ENVIRONMENTAL OFFSETS STRATEGIC MANAGEMENT PLAN

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SUPPLEMENTARY REPORT TO THE EIS

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Report

Offset Strategy

AUSTRALIA

Bowen Gas Project Environmental Offsets Strategic Management Plan

April 2014
42627140/01/01

Prepared for:
Arrow Energy Pty Ltd

Prepared by URS Australia Pty Ltd

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DOCUMENT PRODUCTION / APPROVAL RECORD				
Issue No.	**Name**	**Signature**	**Date**	**Position Title**
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Approved by	Dan Simmons		22 April 2014	Senior Associate – Environmental Scientist

Report Name:
Offset Strategy

Sub Title:
Bowen Gas Project Environmental Offsets Strategic Management Plan

Report No.
42627140/01/01

Status:
FINAL

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DOCUMENT REVISION RECORD		
Issue No.	**Date**	**Details of Revisions**
0	28/01/2014	1st draft
1	25/02/2014	2nd draft
2	12/03/2014	3rd draft
3	25/03/2014	4th draft
4	16/04/2014	5th draft
5	17/04/2014	6th draft
FINAL	22/04/2014	Final for issue

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ABBREVIATIONS

Abbreviation	Description
CSG	Coal Seam Gas
DERM	The Department of Environment and Resource Management
EHP	The Department of Environment and Heritage Protection
EIS	Environmental Impact Statement
EP Act	Environmental Protection Act 1994
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESA	Environmentally Sensitive Area
EVNT	Endangered, Vulnerable or Near Threatened
FCF	Field Compression Facility
FEED	Front End Engineering Design
GBRMPA	Great Barrier Reef Marine Park Authority
GIS	Geographic Information System
HES	High Ecological Significance
HVR	High Value Regrowth
IECA	International Erosion Control Association
LIDAR	Light Detection and Ranging
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NCAP	No Concern At Present
QBOP	Queensland Biodiversity Offset Policy
QGEOP	Queensland Government Environmental Offset Policy
QLD	Queensland
RE	Regional Ecosystem
SSBV	State Significant Biodiversity Value
SREIS	Supplementary Report to the Environmental Impact Statement
TEC	Threatened Ecological Community
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WTF	Water Treatment Facility

EXECUTIVE SUMMARY

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 matters of national environmental significance (MNES). This document sets out Arrow's strategy for providing environmental offsets for the Bowen Gas Project (the Project).

This Plan (Draft Bowen Gas Project Environmental Offsets Strategic Management Plan) presents Arrow's strategy to meet environmental offset obligations for the Project. The aim of this document is to facilitate discussion with the Queensland Government Department of Environment and Heritage Protection (EHP) and Department of the Environment on suitable offsets for unavoidable losses of vegetation and habitat incurred by constructing the Project.

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

Estimated potential impacts to MNES, endangered, vulnerable and near threatened species (EVNTs), and SSBVs are outlined within this report and identify the total maximum potentiation impact for the life of the Project.

Proposed avoidance, mitigation and management measures have been presented in the technical studies undertaken for the Environmental Impact Statement (EIS) and Supplementary Report to the Environmental Impact Statement (SREIS) to achieve the identified environmental protection objectives.

Environmental protection for MNES and SSBVs will be primarily achieved through design and site selection that will aim to avoid high-value environmental areas. Arrow will implement measures to mitigate impacts on terrestrial ecology.

The Project will potentially impact on a number of SSBVs and MNES as discussed in Section 6 of this report.

Arrow has previously developed a staged approach to account for impacts 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.

An offset implementation plan will be developed outlining the proposed methodologies and preferred locations for the provision of offsets for the Project.

1 INTRODUCTION

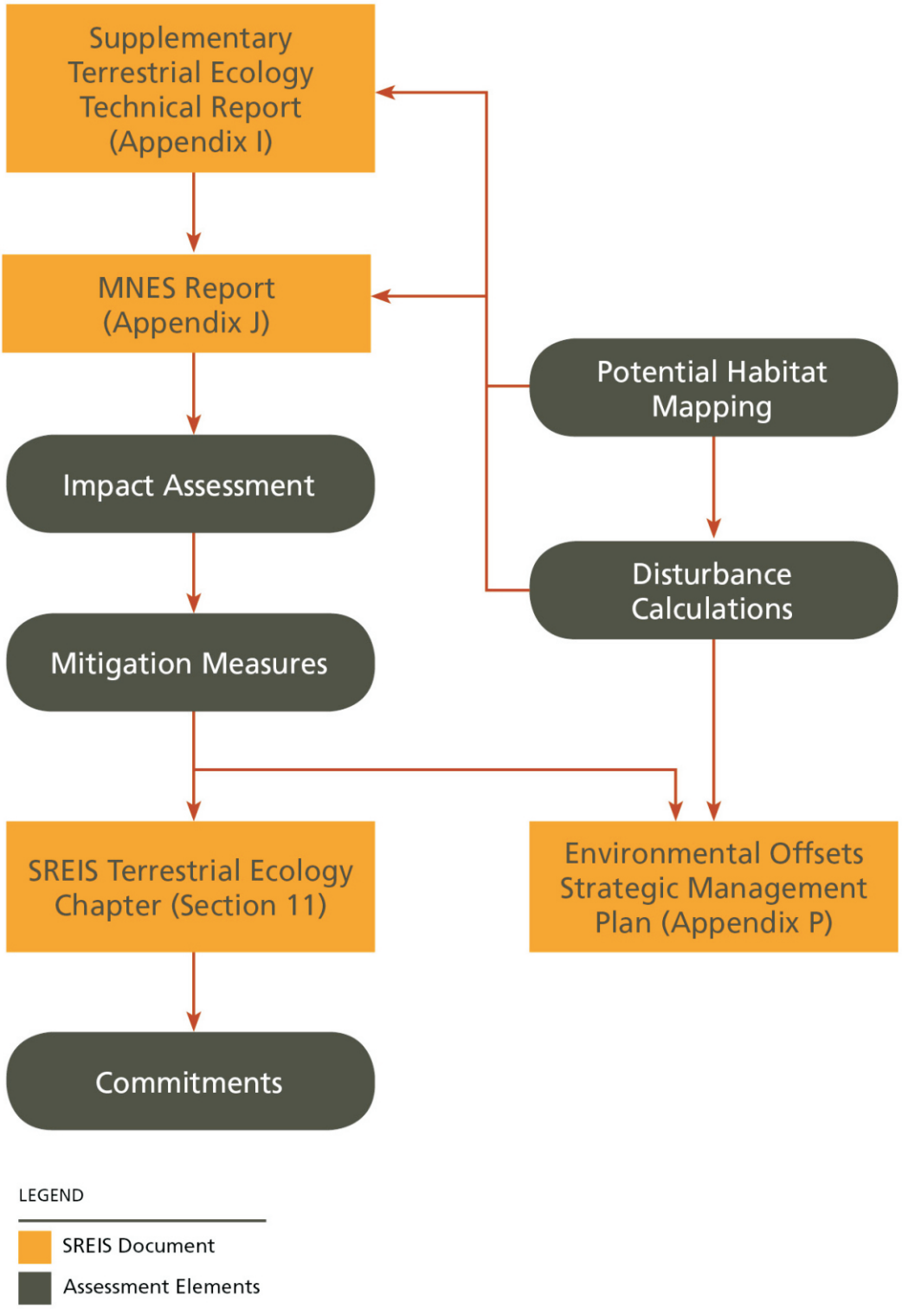
The ecological studies for the supplementary report to the EIS (SREIS) includes a number of supplementary and updated ecological assessments. The relationship between the various elements of the updated supplementary ecological assessments is illustrated below in Figure 1-1. The assessments include:

- **Supplementary Terrestrial Ecology Assessment (Appendix I) of the SREIS:** The Supplementary Terrestrial Ecology Technical Report of the SREIS is a standalone report that outlines the methodology and results of the supplementary assessment undertaken as part of the SREIS.
- **MNES Report (Appendix J) of the SREIS:** 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 (Section 11) of the SREIS:** The Terrestrial Ecology chapter of the SREIS is an update to the terrestrial ecology studies undertaken for the SREIS, and is to be read in conjunction with the Terrestrial Ecology chapter (Section 17) of the EIS.
- **Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS:** This Environmental Offsets Strategic Management Plan is a standalone report outlining the offsets strategy for the Project in line with relevant State and Commonwealth legislation and policy.

