outlining threats, threat abatement and recovery actions.

This conservation advice was taken into consideration for the habitat mapping and subsequent impact assessment. Mitigation measures commited by Arrow have also incorporated recovery and threat abatement measures where practical.

Arrow has made a number of commitments during the EIS and SREIS which aim to protect environmental values by minimising the potential for impact from the Project. These mitigation measures are in line with threat abatement and recovery objectives outlined in the brigalow TEC conservation advice. Threat abatement and recovery objectives in which Arrows commitments support include:

- Protect and conserve remnant and regrowth areas of the ecological community. Prevent clearance of this endangered ecological community and of nearby native vegetation including buffer zones and connecting corridors;
- Management of weeds and feral animals through the application of a Pest and Weed Management Plan;
- Establishment of buffer zones around TEC communities where possible;
- Retaining habitat trees, microhabitat and brigalow regrowth; and
- Leaving trees and other habitat features to maintain habitat connections between brigalow communities

Specific mitigation measures committed by Arrow which are relevant to the brigalow TEC are listed below.

10.1.1.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on this TEC include:

- Aim to avoid disturbance within the following areas [B131]:

  - Endangered EPBC Act TEC: Brigalow Ecological Community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16);

- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers;
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B156];
- Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands) [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.1.1.3 Cumulative Impacts

An analysis of cumulative impacts to the TEC has been undertaken as part of the EIS (Terrestrial Ecology Technical Report (Appendix P, Table 42) which indicates that potential for cumulative impact to the TEC is high. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised intent to develop significant projects (Terrestrial Ecology Technical Report (Appendix P, Section 10) of the EIS).

The outcome of this potential cumulative impact analysis indicates that this TEC is particularly prone to cumulative impacts in the region if the currently proposed projects come to fruition. Given this high sensitivity of the TEC to cumulative impacts, Arrow will manage its Project component of potential cumulative impacts closely with particular emphasis on avoidance, mitigation and specific management procedures as outlined in the mitigation commitments above.

10.1.1.4 Conclusion

Potential impacts on the brigalow TEC have been assessed, and any unpredictable and irreversible impacts are considered unlikely.

The Project activities are unlikely to contribute to the key threats identified to the species (DSEWPaC, 2013ap) as weed species will be managed under the proposed pest management plan and other impacts will be managed through the environmental framework approach.

In conclusion, impacts on the brigalow TEC from the Project are considered unlikely to be significant due to the proposed mitigation commitments for the ecological community.

10.1.2 Natural Grasslands of the Queensland Central Highlands and Northern Fitzroy Basin

10.1.2.1 Conservation Advice, Threat Abatement and Recovery Plans

Conservation advice for the natural grasslands of the Queensland central highlands and northern Fitzroy Basin was approved by the Minister on 15 December 2008. The conservation advice identifies key diagnostic features and REs analogous to the brigalow TEC as well outlining threats, threat abatement and recovery actions.

Threat abatment and recovery actions in which Arrows mitigation measures support include:

- Undertaking survey work to locate possible remnants (pre-clearance surveys);
- Locate infrastructure outside known grassland TEC areas where possible; and
- Implementation of a pest and weed management plan including the implementation of weed hygiene measures such as vehicle washdowns.

Mitigation measures commited to by Arrow in the EIS and SREIS which are consistent with the recovery plan and threat abatement plans are detailed below.

10.1.2.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this TEC include:

- Aim to avoid disturbance within the following areas [B131]:
  - Endangered EPBC Act TEC: Natural Grasslands Ecological Community;
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Dust suppression shall be undertaken during construction and clearing activities, particularly during high wind conditions. Haul roads and other unsealed areas will be watered to suppress dust [B020];
- Dust suppression water quality will meet the prescribed specification prior to use so that water does not pool on the surface, or enter surface waterways via surface runoff [B313];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands) [B158]; and

- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.1.2.3 *Cumulative Impacts*

The outcome of the potential cumulative impact analysis indicates that this TEC is particularly prone to cumulative impacts in the region if the currently proposed projects come to fruition. Given this high sensitivity of the TEC to cumulative impacts Arrow will manage its component of potential cumulative impacts closely with particular emphasis on avoidance, mitigation and specific management procedures as outlined in the mitigation commitments above.

10.1.2.4 *Conclusion*

Potential impacts on the natural grasslands TEC have been assessed, and any unpredictable and irreversible impacts are considered unlikely.

An analysis of cumulative impacts to the natural grasslands TEC has been undertaken as part of the EIS (Terrestrial Ecology Technical Report (Appendix P, Table 42)) that indicates the potential for cumulative impact to the TEC is high. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised intent to develop a significant project (Terrestrial Ecology Technical Report (Appendix P, Section 10) of the EIS).

The Project activities are unlikely to contribute to the key threats identified to the TEC (TSSC, 2008a) as weed species will be managed under the proposed pest management plan and other impacts will be managed through the environmental framework approach.

In conclusion, impacts on the natural grasslands TEC from the Project are considered unlikely to be significant due to the proposed mitigation commitments for the ecological community.

10.1.3 *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions*

10.1.3.1 *Conservation Advice, Threat Abatement and Recovery Plans*

The listing advice for this the semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions does not outline recovery or threat abatement actions. However, the TEC has a National recovery plan (McDonald, 2010), which has been consulted during this assessment.

This recovery plan was taken into consideration for the habitat mapping and subsequent impact assessment. Mitigation measures commited by Arrow have also incorporated recovery and threat abatement measures where practical.

Arrow has made a number of commitments during the EIS and SREIS which aim to protect environmental values by minimising the potential for impact from the Project.

These mitigation measures are consistent with threat abatement and recovery objectives outlined in the recovery plan. Threat abatement and recovery objectives in which Arrows commitments support include:

- Improvement of the knowledge base about the TEC
- The refinement and mapping of the TEC within its region; and
- Develop weed and pest management strategies.

Other recovery objectives for the TEC include the consultation with land-owners and traditional owners as well as increasing the TEC's extent within conservation estate. Arrows Project activities are unlikely to prevent these recover actions occurring. Project activities and mitigation measures below are consistent with the recovery plan.

10.1.3.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on this TEC include:

- Aim to avoid disturbance within the following areas [B131]:
  - Endangered EPBC Act TEC: Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13);
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers;
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167];

- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands) [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.1.3.3 *Cumulative Impacts*

An analysis of cumulative impacts to the TEC has been undertaken as part of the EIS (Terrestrial Ecology Technical Report (Appendix P, Table 42)) which indicates that potential for cumulative impact to the TEC is high. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised serious intent to develop (Terrestrial Ecology Technical Report (Appendix P, Section 10) of the EIS).

The outcome of this potential cumulative impact analysis indicates that this TEC is particularly prone to cumulative impacts in the region if the currently proposed projects come to fruition. Given this high sensitivity of the TEC to cumulative impacts Arrow will manage its component of potential cumulative impacts closely with particular emphasis on avoidance, mitigation and specific management procedures as outlined in the mitigation commitments above.

10.1.3.4 *Conclusion*

Potential impacts on the SEVT TEC have been assessed, and any unpredictable and irreversible impacts are considered unlikely.

The Project activities are unlikely to contribute to the key threats identified to the TEC (DSEWPaC, 2013aq) as weed species will be managed under the proposed pest management plan and other impacts will be managed through the environmental framework approach.

In conclusion, impacts on the SEVT TEC from the Project are considered unlikely to be significant due to the proposed mitigation commitments for the ecological community.

10.1.4 *Weeping Myall Woodlands*

10.1.4.1 *Conservation Advice, Threat Abatement and Recovery Plans*

The conservation advice for the Weeping Myall Woodland TEC was approved by the Minister on the 17 December 2008. The advice identifies priority recover and threat abatement actions.

Arrow has made a number of commitments during the EIS and SREIS which aim to protect environmental values by minimising the potential for impact from the Project. These mitigation measures are in line with threat abatement and recovery objectives outlined in the TEC conservation advice. Threat abatement and recovery objectives in which Arrows commitments support include:

- Protecting remnants from weeds; and
- Appropriately using weed management control measures such as herbicides near remnants.

Specific mitigation measures committed by Arrow which are relevant to the TEC are listed below.

10.1.4.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this TEC include:

- Aim to avoid disturbance within the following areas [B131]:
  - Endangered EPBC Act TEC: Weeping Myall Woodlands (REs 11.3.2 and 11.3.28);
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers;
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands) [B158]; and

- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.1.4.3 *Cumulative Impacts*

An analysis of cumulative impacts to the TEC has been undertaken as part of the EIS (Terrestrial Ecology Technical Report (Appendix P, Table 42)) which indicates that potential for cumulative impact to the TEC is extremely low. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised serious intent to develop (Terrestrial Ecology Technical Report (Appendix P, Section 10) of the EIS).

10.1.4.4 *Conclusion*

Potential impacts on the Weeping Myall Woodland TEC have been assessed, and any unpredictable and irreversible impacts are considered unlikely.

The Project activities are unlikely to contribute to the key threats identified to the TEC (TSSC, 2008b) as weed species will be managed under the proposed pest management plan and other impacts will be managed through the environmental framework approach.

In conclusion, impacts on the weeping myall TEC from the Project are considered unlikely to be significant due to the proposed mitigation commitments for the ecological community.

10.2 Terrestrial Fauna

10.2.1 *Northern Quoll (Dasyurus hallucatus)*

10.2.1.1 *Conservation Advice, Threat Abatement and Recovery Plans*

No conservation advice is available for the northern quoll. However, the national recovery plan (Hill and Ward, 2010) has been adopted. This plan aims to minimise the rate of decline of the northern quoll in Australia. The plan lists a number of recovery objective criteria (Section 9.2.1.1).

Threat abatement measures within the recovery plan, which Arrow supports through the Project avoidance and mitigation measures include:

- Implement controls to protect and mimise northern quolls from feral predators;
- Reduce the risk of introducing disease into northern quoll populations; and
- Minimise habitat degradation from grazing practices and weed invasion.

Mitigation measures (outlined below) and the application of Arrows constraints mapping and risk based framework are consistent with the recovery plan of the northern quoll.

10.2.1.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this species include:

- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species.
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.1.3 *Cumulative Impacts*

An assessment of interacting projects within the region identfied that the northern quoll may be subjected to cumulative impacts. The interacting projects are considered to be of high relevance to the Project given they occur within the same bioregional area, share a common impact pathway and occur over a similar temporal scale. As such the potential for cumulative impacts on the northern quoll is considered moderate.

10.2.1.4 *Conclusion*

The Project is not considered likely to result in threatening processes identified in the National Recovery Plan for the Northern Quoll (Hill and Ward, 2010).

It is considered unlikely that any impacts upon the northern quoll are unknown, unpredictable or irreversible.

The northern quoll has undergone substantial declines throughout its range, including in the Bowen Basin. Major threats to the northern quoll include vegetation clearance, inappropriate roadside clearance, feral animals and inappropriate fire regimes (DSEWPaC, 2013m).

These threats currently exist within the study area and the proposed Project will not exacerbate the present levels. Due to the uncommon occurrence of this species within the Project area and restriction to habitats of low accessibility, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.2 Ornamental Snake (*Denisonia maculata*)

10.2.2.1 *Conservation Advice, Threat Abatement and Recovery Plans*

No prescribed conservation advice is available for the ornamental snake. However, a draft recovery plan for the Queensland Brigalow Belt Reptiles, including the ornamental snake, was drafted by WWF-Australia in 2006 (Richardson, 2006). A species profile was also developed by the Queensland Department of Environment and Heritage Protection (EHP, 2012e). Key recovery actions presented in these documents include:

- Encourage involvement, provide incentives and adopt a collaborative approach with government agencies, NRM regional bodies, the Indigenous community, key industry stakeholders and local governments to deliver region-specific information and implement sustained, effective recovery actions;
- Identify research priorities: develop and support the implementation of research Projects undertaken by tertiary and research institutions;
- Inspect and identify suitable habitat for conservation of the ornamental snake;
- Identify key threats and develop management guidelines to protect key habitat;
- Maximise the establishment of appropriate reserves to protect ornamental snake habitat and landscape connectivity over the long term; e.g. on stock route networks, road reserves and private lands; and
- Ensure ornamental snake conservation is incorporated into appropriate land management decisions made by all levels of government and industry.

Mitigation measures (outlined below) and the application of Arrows habitat mapping and risk based framework are consistent with the recovery objectives for the ornamental snake.

10.2.2.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this species include:

- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species.
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- Trenches should be inspected and monitored as per the *APIA Code of Environmental Practice* [B159];
- 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 [B173]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.2.3 *Cumulative Impacts*

The ornamental snake was identified during the EIS as having a high potential for cumulative impact given it has a restricted distribution (Brigalow Belt) and is sensitive to habitat disturances including habitat fragmentation and alteration of landscape hydrology (particularly in and around gilgai). A number of contiguous projects with a similar impact pathway and temporal scale of operation extenuate the potential for cumulative impacts on this species.

10.2.2.4 *Conclusion*

The Project is considered unlikely to result in threatening processes identified in the draft recovery plan for the Queensland Brigalow Belt Reptiles (Richardson, 2006).

It is considered unlikely that any impacts upon the ornamental snake are unknown, unpredictable or irreversible. The ornamental snake has undergone substantial declines throughout its range, including in the Bowen Basin. Major threats to the ornamental snake include habitat loss through clearing, habitat fragmentation, habitat degradation by stock, alteration of landscape hydrology in and around gilgai environments, alteration of water quality, contact with the cane toad, predation by feral species and invasive weeds. (DSEWPaC, 2013x). These threats currently exist within the study area and the proposed Project will not exacerbate the present levels. Due to the uncommon occurrence of this species within the Project area and restriction to habitats of low accessibility, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

The draft Referral Guidelines for the Brigalow Belt Reptiles (DSEWPaC, 2011b) notes that known important habitat for the ornamental snake includes gilgai depressions and mounds and that habitat connectivity between gilgais and other suitable habitats is important. The draft referral guidelines also note that *"…given that the listed Brigalow Belt reptiles are difficult to detect and population information is limited, the department [DSEWPaC] regards important habitat as a surrogate for important populations in the assessment of whether an action is likely to have a significant impact on one or more of these species"*. On this basis there may be a potential significant impact on the ornamental snake from Project activities. However, adherence to the mitigation commimtments as outlined above will ensure that the ornamental snake will not decline as a result of the Project.

10.2.3 Fitzroy River Turtle (Rheodytes leukops)

10.2.3.1 *Conservation Advice, Threat Abatement and Recovery Plans*

Conservation advice for the Fitzroy River turtle was approved by the Minister on 3 July 2008. This advice provides a species description, distribution, population and threats and recovery objectives.

There is no recovery plan in place for this species. However, the conservation advice lists threat abatement actions which will support the recovery of the species, including:

- Protect areas of riparian habitat where populations are known or have the potential to occur;
- Manage, in such a manner that there is no detrimental impact, any changes to hydrology that may result in changes to the water table levels, increased run-off, sedimentation or pollution, particularly from cotton/grazing production;
- Maintain nesting banks used by the turtles and protect turtle nests from predation and disturbance; and
- Develop a management plan to be implemented for the control and eradication of foxes, pigs, dingoes and cats around breeding colonies of the Fitzroy River turtle.

Mitigation measures (outlined below) and the application of Arrows habitat mapping and risk based constraints framework are consistent with the recovery objectives for the Fitzroy River turtle.

10.2.3.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species.
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - Identification of core habitats for EVNT species; and
  - Identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers).
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187]
- Disturbance exclusion zones (or management buffers) will be established and managed during construction and operations to effectively protect ESAs as defined by the project's constraints mapping (outlined in Section 7 and detailed in Constraints Mapping (Appendix BB of the EIS) [B145].
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Avoid removing riparian vegetation when directional drilling and reduction of right of ways where practical [B138];
- Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142];
- Design creek crossings to ensure that existing flow regimes are maintained [B143];

- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

As outlined in commitment number B187 above, *Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187],* a species management procedure for the Fitzroy River turtle will be implemented should the turtle be discovered during the Project. Recommendations for management procedures to be included in any management procedure for the turtle are provided below.