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 conceptual development footprint has been revised as a result of further project definition since the EIS, reducing the concept to approximately 4,000 production wells to be drilled throughout the Project area over the 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 (Section 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 1-1. 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 the Project Description chapter (Section 3.3) of the SREIS.



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BOWEN GAS PROJECT SREIS

ECOLOGY ASSESSMENT SUMMARY

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OFFSET STRATEGY TECHNICAL REPORT

Figure: **1-1**

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Table 1-1 SREIS Conceptual Multi-Well Pad Disturbance Footprint

Well Pad	Disturbance Footprint
4 wells (2 vertical production + 2 deviated)	130 m x 175 m (22,750 m^2)
8 wells (4 production + 4 deviated)	130 m x 235 m (30,550 m^2)
12 wells (6 production + 6 deviated)	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 significant reduction in the number of gathering lines, resulting in a reduced construction and disturbance footprint; and
- An increase in 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 1-2.

Table 1-2 EIS vs SREIS Estimated Maximum Disturbance Areas of the Conceptual Footprint

Infrastructure	EIS		SREIS	
	Number	**Disturbance**	**Number**	**Disturbance**
Wells (production + deviated)	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 conceptual development layout has been designed for the Project which has been used to estimate the potential disturbance limit for the life of the Project.

The disturbance limits calculated are a conservative maximum disturbance estimate and it is 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 a number of avoidance, mitigation and management measures to be implemented at the planning, site scouting and construction stages, as outlined in Section 5. Further information on the calculation of the disturbance estimate and the conservative approach applied can be found in Section 7.5.

2 PROJECT OFFSETS OVERVIEW

A conceptual description of the Project was prepared to inform the Project 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 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.

As part of the approval process, Arrow has prepared a supplementary report to the EIS (SREIS) to:

- Present any material changes to the conceptual project description;
- Undertake any further impact assessment deemed necessary as a result of these changes; and
- Respond to the stakeholder submissions received during the EIS public comment period.

As part of further information required in the SREIS, Queensland and Australian government policies require the provision of environmental offsets for unavoidable impacts on SSBVs, and unavoidable significant impacts on MNES. This document sets out Arrow's strategy for providing environmental offsets for the Project. The aim of this document is to facilitate discussion with EHP and the Department of the Environment on suitable offsets for unavoidable losses of vegetation and habitat incurred in constructing the project.

This document also describes planned measures to avoid and minimise impacts, the expected extent of disturbance to terrestrial environmental values, and evidence that there are opportunities to offset the estimated losses of remnant vegetation, species and habitat. Arrow's preferred approach for providing environmental offsets is also outlined.

3 LEGISLATIVE FRAMEWORK

The Project Approvals chapter (Section 2) of the SREIS provides an update to the principal approvals required by Arrow to construct and operate and maintain the Project that were detailed in the Project Approvals chapter (Section 2) of the EIS. The legislative framework applicable to offsets is summarised below.

The Project must satisfy the environmental offsets policy requirements of the Queensland and Australian governments, as it triggered assessment under both jurisdictions. Offsets delivered in accordance with Queensland Government policy may, where appropriate, satisfy the Australian Government's requirements. This section describes the legislative framework for environmental offsets. Arrow will work with any changes to offset policy as required, and where appropriate by transitional arrangements. In particular, the Queensland government has identified opportunities to improve its current policy and is looking to address this through policy change.

3.1 Queensland Government Legislation and Policy

The Queensland Government Environmental Offsets Policy (QGEOP), June 2008 (EPA, 2008) provides the supporting framework for environmental offsets in Queensland. The aim of the QGEOP is to outline when offsets should and should not be used and to provide the over-arching principles and guidelines for using and implementing environmental offsets.

The QGEOP outlines seven principles to guide the successful design and implementation of environmental offsets in Queensland:

- Principle 1: Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy.
- Principle 2: Environmental impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact.
- Principle 3: Offsets must achieve an equivalent or better environmental outcome.
- Principle 4: Offsets must provide environmental values as similar as possible to those being lost.
- Principle 5: Offset provision should minimise the time-lag between the impact and delivery of the offset.
- Principle 6: Offsets must provide additional protection to environmental values at risk, or additional management actions to improve environmental values.
- Principle 7: Offsets must be legally secured for the duration of the offset requirement.

The QGEOP applies where current legislation triggers state government assessment of impacts on environmental values. The QGEOP also governs the use of specific-issue offset policies in Queensland. Currently, there are four specific-issue offset policies:

- Vegetation management – *Policy for Vegetation Management Offsets, Version 3, 30 September 2011.*
- Marine Fish Habitat – *Marine Fish Habitat Offset Policy, 2012*

- Koala Habitat - *Offsets for Net Gain of Koala Habitat in South East Queensland Policy, 2010.*
- Biodiversity – *Queensland Biodiversity Offset Policy (version 1.1),* 14 January 2014.

Project activities carried out under the *Petroleum and Gas (Production and Safety) Act 2004* are exempt from the requirements of the *Vegetation Management Act 1999,* which governs the implementation of the *Policy for Vegetation Management Offsets.* Additionally, due to the physical location of the project, the *Marine Fish Habitat Offset Policy* and the *Offsets for Net Gain of Koala Habitat in South East Queensland Policy* do not apply to the project.

The *Queensland Biodiversity Offset Policy (version 1.1)* (QBOP) aims to increase the long-term protection and viability of the state's biodiversity where impacts to state significant biodiversity values (SSBVs) cannot be avoided. SSBVs are outlined in Appendix 1 of the QBOP and are discussed in Section 6 of this report.

The current offset framework in Queensland is currently under review. On the 13 February 2014, the *Environmental Offsets Bill* 2014 (the Bill) was tabled in Queensland parliament. The Bill proposes a new legislative framework for all offsets in Queensland and will aim to replace the five existing offsets policies into one, all-encompassing offsets policy, while retaining a focus on environmental protection. The policy aims to streamline assessment and provision of offsets and will introduce "matters of state environmental significance" (MSES) to replace SSBVs. The draft offsets policy and list of MSES can be found on the EHP website.

3.2 Australian Government Legislation and Policy

The Project will be subject to the EPBC Act Environmental Offsets Policy 2012. There are five key aims of the policy including:

1. Ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act.
2. Provide proponents, the community and other stakeholders with greater certainty and guidance on how offsets are determined and when they may be considered under the EPBC Act.
3. Deliver improved environmental outcomes by consistently applying the policy.
4. Outline the appropriate nature and scale of offsets and how they are determined.
5. Provide guidance on acceptable delivery mechanisms for offsets.

The EPBC Act Environmental Offsets Policy 2012 identifies eight requirements for suitable offsets. These requirements include:

- Deliver an overall conservation outcome that improves or maintains the viability of the protected matter;
- Be built around direct offsets but may include other compensatory measures. Advanced offset will be considered;
- Be in proportion to the level of statutory protection that applies to the protected matter and be tailored specifically to the attribute of the protected matter that is impacted;
- Be of a size and scale proportionate to the residual impacts on the protected matter;
- Effectively account for and manage the risks of the offset not succeeding;

- Be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs;
- Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable; and
- Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

3.3 Revisions to Species or Habitats Schedules

Since the Project was declared a controlled action under the EPBC Act, 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), revisions have been made to the schedules of a number of species or communities. The species below, identified as potentially occurring within the Project area have had changes to their status since the release of the EIS.

Rostratula australis (Australian painted snipe)

The Australian painted snipe was previously listed as vulnerable under the EPBC Act. On 30 April 2013, the conservation status was upgraded to endangered. As a result the species will be considered as endangered for offsetting requirements under the EPBC Act. It is still listed as vulnerable under the NC Act.

Digitaria porrecta

Digitaria porrecta was delisted as a threatened species under the EPBC Act on 07 January 2014. As a result, *Digitaria porrecta* will not be considered as part of the MNES offset requirements. It is still currently listed under the NC Act as near threatened and will be considered for offsets in accordance with the QBOP.

Croton magneticus

Croton magneticus was delisted as a threatened species under the EPBC Act on 15 May 2013. As a result, *Croton magneticus* will not be considered as part of the MNES offset requirements. It is still currently listed under the NC Act as vulnerable and will be considered for offsets in accordance with the QBOP.

Paradelma orientalis (brigalow scaly-foot)

Brigalow scaly-foot was de-listed as a threatened species under the EPBC Act on 29 April 2013. As a result, the brigalow scaly-foot will not be considered as part of the MNES offset requirements. It is still currently listed under the NC Act as vulnerable and will be considered for offsets in accordance with the QBOP.

Delma labialis (striped-tailed delma)

Striped-tailed delma was de-listed as a threatened species under the EPBC Act on 15 May 2013. As a result, the striped-tailed delma will not be considered as part of the MNES offset requirements. It is still currently listed under the NC Act as vulnerable and will be considered for offsets in accordance with the QBOP.

4 BIOREGIONAL CONTEXT

The Project area lies within the Brigalow Belt Bioregion. Geologically, the Project area is diverse. Its northern portion is characterised by a series of variably dissected lateritic plateaus, underlain by Carboniferous age basalt. Between escarpments, the basalt manifests as broad undulating plains formed with cracking clay soils (vertosols). Southwards towards Moranbah, the basalts give way to deeper Cainozoic clays, silts and sands and the breakaways are higher, more pronounced and formed by quartzose sandstones. In the southern portion of the study area, to the south of Dysart and Blackwater, the clay plains are broader, more extensive and the lateritic breakaway plateaus more widely dispersed. The characteristically broad, discontinuous floodplains and associated tributaries of the Isaac River in the north and Mackenzie River in the south provide a source for the major alluvial landforms in the Project area. In the far south of the Project area, towards Blackwater, the relictual sandstone plateau of the Blackdown Tableland slightly intrudes into the Project area.

Only 40% of vegetation in the Project area retains remnant status. The majority of this remnant vegetation persists on the breakaway scarps, escarpments and plateaus that are historically less amenable to land development. Open forests of lancewood (*Acacia shirleyi*) characterise the steeper breakaways and escarpments although they mix with eucalypt dominant woodland and open forest comprising species, which include ironbark (*Eucalyptus crebra*, and *Eucalyptus xanthoclada*), Gympie messmate (*Eucalyptus cloeziana*), brown bloodwood (*Corymbia trachyphloia*), spotted gum (*Corymbia citriodora*) and Clarkson's bloodwood (*Corymbia clarksoniana*). Small patches of vine thicket are also associated with breakaway areas, as well as basaltic landforms in the northern portion of the Project area.

The Brigalow forest that was once characteristic of clay plains in the Project area has been significantly impacted by land clearing, fragmentation and attrition, as it has for the broader Brigalow Belt North Bioregion. With the exception of a few better-preserved remnants, Brigalow now persists in the landscape as scattered fragments and disturbed regrowth. Severe fragmentation has also affected eucalypt woodland habitats associated with clay plains. Better-preserved vestiges can however be located on a number of properties in the northern and central portions of the Project area where land disturbance has not been excessive.

In a better state of preservation are the habitats associated with basaltic landforms that are extensive to the north of Moranbah. The basaltic plains form the substrate to an extensive, relatively intact belt of natural grassland and woodland habitat. The natural sparseness of trees in the landscape has assisted in the preservation of these habitats, because mechanical clearing of trees was not necessary. The native pastures were also particularly amenable to grazing and did not require intervention or introduction of exotic species to be productive. Gradual and pervasive alteration of these habitats is however an ongoing process with exotic grasses including Indian couch *(Bothriochloa pertusa),* buffel grass *(Pennisetum ciliare)* and purple pigeon grass *(Setaria incrassata)* becoming established in areas that have been subject to more pronounced grazing pressure and recent disturbance.

5 AVOIDANCE, MITIGATION AND MANAGEMENT MEASURES

Under the current state and federal offset legislation, proponents must demonstrate that actions have been taken to avoid, minimise and mitigate impacts to ecological values prior to proposing offsets. Arrows' proposed avoidance, minimisation, mitigation and management measures have been presented in the technical studies undertaken for the EIS and SREIS to achieve the identified environmental protection objectives.

The mitigation and management measures set out in the EIS and SREIS are Arrow's commitments to the effective management of the potential environmental and social impacts of the Project (Commitments Summary (Appendix D) of the EIS and Commitments Update (Appendix O) of the SREIS).

Implementation of avoidance, mitigation and management measures set out in this section will aim to avoid adverse impacts from Project activities, or reduce the severity of their magnitude on species and communities in the Project area. In the absence of certainty about the precise location of Project infrastructure, Arrow has developed an 'environmental framework' approach (see the Environmental Framework chapter (Section 7) of the EIS) which includes constraints mapping that assists during the planning process in guiding site and route selection to avoid and minimise environmental impacts from its Project activities.

5.1 Avoidance

The following general mitigation and management measures have been developed to address the potential impacts on MNES and SSBVs. 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 and SSBVs will be primarily achieved through design and site selection that aims to avoid high-value environmental areas. Arrow will conduct the measures in Section 5.1.1 to mitigate impacts on terrestrial ecological values during various stages of the Project.

5.1.1 General Avoidance Strategies for the Project

During the planning and design phase, areas of very high sensitivity will be avoided by implementing the following mitigation commitments from the EIS:

- 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];
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135];
- 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]; and

- 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.

5.1.2 Construction and Operations Phase

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

- 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];
- 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];
- 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) [B154];

- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques [B146];
- 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];
- A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152];
- 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).

5.1.3 Decommissioning Phase

Prior to commencing ground disturbance activities, a rehabilitation plan will be developed that will include a number of avoidance, mitigation and management activities. The rehabilitation plan will include the following practices to maximise the potential for meeting the proposed rehabilitation success criteria and management of potential impacts to MNES and SSBVs:

- 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, 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 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 and SSBVs is detailed in the Decommissioning and Rehabilitation chapter (Section 29.7) of the EIS.

6 ENVIRONMENTAL VALUES TO BE OFFSET

The EPBC Act and QBOP outline specific environmental values that require offsetting if impacts to those values occur. Matters of National Environmental Significance are listed in Table 6-1 below, and State Significant Biodiversity Values are listed in Table 6-2. These values will be reviewed in conjunction with updates or amendments to both federal and state offsets legislation and policy.