The objective of the species management procedure should aim to minimise impacts from the Project by informing construction activities on appropriate mitigation measures within Fitzroy River turtle habitat. Information and possible mitigation measures in which the species management plan may include are listed below:

- Detailed description of the biology and reproduction of the species, including information such as nesting periods;
- Detailed description of suitable habitat in which the species is known to utilise, including nesting habitat;
- Incorporation of habitat assessments and habitat mapping, including detailed maps of any known locations;
- Mitigation measures to avoid, minimise and manage potential impacts. Consideration to be made for avoiding impact on a first basis. Where avoidance may not be possible, the following construction mitigation measures may be incorporated into the management plan:
  - Consideration of clearing limits being clearly marked out, with no go signs or barricading erected prior to any clearing or waterway crossing works to prevent unauthorised access;
  - Construction activities within waterways in which the Fitzroy River turtle is known to occur to consider avoiding all works during the known nesting and breeding season of the species;
  - Fauna spotter catchers should be considered during all waterway crossing works within known Fitzroy River turtle habitat;
  - Consideration should be given into the rehabilitation of riparian zones (within known Fitzroy River turtle habitat) and associated turtle nesting areas immediately after construction is completed;
- Consideration of vehicle and pedestiran access to be restricted to defined tracks to avoid any impact on regenerating riparain zone and associated turtle nesting areas; and

- A monitoring programme in known Fitzroy River turle habitat where construction activites have been undertaken should be considered.

The management plan inclusions outlined above are recommendations only. Final mitigation measures will be determined and outlined should the Fitzroy River turtle be identifed during the Projects life. As well as mitigation measures outlined above, industry mitigation measures to protect waterways such as erosion and sediment controls will be implemented [B207].

10.2.3.3 *Cumulative Impacts*

The Fitzroy River turtle has been included in the habitat and impact assessment on a precautionary basis. Core habitat for the species is appears to occur south east of the Project area (downstream). Impacts on this species are most likely to be associated with degradation of waterways such as erosion and sediment laden runoff from resource and agricultural operations as well as nest destruction and predation from feral animals. Pest species are well established within the region and curent levels are not expected to be exacerbated from Project activites.

Given that core habitat for the species exists outside the Project area and the application of erosion and sediment controls will occur throughout contruction activities (including riparian buffers), contributing impacts from the Project on this species are considered minimal. Given the number of Projects and agricultural operations upstream, cumulative impacts on this species are considered moderate.

10.2.3.4 *Conclusion*

It is considered unlikely that any impacts upon the Fitzroy River turtle are unknown, unpredictable or irreversible.

The species faces a number of threats, primarily loss and degradation of habitat and feral animals. These threats currently exist within the Project area and are unlikely to be significantly exacerbated by Project activities. The distance of Project activities from core populations, and the implementation of mitigation measures for downstream impacts reduce the likelihood of impacts to the species. The impact of pest flora and fauna will not increase as a result of Project development given the proposed implementation of a pest management plan as committed to by Arrow.

In conclusion, impacts on the Fitzroy River turtle from the Project are not deemed to be significant as important populations are located remote from the Project area and the proposed Project mitigation controls will be implemented to minimise impacts to the species.

10.2.4 Squatter pigeon (Geophaps scripta scripta)

10.2.4.1 *Conservation Advice, Threat Abatement and Recovery Plans*

There is no recovery plan in place for the squatter pigeon. The conservation advice for the species identifies numerous threat abatement actions, including:

- Implement appropriate feral animal controls include those outlined in the Threat Abatement Plan for Predation by Feral Cats (DEWHA, 2008a) and the Threat Abatement Plan for Predation by the European Red Fox (DEWHA, 2008b);
- Manage threats to areas of vegetation that support important populations; and
- Identify populations of high conservation priority.

Project activities are consistent with recovery objectives and conservation advice for the species. Mitigation measures which will minimise impacts to the squatter pigeon are outlined below.

10.2.4.2 *Mitigation Measures*

Mitigation measures for this species will include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species;
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Develop speed limits on Project controlled roads with due consideration to reduce the potential for vehicle collisions with wildlife [B154];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];

- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B157];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

The distributed nature of many of the physical impacts from this and other CSG Projects in the region, in conjunction with the species' wide distribution across a variety of habitats within the Project area mean that the intersection of habitat with infrastructure will be avoidable in many instances. Potential cumulative impacts are further discussed in Section 11.

10.2.4.3 *Cumulative Impacts*

The squatter pigeon is widespread throughout the region and is likely to be impacted by a considerable number of projects. However, given its widespread occurrence its mobile nature lessens the squatter pigeon susceptibility to cumulative impacts. The potential for cumulative impacts on this species is considered low.

10.2.4.4 *Conclusion*

It is considered unlikely that any impacts upon the squatter pigeon are unknown, unpredictable or irreversible. The squatter pigeon population is considered likely to be stable at present (Garnett and Crowley, 2000 in DSEWPaC, 2013h), although significant declines in population occurred during the late 19th and early 20th centuries. The decline in population is primarily attributed to loss of habitat due to clearing for agricultural or more recently, resource extraction purposes.

These threats currently exist within the study area and the proposed Project will not exacerbate the present levels. Due to the infrequent occurrence of this species within the Project area and restriction to habitats of low accessibility, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.5 *Koala (Phascolarctos cinereus)*

10.2.5.1 *Conservation Advice, Threat Abatement and Recovery Plans*

A recovery plan for the koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) will be developed and is to commence following the expiration of the National Koala Conservation and Management Strategy in 2014.

There are a number of conservation instruments, guidelines and plans already in place for the koala across its entire range, in individual states, and for some regional populations. However, there is no existing overarching conservation strategy for the entity “Koala populations occurring in Queensland, New South Wales and the Australian Capital Territory”.

The Conservation Advice for the Koala (TSSC, 2012) notes that the status of, and threats to, individual koala populations vary over their range, and that a range of management prescriptions have been applied to varying circumstances. The advice identifies threat abatement actions that would support the recovery of the koala in Queensland, NSW and the ACT, including:

- Develop and implement a development planning protocol to be used in areas of koala populations to prevent loss of important habitat, koala populations or connectivity options;
- Development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, koala habitat;
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary;
- Identify populations of high conservation priority;
- Investigate formal conservation arrangements, management agreements and covenants on private land, and for Crown and private land investigate and/or secure inclusion in reserve tenure if possible;
- Manage any other known, potential or emerging threats such as bell miner (*Manorina melanophrys*) Associated Dieback or Eucalyptus rust;
- Develop and implement options of vegetation recovery and re-connection in regions containing fragmented koala populations, including inland regions in which koala populations were diminished by drought and coastal regions where development pressures have isolated koala populations;
- Develop and implement a management plan to control the adverse impacts of predation on koalas by dogs in urban, peri-urban and rural environments; and
- Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for the Koala.

10.2.5.2 *Mitigation Measures*

Mitigation measures for this species will include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species.

- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- Retain habitat trees where practicable [B137];
- Identify key koala trees, and visually inspect prior to clearing to ensure that they are free of koalas. If koalas are located, the tree should be retained until the animals have moved on, typically overnight [B190].
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.5.3 *Cumulative Impacts*

The cumulative impacts on the koala were assessed in the EIS (Appendix P). During this assessment the majority of interacting projects within the region presented potential impacts to the koala. These interacting projects were assessed as extremely relevant to the Project given they shared boundaries or occurred within the same bioregion and they also share similar impact pathways and temporal scale of operation. As such there is a high potential for cumulative impact on the koala.

10.2.5.4 *Conclusion*

It is considered unlikely that any impacts upon the koala are unknown, unpredictable or irreversible. Koala population density is low within the Project area and the wider Bowen Basin and threats specific to this area have not been well studied. In general, threats will be similar to those identified for the population in south-east Queensland, as outlined on the SPRAT database (DSEWPaC, 2013q), which include habitat loss, fragmentation and degradation; drought and extreme weather events; feral animals; vehicle strike, wildfire, disease, over population and low genetic variability.

Many of these threats currently exist within the study area and the proposed Project will not exacerbate the present levels. Due to the uncommon occurrence of this species within the Project area, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.6 South-Eastern Long-Eared Bat (*Nyctophilus corbeni*)

10.2.6.1 *Conservation Advice, Threat Abatement and Recovery Plans*

The draft National Recovery Plan for the south-eastern long-eared bat (Schulz and Lumsden, 2010 in DSEWPaC, 2013r) aims to achieve down-listing of the south-eastern long-eared bat from 'Vulnerable' nationally to a lower threat category. This down-listing is to be achieved by securing the long-term protection of the species through a reduction in the impact of threatening processes and to improve the standard of information available to guide recovery (Schulz and Lumsden, 2010 in DSEWPaC, 2013r). The recovery plan seeks to achieve this goal through the use of 10 specific objectives:

- Clarify the current fine-scale distribution patterns and habitat requirements across the species' range;
- Increase the understanding of critical aspects of the biology and ecology of the south-eastern long-eared bat that will assist in the long-term management of the species;
- Identify key populations and protect these from habitat loss and fragmentation;
- Identify and alter inappropriate fire regimes;
- Identify and minimise forestry practices that may impact this species;
- Reduce exposure to agrichemicals;
- Identify the extent of population fragmentation and instigate measures to increase habitat connectivity where recent isolation has occurred;
- Identify and reduce the potential impact of feral species on key populations;
- Identify the key threats to the conservation of the species; and
- Build community support for the conservation of the species.

Curtis *et al.* (2012) note the following recovery efforts are required for the species:

- Prevent native vegetation clearing;
- Encourage the protection and enhancement of understorey vegetation;

- Reduce grazing pressure in native forests;
- Promote the protection of native vegetation and hollow bearing trees on private lands;
- Retain hollow-bearing trees during logging and timber removal operations;
- Review fire management practices to retain hollow bearing trees;
- Develop and promote state-wide bat awareness programs;
- Restore degraded habitat; and
- Install escape nets in water tanks so that bats falling in while drinking can climb out again.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for the south-eastern long-eared bat.

10.2.6.2 Mitigation Measures

Mitigation measures for this species will include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species.
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- 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 [B189];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];

- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.6.3 *Cumulative Impacts*

The cumulative impacts on the south-eastern long-eared bat were assessed in the EIS (Appendix P). During this assessment the no other interacting projects were identified as having this species known to occur or potentially occurring. As such, impacts on this species from other projects were identified as unlikely. Potential cumulative impacts were determined as being negligible.

10.2.6.4 *Conclusion*

The Project is not considered likely to result in processes that may threaten the species.

It is considered unlikely that any impacts upon the south-eastern long-eared bat are unknown, unpredictable or irreversible. The south-eastern long-eared bat is rare throughout most of its distribution, with the species preferring large intact tracts of native vegetation. Major threats to the south-eastern long-eared bat include habitat loss and fragmentation along with forestry activities, fire and overgrazing.

These threats currently exist within the study area and while the proposed Project may result in loss of habitat, it will not result in a decline in the species. Due to the uncommon occurrence of this species within the Project area and restriction to habitats of low accessibility, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.7 *Large-eared Pied Bat (Chalinolobus dwyeri)*

10.2.7.1 *Conservation Advice, Threat Abatement and Recovery Plans*

Although a recovery plan has not been developed for the species, the following recovery objectives have been identified for the large-eared pied bat:

- Identify priority roost and maternity sites for protection (DERM, 2011 in DSEWPaC, 2013s);
- Implement conservation and management strategies for priority sites (Qld DERM, 2011 in DSEWPaC, 2013s), especially as the species has narrow habitat requirements (sandstone overhangs and higher productive landscapes) (NSW DECC 2007d in DSEWPaC, 2013s);

- Management of the species should focus on the protection and enhancement of higher fertility soils (NSW DECC 2007d in DSEWPaC, 2013s);
- Educate the community and industry to understand and participate in the conservation of the large-eared pied bat (Qld DERM 2011 in DSEWPaC, 2013s);
- Research to augment biological and ecological data to enable conservation management (Qld DERM 2011 in DSEWPaC, 2013s);
- Collect genetic data throughout the distribution of the large-eared pied bat (Qld DERM 2011 in DSEWPaC, 2013s); and
- Reassess status of and threats to the large-eared pied bat following targeted survey and research (Qld DERM 2011 in DSEWPaC, 2013s).

Curtis et al. (2012) note the following recovery efforts are required for the species:

- Protect known and potential roost sites and/or manage the impacts of mining and recreational caving;
- Exclude feral goats from overhang roost sites along cliff faces;
- Identify the maternity roost requirements and protect known maternity sites; and
- Protect, manage and/or rehabilitate native vegetation around known roost sites.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for the large-eared pied bat.

10.2.7.2 Mitigation Measures

Mitigation measures for this species will include:

- Aim to avoid disturbance within the following areas [B131]:
  – Mapped Essential habitat for the species; and
  – Core habitat for EVNT species;
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  – vegetation mapping at a scale suitable for site-specific planning;
  – identification of core habitats for EVNT species; and
  – identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear

corridors of vegetation. Areas cleared for field development should be as small as practical [B136];

- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.7.3 *Cumulative Impacts*

An assessment of cumulative impacts for this species was undertaken during the EIS. It was identified that the potential for impact on this species from the Project was low given the preferential habitat (cliffs) of the species. Additionally, no other interacting projects in the region (assessed in the EIS) identified this species as a known or potential occurrence. As such, the potential for cumulative impact on this species is considered low to negligible.

10.2.7.4 *Conclusion*

The Project is considered unlikely to threaten the large-eared pied bat species.

The large-eared pied bat is rare throughout most of its distribution, with the species preferring large intact tracts of native vegetation. Major threats to the large-eared pied bat include habitat loss and disturbance of roost sites.

These threats currently exist within the study area and while the proposed Project may result in loss of foraging habitat, it will not result in a decline in the species. Due to the uncommon occurrence of this species within the Project development area and restriction to habitats of low accessibility, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.8 Australian Painted Snipe (*Rostratula australis*)

10.2.8.1 *Conservation Advice, Threat Abatement and Recovery Plans*

There is no species specific recovery plan for the Australian painted snipe. However, the Action Plan for Australian Birds 2010 (Birds Australia, 2011) features a brief recovery outline for the Australian painted snipe. Recovery management actions include:

- Protect and manage principal breeding wetlands and wintering grounds. As a precaution, identify and protect habitat used by painted snipe in the last 10 years;
- Rehabilitate selected former breeding wetlands;
- Monitor abundance at a landscape scale using, initially, the Atlas of Australian birds; and
- If deemed necessary on the basis of monitoring, develop techniques for maintain a captive population.

Additional actions as prescribed on the SPRAT database (DSEWPaC, 2013k) for the species include:

- Develop guidelines, in consultation with landholders, for the management of suitable wetlands;
- Initiate control programs for feral animals, and erect fencing to prevent grazing and trampling of wetlands by cattle, at suitable wetlands;
- Undertake further research to determine movements and improve knowledge of habitat preferences; and
- Encourage participation of community groups and other relevant bodies in the recovery effort.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for the south-eastern long-eared bat.

10.2.8.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species;
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139];

- Deviate access tracks and pipelines around sensitive vegetation where practicable [B140];
- Avoid construction activities in waterbodies frequented by migratory species [B141]; and
- Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142].
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- Reduce the impact of CSG water on soil structure and aquatic values, by designing and constructing wells in accordance with the *Code of Practice for Constructing and Abandoning CSG wells in Queensland* (NRM, 2013) [B168];
- Design creek crossings to ensure that existing flow regimes are maintained [B143]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.8.3 *Cumulative Impacts*

The distributed nature of many of the physical impacts from this and other CSG Projects in the region, in conjunction with the species' restriction to wetland habitats (to be avoided) within the Project area mean that the intersection of habitat with infrastructure will be avoidable in many instances. Potential cumulative impacts are further discussed in Section 12.

10.2.8.4 *Conclusion*

As outlined, the Project is considered unlikely to threaten the Australian painted snipe.

It is considered unlikely that any impacts upon the Australian painted snipe are unknown, unpredictable or irreversible. The Australian painted snipe has evidently declined substantially (DSEWPaC, 2013k). Major threats to the snipe are the loss and modification of wetland habitat (DSEWPaC, 2013k).