Table 6-1 Matters of National Environmental Significance and their Applicability to the Project

MNES	Description	Applicability to Bowen Gas Project
Word Heritage Properties		
World Heritage Properties	Australian heritage places that are of outstanding universal value and have been included on the United Nations Educational, Scientific and Cultural Organisation (UNESCO) managed list.	No World Heritage sites are present within or near the Project area, however five world heritage places exist in Queensland: The Wet tropics, The Great Barrier Reef, Fraser Island, Gondwana Rainforests of Australia and the Australia Fossil mammal sites (Riversleigh).
Ramsar Wetlands		
Ramsar Wetlands	A 'declared Ramsar wetland' is an area that has been designated under Article 2 of the Ramsar Convention or declared by the Minister to be a declared Ramsar wetland under the EPBC Act.	The nearest Ramsar wetland is Bowling Green Bay National Park, near Townsville. The Project will not impact on any Ramsar wetlands.
Nationally listed threatened species and ecological communities		
Nationally listed threatened species and ecological communities	Species or communities listed under the EPBC Act.	Nationally listed threatened species and ecological communities as listed in the EPBC Act will be impacted by the Project. Determination of impacts to species and communities listed under the EPBC Act are outlined in Appendix J of the SREIS. Impacts to these MNES are listed in Table 7-4 and Table 7-5.
Listed Migratory Species		
Listed Migratory Species	Many migratory species listed under the international conventions and agreements Australia is party to, are protected under the EPBC Act.	Listed migratory species occurring within the project area are listed in the MNES Report (Appendix J) of the SREIS. Impacts to listed migratory species are discussed in the MNES Report (Appendix J) of the SREIS and are expected to be insignificant, and therefore will not require offsetting.

MNES	Description	Applicability to Bowen Gas Project
Activities related to nuclear energy, including uranium mining		
Activities related to nuclear energy, including uranium mining	Activities related to nuclear energy, including uranium mining. Includes nuclear actions as defined in the EPBC Act.	Not applicable.
The Commonwealth marine environment		
The Commonwealth marine environment	Marine areas as defined by the EPBC Act and broadly grouped into South-west, North-west, North and Temperate East marine zones.	Not applicable.
National Heritage Places		
National Heritage Places	A list of natural, historic and Indigenous places of heritage significance.	Not applicable.
The Great Barrier Reef Marine Park		
Great Barrier Reef Marine Park	The Great Barrier Reef Marine Park managed by The Great Barrier Reef Marine Park Authority (GBRMPA).	Not applicable.

Table 6-2 State Significant Biodiversity Values and their Applicability to the Project

SSBV	Description	Applicability to Bowen Gas Project
Regional Ecosystems		
Endangered REs	Regional ecosystems which: – are listed in schedule 1 of the Vegetation Management Regulation 2012. – are mapped as a Category B area on the regulated vegetation management map. – fits the description for the regional ecosystem contained in the Regional Ecosystem Description Database.	Remnant endangered REs within the Project development area are summarised in Table 7-3, and an estimate of the availability of these REs as suitable areas for offset sites (following the QBOP) is presented in Table 8-1.
Endangered grassland REs	Regional ecosystems which: – are listed in Appendix 4 of the Biodiversity Offset Policy – are mapped as a Category B area on the regulated vegetation management map. – fit the description for the regional ecosystem contained in the Regional Ecosystem Description Database.	Remnant endangered grassland REs (as defined in Appendix 4 of the QBOP). The extent of these REs within the Project area is presented in Table 7-3, and an estimate of the availability of these REs as suitable areas for offset sites (as per the QBOP) is presented in Table 8-1.
Of concern REs	Regional ecosystems which: – are listed in schedule 2 of the Vegetation Management Regulation 2012 – are mapped as a Category B area on the regulated vegetation management map. – fit the description for the regional ecosystem contained in the Regional Ecosystem Description Database.	Remnant of concern REs within the Project area are summarised in Table 7-3, and an estimate of the availability of these REs as suitable areas for offset sites (as per the QBOP) is presented in Table 8-1.
Of concern grassland REs	Regional ecosystems which: – are listed in Appendix 4 of this Policy – are mapped as a Category B area on the regulated vegetation management map. – fit the description for the regional ecosystem contained in the Regional Ecosystem Description Database.	Remnant of concern grassland REs within the Project area are summarised in Table 7-3, and an estimate of the availability of these REs as suitable areas for offset sites (as per the QBOP) is presented in Table 8-1.
Critically limited REs	Regional ecosystems which: – are listed in Appendix 5 of the QBOP – are mapped as a Category B area on the regulated vegetation	There are no critically limited REs within the Project area.

SSBV	Description	Applicability to Bowen Gas Project
	management map. – fit the description for the regional ecosystem contained in the Regional Ecosystem Description Database.	
Essential Habitat		
Essential Habitat	Regional ecosystems which: – are mapped as a Category B area on the regulated vegetation management map. – Identified as essential habitat on the essential habitat map.	Essential habitat for NC Act listed species as regulated under the Vegetation Management Act was considered within the EIS and SREIS assessments. Essential habitat may be drawn from a number of data sources, both verified and non-verified, is not regularly updated and does not account for all previously recorded occurrences of a species. Essential habitat is therefore considered secondary to the classification of core habitat known in the project development area (as discussed in the Terrestrial Ecology Technical Report (Appendix I, Appendix A2) of the SREIS). Essential habitat as recognised by EHP, is captured within those areas mapped as core habitat known for a particular species. This will create an overlap of essential habitat and core habitat known for the same value, therefore, offsets will only be provided for core habitat known areas and not for essential habitat. Areas of core habitat known for listed species (both EPBC Act and NC Act) are presented within Table 7-5.
Wetlands		
Wetland (VM Act)	Regional ecosystems which: – Are mapped as a Category B area on the regulated vegetation management map. – Identified as a wetland on the vegetation management wetlands map.	VM Act wetlands as identified in the SSBV description (a & b) that are contained within the Project area are summarised in Table 7-6. Through the framework approach, Arrow has committed to avoiding impacts to wetlands.

SSBV	Description	Applicability to Bowen Gas Project
Watercourses		
Watercourses	Regional ecosystems which: – Are mapped as a Category B area on the regulated vegetation management map. – Identified as a watercourse on the vegetation management watercourse map.	Watercourse values as outlined in the SSBV description contained within the Project area are summarised in Table 7-3.
Connectivity		
Connectivity	Areas which consist of remnant vegetation where the proposed impact area: – contains State significant biodiversity values; or – is within 500 meters of a State significant biodiversity value; and – forms an important link or stepping stone in the landscape; or – forms part of a patch which is five ha or greater; and – will compromise the function of State significant biodiversity values.	Impacts to connectivity will be assessed through a combination of pre-clearance surveys and mapping. Through pre-clearance surveys, it will be determined if the function of a SSBV is compromised and (if required) whether the impact area forms an important link or stepping stone in the landscape.
Protected animals		
Protected animals	Endangered, vulnerable, near threatened and special least concern animals under the *Nature Conservation Act 1992.*	Estimated areas of core habitat known and core habitat possible within the Project development area for listed species (both EPBC Act and NC Act) are presented within Table 7-5.
Legally secured offset area under state legislation		
Legally secured offset area under state legislation	An offset area approved by the administering authority associated with a legislative or policy requirement for the provision of an offset.	One legally secured offset is contained within the Project area, however it is contained outside proposed development areas.
B2 Nature Conservation Act 1992		
Protected Plants	Extinct in the wild, endangered, vulnerable or near threatened protected plants under the *Nature Conservation Act 1992.*	Estimated areas of core habitat known and core habitat possible within the Project development area for listed species (both EPBC Act and NC Act) are presented within Table 8-1. Predicted unavoidable impacts to these habitat types that are proposed to be offset are also described

SSBV	Description	Applicability to Bowen Gas Project
B3 State Planning Policy 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments		
Wetland Protection Areas	Means an area shown as a wetland protection area on the Map of Referrable Wetlands*, and as defined in Annex 3 of State Planning Policy 2.11.	Wetlands of high ecological significance mapped within the Project area are summarised in Table 7-6,

* Refer to Appendix 1 of the State Planning Policy 2/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments Guideline (2011) for the wetland protection area mapping methodology.

7 POTENTIAL AREA OF DISTURBANCE

7.1 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 implementing 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.

A key premise of standard 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 challenging for the development of an offset strategy 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.

Further detail regarding the framework approach and how the impact assessment has been conducted can be found in the MNES report (Appendix J) of the SREIS.

7.2 Field Development Planning

Field development planning has advanced since preparation of the EIS, with the overall Project development area now being separated into 33 smaller drainage areas. Each drainage area is generally a 6 km radius catchment area for gathering well production (gas and water) and surface production facilities located at or near the centre of the circle. Each of these centrally located surface production facilities is a field compression facility (FCF).

The application of the drainage area approach has allowed for a refined analysis of the REs potentially affected by the Project. The focus of development will occur within the drainage area, although there may be impacts beyond the drainage area boundary. Within each drainage area, a discrete set of REs can be identified and potential impacts can be determined in isolation or in combination with other drainage areas. Potential impact areas outside the drainage areas can also be estimated once a conceptual footprint has been defined.

Thirty-three drainage areas are located across the Project tenements. These have been scheduled for development across three distinct phases.

The first development phase of the Project targets the regions with the highest confidence for gas returns. 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 water treatment facilities (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 layout of the draining areas is a preliminary layout for this SREIS reference case, and may be revised as understanding of the resource matures. As studies progress and further exploration, appraisal, pilot and production data becomes available; it is possible that development emphasis will shift to additional areas within the Project area, and / or that the currently proposed development sequence will be revised.

The potential area of disturbance for REs, TECs and species of conservation significance has been determined based upon the conceptual Project disturbance footprint combined with the following datasets:

- Version 6.1 Regional Ecosystem digital data (EHP, 2013);
- Draft Pre-clearing with Regional Ecosystems (DERM, 2009);
- VM Act Essential Habitat Version 3 (DERM, 2009);
- URS habitat mapping (Appendix J) of the SREIS; and
- 3D Environmental technical study (Appendix P) of the EIS.

7.3 Disturbance Calculation Method

Due to the nature of CSG development and the Framework approach used, the actual construction footprint for the life of the Project is yet to be defined. A sample conceptual footprint has been designed for the Project to calculate the likely potential estimated maximum disturbance for the Project. This sample conceptual footprint was used to estimate maximum potential impacts to the habitat categories of Core Habitat Known and Core Habitat Possible.

Core Habitat Known is defined as: Known recent records (since 1980) or confirmed sightings, generally buffered by a one kilometre radius. Core habitat known may also include remnant or regrowth vegetation contiguous with areas where known sightings have occurred.

Core Habitat Possible is defined as: Areas of potential habitat with a number of features or values known to contribute to, or be important for the occupation of the species.

It is expected that the disturbance limits calculated and represented in Table 7-5 are a maximum disturbance and that the actual disturbance will be lower. Not all the disturbed values presented will be offset as only those values required to be offset under the various policies will be offset.

7.4 Offset Area Rationalisation

Whilst effort has been made to improve the quality of potential habitat mapping through the application of LIDAR, refinement of mapping rules through the use of additional data and information, the mapping produced is still an indication of potential habitat and does not necessarily mean that a particular species will inhabit an area indicated by the mapping. Further refinement of potential habitat mapping for species is outside the scope of this assessment and is not plausible at the desktop level without undertaking a time and resource intensive, long-term predictive modelling exercise.

In order to rationalise the potential habitat mapping with inherent inaccuracies contained within mapping data layers and scale, a matrix of likelihood of occurrence and quality of potential habitat mapping has been produced.

This matrix has been developed to rationalise a reasonable percentage for each area of “Core Habitat Possible” to account of the inaccuracies outlined above in the original estimates of these areas. The percentage presented is the percentage of the habitat mapping that is to be retained for “Core Habitat Possible” and presented in the impacts section of the SREIS. It should be noted that 100% of Core habitat known is to be retained. Estimated disturbance areas less than ten hectares have not been rationalised.

The matrix is outlined below in 7-1 and Table 7-2. The assessment criteria for potential habitat mapping confidence is as follows:

Low confidence: The potential habitat mapping rules are predominantly based on mapping layers other than those listed below. Example layers include (but are not limited to) high value regrowth, remnant vegetation (not specific to any particular REs), areas under cultivation and vegetation patch size.

Medium confidence: The potential habitat mapping rules are predominantly based on remnant RE mapping that hasn’t been ground truthed.

High Confidence: The potential habitat mapping rules includes the incorporation of LIDAR refinements, watercourse mapping and/or ground truthing.

Likelihood of occurrence is taken from the assessment performed in either the MNES Report (Appendix J) of the SREIS, or Terrestrial Ecology Technical Report (Appendix P) of the EIS. Where a species appears in both reports, the MNES status is used. Areas less than ten hectares were not reduced.

Species that rated a likelihood of occurrence of Moderate, Possible, High or Known were the subject of species profiles and habitat mapping in the MNES report. Species of a low or unlikely rating of likelihood of occurrence were not subject to habitat mapping.

Table 7-1 Percentage Rationalisation Matrix for NC Act Species

Potential Habitat Mapping Confidence	High	Medium	Low
Recorded occurrence	90%	80%	70%
High likelihood of occurrence	85%	60%	35%
Moderate likelihood of occurrence	75%	40%	10%

Table 7-2 Percentage Rationalisation of MNES and SSBV Potential 'Core Habitat Possible' Areas

Potential Habitat Mapping Confidence	High	Medium	Low
Known likelihood	80%	65%	40%
Likely likelihood	70%	50%	30%
Possible likelihood	60%	30%	10%

7.5 Conservative Approach for Impact Estimates

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 estimated disturbance calculations:

- The disturbance calculation methodology is a mathematical approach that assumes an estimated maximum impact footprint on all environmental values within a drainage area, rather than applying a generic footprint template approach that would avoid some environmental values.
- 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 infrastructure will be positioned in accordance with constraints mapping, site scouting surveys and ground truthing.
- Linear infrastructure such as power lines and gas transmission pipelines have been calculated as individual disturbance corridors when in reality the majority will be co-located where possible and will also utilise existing disturbed areas where possible.
- A 25 m wide construction right of way for all pipelines, when it has been identified that a smaller right of way will be possible in places due to different construction techniques, such as ploughing-in gathering lines.
- The maximum disturbance footprint for each element of infrastructure has been incorporated, when it will be possible in some circumstances to reduce the disturbance footprint.
- The sample conceptual footprint uses the maximum number of well pads for the life of the project, when in reality this number is expected to be further rationalised to a lesser extent.

- 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.
- The potential habitat mapping rules do not exclude heterogeneous polygons or attempt to separate the unlisted REs contained within heterogeneous polygons out of the potential habitat mapping.
- Implementing the precautionary principle when determining habitat areas.
- Ground truthing of regional ecosystems and habitat areas prior to commencement of construction.

The potential area of disturbance to REs is detailed below in Table 7-3 based on the sample conceptual Project disturbance footprint. Table 7-4 describes potential impacts to TECs and Table 7-5 provides potential impacts to EPBC Act and NC Act listed species.