These threats previously existed within the Project area and the proposed Project will not exacerbate the present levels. Due to the uncommon occurrence of this species within the Project area and restriction to wetland habitats, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.9 Red Goshawk (*Erythrotriorchis radiatus*)

10.2.9.1 *Conservation Advice, Threat Abatement and Recovery Plans*

A national recovery plan for the red goshawk (DERM, 2012) was created with the objective to maintain populations of the red goshawk across their range and implement measures to promote recovery of the species.

Key threat abatement actions outlined in the recovery plan to meet the objectives include:

- Monitor red goshawk habitat and determine territory occupancy and productivity, and use DNA analyses of feathers to determine adult survival rates;
- Collate information on known nest sites from the past 25 years and produce descriptive maps of important habitat and ensure information is secure;
- Conduct searches to identify previously unknown pairs of red goshawks, nest sites, and habitats critical for red goshawk survival;
- Identify important populations and nest sites, and use the information to inform monitoring programs and state and federal government planning frameworks;
- Provide specific information and advice to assist with the identification, acquisition and management of important habitat for the red goshawk;
- Conduct research to understand the relationship between habitat fragmentation, prey density and population persistence to better inform management;
- Protect habitat through acquisition or voluntary conservation agreements;
- Reduce the effects of red goshawk habitat fragmentation and degradation by encouraging landholders to protect and manage threatened red goshawk territories;
- Train personnel from state and local government to identify and understand the threats to red goshawk habitat;
- Produce and distribute information on the conservation status and habitat requirements of the red goshawk;
- Provide feedback to the public and agency personnel on progress of red goshawk recovery; and
- Review the effectiveness of the community awareness program.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for the red goshawk.

10.2.9.2 *Mitigation Measures*

Mitigation measures commited to by Arrow which will minimise potential impacts on the red goshawk include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species.
- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.9.3 *Cumulative Impacts*

Within the Project area, general habitat for the red goshawk comprises remnant vegetation supporting tall nesting trees (25 m or greater) within 1 km of permanent water. Given that permanent water within the Project area is minimal and that the species is known from the wider region, this species is considered a moderate occurrence.

The cumulative impacts on this species are considered low given the absence of core habitat within the Project.

10.2.9.4 Conclusion

The Project is considered unlikely to threaten the red goshawk. The red goshawk occurs in low densities within Central Queensland due to the association of suitable nesting and foraging habitat with permanent water. Occurrences of the red goshawk within the region, particularly where permanent water is absent, are most likely transient individuals. Given this, the potential impact on resident pairs is considered unlikely.

The major threat on the species includes habitat loss. This threat currently exists within the study area and while the proposed Project may result in loss of foraging habitat, it will not result in a decline in the species. Due to the uncommon occurrence of this species within the Project development area, Project-related threatening processes will have impacts of low magnitude. The impact of pest flora and fauna will not increase as a result of Project development given the implementation of a pest management plan as committed to by Arrow.

10.2.10 Yakka Skink (*Egernia rugosa*)

10.2.10.1 Conservation Advice, Threat Abatement and Recovery Plans

The Queensland Brigalow Belt Reptile Recovery Plan (Richardson, 2006) identifies the following objectives are required to secure and improve the long term survival of the species and key habitat:

- Identify and protect key habitat and important populations on private and state controlled lands through the development of partnerships between relevant stakeholders.
- Reduce and manage the major threatening processes affecting threatened reptiles in the Queensland Brigalow Belt.
- Ensure reptile conservation is incorporated into appropriate land management decisions within all levels of government, industry and community.
- Increase community participation, awareness and understanding in the conservation and management issues of threatened reptiles.
- Increase knowledge and understanding of the species and their ecology necessary to effect their conservation and management.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for the yakka skink.

10.2.10.2 Mitigation Measures

Mitigation measures for this species will include:

- Aim to avoid disturbance within the following areas [B131]:
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species;

- Conducting pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Designing infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Minimising vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development should be as small as practical [B136];
- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands [B158]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.2.10.3 *Cumulative Impacts*

The distributed nature of many of the physical impacts from this and other CSG Projects in the region, mean that the intersection of habitat with infrastructure will be avoidable in many instances.

As identified in the habitat assessment for this species, it appears that the majority of the Project area is situated outside the distribution of this species. Additionally, given the lack of suitable habitat within the the southern Project gas field, the cumulative impact on this species associated with this Project is considered low.

10.2.10.4 *Conclusion*

The Project is unlikely to result in processes that may threaten the species. The distribution of the yakka skink suggests the majority of the Project area is outside the species' range. In the southern Project gas field where the occurrence of the yakka skink is considered moderate (the northern Project gas field has been included as moderate as a precaution), potential habitat is minimal and no important populations are known to occur. It is considered unlikely that the Project will significantly impact this species.

10.3 Terrestrial Flora

10.3.1 Black Ironbox (Eucalyptus raveretiana)

10.3.1.1 Conservation Advice, Threat Abatement and Recovery Plans

The conservation advice for this species was approved by the Minister on 16 December 2008. The conservation advice lists priority recovery and threat abatement actions which can be done to support the recovery of the black ironbox, including:

- Identify populations of high conservation priority;
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on Black Ironbox;
- Minimise adverse impacts from land use at known sites, particularly in relation to forest operations and maintenance of stream bank and riparian vegetation integrity;
- Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate inclusion in reserve tenure if possible;
- Implement a pest and weed management, particularly for the control of rubber vine and to prevent the introduction of invasive weeds which could threaten the species.

The above threat abatement actions are consistent with mitigation measures commited to by Arrow. Mitigation measures relevant to the species are listed below.

10.3.1.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131]:
  - Category C ESAs (including black ironbox habitat RE 11.3.25);
  - Mapped Essential habitat for the species;
  - Core habitat for EVNT species.
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species;
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear

corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];

- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B157];
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.3.1.3 *Cumulative Impacts*

The distributed nature of many of the physical impacts from this and other CSG Projects in the region, in conjunction with the species' restriction to riparian habitat within the Project area mean that the intersection of habitat with infrastructure will be avoidable in many instances. Potential cumulative impacts are further discussed in Section 10.

An analysis of cumulative impacts upon black ironbox has been undertaken as part of the EIS (EIS Appendix P, Table 42) which indicates that potential for cumulative impact to the species is moderate. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised serious intent to develop (refer to EIS Appendix P, Section 10).

10.3.1.4 *Conclusion*

Given the restricted distribution of the species within the Project area and the protection of potential habit through the framework approach and proposed pre-clearance surveys the Project activities are not expected to have a significant impact upon any important populations of the species.

The Project activities are unlikely to contribute to the key threats identified to the species (DSEWPaC, 2013ar) as weed species will be managed under the proposed pest management plan.

In conclusion, impacts on the black ironbark from the Project are not deemed to be significant due to the proposed mitigation commitments for the species and because the Project area forms only a small portion of the known distribution of the species.

10.3.2 Bluegrass (Dichanthium setosum)

10.3.2.1 *Conservation Advice, Threat Abatement and Recovery Plans*

The conservation advice for bluegrass (*Dichanthium setosum*) was approved by the Minister / Delegate of the Minister on 26 March 2008. The advice lists priority recovery and threat abatement actions which can be done to support the recovery of the species, including:

- Identify populations of high conservation priority;
- Manage threats to areas of vegetation that contain populations / occurrences / remnants of *D. setosum*;
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on *D. setosum*;
- Ensure road widening and maintenance activities (or other infrastructure or development activities as appropriate) in areas where *D. setosum* occurs do not adversely impact on known populations;
- Investigate formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure; and
- Develop and implement a management plan for the control of introduced grasses.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement actions for bluegrass.

10.3.2.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131]:
  - Endangered EPBC Act TEC: Natural Grasslands Ecological Community (RE 11.8.11);
  - Category B ESAs;
  - Category C ESAs;
  - Mapped Essential habitat for the species; and

  - Core habitat for EVNT species;
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species;
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B157]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.3.2.3 *Cumulative Impacts*

An analysis of cumulative impacts upon *Dichanthium setosum* has been undertaken as part of the EIS (EIS Appendix P, Table 42) which indicates that potential for cumulative impact to the species is moderate. This cumulative assessment has been based upon an impact significance matrix and considers future Projects in the region where there is a recognised serious intent to develop (refer to EIS Appendix P, Section 10).

10.3.2.4 *Conclusion*

The Project activities are unlikely to contribute to the key threats identified to the species (DSEWPaC, 2013as) as weed species will be managed under the proposed pest management plan.

In conclusion, impacts on *Dichanthium setosum* from the Project are not deemed to be significant due to the proposed mitigation commitments for the species and because the Project area forms only a small portion of the known distribution of the species.

10.3.3 *King Bluegrass (Dichanthium queenslandicum)*

10.3.3.1 *Conservation Advice, Threat Abatement and Recovery Plans*

Conservation advice for *Dichanthium queenslandicum* was approved by the Minister on 30 January 2013. The advice identifies priority recovery and threat abatement actions which can be done to support the recovery of the species, including:

- Develop and implement a management plan for king blue-grass for the control of parthenium (*Parthenium hysterophorus*) and parkinsonia (*Parkinsonia aculeata*) in the region;
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on king blue-grass;
- Monitor known populations to identify key threats;
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary;
- Identify populations of high conservation priority;
- Ensure there is no disturbance in areas where king blue-grass occurs, excluding necessary actions to manage the conservation of the species/ecological community; and
- Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for king bluegrass.

10.3.3.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131]:

- – Endangered EPBC Act TEC: Natural Grasslands Ecological Community (RE 11.8.11);
- – Category B ESAs;
- – Category C ESAs;
- – Mapped Essential habitat for the species; and
- – Core habitat for EVNT species.

- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - – vegetation mapping at a scale suitable for site-specific planning;
  - – identification of core habitats for EVNT species;
  - – identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B156]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.3.3.3 Cumulative Impacts

An analysis of cumulative impacts upon king blue-grass has been undertaken as part of the EIS (EIS Appendix P, Table 42) which indicates that potential for cumulative impact to the species is extremely high. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised serious intent to develop (refer to EIS Appendix P, Section 10).

The outcome of this potential cumulative impact analysis indicates that this species is particularly prone to cumulative impacts in the region if the currently proposed projects come to fruition. Given this high sensitivity of the species to cumulative impacts Arrow will manage its component of potential cumulative impacts closely with particular emphasis on avoidance, mitigation and specific threatened species management procedures as outlined in the mitigation commitments above.

10.3.3.4 Conclusion

The Project activities are unlikely to contribute to the threats identified to the species as weed species will be managed under the proposed pest management plan.

In conclusion, impacts on *Dichanthium queenslandicum* from the Project are not deemed to be significant due to the proposed mitigation commitments for the species.

10.3.4 Aristida annua

10.3.4.1 Conservation Advice, Threat Abatement and Recovery Plans

No specific conservation advice or recovery plans are available for this species. However, the *Draft Recovery plan for the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community* (Qld DERM 2011) is recognised by Department of the Environment as having a number of recovery objectives which would benefit *Aristida annua*, including:

- Identify and evaluate the condition and environmental values of mapped remnants;
- Improve the conservation status of the ecological community and EPBC Act and state listed species;
- Encourage 'best practice' management of the natural grassland ecological community;
- Enhance the ability of government and non-government organisations at the national, regional and local levels to recognise and incorporate natural grassland conservation issues into planning processes; and
- Increase knowledge of cultural values and biota of the natural grassland ecological community.

Threat abatement measures above were considered during development of mitigation measures for the Project. Project activities and mitigation measures are consistent with threat abatement and recovery plans for *Aristida annua*.

10.3.4.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131]:
  - Endangered EPBC Act TEC: Natural Grasslands Ecological Community (RE 11.8.11);
  - Category B ESAs
  - Category C ESAs;
  - Mapped Essential habitat for the species; and
  - Core habitat for EVNT species;
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species;
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring [B155];
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];

- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B157]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.3.4.3 Cumulative Impacts

An analysis of cumulative impacts upon *Aristida annua* has been undertaken as part of the EIS (EIS Appendix P, Table 42) which indicates that potential for cumulative impact to the species is low. This cumulative assessment has been based upon an impact significance matrix and considers future projects in the region where there is a recognised serious intent to develop (refer to EIS Appendix P, Section 10).

10.3.4.4 Conclusion

Given the proposed protection of potential habit through the framework approach and pre-clearance surveys the Project activities are not expected to have a significant impact upon any important populations of the species.

In conclusion, impacts on *Aristida annua* from the Project are not deemed to be significant due to the proposed mitigation commitments for the species.

10.4 Migratory Species

10.4.1 Migratory Wetland Species

10.4.1.1 Conservation Advice, Threat Abatement and Recovery

No specific species conservation or recovery plans are available for the migratory wetland species identified in Section 9.3.1. However the Latham's snipe is included within the conservation plan for migratory shorebirds (Department of the Environment, 2006). Within this plan, a range of conservation objectives and associated actions are identified. Actions largely include the indentification of conservation areas and refinement or development of existing shorebird maps.

Key threats outlined on the SPRAT profile for the great egret identify that the most important issue of great egret conservation is the loss and/or degradation of wetland habitats. Threat abatement measures therefore involve any measures which avoid or reduce the loss and/or degradation of wetlands.

The identification of wetlands which may support the above species through Arrow's constraint mapping and pre-construction surveys are consistent with the conservation plan and threat abatement measures.

10.4.1.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on migratory wetland species identified in Section 9.3.1.1 include:

- Aim to avoid disturbance within the following areas [B131]
  - Category B and C ESAs; and
  - Waterbodies frequented by migratory wetland species;
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques [B146];
- Design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat [B099];
- Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person [B149];
- 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 key weed species at risk of spread through Project activities. The pest management plan should include, as a minimum, training, management of pest spread, management of pest infestations and monitoring effectiveness of control measures [B191];
- 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 [B193];
- Reduce the impact of CSG water on soil structure and aquatic values by designing and constructing wells in accordance with the Code of Practice for Constructing and Abandoning Coal Seam Gas Wells in Queensland (NRM, 2013) [B168];
- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats to increase the rate of recovery [B157];
- Design washdown facilities to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas [B172];
- Install and maintain appropriate sediment and erosion control structures at work sites [B160];

- Carry out corrective actions upon the identification of any contamination of soil or groundwater that has occurred as a result of project activities [B179]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.4.1.3 *Conclusion*

Given the protection of potential habitat through the framework approach and proposed pre-clearance surveys the Project activities are not expected to have a significant impact upon any important populations of the species.

The Project activities are unlikely to have an impact on the great egret and cattle egret populations given their wide distribution and broad habitat requirements (including disturbed habitat). The application of mitigation measures such as the aim to avoid disturbance within Category B and C ESAs and waterbodies will result in minimal impact on Latham’s snipe.

The creation of water treatment ponds and farm dams across the Project area and region means that the potential cumulative impact on the great egret and cattle egret is considered to be minimal. Wetland habitat for Latham’s snipe is restricted to larger, well vegetated waterbodies. Where practicable, avoidance of these areas will reduce the cumulative impact on this species.

In conclusion, impacts on migratory wetland species from the Project are not deemed to be significant as the Project area forms only a small portion of the known distribution of the species and the proposed Project mitigation controls have the capacity to minimise impacts to the species.

10.4.2 *Migratory Woodland Species*

10.4.2.1 *Conservation Advice, Threat Abatement and Recovery Plans*

No conservation advice, threat abatement or recovery plans are available for these species. Mitigation measures outlined below will minimise potential impacts against these species.

10.4.2.2 *Mitigation Measures*

Mitigation measures for the Project that will reduce the impact on migratory woodland species identified in Section 9.3.1.2 include:

- Aim to avoid disturbance within the following areas [B131];
  - Category B and C ESAs;
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;

  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139];
- Deviate access tracks and pipelines around sensitive vegetation where practicable [B140];
- Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142];
- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques [B146];
- Design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat [B099];
- Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person [B149];
- 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 [B189];
- 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 key weed species at risk of spread through Project activities *(mesquite, parthenium*, African lovegrass 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 [B191]; and

- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.4.2.3 Conclusion

Given the protection of potential habitat through the framework approach and proposed pre-clearance surveys the Project activities are not expected to have a significant impact upon any important populations of migratory bird species.

The Project activities are unlikely to have an impact on migratory woodland species given their high mobility, wide distribution and relatively broad habitat requirements. The design of infrastructure to avoid undisturbed tracts of remnant vegetation will minimise impacts on these species (specifically in riparian areas).

In conclusion, impacts on migratory woodland species from the Project are not deemed to be significant as the Project area forms only a small portion of the known distribution of the species and the proposed Project mitigation controls have the capacity to minimise impacts to the species.

10.4.3 Migratory Aerial Species

10.4.3.1 Conservation Advice, Threat Abatement and Recovery Plans

Due to the limited nature of any threats to both aerial species and their mobility, there is no threat abatement or recovery actions either underway or proposed. Mitigation measures outlined below will minimise potential impacts against these species.

10.4.3.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on migratory aerial species identified in Section 9.3.1.3 include:

- Dust suppression shall be undertaken during construction and clearing activities, particularly during high wind conditions. Haul roads and other unsealed areas may be watered to suppress dust [B020];
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136]; and
- Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139].

10.4.3.3 Conclusion

Given that two migratory species are exclusively aerial and are known to fly over all habitat types, it is considered that Project activities will have a negligible impact. Despite the expected negligible impact, dust suppression (being implemented on site as part of the project mitigation activities) will have the added benefit of reducing impacts to any aerial species flying over the Project area.

10.4.4 White-bellied-Seaeagle (Haliaeetus leucogaster)

10.4.4.1 Conservation Advice, Threat Abatement and Recovery Plans

Within Queensland, no recovery plans, conservation advice or threat abatement plans are in place for this species. Threat abatement actions adopted in other Australian states include:

- The protection of suitable habitat (and especially known nesting sites) on public land, including the establishment of 'buffer zones around nest sites to limit disturbance by humans or human activity;
- Reduce the proportion of nests subject to disturbance; and
- The introduction of annual, broad surveys to (1) monitor known nest sites, (2) locate new nest sites, (3) determine breeding success and trends in populations, and (4) determine areas of critical habitat.

The threat abatement measures identified above are not exhaustive, however identify the general measures required to minimise impacts to this species. Arrows commitments listed below are consistent with threat abatement actions for this species.

10.4.4.2 Mitigation Measures

Mitigation measures for the Project that will reduce the impact on this species include:

- Aim to avoid disturbance within the following areas [B131];
  - Category B and C ESAs;
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Develop threatened species management procedures as and when Project activities are identified as likely to impact upon individuals [B187];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134];

- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139];
- Deviate access tracks and pipelines around sensitive vegetation where practicable [B140];
- Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142];
- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques [B146];
- Design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat [B099];
- Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person [B149];
- 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 [B189];
- 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 key weed species at risk of spread through Project activities (mesquite, parthenium, African lovegrass 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 [B191]; and
- Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144]. Further information on the proposed offsets strategy is outlined in Section 6.11.

10.4.4.3 *Conclusion*

Given the protection of potential habitat through the framework approach and proposed pre-clearance surveys the Project activities are not expected to have a significant impact upon any important populations of white-bellied sea eagles.

With the consideration of mitigation measures above, the Project activities are unlikely to have a significant impact on the white-bellied sea-eagle. The identification of white-bellied sea-eagle nests during preclearance surveys will ensure appropriate mitigation measures are taken resulting in minimal impact.

Cumulatively, habitat loss specifically within riparian communities along major watercourses may impact this species over time. However, where practical the avoidance of remnant riparian communities and active white-bellied sea-eagle nests will minimise this impact.

In conclusion, impacts on the white-bellied sea-eagle from the Project are not deemed to be significant as the Project area forms only a small portion of the known distribution of the species and the proposed Project mitigation controls have the capacity to minimise impacts to the species.

11 RESIDUAL IMPACT EVALUATION

Due to the requirement to consider an extensive number of ecological factors across a broad Project area, the residual impact significance assessment presented within Table 11-1 provides a summary only. The impact evaluation has been undertaken using the matrix discussed in Section 5.7. The impact evaluation summary deals specifically with the significance of residual impact to:

- Threatened ecological communities;
- Threatened flora species assemblages and habitat; and
- Threatened fauna species habitat.

In addition to the general assessment of residual impacts, Table 11-2, Table 11-3, and Table 11-4 address the effectiveness of the proposed mitigation measures on TECs and EPBC Act listed species that have been identified as likely to occur.

Table 11-1 Residual Impact Assessment and Mitigation Measures for TECs and MNES Species Habitat

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
Activities associated with direct direct impacts to TECs, MNES habitat fragmentation, edge effects and loss of habitat important to MNES flora / fauna								
Field Development Production well design and installation; • Gathering infrastructure design and installation; • Access track design and installation; and • Electricity supply design and installation; being a combination of grid based (overhead lines) network and local power generation near field facilities. **Facility Development** • FCF, CPGF design and installation; • WTF design and installation; • Power generation facility and/or powerlines design and installation; • Sewerage treatment facility design and	Moderate to High	Low to High	Low to High	• Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]: – vegetation mapping at a scale suitable for site-specific planning; – identification of core habitats for EVNT species; and – data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing and used until rehabilitation is complete [B163]. • Aim to avoid disturbance within the following areas [B131]: – endangered EPBC Act TECs: Brigalow Ecological Community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16); Natural Grasslands Ecological Community (REs 11.8.11); Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13); Weeping Myall Woodlands (REs 11.3.2 and 11.3.28);	Extremely Low	Low	Extremely Low to Low	Low to Moderate

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
installation.				– category B ESAs; – category C ESAs including Arthur's Bluff State Forest and gazetted nature reserves; – stock routes and state or regionally significant bioregional wildlife corridors; – essential habitat; – core habitat for EVNT species; – state forests and resource reserves; and – state-listed 'of concern' REs. Disturbance exclusion zones (or management buffers) will be established and managed during construction and operations to effectively protect ESAs. This may include the following actions [B145]: • Manage impacts to Category A, B and C ESAs through implementation of management buffers. The buffers outlined below are indicative based on current regulatory conditions, however these may be subject to change in future. The buffers that will be implemented for the project will be in line with the regulatory requirements at the time of implementation. Indicative buffers at this time include: – In areas mapped as high constraint a buffer of 100 m, measured from the				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
				bank edge, will be adopted during all phases of the Project, with a further 100 m constrained to low impact activities; and – For areas mapped as moderate constraint, the following buffer zones, measured from the high bank edge, will be adopted during all phases of the Project: o a riparian buffer of 50 m width on either side of first and second order streams; and o a riparian buffer of 100 m width on either side of third, fourth, fifth and higher order streams • Develop site induction procedures to ensure that all worksite personnel, including contractors are made aware of the location of these sensitive habitats (and buffers) and are guided by qualified personnel when clearing is undertaken. • Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals [B187] • Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
				possible [B133]. • Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134]. • Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135] • Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136]. • Retain habitat trees as a priority [B137]. • Avoid removing riparian vegetation by directional drilling and reduction of right of ways where practical [B138] • Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139] • Deviate access tracks and pipelines around sensitive vegetation where				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
				practicable [B140] • Avoid construction activities in waterbodies frequented by migratory species [B141] • Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142] • Design creek crossings to ensure that existing flow regimes are maintained [B143]. • Preparation of biodiversity offsets (DSEWPaC, 2011a; DERM, 2011) for Commonwealth and State significant biodiversity values [B144].				
All activities associated with field development plus: **Field Operation and Maintenance** • Production well operation and maintenance; • Gathering infrastructure operation and maintenance; • Access track operation and maintenance; • Electricity supply operation and	Moderate to High	Extremely Low to High	Low to High	• 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 [B172]. • Where possible, restrict traffic to designated access tracks [B148]. • Install and maintain appropriate sediment and erosion control structures at work sites [B160]. • Inspect management buffers and areas of avoidance to ensure boundaries are clearly delineated prior to clearing	Extremely Low	Low	Extremely Low to Moderate	Low to Moderate

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
maintenance. **Facility Operation and Maintenance** • FCF, CPGF, operation and maintenance; • Water storage and treatment facility operation and maintenance; • Power generation facility operation and maintenance; • Sewerage treatment facility operation and maintenance. **Decommission and Rehabilitation** • Production well decommission and rehabilitation; • Gathering infrastructure decommission and rehabilitation; • Access track decommission and rehabilitation; • Electricity supply decommission and				[B166]. • Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167]. • Trenches should be inspected and monitored as per the APIA *Code of Environmental Practice* (APIA 2009) code of practice. • Inspect at risk erosion and sediment control measures following significant rainfall events to ensure effectiveness of measures is maintained [B094]. • Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169]. • Develop monitoring programs that are site specific and based on the identified risk to the conservation or maintenance of a viable population [B185]. • Inspect food scrap bins and exclusion fences to ensure effectiveness [B170]. • Routinely inspect for pest flora and evidence of pest fauna species within Project disturbed areas [B217].				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
rehabilitation; • FCF, CPGF, decommission and rehabilitation; • Water storage and treatment facility decommission and rehabilitation; • Power generation facility decommission and rehabilitation; and • Sewerage treatment facility decommission and rehabilitation.				• Visually inspect physical form and monitor hydrology, turbidity and pH upstream and downstream of crossings immediately prior to, during and after construction of watercourse crossings [B216]. • Routinely monitor buffer zones and project footprint using satellite imagery [B215]. • Carry out routine monitoring of rehabilitation success [B183]. • Woody debris, logs and rocks should be retained for use in rehabilitation. Where practical, these should be piled along the edge of the cleared corridor. However, spreading these features over part or all of the corridor is preferred as it will provide refugia for crossing fauna. Systematic removal of surface debris should be avoided and cleared timber should never be burnt [B161]. • During rehabilitation works, care will be taken when moving stockpiled logs and vegetation to avoid fauna mortality [B186]. • Plant species used for rehabilitation are specific to the original ecosystem and local provenance, wherever possible unless the area has been cropped or contains improved pasture to be				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	Magnitude	Significance		Magnitude	Significance	Magnitude	Significance
				reinstated [B162]. • Inspect rehabilitation areas after decommissioning for regrowth similar to the surrounding environment [B177]. • Reinstate self-supporting drainage lines [B176]. • Implement site planning, preparation and management requirements in accordance with a decommissioning and rehabilitation plan [B175].				

Table 11-2 EPBC Act Threatened Ecological Communities Residual Impact Assessment

Unmitigated Impact Assessment			Effectiveness of Mitigation Measures[1]		Residual Impact Assessment					
					Total Avoidance			Others		
Sensitivity Ranking	Magnitude Ranking	Significance	Avoidance[2]	Others[3]	Sensitivity Ranking	Magnitude Ranking	Significance	Sensitivity Ranking	Magnitude Ranking	Significance
EPBC Significant Ecological Community: Brigalow (*Acacia harpophylla* dominant and co-dominant) (endangered) **REs:** 11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16, 11.9.1, 11.9.5										
High	Moderate	Moderate	Totally Effective	Mostly Effective	High	Extremely Low Magnitude	Low	High	Low	Moderate
Ecological Community: : Natural Grasslands Ecological Community (endangered) **REs:**11.3.21, 11.4.4, 11.4.11, 11.8.11, 11.9.3										
High	High	High	Totally Effective	Mostly Effective	High	Extremely Low Magnitude	Low	High	Low	Moderate
Ecological Community: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (endangered) **REs:** 11.3.11, 11.4.1, 11.5.15, 11.8.3, 11.8.13, 11.9.4, 11.11.18										
High	High	High	Totally Effective	Mostly Effective	High	Extremely Low Magnitude	Low	High	Moderate	Moderate
Ecological Community: Weeping Myall Woodlands (endangered); Regional Ecosystems: Not Represented										
High	Low	Moderate	Totally Effective	Unknown	High	Extremely Low Magnitude	High	Low	Moderate	Moderate
Ecological Community: Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (endangered): **REs:** 11.3.3.										
Moderate	Low	Low	Totally Effective	Mostly Effective	Moderate	Extremely Low Magnitude	Low	Moderate	Extremely Low	Low

1. Mitigation measures where the effectiveness is considered unknown / untested may include mitigation measures which may partially mitigate against an impact.
2. No clearing of vegetation within areas known habitat
3. Clearing within areas of known habitat is unavoidable

Table 11-3 EPBC Act Listed Threatened Flora Species Residual Impact Significance Assessment

Species	EPBC Act status	Unmitigated Impact Assessment			Effectiveness of Mitigation Measures[1]		Residual Impact Assessment			
							Avoidance		Others	
		Sensitivity	Impact Magnitude	Significance	Avoidance[2]	Others[3]	Magnitude	Significance	Magnitude	Significance
Dichanthium queenslandicum king blue-grass	V	High	High	High	Totally	Mostly	Extremely Low	Low	Low	Moderate
Aristida annua	V	High	Moderate	Moderate	Totally	Mostly	Extremely Low	Low	Low	Moderate
Dichanthium setosum	V	High	Moderate	Moderate	Totally	Mostly	Extremely Low	Low	Low	Moderate
Eucalyptus raveretiana black ironbox	V	High	Moderate	Moderate	Totally	Mostly	Extremely Low	Low	Low	Moderate

1. Mitigation measures where the effectiveness is considered 'unknown – untested' may include mitigation measures which may partially mitigate against and impact.
2. No clearing of vegetation within areas of habitat known or habitat possible and assumes surveys were carried out in optimal seasonal conditions i.e. flowering period.
3. Clearing of habitat known and possible is unavoidable.

E = Endangered.
V = Vulnerable

Table 11-4 EPBC Act Listed Threatened Fauna Species Residual Impacts Significance Assessment

Scientific Name Common Name	EPBC Act status	Preliminary Impact Assessment			Effectiveness of Mitigation Measures		Residual Impact Assessment			
		Sensitivity	Magnitude	Significance	Avoidance	Others	Avoidance		Others	
							Magnitude	Significance	Magnitude	Significance
Denisonia maculata, ornamental snake	V	Moderate	Moderate	Moderate	Mostly Effective	Moderate	Ext. Low	Low	Moderate	Moderate
Geophaps scripta scripta, squatter pigeon	V	Moderate	Low	Low	Mostly Effective	Moderate	Ext. Low	Low	Low	Low
Phascolarctos cinereus, koala	V	High	High	High	Completely	Moderate	Ext. Low	Low	Moderate	Moderate
Dasyurus hallucatus, northern quoll	V	Moderate	Low	Low	Low	Low	Low	Low	Low	Low
Chalinolobus dwyeri, large-eared pied bat	V	Moderate	Low	Low	Mostly Effective	Slightly	Low	Low	Low	Low
Nyctophilus corbeni, south-eastern long-eared bat	V	Moderate	Moderate	Moderate	Potentially Effective	Slightly	Ext. Low	Low	low	Low

E = Endangered
V = Vulnerable

12 CUMULATIVE IMPACTS

12.1 Cumulative Impact Assessment

A number of future projects were identified as having the potential to interact cumulatively. These have been assessed in regard to their potential to interact with the Project in terms of geographic location, temporal scale of development and impact pathway. A full description of the assessment process can be found in the Cumulative Impacts chapter of the EIS (Section 31) and the Terrestrial Ecology Technical Report (Section 10 of Appendix P) in the EIS.

The cumulative impact assessment is targeted specifically at identifying those MNES values that are at risk of incurring cumulative impact and the interacting projects that pose greatest risk to those values. In this regard, individual ecological values are considered only (i.e. individual significant fauna or flora species or threatened vegetation communities) rather than groups of values. This is because it is unfeasible to compare ecological values as groups between projects which may have a range of different impact sensitivities and magnitudes. It should be noted that the cumulative impact assessment is based on the following assumptions:

- The assessment is relevant only to those ecological values identified in the Project area and does not consider values identified only in other interacting project that have not been identified in the Project area.
- An overall residual impact significance (as a function of impact sensitivity and impact magnitude) has already been considered for individual values in the Project area. A similar assessment of impact significance is interpreted for individual values in interacting projects based on available information in EIS and IAS documentation. While this process is considered subjective, it is based on available information and in the context of standard impact assessment processes.
- The assessment assumes that conditions applied to projects will ensure that mitigation measures will be adequately implemented and successful in all cases.