Table 7-3 Potential Area of Disturbance of Regional Ecosystems in Project Area (sorted by VM Act status)

RE Code	Regional Ecosystem	VM Class	BD Status[1]	EPBC Act	Area of RE within Project Area (ha)	Potential Area of RE within Disturbance Footprint (ha)	Offset Assessment Method[2] or method accepted by government
Endangered Regional Ecosystems							
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	E	E	E	3,979.4	42.95	Ecological equivalence method
11.3.1b	Palustrine wetland (e.g. vegetated swamp). Open forest dominated by *Acacia harpophylla* and/or *Casuarina cristata*	E	E	E	90.8	1.11	Ecological equivalence method
11.3.11	Semi-evergreen vine thicket on alluvial plains	E	E	E	23.5	0	NA
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. gras sland on alluvial plains. Cracking clay soils	E	E	E	460.9	0.5	Ecological equivalence method
11.4.1	Semi-evergreen vine thicket +/- *Casuarina cristata* on Cainozoic clay plains	E	E	E	23.8	0	NA
11.4.7	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on Cainozoic clay plains	E	E	E	3.7	0	NA
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	E	E	E	1,821.8	35.64	Ecological equivalence method
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic	E	E	E	8,899	175.90	Ecological equivalence method

RE Code	Regional Ecosystem	VM Class	BD Status[1]	EPBC Act	Area of RE within Project Area (ha)	Potential Area of RE within Disturbance Footprint (ha)	Offset Assessment Method[2] or method accepted by government
	clay plains						
11.4.9a	*Acacia harpophylla, Lysiphyllum carronii +/- Casuarina cristata* open forest to woodland	E	E	E	164	3.78	Ecological equivalence method
11.4.9b	*Acacia harpophylla, Eucalyptus thozetiana* (sometimes *E. cambageana*) open forest to woodland	E	E	E	20.1	0.18	Ecological equivalence method
11.5.16	*Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces	E	E	E	190.1	7.86	Ecological equivalence method
11.5.17	*Eucalyptus tereticornis* woodland in depressions on Cainozoic sand plains/remnant surfaces	E	E	-	72.4	0.57	Ecological equivalence method
11.8.13	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks	E	E	E	2,210.9	67.80	Ecological equivalence method
11.8.15	*Eucalyptus brownii* or *Eucalyptus populnea* woodland on Cainozoic igneous rocks	E	E	-	370.1	18.29	Ecological equivalence method
11.9.1	*Acacia harpophylla-Eucalyptus cambageana* woodland to open forest on fine-grained sedimentary rocks	E	E	E	1,360.2	8.45	Ecological equivalence method
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	E	E	E	5,236.3	108.42	Ecological equivalence method
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees	E	E	E	42.6	0	NA

RE Code	Regional Ecosystem	VM Class	BD Status[1]	EPBC Act	Area of RE within Project Area (ha)	Potential Area of RE within Disturbance Footprint (ha)	Offset Assessment Method[2] or method accepted by government
	of metamorphism and folding						
Of concern Regional Ecosystems							
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	OC	OC	E*	25,190.9	288.27	Ecological equivalence method
11.3.2b	Palustrine wetland (e.g. vegetated swamp). *Eucalyptus camaldulensis* (sometimes *E. populnea* and or *E. tereticornis*) woodland in drainage depressions	OC	OC	E*	27.2	0.75	Ecological equivalence method
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	OC	OC	-	1,923.1	27.16	Ecological equivalence method
11.3.3a	Riverine wetland or fringing riverine wetland. *Melaleuca bracteata* woodland. On alluvial plains	OC	OC	-	0.3	0	NA
11.3.3c	Palustrine wetland (e.g. vegetated swamp). *Eucalyptus coolabah* woodland to open woodland	OC	OC	-	59.8	0.5	Ecological equivalence method
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains	OC	OC	-	7,445.1	107.03	Ecological equivalence method
11.3.36	*Eucalyptus crebra* and/or *E. populnea* and/or *E. melanophloia* on alluvial plains	OC	OC	-	96.5	0.01	NA
11.4.2	*Eucalyptus* spp. and/or *Corymbia* spp. grassy or shrubby woodland on Cainozoic clay plains	OC	OC	-	3,640.5	82.84	Ecological equivalence method

RE Code	Regional Ecosystem	VM Class	BD Status[1]	EPBC Act	Area of RE within Project Area (ha)	Potential Area of RE within Disturbance Footprint (ha)	Offset Assessment Method[2] or method accepted by government
11.4.4	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains	LC	OC	E	1,642.5	3.45	Ecological equivalence method
11.4.11	*Dichanthium sericeum*, *Astrebla* spp. and patchy *Acacia harpophylla*, *Eucalyptus coolabah* on Cainozoic clay plains	OC	OC	E	0.2	0	NA
11.5.18	*Micromyrtus capricornia* shrubland on Cainozoic sand plains/remnant surfaces	OC	OC	-	242.7	6.62	Ecological equivalence method
11.7.1	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust	LC	OC	-	312.0	2.53	Ecological equivalence method
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks	OC	OC	E	1,033.5	4.35	Ecological equivalence method
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	OC	OC	E	13,826.8	793.72	Ecological equivalence method
11.8.14	*Eucalyptus crebra*, *Corymbia dallachiana* woodland on Cainozoic igneous rocks	OC	OC	-	40.3	0.66	Ecological equivalence method
11.9.4a	Semi-evergreen vine thicket, generally dominated by a low tree layer (5-10m high) which is floristically diverse and variable	OC	E	E	685.5	12.06	Ecological equivalence method
11.9.7	*Eucalyptus populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	OC	OC	-	0.3	0.01	NA

RE Code	Regional Ecosystem	VM Class	BD Status[1]	EPBC Act	Area of RE within Project Area (ha)	Potential Area of RE within Disturbance Footprint (ha)	Offset Assessment Method[2] or method accepted by government
11.9.7a	*Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (10-15 m high)	OC	OC	-	18,873.0	285.54	Ecological equivalence method
11.9.10	*Eucalyptus populnea, Acacia harpophylla* open forest on fine-grained sedimentary rocks	OC	E	-	1,234.8	35.18	Ecological equivalence method
11.9.13	*Eucalyptus moluccana* or *E. microcarpa* open forest on fine grained sedimentary rocks	OC	OC	-	1,214.7	36.21	Ecological equivalence method
11.10.8	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks	OC	OC	-	655.8	10.45	Ecological equivalence method

1 SSBVs are determined by the QBOP and VM Act status for REs. BD status is determined by the EP Act. BD status is included in this table as a reference

2 Current legislation outlines ecological equivalence as a suitable method for determining the quality of an RE to be impacted as well as the quality of an offset area. Assessment methods may change.

Table 7-4 Potential Area of Disturbance of TECs in Project Area

TEC	EPBC Act Status	NC Act Status	Area of TEC Within Project Area (ha)	Rationalised Potential Disturbance Footprint (ha)	Offset Assessment Method[1]
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

1 Current legislation outlines ecological equivalence as a suitable method for determining the quality of an RE to be impacted as well as the quality of an offset area. Assessment methods may change.

* Actual extent of Weeping Myall woodlands expected to be much lower. Calculation is based on impacts to REs 11.3.2 and 11.3.28 which may not necessarily be the Weeping Myall TEC.

Table 7-5 Potential Area of Disturbance of Species Habitat for Species Likely to Occur in the Project Area *

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Project Area - Core Habitat Known (ha)	Disturbance Footprint - Core Habitat Known (ha)	Project Area - Core Habitat Possible (ha)	Rationalised Potential Disturbance Footprint (ha)	Offset Assessment Method[1]
Threatened Fauna Species (EPBC Act)								
Geophaps scripta scripta	squatter pigeon	V	V	4,324.72	74	101,482.89	1,341.22	A
Rostratula australis	Australian painted snipe	E	V	658.8	5.14	197.9	0.55	A
Dasyurus hallucatus	northern quoll	E	-	0	0	58.93	1.54	A
Phascolarctos cinereus	koala	V	LC (outside of SEQ bioregion)	3,883.81	3.06	162,857.47	2,462.98	A
Nyctophilus corbeni	south-eastern long-eared bat	V	V[2]	0	0	295,648.22	2,282.57	A
Chalinolobus dwyeri	large-eared pied bat	V	V	0	0	176,459.61	1,451.44	A
Denisonia maculata	ornamental snake	V	V	1,988.37	2.9	59,481.71	1,027.41	A
Rheodytes leukops	Fitzroy River turtle	V	V	0	0	535.29	0.87	A
Erythrotriorchis radiatus	red goshawk	V	E	0	0	27,001.92	187.14	A
Egernia rugosa	yakka skink	V	V	0	0	0	0	A
Threatened Flora Species (EPBC Act)**								
Aristida annua	-	V	V	0	0	0	0	A
Dichanthium queenslandicum	king blue-grass	E	V	329.82	27.20	35,886.6	1,134.03	A
Dichanthium setosum	blue-grass	V	-	19.41	0	52,898.2	809.59	A
Eucalyptus raveretiana	black ironbox	V	V	0	0	18,749	258.32	A