The assessment indicates three TECs have high potential for cumulative impact. These are:

- The Brigalow (*Acacia harpophylla* dominant and co-dominant) Ecological Community;
- The Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin Ecological Community; and
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.

One EPBC Act listed flora species are indicated as having high potential for cumulative impact being:

- King blue-grass (*Dichanthium queenslandicum*).

Two EPBC Act listed fauna species are indicated as having high potential for cumulative impact being:

- Ornamental snake (*Denisonia maculata*); and
- Koala (*Phascolarctos cinereus*).

These communities and species typically have a number of attributes that renders them susceptible to cumulative impact including restricted distribution, sensitivity to disturbance, possessing core populations within the Project area, or are endemic to the Brigalow Belt North Bioregion.

12.2 Cumulative Impact Management

Impacts to those TECs and threatened flora and fauna species identified in Section 7 can best be managed at the individual project scale, at the site location level. Specific mitigation measures for these impacts are detailed in Section 10, with an analysis of residual Project potential impacts provided above in Section 11. Broader recommendations can be also made in respect to the regional scale management of cumulative impacts across projects at a collaborative level. These include:

- Research into species ecology and effective impact mitigation techniques being sponsored collaboratively by proponents of the projects contributing to potential impact;
- Ensuring all interacting projects identified as potentially contributing to a significant cumulative impact are made aware of this potential and their responsibilities towards management of these impacts are identified; and
- A collaborative approach between projects for the purpose of effective ecological offsetting (e.g. joint funding for management of a specific habitat offset for a species or ecological community that is heavily impacted by a number of projects).

13 MNES WATER RESOURCES

Water resources were introduced into the Environment Protection and Biodiversity Conservation Act 1999 as a Matter of National Environmental Significance in 2013. The trigger applies to coal seam gas and large coal mining development and covers surface water and groundwater resources. Impacts to hydrogeology, hydrology, water quality and associated impacts to water dependent ecosystems must be assessed to determine their significance.

The Significant impact guidelines 1.3: Coal seam gas and large coal mining developments—impacts on water resources state:

For water-dependent ecosystems, a significant impact is likely if the predicted change in water quality is greater than that required for 'moderately to slightly disturbed' systems as described in the relevant local or regional water quality objectives (typically the 80% to 95% ecosystem protection guideline values listed in the Australian Water Quality Guidelines).

The Australian Water Quality Guidelines are the Australian and New Zealand guidelines for fresh and marine water quality (ARMCANZ, 2000).

This section describes the potential impacts on water resources from coal seam gas activities associated with the Bowen Gas Project. It summarises the findings of studies undertaken as part of the EIS and SREIS. It specifically references SREIS Appendix E Supplementary Groundwater Assessment, Appendix F Surface Water Quality Technical Report and Appendix G Hydrology and Geomorphology Technical Report.

13.1 Project Description

The project description for the Bowen Gas Project has been revised since submission of the EIS. The number of water treatment facilities has been reduced to two facilities; one in the Goonyella area and one in the Peak Downs area. A third water treatment facility in the Blackwater area is still under consideration. Two reaches of the Isaac River where the water treatment facilities might discharge treated, and in certain instances untreated coal seam gas water, have been identified. Arrow does not intend to take surface water other than small volumes for construction purposes where alternative sources (Arrow facilities) are not available.

The Coal Seam Gas Water and Salt Management Strategy presented in the EIS has been revised. The strategy was prepared in accordance with the Queensland Coal Seam Gas Water Management Policy (EHP, 2012). The policy requires coal seam gas water to be beneficially used as a priority and if beneficial use is not feasible, disposed in a way that minimises impacts to the environmental values of the receiving environment. Consistent with this policy, Arrow's preference is to beneficially use the associated water. Possible beneficial uses include supply of water to domestic and urban users, supply of water to water service providers, supply of water to industrial users such as coal mines, supply of water to agricultural users (irrigation and/or livestock watering) and use by Arrow for Project operations. When beneficial use is not feasible or the capacity of beneficial users to take water is reduced or unavailable, discharge to a watercourse, under defined conditions, may be required.

The policy requires a similar approach to the management of brine or salt residues from the treatment of coal seam gas water: beneficial use through the recovery of salt products or disposal in a way that protects the environment. Coal seam gas water will be treated using reverse osmosis. The produced brine will be stored in dams at water treatment facilities. The management options for brine have been reviewed and Arrow has determined that disposal of waste salt concentrate to a regulated waste facility is the most feasible option. Other brine management options including selective salt recovery, injection and discharge to the ocean were found to be infeasible or unviable.

13.2 Investigations

Investigations progressed since exhibition of the EIS have provided further information on the likely impacts to surface water and groundwater resources. The investigations include an uncertainty analysis of the groundwater modelling results, horizontal flow barrier modelling to determine the behaviour of groundwater at faults, an analysis of faulting in the Bowen Basin and its susceptibility to seismic events from hydraulic stimulation activities, historic and potential subsidence, and review of the potential for groundwater dependent ecosystems to exist in the Project area.

Water quality data and aquatic ecology survey results for mining developments (operations monitoring and data collected for environmental impact assessments) has been acquired and combined with data collected as part of the EIS. The water quality dataset extends over three years and the aquatic ecology survey results cover the early wet and late wet seasons over a 12-month period. An environmental flow assessment incorporating a spells analysis, and hydraulic and hydrologic modelling have been undertaken for two reaches of the Isaac River, potential areas where discharges from proposed water treatment facilities might be located.

13.3 Hydrogeology

Groundwater systems in the Bowen Basin were described in the EIS, Appendix L and revised in the SREIS, Appendix E. Four systems were identified and are conceptualised in Figure 4-22 of the EIS. They are:

- Shallow groundwater system comprising unconfined or watertable aquifers associated with Quaternary alluvium, Tertiary basalts, and Tertiary sediment principally the Isaac River alluvium;
- Intermediate groundwater system comprising aquifers located above the formations associated with the coal seams including the Triassic Clematis Sandstone and Rewan Formation. Although the Rewan Formation is considered to be a regional aquitard there is potential for groundwater at weathered and fractured outcroppings and subcroppings. Groundwater drawdown simulations explicitly included the influence of the Rewan Formation whether it is present or absent;
- Coal seam groundwater system comprising aquifers associated with the Rangal, Fort Cooper and Moranbah coal measures within the Permian Blackwater Group; and
- Deep groundwater system comprising aquifers below the coal seams including the Permian Back Creek Group.

Depressurisation of groundwater formations associated with the Rangal and Moranbah coal measures, the production targets, is predicted to impact directly on those aquifers and indirectly on the overlying and underlying aquifers. The extent to which the overlying aquifers will be affected is strongly influenced by the presence or absence of the Rewan Formation which acts as an aquitard.

13.3.1 Groundwater Modelling

Predicted impacts on the identified groundwater systems were determined by numerical groundwater modelling. The groundwater model assumed production of 274 GL of groundwater over 55 years. The estimated production was revised in the SREIS to 153 GL over 36 years. Therefore, drawdown presented in the EIS is conservative (SREIS, Appendix E).

The numerical groundwater model was peer reviewed by CDM Smith (formerly NTEC Environmental Technology) with respect to the Australian Groundwater Modelling Guidelines (Barnett et al, 2012). CDM Smith noted that the model was well-designed and executed, that the conceptualisation of the groundwater flow regime was complete and that the calibration to steady state groundwater measurements was a good fit. CDM Smith also noted that although the model had many features of a higher class model, the limited availability of regional groundwater data, restricted its confidence level classification to a Class 1 model.

Uncertainty analyses (Null Space Monte Carlo and Pareto) were undertaken to assess the predictive error or uncertainty in the model to understand its limitations. The analyses confirmed the conservatism of the numerical groundwater model. The probability of predicted drawdown in the shallow groundwater system of more than 2 m was found to be low. The analysis identified the representation of vertical and horizontal conductivities in the deep groundwater system as having the greatest predictive error, warranting focus for future monitoring. Importantly, the analyses found that the predictions of drawdown and the areal extents of drawdown resulting from depressurisation were close to worst case (Ausenco-Norwest, 2012).

The Independent Expert Scientific Committee raised several key issues in its review of the EIS. They were the capacity of faults to act as conduits for groundwater flow, the potential for hydraulic stimulation to trigger seismic events affecting faults, subsidence arising from depressurisation of coal seam groundwater systems, and the existence of groundwater dependent ecosystems. These were investigated as part of the SREIS.

13.3.2 Faults

The potential for faults to become seismically active as a consequence of hydraulic stimulation (SREIS, Appendix E (Appendix A)) or to act as conduits for groundwater flow between formations has been investigated (SREIS, Appendix E (Appendix C)).

Induced Seismicity

Seismic events have been recorded in the Bowen Basin, including a magnitude 5.7 earthquake in April 2011. Notwithstanding this and previously recorded events, the Bowen Basin is considered to be relatively aseismic (Hillis et al, 1999).

Geoscience Australia (2013) notes that experience in Australia and elsewhere in the world indicates that the risks of induced seismicity that can result from hydraulic stimulation are low compared to natural earthquakes.

Despite hydraulic stimulation being conducted throughout the world over a long period of time, there are very few instances where injection of fluids may have triggered a seismic event. Low magnitude seismic events have occurred in Blackpool in the United Kingdom where high pressure fluids lubricated strata under elastic strain. The resulting seismic events were magnitude 1.5 and 2.3, below the magnitude felt at the surface. An independent study of the seismic events by Pater and Baisch (2011) found that the seismic events were two orders of magnitude higher than those typically resulting from hydraulic stimulation and probably occurring as a result of direct injection of fluids into a fault.

Microseismic mapping of fractures resulting from hydraulic stimulation has been undertaken by Arrow. The areal extent of fractures was found to develop early in the stimulation process and could become more complex as the process continued, particularly following the introduction of gels and other propping agents to the water used in the initial phase. Arrow observed that fractures appeared to be contained in the target interval with lateral spread from the bore hole of up to 65 m. Very low magnitude microseismic events (-3.07 Mw and -3.91 Mw or less than magnitude 1 on the Richter scale) were observed up to 242 m from the bore hole.

Coffey (2013) concluded that the risk of induced seismicity in the Bowen Basin was low.

Faults acting as Conduits

Stresses in geological strata in the Bowen Basin are predominantly compressive. Consequently, faults are typically low permeability discontinuities that result in compartmentalisation of hydro-stratigraphic units within the groundwater systems.

The numerical groundwater model simulated drawdown without faults and with ‘sealing’ faults or faults acting as horizontal flow barriers. The results from the two scenarios showed little difference in the predicted drawdown at the end of coal seam gas production and 50 years afterwards for the 2 m and 5 m drawdown contours; the trigger levels for unconsolidated and consolidated aquifers respectively under the Water Act 2000.

To further assess the potential for faults to act as preferential pathways for groundwater flow, a Telescopic Mesh Refinement (TMR) model was built for a discrete area of the Project area. The model tested two hypotheses:

- Hypothesis 1 - Closed faults or conduits act as barriers to groundwater flow along and across faults near a coal seam gas well.
- Hypothesis 2 - Coal seam gas production from a well in close proximity to an open fault or conduit will increase flow along the fault plane or conduit towards the pumping zone, resulting in aquifer connectivity.

The TMR modelling exercise confirmed that:

- Faults in the Bowen Basin behave as barriers to groundwater flow along and across fault planes near coal seam gas wells.
- In the event that a fault zone or weathered dyke represents an existing preferential pathway for flow, the fault or dyke will only play a minor role in propagation of drawdown impacts across formations.

13.3.3 Subsidence

Altamira Information Ltd (2013) was engaged to undertake a ground motion study of the Moranbah Gas Project to determine the amount of settlement over the period December 2006 to January 2011, during which coal seam gas water was extracted by Arrow. The study found considerable variability across the project area with areas of both uplift and subsidence identified. The uplift arises from seasonal factors (swelling of soils) and subsidence occurs from settling of manmade structures such as railway embankments. The results showed the majority of the area monitored was subject to rates of movement of less than 8 mm/year (in either direction) over the monitoring period, which Altamira defined as "stable" (i.e. below the measurement threshold). Isolated locations with greater rates of movement were identified.

An assessment to determine whether regional ground movement had occurred was undertaken (Coffey, 2013b). The interpreted ground motion for most of the study area was less than 10 mm (uplift or subsidence). Minor subsidence (between 10 mm and 20 mm) was interpreted to have occurred at a number of dispersed locations within the area studied, including along the western margin of Petroleum Lease 191 where both coal seam gas extraction and coal mining are taking place.

An assessment of aggregate subsidence in the Moranbah Gas Project area due to coal seam gas extraction was undertaken (Coffey, 2013a). The assessment used conservative assumptions for coal and rock stiffness and used predicted groundwater depressurisation rather than actual measurements. The calculated settlement from shrinkage in the coal measures from gas extraction was in the order of 10 mm (with a range of 5 to 15 mm) and settlement due to depressurisation of groundwater formations was in the order of 30 mm (with a range of 10 to 60 mm), resulting in overall settlement of 40 mm, with a range of 15 to 75 mm.

The settlement observed by Altamira and interpreted by Coffey for the study period (2006–2011) is at the lower end of the range of aggregate settlement calculated using rock mechanics and geotechnical data. It reflects the use of conservative coal and rock stiffness properties for the calculation of potential subsidence. Altamira and Coffey determined that natural processes such as clay swelling produced more significant ground movement (both uplift and subsidence) than any subsidence that may have been caused by coal seam gas extraction.

It is concluded that these outcomes will also apply to the Bowen Gas Project because the Moranbah Gas Project area and the activities undertaken are considered to be a reasonable analogue of the Project area and the Bowen Gas Project activities. In addition, it is noted that any subsidence resulting from CSG development would be broadly distributed and that differential subsidence would not occur, further reducing the risks of surface impacts arising.

13.3.4 Groundwater Dependent Ecosystems

A review of groundwater dependent ecosystems (GDE) was carried out as part of the SREIS. The review focussed on identifying those features that might support GDEs. The GDE Atlas and Queensland Springs Dataset were reviewed, as well as information compiled as part of the Surat Cumulative Management Area Underground Water Impact Report (Surat CMA UWIR).

No known springs are located in the Project area. Several springs complexes and vents were identified in a 50 km buffer to the Project area. The springs in the Blackwater area were identified as recharge springs. Recharge springs rely on interaction of the water table or perched aquifers with the surface. These springs will not be affected by groundwater drawdown, as predicted drawdown in source aquifers does not extend to that area. A further two potential springs identified in studies carried out as part of the Surat CMA UWIR are being investigated by Halcrow (2012 and 2013) as part of detailed study commissioned by Santos Ltd. These potential springs are beyond the 10 km buffer of the 0.2 m drawdown contour for predicted groundwater drawdown associated with the Bowen Gas Project, and are therefore not considered to be potentially impacted.

Several watercourse springs were identified in the 50 km buffer to the Project area. No known watercourse springs were identified in the Project area. The springs are associated with Mimosa Creek and a tributary, the upper and middle reaches of the Connors River, upper and middle reaches of Funnel Creek, upper reaches of Denison Creek and Lotus Creek, and lower reaches of the Isaac River.

Lake Elphinstone, a nationally important wetland, was identified as a potentially groundwater dependent ecosystem. The lake is fed by local run-off and stream flow from the local catchment but could also receive flows from shallow groundwater systems. The Bowen River: Birralee-Pelican Creek has the potential to receive groundwater baseflow from the volcanic bedrock into which it has incised but it is beyond the predicted extent of groundwater drawdown from coal seam gas development for the Bowen Gas Project.

13.3.5 Impact Assessment

Drawdown levels or trigger thresholds set out in the Water Act 2000 formed the basis for the impact assessment presented in the EIS. These values were adopted for the SREIS, with the sensitivity of groundwater (environmental) values being reviewed and revised to separate the deep groundwater system from the coal measures groundwater system.

The trigger thresholds under the Water Act 2000 are:

- 0.2 m for spring vents, spring complexes, and watercourse springs.
- 2 m drawdown for unconsolidated aquifers.
- 5 m drawdown for consolidated aquifers.

Consistent with the approach adopted by the Office of Groundwater Impact Assessment (OGIA) in the Surat CMA UWIR (QWC, 2012), the spring trigger threshold was applied to the area encompassed by a 10-km buffer beyond the 0.2 m drawdown contour for the source aquifer.

The review confirmed the impact assessment presented in the EIS, with only minor revisions due to the additional information available since publication of the EIS. Direct impacts to groundwater systems associated with the coal measures were confirmed. Key findings of the SREIS in relation to indirect impacts are:

- GDEs associated with coal measure outcrops and watercourses are unlikely to be affected because the water table is typically greater than 10 m below ground level, beyond the root zone for vegetation.
- A single spring vent (North Escarp) is classified under the Water Act 2000 as being potentially affected as it overlies areas subject to drawdown in excess of the 0.2 m trigger threshold for any underlying aquifer. However, as its source aquifer (shallow groundwater system) has no predicted drawdown at this location, it is not considered to be affected.

- Several sites of Indigenous cultural significance were identified in the Project area with one located in the 10 km buffer to the 0.2 m drawdown contour associated with the Fort Cooper Coal Measures. The condition of the natural well has not been established and its source aquifer has not been confirmed. If affected, the potential impact would extend beyond 50 years after cessation of coal seam gas production.
- The Bowen River: Birralee-Pelican Creek will not be impacted as it is outside the area predicted to experience drawdown. Lake Elphinstone is outside the Project area but within the 10 km buffer to the 0.2 m drawdown contour for the shallow and intermediate groundwater systems.

13.3.6 Cumulative Impacts

The cumulative effects of coal seam gas development on groundwater formations were reviewed as part of the SREIS. The review comprised a quantitative and qualitative assessment. The quantitative assessment was done as part of the EIS using the numerical groundwater model. Two scenarios were modelled: groundwater extraction from the Bowen Gas Project and extraction from the Bowen Gas Project, Moranbah Gas Project and registered groundwater users as recorded in the Queensland Department of Natural Resources and Mines' (DNRM) Water Management System. Groundwater drawdown predictions presented in the EIS include the cumulative impact scenario modelled.

The qualitative assessment undertaken as part of the SREIS comprised a review of publicly available information for existing coal mine developments in the Bowen Basin. The review concluded that groundwater drawdown was generally localised to the mine and surrounding area and limited in time to the period of operations. In some instances, particularly along the western edge of the Project area, shallow groundwater formations are likely to have been dewatered to the depth of the mine pit. The review of existing DNRM Water Management System revealed that no bore water level records showed distinct mine-related impacts in the northern Bowen Basin.

Cumulative impacts have been assessed through numerical groundwater modelling of direct extraction of groundwater by coal seam gas developers and groundwater users. The contribution of groundwater extraction (dewatering) for coal mining operations to cumulative impacts is limited due to the localised nature of the impacts.

13.3.7 Management Measures and Monitoring

The Queensland Government has established a comprehensive framework for monitoring and management of groundwater resources. The Water Act 2000 set outs the groundwater monitoring and management requirements, and the Environmental Protection Act 1994 set out the groundwater monitoring and groundwater dependent ecosystems management requirements, and conditions for hydraulic stimulation.

The Water Act 2000 requires the preparation of an Underground Water Impact Report (UWIR) which incorporates a Water Monitoring Strategy (WMS) and a Spring Impact Management Strategy (SIMS). Arrow, as the responsible tenure holder, will prepare a UWIR for that part of the Project area not covered by existing UWIRs. For the area of the project within the Surat CMA UWIR, Arrow will be responsible for providing the OGIA with groundwater monitoring data and updates to production plans on an annual basis.

The Water Act 2000 requires the UWIR to include prediction of the immediate and long-term affected areas for each successive three-year period based on the trigger thresholds (2 m drawdown for unconsolidated aquifers and 5 m drawdown for consolidated aquifers) enabling make good measures for affected groundwater bores to be implemented ahead of impacts occurring. The WMS details the monitoring program for detecting changes in groundwater levels and water quality. The UWIR also includes a SIMS which details the investigations and mitigation measures required to manage potential impacts on spring complexes, spring vents, and watercourse springs if identified in the areas affected by drawdown.

The Environmental Protection Act 1994 regulates coal seam gas activities through the issue of environmental authorities which set out the conditions under which the activity may be carried out and the monitoring required to determine if the environmental protection objectives are met. An environmental authority under the Environmental Protection Act 1994 is required for hydraulic stimulation activities. A risk assessment of the activity is required as part of the application process and requires the provision of evidence that restricted chemicals will not be used in hydraulic stimulation fluids. An environmental authority for coal seam gas activities requires a groundwater monitoring plan, and management of non-spring based groundwater dependent ecosystems and cultural and spiritual sites.

13.4 Hydrology and Water Quality

Arrow does not intend to take or divert surface waters to develop coal seam gas reserves in the Bowen Basin other than small volumes for construction purposes where alternative sources (Arrow facilities and exploration and appraisal well dams) are not available.

Project activities that have the potential to impact watercourses are:

- discharges from water treatment facilities (WTFs);
- the construction and rehabilitation of watercourse crossings for infrastructure (principally water and gas gathering lines and medium pressure pipelines); and
- disturbance by vehicle movements, particularly where crossings are not reinforced (causeways) or elevated (bridges).

Coal seam gas water will be discharged when beneficial uses are not feasible or beneficial users are unable to take water. Two potential localities have been identified for the WTFs enabling two reaches of the Isaac River to be identified as potential locations for discharges. The WTFs will discharge treated (and in certain instances untreated) coal seam gas water to the Isaac River or tributaries in the vicinity of Goonyella in the north of the Project area and near Peak Downs in the south of the Project area. These WTF's have a nominal capacity of 20 ML/d. Arrow is still considering a potential third WTF (and discharge location) in the Blackwater area.

Investigations to understand the capacity of the Isaac River (or a tributary) to accept the discharges undertaken as part of the SREIS are described below along with the key findings.

13.4.1 Hydraulic and Geomorphic Assessment

The bankfull capacity of the Isaac River was calculated to determine the capacity of the river to receive coal seam gas water discharges. The Isaac River was found to have a bankfull capacity of 23.3 GL/d near Goonyella and 203 GL/d near Peak Downs, well in excess of the nominal capacity of the WTFs of 20 ML/d.

The geomorphology of the Isaac River reflects the ephemeral nature of the watercourse and its periodic flushing with high flow events of short duration. The wide channel and mobile bedforms are reflective of flood flows. Flows up to bankfull events are not expected to result in changes to the geomorphology of the Isaac River.

13.4.2 Environmental Flows Assessment

An environmental flows assessment comprising a spells analysis was done for the two reaches of the Isaac River identified as likely locations for discharges. The spells analysis confirmed the highly ephemeral nature of the watercourse. Cease to flow conditions prevailed for approximately 90% of the low flow season (May to November) and 50% to 70% of the high flow season (December to April). High flow events occurred three to four times per high flow season, lasting on average for 7 to 16 days. Bankfull events occurred on average every two years and lasted two days on average. Flow recession is likely to be rapid with sustained baseflow only occurring where rainfall persists through the flow recession period. The environmental flows assessment established the flow regime for the Isaac River, a key input to the design of a discharge strategy.

13.4.3 Water Quality

Preliminary water quality objectives (WQO) for the protection of environmental values associated with watercourses in the Project area were identified and presented in the EIS (Appendix N, Section 7.1). The WQOs for physico-chemical stressors were derived on a regional basis from the Queensland Water Quality Guidelines (QWQG) (EHP 2009, Central Coast region) and the relevant ANZECC/ARMCANZ (2000) guidelines for toxicants.

Data relied upon to develop the preliminary WQO was augmented in the SREIS enabling review of the objectives. Operations data and data acquired to support environmental impact assessments for coal mining developments in the northern Bowen Basin was obtained and combined with data collected for the EIS. The resulting dataset covering three years was analysed and values compared to the preliminary WQOs.

The water quality of the Isaac River is directly related to stream flow. The electrical conductivity decreases with increasing flows, with a threshold for decreasing electrical conductivity observed at a flow of 3.5 m^3/sec. WQOs were exceeded for a number of parameters indicating the need for revision of the preliminary WQOs. Revised WQOs were developed using the methodology outlined in QWQG (2009).

13.4.4 Impact Assessment

Studies and assessments carried out for the SREIS confirmed the findings of the EIS, with revision of the WQOs recommended to account for the existing conditions in the Isaac River. Characterisation of the geomorphology, hydrology, hydraulic performance, flow regime and water quality in the Isaac River, the watercourse likely to receive discharges of treated (and in certain instances untreated) coal seam gas water, will enable design of the discharges to ensure protection of the environmental values. The discharge strategy will consider volumes, discharge rates, duration and frequency of flows to the Isaac River. Where designed and managed to meet the WQOs and principles set out in SREIS Appendix F, significant impacts to surface water resources are unlikely.

13.4.5 Management Measures and Monitoring

The Queensland Government has established a comprehensive framework for the management and protection of surface water resources. The Water Act 2000 and Environmental Protection Act 1994 are the principal legislation that regulates coal seam gas water and its impact on surface waters.

Arrow has prepared a Coal Seam Gas Water and Salt Management Strategy that reflects the priorities in the Coal Seam Gas Water Management Policy (EHP, 2012). The policy places a priority on beneficial use of coal seam gas water, and on brine produced in the treatment of water using reverse osmosis.

Arrow’s preference for the management of coal seam gas water is beneficial use. However, if beneficial use is not feasible or users are unable to take their allocation, discharge to watercourses will be the preferred alternative management option.

Discharges to watercourses are managed by environmental authorities issued under the Environment Protection Act 1994. Environmental authorities set out the conditions under which coal seam gas water can be discharged, and the monitoring requirements to ensure the applicable water quality objectives are met and environmental values protected. Arrow will apply for or apply to amend an environmental authority for the discharges.

Arrow currently holds an environmental authority to discharge for the Moranbah Gas Project where a reverse osmosis plant is in operation. That environmental authority permits discharges to the Isaac River during and immediately after flow events, providing the necessary flexibility to manage treated, and in certain instances untreated, coal seam gas water where beneficial uses are not feasible or unavailable.

Brine produced from the treatment of coal seam gas water using reverse osmosis will be stored in dams, and reduced to a waste salt concentrate via evaporation. The waste salt concentrate will then be disposed to a regulated waste facility. Other brine management options including selective salt recovery, injection and discharge to the ocean were found to be not feasible, due to being commercially unviable (low volumes), a lack of a suitable formation for injection purposes, and being uneconomic (high cost), respectively.

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15 LIMITATIONS

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Arrow Energy Pty Ltd and only those third parties who have been authorised in writing by URS to rely on this Report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated 27th January 2012.

Where this Report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information except as expressly stated in the Report. URS assumes no liability for any inaccuracies in or omissions to that information.

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It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the site.

Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

APPENDIX A EPBC ACT PROTECTED MATTERS REPORT

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

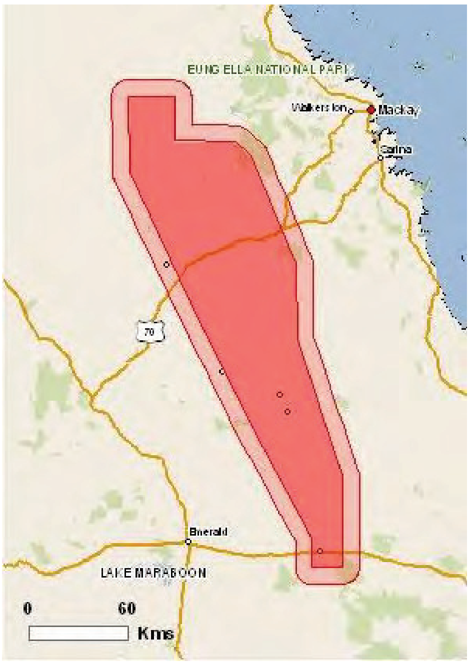
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

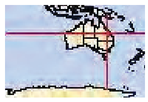
Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 29/04/12 09:44:49



Coordinates

Buffer: 10.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	5
Threatened Species:	35
Migratory Species:	17

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

Place on the RNE:	3
State and Territory Reserves:	11
Regional Forest Agreements:	None
Invasive Species:	13
Nationally Important Wetlands:	1

Details

Matters of National Environmental Significance

Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Coolibah - Black Box Woodlands of the Darling	Endangered	Community may occur

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Riverine Plains and the Brigalow Belt South Bioregions		within area
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Threatened Species [Resource Information]

Name	Status	Type of Presence
BIRDS		
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Black-throated Finch (southern) [64447]	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Vulnerable	Species or species habitat likely to occur within area
FROGS		
Taudactylus eungellensis Eungella Day Frog [1887]	Endangered	Species or species habitat likely to occur within area
MAMMALS		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat known to occur within area
Nyctophilus timoriensis (South-eastern form) Greater Long-eared Bat, South-eastern Long-eared Bat [66888]	Vulnerable	Species or species habitat may occur within area
Onychogalea fraenata Bridled Nail-tail Wallaby [239]	Endangered	Species or species habitat likely to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
Pteropus conspicillatus Spectacled Flying-fox [185]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Species or species habitat may occur within area
OTHER		

Name	Status	Type of Presence
Cycas ophiolitica [55797]	Endangered	Species or species habitat likely to occur within area
Macrozamia platyrhachis [3412]	Endangered	Species or species habitat likely to occur within area
PLANTS		
Acacia ramiflora [7242]	Vulnerable	Species or species habitat may occur within area
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Croton magneticus [16681]	Vulnerable	Species or species habitat likely to occur within area
Daviesia discolor [3567]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium queenslandicum King Blue-grass [5481]	Vulnerable	Species or species habitat likely to occur within area
Digitaria porrecta Finger Panic Grass [12768]	Endangered	Species or species habitat likely to occur within area
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Leucopogon cuspidatus [9739]	Vulnerable	Species or species habitat likely to occur within area
Omphalea celata [64586]	Vulnerable	Species or species habitat known to occur within area
Quassia bidwillii Quassia [10094]	Vulnerable	Species or species habitat likely to occur within area
Taeniophyllum muelleri Minute Orchid, Ribbon-root Orchid [10771]	Vulnerable	Species or species habitat may occur within area
REPTILES		
Delma labialis Striped-tailed Delma, Single-striped Delma [25930]	Vulnerable	Species or species habitat may occur within area
Delma torquata Collared Delma [1656]	Vulnerable	Species or species habitat likely to occur within area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat known to occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Lerista allanae Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
Lerista vittata Mount Cooper Striped Lerista [1308]	Vulnerable	Species or species habitat may occur within area
Paradelma orientalis Brigalow Scaly-foot [59134]	Vulnerable	Species or species habitat known to occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle [1761]	Vulnerable	Species or species habitat may occur within area

Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Marine Species		
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Breeding likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Breeding may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose [25979]		Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - BLACKWATER TRAINING DEPOT

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Monarcha melanopsis		
Black-faced Monarch [609]		Breeding may occur within area
Monarcha trivirgatus		
Spectacled Monarch [610]		Breeding likely to occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis		
Australian Cotton Pygmy-goose [25979]		Species or species habitat may occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Breeding may occur within area
Rostratula benghalensis s. lat.		
Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area
Reptiles		
Crocodylus porosus		
Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Blackdown Tableland Area	QLD	Registered
Dipperu National Park	QLD	Registered
Historic		
Nebo Hotel	QLD	Indicative Place

State and Territory Reserves [Resource Information]

Name	State
Blackdown Tableland	QLD
Blackjack Mountain	QLD
Blackwater	QLD
Coolibah	QLD
Dipperu (Scientific)	QLD
German Creek	QLD
Homevale	QLD
Homevale	QLD
Junee	QLD
Kemmis Creek	QLD
Newlands	QLD

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit,

Name	Status	Type of Presence
Frogs		
Bufo marinus		
Cane Toad [1772]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Lake Elphinstone	QLD

Coordinates

-21.077 147.8293,-21.498 147.8344,-22.206 148.169,-22.8779 148.4991,-23.4977 148.834, -23.6651 148.834,-23.6627 149.0014,-23.1628 149.0014,-22.4117 148.7526,-21.9955 148.7478,-21.4071 148.5039,-21.3306 148.413,-21.3162 148.0877,-21.0818 148.0829,-21.077 147.8293

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX B MNES MAPPING RULES

APPENDIX B HABITAT MAPPING RULES

B.1 MNES Fauna

B.1.1 Large-eared Pied bat (Chalinolobus dwyeri)

1 Distribution ranges from Shoalwater bay near Rockhampton, south into NSW.
2 Any RE polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known.'
3 Any RE polygon within 10km of a recent, accurate record is classed as core habitat possible.
4 Cliffs (and surrounding REs) within 10 km of remnant or regrowth vegetation should be classed as core habitat possible (including vegetation).
5 Other cliffs should be classed as absence suspected.