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Project Area - Core Habitat Known (ha)	Disturbance Footprint - Core Habitat Known (ha)	Project Area - Core Habitat Possible (ha)	Rationalised Potential Disturbance Footprint (ha)	Offset Assessment Method[1]
Threatened Fauna Species (NC Act)								
Paradelma orientalis	Brigalow scaly-foot	-	V	42.84	1.11	62,847.92	647.80	B
Ephippiorhynchus asiaticus	black-necked stork	-	NT	0	0	1,106.6	5.11	B
Melithreptus gularis	black-chinned honeyeater	-	NT	0	0	132,628.36	1,585.16	B
Nettapus coromandelianus	cotton pygmy-goose	-	NT	0	0	1,330.91	4.87	B
Jalmenus eubulus	pale imperial hairstreak	-	V	0	0	38,987.22	191.06	B
Acanthopis antarcticus	common death adder	-	NT	0	0	280,416.7	2,274.83	B
Chalinolobus picatus	little pied bat	-	NT	0	0	305,831.8	3,953.74	B
Threatened Flora Species (NC Act)**								
Bertya pedicellata	-	-	NT	0	0	15,669.92	155.76	C
Capparis humistrata	-	-	E	0	0	1,019.89	2.31	C
Cerbera dumicola	-	-	NT	0	0	10,683.85	129.94	C
Croton magneticus	-	-	V	0	0	886.49	4.67	C
Cyperus clarus	-	-	V	0	0	68,661.19	546.12	C
Desmodium macrocarpum	-	-	NT	0	0	66,379.85	940.02	C
Digitaria porrecta	finger panic grass	-	NT	0	0	70,956.03	1,208.32	C
Euphorbia sarcostemmoides	-	-	V	0	0	22,743.86	363.6	C
Graptophyllum ilicifolium	-	-	V	0	0	28,096.41	101.87	C

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Project Area - Core Habitat Known (ha)	Disturbance Footprint - Core Habitat Known (ha)	Project Area - Core Habitat Possible (ha)	Rationalised Potential Disturbance Footprint (ha)	Offset Assessment Method[1]
Macropteranthes leiocaulis	-	-	NT	0	0	386.49	4.21	C
Paspalidium scabrifolium	-	-	NT	0	0	14,572.49	150.19	C
Peripleura scabra	-	-	NT	0	0	0	0	C
Solanum adenophorum	-	-	E	0	0	47,689.96	224.27	C
Solanum elachophyllum	-	-	E	0	0	56,729.38	618.17	C
Trioncinia retroflexa	-	-	E	0	0	15,993.9	271.04	C

1 A = EPBC Act Offsets assessment guide, B = Ecological equivalence method, C = Offset liability to be determined as plants are identified in pre-clearance surveys. Note: Current legislation outlines acceptable assessment methods. Assessment methods may change.

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).

* Species likelihood of occurrence has been performed in the Terrestrial Ecology Technical report (Appendix P) of the EIS and the MNES report (Appendix J) of the SREIS.

** Flora disturbance areas are provided as a guide. Endangered and vulnerable flora species will be offset if there is an unavoidable impact to the species. Impacts will be determined through pre-clearance surveys. Species that are also listed as MNES are not included in the list of NC Act Flora.

7.6 Preliminary Offset Requirements - State Significant Biodiversity Values

The Project will potentially impact on a number of SSBVs as discussed in Section 6 of this report. SSBVs are defined in Appendix 1 of the QBOP and those identified as likely to occur within the Project area are outlined in Table 7-3 and Table 7-5. The SSBVs and associated impacts for life of Project that may require offsetting are summarised below in Table 7-6.

Table 7-6 State Significant Biodiversity Values Potentially Impacted Within the Project Area

SSBV	Area potentially disturbed (ha)
Endangered REs	471.45
Endangered Grassland REs	0.5
Of concern REs	1,697.34
Of concern grassland REs	793.72
Critically Limited REs	0
Essential Habitat (mapped)	
Chalinolobus picatus	1.22
Dichanthium setosum	7.74
Cerbera dumicola	9.64
Eucalyptus raveretiana	4.39
Watercourses REs	
Stream order 1	316.92
Stream order 2	138.50
Stream order 3	178.53
Stream order 4	66.89
Stream order 5	87.59
Stream order 6	56.88
Stream order 8	1.36
Wetlands	NA*
Connectivity	TBD

* Under the framework approach constraints mapping , Arrow has made a commitment to avoid impacts to wetlands through implementation of buffers.

** Protected plant disturbance areas are provided as a guide. Endangered and vulnerable flora species will be offset if there is an unavoidable impact to the species. Impacts will be determined through pre-clearance surveys. Does not include plants that are also listed as MNES.

8 PRELIMINARY ASSESSMENT OF AVAILABILITY OF AFFECTED REGIONAL ECOSYSTEMS

The availability of REs on freehold land within the bioregion can determine whether offsets would be potentially available for the purposes of the project.

A full assessment of potentially available areas, along with a preferential list of potential offset sites will be provided with in the Bowen Gas Project Offset Implementation Plan to be developed.

A preliminary assessment has been performed on endangered and of concern REs that will be potentially impacted by project activities. These REs are analogous to many of the SSBVs and MNES (including TECs) outlined in this strategy. The area of potential impact to endangered and of concern REs was compared to the area of the same REs on freehold land in Table 8-1. Whilst offsets are usually provided by securing regrowth vegetation, this provides a starting point for the availability of the REs within the bioregion prior to performing a full analysis of available offset sites. Analysis of offset sites will incorporate a much higher level of detail incorporating potential availability of each MNES and SSBV. Offsets for the Project may be provided on a variety of land tenures.

The total area of each RE within the bioregion indicates that a suitable offset area will able to be located for the size of disturbance proposed, with the exception of RE 11.8.14 which only has 2.55 ha available on freehold land. It is recommended that any disturbance to RE 11.8.14 is avoided due to the limited availability of potential offset areas.

Table 8-1 Estimate of Potential Offset Areas within the Bioregion

RE Code	Potential Area of Disturbance (ha)	Estimate of RE on freehold land in Bioregion (ha)
Endangered Regional Ecosystems		
11.3.1	42.95	33,324.34
11.3.1b	1.11	96.46
11.3.11	0	781.81
11.3.21	0.5	24,735.03
11.4.1	0	351.61
11.4.7	0	14,459.88
11.4.8	35.64	14,358.79
11.4.9	175.90	31,366.65
11.4.9a	3.78	
11.4.9b	0.18	1,299.15
11.5.16	7.86	957.41
11.5.17	0.57	1,137.33
11.8.13	67.80	3,134.66
11.8.15	18.29	1,225.89
11.9.1	8.45	16,139.59
11.9.5	108.42	39,108.83
11.11.18	0	3,013.40

RE Code	Potential Area of Disturbance (ha)	Estimate of RE on freehold land in Bioregion (ha)
Of Concern Regional Ecosystems		
11.3.2	288.27	162,814.60
11.3.2b	0.75	54.47
11.3.3	27.16	114,645.92
11.3.3a	0	114,645.92
11.3.3c	0.5	595.22
11.3.4	107.03	71,137.08
11.3.36	0.01	356.80
11.4.2	82.84	17,557.33
11.4.4	3.45	7,188.30
11.4.11	0	7,104.97
11.5.18	6.62	1,573.09
11.7.1	2.53	37,454.61
11.8.3	4.35	12,071.12
11.8.11	793.72	115,650.44
11.8.14	0.66	2.55
11.9.4a	12.06	12,565.85
11.9.7	0.01	12,265.79
11.9.7a	285.54	13,402.58
11.9.10	35.18	20,976.60
11.9.13	36.21	10,110.63
11.10.8	10.45	2,016.37

9 APPROACH FOR PROVIDING OFFSETS

This environmental offset strategic management plan provides a high level analysis of impacts on biodiversity values within the Project.