B.1.2 Northern Quoll (Dasyurus hallucatus)

1 The indicative distribution of this species encompasses the entire project development area.
2 Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as core habitat known.
3 Areas featuring high relief and within 1 km of permanent water is an indicator of 'Core Habitat Possible'.
4 All remnant and regrowth vegetation within 5 km of high relief areas and permanent water is general habitat.

B.1.3 Ornamental Snake (Denisonia maculata)

1 The indicative distribution of this species encompasses the entire project development area.
2 Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known'.
3 Areas within 500 m of gilgai and other water sources (ephemeral or permanent), on land zones 3, 4, 8 and 9 should be classed as 'core habitat possible'.
4 Patches of remnant vegetation greater than 5ha in size, with the following REs: 11.4.3, 11.4.6, 11.4.8, 11.4.9 should be classed as 'core habitat possible'.
5 Areas identified in Footprints habitat mapping as "high" probability should be classed as 'core habitat possible'.
6 Areas within 1 km of gilgai and other fresh water sources, on land zone 3, not classed as 'core habitat possible' should be classed as 'general habitat'.
7 Patches less than 5ha in size of the following REs: 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.3.3, 11.5.16 should be 'General Habitat.'
8 Areas identified in footprints habitat mapping as "medium" probability should be classed as 'general habitat'.
9 Areas of non-remnant or regrowth vegetation within 1 km of gilgai and other water sources should be classed as 'general habitat'.
10 All other vegetation greater than 1 km from water or gilgai should be 'absence suspected'.

B.1.4 Yakka Skink (Egernia rugosa)

1 Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known'.
2 Records indicate that the known distribution of the yakka skink encompasses the entire project development area.

3 Within the Project area, remnant vegetation comprising REs 11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.6, 11.3.7, 11.3.9, 11.3.10, 11.3.12, 11.3.25, 11.3.27, 11.3.35, 11.3.36, 11.3.37, 11.4.2, 11.4.7, 11.4.8, 11.4.9, 11.4.13, 11.5.2, 11.5.3, 11.5.15, 11.5.16, 11.5.17, 11.10.12, 11.10.13, 11.9.1, 11.9.2, 11.9.3, 11.9.4, 11.9.5, 11.9.9, 11.9.10, 11.9.13, 11.10.1, 11.10.3, 11.10.4, 11.10.5, 11.10.7, 11.7.1, 11.7.2, 11.7.3, 11.7.4, 11.7.6 are classed as 'general habitat'.

4 Remaining REs are classed as 'Absence Suspected'.

B.1.5 Red Goshawk (Erythrotriorchis radiatus)

1 Remnant woodland (all REs except: 11.1.1, 11.1.3, 11.2.2, 11.3.21, 11.3.24, 11.3.31, 11.4.11, 11.4.4, 11.5.14, 11.5.6, 11.8.10, 11.8.11, 11.9.12, 11.9.3, and 11.11.17) within 1 km of permanent water is considered to constitute 'Core habitat possible' for this species.

2 Remnant woodland (REs as listed in point 1) further than 1 km from permanent water is considered to constitute 'General habitat' for this species.

3 All remaining areas are 'Absence Suspected.'

B.1.6 Squatter Pigeon (Geophaps scripta scripta)

1 The known distribution of this species encompasses the entire project development area.

2 All land (remnant or non-remnant), except tilled land, within 1 km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known' for management purposes.

3 Woodlands, native grasslands and derived native grasslands (regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.21, 11.3.25, 11.3.26, 11.4.12, 11.5.1, 11.5.4, 11.5.20, 11.7.4c, 11.8.2a, 11.9.9, 11.9.10) are considered to be 'core habitat possible.' Mature Regrowth (EHP 2012b) are also included in the mapping assessment.

4 'General habitat' that might be used by this species includes REs 11.3.18, 11.7.4, 11.7.7, 11.7.9, 11.8.4, 11.8.5, 11.9.1, 11.9.7, 11.10.1 and 11.10.7.

5 All remaining REs are 'Absence Suspected.'

6 For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.1.7 South-Eastern Long-Eared Bat (Nyctophilus corbeni)

1 The known distribution of this species encompasses the entire project development area.

2 Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known' unless it is a heterogeneous polygon that includes RE 11.3.21. Such areas should be excluded.

3 All remaining remnant vegetation (except RE 11.3.21) should be considered 'core habitat possible.'

4 All 'core habitat possible' REs within 1 km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known.'

5 Regrowth and Mature Regrowth (as per EHP 2012b) should be classed as 'absence suspected'.

6 Cleared non-remnant areas are classed as 'Absence Suspected.'

B.1.8 Koala (Phascolarctos cinereus)

1. Any RE polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known.'
2. Any vegetation (remnant or regrowth) within 20km of a recent, accurate record should be classed as 'core habitat possible'.
3. Vegetation communities dominated by eucalypt species (REs 11.3.2, 11.3.4, 11.3.14, 11.3.18, 11.3.19, 11.3.25, 11.3.26, 11.3.27a, 11.3.27b, 11.4.3a, 11.4.10, 11.4.12, 11.5.1, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.8.2a, 11.9.1, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1, 11.10.1a, 11.10.1b) should be classed as general habitat. Mature regrowth is treated according to its parent RE.
4. General habitat (as above) with a canopy height above 3m and above a medium density threshold (as measured by 1000 LIDAR returns per ha) should be classed as core habitat possible.

B.1.9 Fitzroy River Turtle (Rheodytes leukops)

1. Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known.'
2. Any RE within 500m of a recent, accurate record and extending 15m from the high bank of a watercourse within the Fitzroy river catchment is classed as core habitat known.
3. Watercourses within Fitzroy river catchment surrounded by REs 11.3.4, 11.3.25 and 11.5.17 (extending to 15m from high bank) and banks up to 4m above water level, with a gradient less than 150% should be classed as 'core habitat possible'.
4. Watercourses within Fitzroy river catchment (extending to 15m from high bank) should be classed as general habitat.
5. All other REs and locations should be classed as absence suspected.

B.1.10 Australian painted snipe (Rostratula australis)

1. The known distribution of this species encompasses the entire project development area.
2. The water containment area of Lake Vermont, Five Mile Lagoon, and Burton Gorge Dam and a buffer of 100 m should be considered 'Core Habitat Possible.'
3. Areas within the Isaac River where water collection might occur following surface flow should be considered 'Core Habitat Possible.'
4. All ephemeral wetlands within the project area should be classed as 'General Habitat.'
5. Remaining REs or tilled crops are classed 'Absence Suspected.'

B.2 MNES Flora

B.2.1 *Aristida annua*

1 Confirmed species records (<500 m precision) should be buffered by a 1 km radius and classed as 'core habitat known'.
2 RE 11.8.5 within the Emerald and Springsure districts are core habitat possible.
3 Occurs in eucalypt woodlands with *Eucalyptus orgadophila*. REs 11.8.1, 11.8.12, 11.8.14, 11.8.15, 11.8.2, 11.8.4, 11.8.8 and 11.8.11 should be classed as general habitat
4 Other REs should be classed as absence suspected.

B.2.2 *Dichanthium queenslandicum*

1 Confirmed species records (<500 m precision) should be buffered by a 1 km diameter and treated as 'core habitat known' ('high' confidence is applied) where it intersects remnant habitats.
2 The following regional ecosystems in the project development area should be classed as 'core habitat possible':

  a. RE 11.8.11 & 11.8.5 ('high' confidence applied to property scale vegetation mapping; 'moderate' confidence applied to revised RE mapping at 1:40 000 scale and low confidence applied to RE mapping produced at 1:100 000 (EHP 2012a)).

3 The following habitats should be classified as 'general habitat'

  a. RE11.3.21, 11.3.2 and 11.3.3.

  b. Non-remnant derived grasslands on land zone 3 ('high' to 'moderate' confidence applies).

  c. Regrowth vegetation derived from REs classified as 'core habitat possible' including those from Mature Regrowth (EHP 2012b).

4 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be classified as 'absence suspected'.

For heterogeneous polygons the above rules should be applied where the relevant regional ecosystems are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.2.3 *Dichanthium setosum*

1 Confirmed species records (<500 m precision) should be buffered by a 1 km diameter and classed as 'core habitat known'.
2 REs 11.4.4, 11.4.11, 11.8.11, 11.3.2, 11.3.3, 11.3.4 should be classed as 'core habitat possible'.
3 Other REs should be classed as "absence suspected".

B.2.4 *Eucalyptus raveretiana*

1 Confirmed species records (<500 m precision) should be buffered by a 1 km radius and REs on land zone 3 classed as 'core habitat known'.
2 Areas consisting of RES 11.3.4 and 11.3.25 within 200m of watercourse, from 0-300m AHD with annual rainfall of 650 – 1100mm should be classed as 'core habitat possible'.
3 REs (remnant and regrowth) within 200m of watercourse from 0-300m AHD with annual

rainfall of 650 – 1100mm should be classed as general habitat.

4 REs (remnant and regrowth) outside 200m of watercourse from 0-300m AHD with annual rainfall of 650 – 1100mm should be classed as ‘absence suspected’.

5 Other areas should be classed as absence suspected.

B.3 NC Act Fauna

B.3.1 Common death adder (Acanthopis antarcticus)

1. The known distribution of this species encompasses the entire project development area.
2. Listed remnant REs >100 ha in extent or within 500 m of a larger vegetation patch, and below 950m AHD should be classed as 'Core Habitat Possible' with the exception of grasslands (REs 11.3.21 and 11.3.24). This must be applied on a site-specific basis and has not been applied uniformly across the project development area. REs are listed as follows:
   11.1.4, 11.2.1, 11.2.2, 11.2.5, 11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.5, 11.3.6, 11.3.7, 11.3.8, 11.3.9, 11.3.10, 11.3.12, 11.3.13, 11.3.14, 11.3.15, 11.3.16, 11.3.17, 11.3.18, 11.3.19, 11.3.20, 11.3.23, 11.3.25, 11.3.26, 11.3.27, 11.3.28, 11.3.29, 11.3.30, 11.3.32, 11.3.33, 11.3.34, 11.3.35, 11.3.36, 11.3.37, 11.3.38, 11.3.39, 11.4.2, 11.4.3, 11.4.5, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.4.12, 11.4.13, 11.5.1, 11.5.2, 11.5.3, 11.5.4, 11.5.5, 11.5.7, 11.5.8, 11.5.9, 11.5.10, 11.5.11, 11.5.12, 11.5.13, 11.5.14, 11.5.16, 11.5.17, 11.5.18, 11.5.20, 11.5.21, 11.7.1, 11.7.2, 11.7.3, 11.7.4, 11.7.5, 11.7.6, 11.7.7, 11.8.1, 11.8.2, 11.8.4, 11.8.5, 11.8.7, 11.8.8, 11.8.9, 11.8.11, 11.8.12, 11.8.14, 11.8.15, 11.9.1, 11.9.2, 11.9.3, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.10, 11.9.13, 11.9.14, 11.10.1, 11.10.2, 11.10.4, 11.10.5, 11.10.6, 11.10.7, 11.10.9, 11.10.11, 11.10.12, 11.10.13, 11.11.1, 11.11.2, 11.11.3, 11.11.4, 11.11.6, 11.11.7, 11.11.8, 11.11.9, 11.11.10, 11.11.11, 11.11.12, 11.11.13, 11.11.14, 11.11.15, 11.11.16, 11.11.17, 11.11.19, 11.11.20, 11.12.1, 11.12.2, 11.12.3, 11.12.5, 11.12.6, 11.12.7, 11.12.8, 11.12.9, 11.12.10, 11.12.11, 11.12.12, 11.12.13, 11.12.14, 11.12.16, 11.12.17, 11.12.18, 11.12.19, 11.12.20, 11.12.21
3. 'Core habitat possible' within one km of a recent (1980+), accurate (location information provided) record is classed as 'core habitat known.'
4. Regrowth vegetation including mature regrowth should be classed 'absence suspected.'
5. Cleared farmland or tilled crops are classed 'absence suspected.'

B.3.2 Grey goshawk (Accipiter novaehollandiae)

1. The known distribution of this species encompasses the entire project development area.
2. REs 11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.6, 11.3.7, 11.3.10, 11.3.25, 11.3.27, 11.3.35, 11.3.36, 11.3.37, 11.4.2, 11.4.8, 11.4.9, 11.5.2, 11.5.3, 11.5.12, 11.5.16, 11.5.17, 11.7.1, 11.7.2, 11.8.13, 11.8.14, 11.8.15, 11.9.1, 11.9.2, 11.9.5, 11.9.7, 11.9.9, 11.9.10, 11.9.13, 11.10.1, 11.10.4, 11.10.7, 11.10.8, 11.10.13, 11.11.1 and 11.12.1 within 1 km of permanent water are suitable nest sites for this species and should be mapped as 'core habitat possible'.
3. All other remnant woodland REs and mature regrowth should be mapped as 'general habitat'.
4. All other areas of remnant vegetation (i.e. grasslands) should be mapped as 'absence suspected.'
5. All areas of non-remnant vegetation and cleared land should be mapped as 'absence suspected.'

B.3.3 Glossy black-cockatoo (Calyptorhynchus lathami)

1. The known distribution of this species encompasses the entire project development area.
2. REs containing belah (*Casuarina cristata*) (REs 11.3.1, 11.8.3, 11.9.4b, 11.9.5) throughout the area are classed as 'core habitat possible.'
3. The species will utilise belah regrowth and hence mature regrowth of the above

communities should be classed 'core habitat possible.'

4 REs containing *Allocasuarina* species and *Casuarina cunninghamiana* (REs 11.3.25, 11.5.2, 11.5.3, 11.5.8, 11.9.13, 11.10.4) are classed as 'general habitat'.
5 'Core habitat possible' and 'general habitat' within one km of a recent (1980+), accurate (location data provided) is classed as 'core habitat known.'
6 RE polygons coinciding with confirmed records (location data provided) should be classed as 'core habitat known'.
7 All remaining regional ecosystems are classed 'absence suspected.'
8 Non-remnant and agricultural land is classed 'absence suspected.'
9 For heterogeneous polygons, the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
10 The species can use individual or small clumps of large *C. cristata* in non-remnant areas. These resources cannot be mapped and must be evaluated through field inspection on a site by site basis.

B.3.4 Little pied bat (Chalinolobus picatus)

1 The known distribution of this species encompasses the entire project development area.
2 All remnant vegetation up to 850m AHD, with the exception of grasslands without canopy trees (REs 11.3.21, 11.3.24), is considered 'Core Habitat Possible.' However, it is noted that within these areas the species is most likely to occur along waterways. This assessment also includes mature regrowth and other advanced regrowth vegetation.
3 All 'core habitat possible' within one km of a recent (1980+), accurate (location data provided) record is classed as 'core habitat known.'
4 RE polygons coinciding with confirmed records (location data provided) should be treated as 'core habitat known'.
5 All remaining areas are mapped as 'absence suspected.'

B.3.5 Ornamental snake (Denisonia maculata)

1 See MNES mapping rules.

B.3.6 Black-necked stork (Ephippiorhynchus asiaticus)

1 The known distribution of this species encompasses the entire project development area.
2 Areas within Lake Vermont, Five Mile Lagoon, Burton Gorge Dam and the Isaac river where water collection might occur following surface flow should be considered 'core habitat possible.'
3 Large artificial dams (e.g., greater than five ha) should be classed as 'core habitat possible.'
4 Waterbodies along the Isaac River and its major tributaries are classed as 'core habitat possible.'
5 'Core habitat possible' within one km of a recent (1980+), accurate (location data provided) record is classed as 'core habitat known.' (including mature regrowth vegetation).
6 RE polygons coinciding with confirmed records (location data provided) should be treated as 'core habitat known'.

7 Remaining REs, cleared farmland or tilled crops are classed as 'absence suspected.'
8 Records of this species in modified landscapes (e.g., farming land) away from any large dams are considered to be incidental occurrences by transient individuals. These reflect opportunistic foraging and do not indicate important habitat values.

B.3.7 Squatter pigeon (Geophaps scripta scripta)

1 See MNES mapping rules.

B.3.8 Pale imperial hairstreak (Jalmenus eubulus)

1 The known distribution of this species encompasses the entire project development area.
2 Within the area, all areas of remnant brigalow (REs 11.3.1, 11.9.1, 11.9.5, 11.9.10) are classed as 'core habitat possible.'
3 All remnant and regrowth vegetation within one km of a recent (1980+), accurate ((location information provided) record is classed as 'core habitat known.' This allows for the species' mobility.
4 RE polygons coinciding with confirmed records (location data provided) should be treated as 'core habitat known'.
5 The remnant and regrowth REs 11.3.2, 11.3.3, 11.3.4, 11.3.6, 11.3.7, 11.3.10, 11.3.25, 11.3.27, 11.3.35, 11.3.36, 11.3.37, 11.4.2, 11.4.8, 11.4.9, 11.4.13, 11.5.2, 11.5.3, 11.5.12, 11.5.16, 11.5.17, 11.7.1, 11.7.2, 11.7.3, 11.8.4, 11.8.5, 11.8.11, 11.8.14, 11.8.15, 11.9.2, 11.9.3, 11.9.7, 11.9.9, 11.10.1, 11.10.3, 11.10.4, 11.10.7, 11.11.1, 11.11.2, 11.11.3, 11.11.4, 11.12.1 should be treated as 'General Habitat'.
6 Cleared agricultural and grazing land is classed as 'absence suspected.'
7 For heterogeneous polygons, the above rules were applied where the relevant REs were found in the polygon descriptions. However, due to the species' mobility, the habitat value category should refer to the entire polygon.

B.3.9 Square-tailed kite (Lophoictinia isura)

1 The known distribution of this species encompasses the entire project development area.
2 RE polygons coinciding with confirmed records (location data provided) should be treated as 'core habitat known'.
3 All 'core habitat possible' and 'general habitat' within one km of a recent (1980+), accurate (location data provided) record is classed as 'core habitat known.'
4 The species has very broad habitat requirements, potentially using all woodland and forested areas. However, square-tailed kites will more frequently use riparian vegetation, especially RE 11.3.25 and RE 11.3.4 to a lesser extent. These REs and all remnant vegetation within 100 m of a creek line or waterway should be mapped as 'Core Habitat Possible.' Mature regrowth derived from these REs should also be classified as 'Core Habitat Possible.' Mapping of 100 m buffer zones adjacent to waterways must be applied on a site-specific basis and has not been applied uniformly across the project development area.
5 The species is more likely to occur within large contiguous patches of vegetation greater than 500 ha. These patches, and any patches within 500 m of another patch whose accumulative total approximates 500 ha, should be mapped as 'Core Habitat Possible.' This must be applied on a site-specific basis and has not been applied uniformly across mapping in the project development area.
6 All remaining remnant vegetation should be mapped as 'general habitat.'

7 Open pasture, crops and urban landscapes are classed as 'absence suspected.'

B.3.10 Black-chinned honeyeater (Melithreptus gularis)

1 The known distribution of this species encompasses the entire project development area.
2 Vegetation communities dominated by eucalyptus species are classed as 'core habitat possible.' Mature regrowth vegetation is treated according to its parent RE.
3 All 'core habitat possible' within one km of a recent (1980+), accurate (location data provided) record is classed as 'core habitat known.'
4 RE polygons coinciding with confirmed records (location data provided) should be treated as 'core habitat known'.
5 Open pasture, crops and urban landscapes are classed as 'absence suspected.'

B.3.11 Cotton pygmy-goose (Nettapus coromandelianus)

1 The known distribution of this species encompasses the entire project development area.
2 Large lakes (Lake Vermont, Five Mile Lagoon, and Burton Gorge Dam), artificial dams and wetlands (e.g. RE11.3.27) on the Isaac River Floodplain (and its major tributaries) greater than five ha in extent should be classed as 'core habitat possible.'
3 All 'core habitat possible' within one km of a known recent (1980+) record should be 'core habitat known.'
4 RE polygons coinciding with confirmed records (location data provided) should be treated as 'core habitat known'.
5 Smaller dams and wetlands (e.g. small lakes, swamps) should be designated 'General Habitat'.
6 All remaining terrestrial habitats should be classed as 'absence suspected.'

B.3.12 South-eastern long-eared bat (Nyctophilus corbeni)

1 See MNES mapping rules.

B.3.13 Brigalow scaly-foot (Paradelma orientalis)

1 The known distribution of this species encompasses the entire project development area.
2 Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known.'
3 All contiguous remnant vegetation within a one km buffer of recent (1980+), accurate (with confirmed locations) records in the area is classed as 'core habitat known', regardless of RE type.
4 Within the Bowen Gas Project area, the REs 11.3.1, 11.3.17, 11.3.18, 11.3.19, 11.4.3, 11.4.3b, 11.4.10, 11.4.12, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.5, 11.7.6, 11.7.7, 11.9.1, 11.9.4a, 11.9.4b, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1 11.10.1a, 11.10.1d 11.10.4, 11.10.7, 11.10.9, 11.10.11 and 11.10.12. are classed as 'Core Habitat Possible' unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
5 Patches of the REs listed above that are less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation are classed as 'General Habitat.'
6 Within the Bowen Gas Project area, REs 11.3.4, 11.3.14, 11.3.25, 11.3.26, 11.3.27b, 11.3.27d and 11.4.3a are classed as 'General Habitat' unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.

7 REs 11.3.4, 11.3.14, 11.3.25, 11.3.26, 11.3.27b, 11.3.27d and 11.4.3a are classed as 'Absence Suspected' if less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.

8 Regrowth vegetation (3+ years) within 200 m of remnant vegetation classed as 'Core Habitat Possible' is considered to be 'General Habitat.'

9 All mapped 'Mature Regrowth (EHP 2012b)' that includes RE attributed polygons is classed 'General Habitat' for REs 11.3.1, 11.3.17, 11.3.18, 11.3.19, 11.4.3, 11.4.3b, 11.4.10, 11.4.12, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.5, 11.7.6, 11.7.7, 11.9.1, 11.9.4a, 11.9.4b, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1 11.10.1a and 11.10.1d unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation. Ground-truthing of mature regrowth may result in it being elevated to 'Core Habitat Possible.'

10 Cleared agricultural and grazing land is classed as 'Absence Suspected.'

11 For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present. For rules 4 to 9, these are applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

B.4 NC Act Flora

B.4.1 Aristida annua

1 See MNES mapping rules.

B.4.2 Bertya pedicellata

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.
3 The following REs (remnant and regrowth) should be classed as 'core habitat possible':
   - 11.7.2
   - 11.7.1x1
   - 11.10.3
   - 11.10.8
4 All other remnant and regrowth vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".
5 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.3 Capparis humistrata

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.
3 The following REs with a medium density (1000 LIDAR hits per hectare), mid-height vegetation layer should be classed as 'core habitat possible':
   - 11.10.4
   - 11.9.1.
4 REs listed in criteria 3, without a medium density shrub layer should be classed as 'general habitat'.
5 The following REs should be classes as 'general habitat':
   - 11.9.9.
6 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".
7 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.4 *Cerbera dumicola*

1. Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2. RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.
3. The following REs should be classed as 'core habitat possible':
   - 11.7.2.
4. The following REs should be classed as 'general habitat':
   - 11.5.9
   - 11.10.4
   - 11.10.8.
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".
6. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.5 *Croton magneticus*

1. Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2. RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.
3. The RE 11.8.3 should be classed as 'core habitat possible'
4. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.6 *Cyperus clarus*

1. Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2. RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.
3. The following REs should be classed as 'core habitat possible':
   - RE 11.3.2
   - RE 11.3.3
   - RE 11.3.21

- RE 11.3.24
- RE 11.3.27
- RE 11.8.4
- RE 11.8.5
- RE 11.8.11.

4 Non remnant (derived grasslands) on alluvium should be considered ‘general habitat’.
5 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
6 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.7 Desmodium macrocarpum

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as ‘core habitat known’ (‘core habitat known’ calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2 RE polygons with confirmed records (<500 m precision) should be classed as ‘core habitat known’.
3 The following REs should be classed as ‘core habitat possible’:

- 11.5.3
- 11.5.9
- 11.7.2
- 11.7.1

4 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
5 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.8 Dichanthium queenslandicum

1 See MNES mapping rules.

B.4.9 Dichanthium setosum

1 See MNES mapping rules.

B.4.10 Digitaria porrecta

1 Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as ‘core habitat known’ (‘high’ confidence is applied) where it intersects remnant habitats.
2 RE polygons with confirmed records (<500 m precision) should be treated as ‘core habitat known’ (‘high’ when applied to property specific mapping (3D Environmental 2013), ‘moderate’ when applied to 1: 40 000 scale mapping (3D Environmental 2013) and ‘low’

when applied to mapping produced by DEHP, 2012a and 2012b).

3 Derived grassland and Mature Regrowth (EHP 2012b) should also be treated as 'core habitat known' when applied as rules 1 and 2.

4 The following regional ecosystems should be classed as 'core habitat possible':

   a. REs11.3.2, 11.3.4, 11.3.21, 11.8.5, 11.8.11 and RE11.3.24 (confidence levels as applied in 2).

5 Non remnant derived grassland and regrowth woodland habitats derived from RE11.3.2 should otherwise be classified as 'general habitat' (confidence levels as applied in 2).

All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be classified as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.11 *Eucalyptus raveretiana*

1 See MNES mapping rules.

B.4.12 *Euphorbia sarcostemmoides*

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).

2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.

3 The following REs should be classed as 'core habitat possible':

- 11.7.2.

4 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

5 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.13 *Graptophyllum ilicifolium*

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).

2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.

3 Remnant vegetation within 100m of watercourses and below 300m AHD incorporating the following REs should be classed as core habitat possible:

- 8.12.3
- 8.12.12

- 12.12.13.

4 Remnant vegetation on slopes ranging from 10% to 100% below 300m AHD incorporating the following REs should be classed as core habitat possible:

- 8.12.3
- 8.12.12
- 12.12.13.

5 Remnant vegetation on slopes ranging from 10% to 100% below 300m AHD should be classed as general habitat.

6 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.14 Macropteranthes leiocaulis

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).

2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.

3 The following REs should be classed as 'core habitat possible':

- 11.4.1
- 11.10.8.

4 The following REs should be classed as 'general habitat':

- 11.5.16
- 11.7.1x1
- 11.9.4
- 11.8.3
- 11.8.13
- 11.11.18.

5 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

6 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.15 Paspalidium scabrifolium

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).

2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.

3 The following REs should be classed as 'core habitat possible':

- 11.3.1
- 11.4.9
- 11.4.8.

4 Non remnant (derived grasslands) on alluvium should be considered 'general habitat'.

5 All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

6 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.16 Peripleura scabra

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).

2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.

3 The following REs should be classed as 'general habitat':

- 11.11.15
- 11.12.16.

4 Any mapped 'general habitat' between 0m AHD and 1100m AHD and on a hill slope between 5% and 80% should be mapped as 'core habitat possible'.

5 For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.17 Solanum adenophorum

1 Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).

2 RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.

3 The following REs on slopes of 5-20% should be classed as 'core habitat possible':

- 11.3.1, 11.3.5, 11.3.16, 11.3.17
- 11.4.3, 11.4.6, 11.4.7, 11.4.8, 11.4.9, 11.4.10
- 11.8.3, 11.8.13.

4 The REs listed above, not classified as 'core habitat possible', should be classed as 'general habitat'.

5 All other remnant and regrowth vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

6 For heterogeneous polygons the above rules were applied where the relevant REs were

found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.18 Solanum elachophyllum

1. Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2. RE polygons with confirmed records (<500 m precision) should be classed as 'core habitat known'.
3. The following REs should be classed as 'core habitat possible':
    - 11.4.8
    - 11.4.9
    - 11.3.1
    - 11.9.5.
4. The following REs should be classed as 'general habitat'
    - 11.10.4
    - 11.8.13.
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be classes as "absence suspected".
6. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.4.19 Trioncinia retroflexa

1. Confirmed species record (<500m precision) should be buffered by a 1km diameter and treated as 'core habitat known' ('core habitat known' calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2. RE 11.8.11 (remnant and regrowth) should be classed as 'core habitat possible'. (Occurs exclusively in this RE. (Fensham and Fairfax 2005).
3. All other remnant and regrowth vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".
4. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

B.5 TECs

B.5.1 Brigalow

1 EHP RE mapping database (EHP 2012a); The Brigalow TEC is applied to RE11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5. 11.9.6, 11.11.14, 11.12.21. Where these REs contribute <50% to the total area of a heterogeneous polygon, they are mapped as 'Brigalow sub-dominant'. Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Brigalow dominant'.

2 EHP mature regrowth database (EHP 2012b): As applied to EHP 2012a.

3 3D Environmental database (3d Environmental 2013); The Brigalow TEC is applied to RE11.3.1, 11.4.3, 11.4.3a, 11.4.10 and Brigalow regrowth (>15yrs old), 11.9.5. 11.9.6. Brigalow patches <0.5 ha and <15 years old are excluded from the mapping.

4 The 3d Environmental database takes precedence for mapping purposes although this is subject to refinement following detailed field survey.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The Brigalow TEC refers only to that part of the polygon where applicable REs are present.

B.5.2 Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

1 EHP RE mapping database (EHP 2012a); The Natural Grassland TEC is applied to RE11.3.21, 11.4.4, 11.4.11, 11.8.11, 11.9.3, 11.9.12, and 11.11.17. Where these REs contribute <50% to the total area of a heterogeneous polygon, they are mapped as 'Natural Grassland sub-dominant'. Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Natural Grassland dominant'.

2 EHP Mature Regrowth dataset (EHP 2012b): The Natural Grassland TEC is not applied to the Mature Regrowth dataset (EHP 2012b).

3 Refer to DSEWPC 2012 for mapping and floristic thresholds.

4 The 3d Environmental database takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The Natural Grassland TEC refers only to that part of the polygon where applicable REs are present.

B.5.3 SEVT

1 EHP RE mapping database (EHP 2012a); The Semi-evergreen Vine Thicket TEC is applied to RE 11.2.3, 11.3.11, 11.4.1, 11.5.15, 11.8.3, 11.8.6, 11.8.13, 11.9.4, 11.9.8 and 11.11.18. Where these REs contribute <50% to the total area of a heterogeneous polygon, they are mapped as 'Semi-evergreen Vine Thicket Sub-dominant). Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Semi-Evergreen Vine Thicket Dominant'.

2 EHP Mature Regrowth dataset (EHP 2012b): As applied to EHP (2012a).

3 3D Environmental database (3d Environmental 2013); The Semi-Evergreen Vine Thicket TEC is not applied in the 3D Environmental Dataset (3D Environmental 2013) as the ecological community has not been identified. Refer to TSSC (2001b) for mapping and floristic thresholds.

4 The 3D Environmental database takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

B.5.4 Weeping Myall

1 The Weeping Myall TEC is not recorded in the EHP RE mapping database (EHP 2012a) nor Regrowth mapping database (EHP 2012b).

2 Confirmed species records (<500 m precision) within REs 11.3.2 and 11.3.28 should be buffered by a 1 km radius and classed as 'core habitat possible'.

3 3D Environmental database (3d Environmental 2013); The Weeping Myall Woodland TEC is mapped down to threshold limits of 0.5 ha. Further condition thresholds are described within TSSC 2008t.

4 REs 11.3.2 and 11.3.28 should be classified as core habitat possible.

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