Queensland and Australian government policies allow a range of options for offsets including direct and indirect offsets, funding arrangements for research and managing offsets obtained by brokerage or banking services. These options have informed Arrow's preferred hierarchy to deliver offsets.

Arrow has developed the environmental framework to address the uncertainty inherent CSG field development (Section 7) of the EIS. The framework includes a constraints mapping planning tool (Appendix BB) of the EIS to guide site and route selection; the key objective being to avoid sensitive environmental values. Estimating an upfront offset based on estimated disturbance to identified environmental values does not incentivise avoidance as promoted by the Framework approach.

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.

As part of the staged approach, estimated impacts are reconciled against actual impacts and the balance accrued against the values actually offset. The above steps are further detailed in the sections below.

9.1.1 Estimating Disturbance

Inherent inaccuracy in RE mapping and the preliminary nature of the conceptual field development plan used to estimate the area of disturbance presented in the SREIS necessitates reviewing preliminary estimates (in consultation with EHP and the Department of the Environment) to agree an area of disturbance for significant impacts to the communities and species.

The agreed estimate of the area of disturbance will be adopted as the upper limit of disturbance authorised under Queensland and Australian government conditions of approval for the Project. It will inform the estimate of values potentially required to be offset for the Project. Values presented within this strategy will not necessarily be offset, as there is no requirement under the current policy. This may include threatened flora species where there is no impact to the species.

9.1.2 Demonstrating Avoidance

Field development planning is the first step in avoiding mapped environmental values. Preclearance surveys will be undertaken to confirm and quantify the actual unavoidable disturbances to sensitive environmental values.

Where unavoidable disturbance within threatened communities and habitat for threatened species is likely, a review of the offset obligations against the estimated area of disturbance will be undertaken. This staged process will also be used to demonstrate Arrow's avoidance of loss of threatened communities and habitat for threatened species on an annual basis.

9.2 Offset Sites

Arrow will comply with the conditions of the respective offset policies and any other conditions of approval relating to offsets. It is prudent to consider offset options that may provide cost efficiencies to the company and promote better environmental outcomes from the Project. Arrow also seeks to deliver offsets that provide opportunities for strategic, landscape-scale, decision making around whole of project offset liabilities. Offset options will be considered that will allow for advanced offsets, thus allowing Arrow's multiple project offset requirements to be grouped together if possible. This has the potential to improve the environmental benefit of the outcome, due to the scale of the offset (reduced deleterious effects from edge effects). Any method or arrangement to improve the efficiency of implementing offsets will be considered.

Arrow's preferred hierarchy for the delivery of offsets to fulfil its offset obligations is to source properties in which the government has a biodiversity interest, as this option requires fewer management inputs than other options over the life of the offset. The delivery of this type of offset may be as a nature refuge, additional national park estate, or the purchase of a property where the long term management can be passed to another party (such as the landholder). This method allows for multiple offsets to be grouped and to be used in a staged approach to the delivery of offsets. This staged approach is outlined in Figure 9-1.

The approach outlined above is a pragmatic way to manage the delivery of offsets in conjunction with a staged offset approach, thus mitigating the inherent inaccuracy in data used to inform the estimate of area of disturbance and the uncertainty associated with the incremental nature of CSG development.

It is noted that as field development progresses, prediction of likely unavoidable impacts will become more accurate and greater certainty about the need for offsets in advance of the relevant reporting period will be possible. This will, in some instances, enable offsets to be secured in advance of actual losses and improve offset outcomes and calculations for offset requirements during later offset stages.

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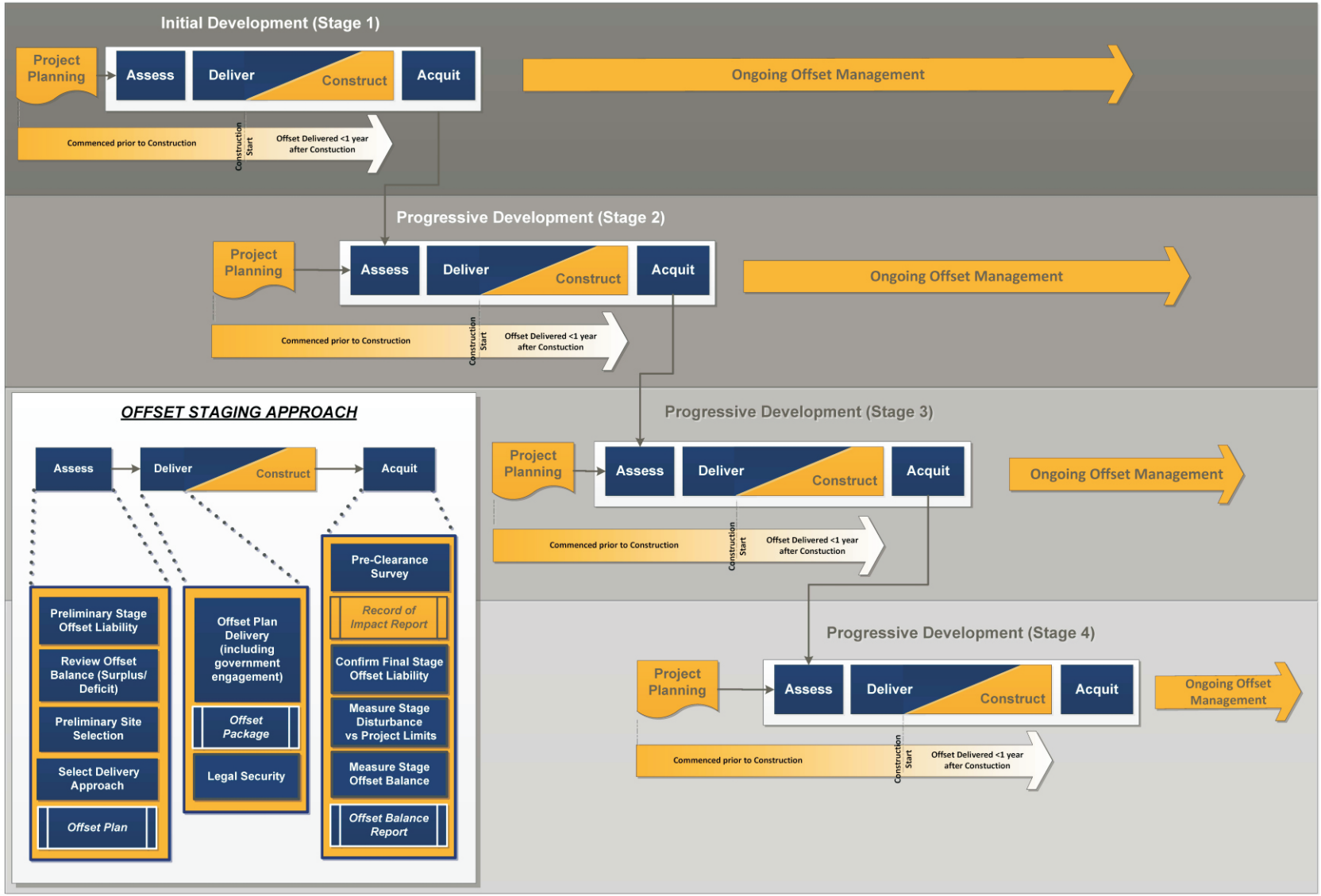

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BOWEN GAS PROJECT SREIS

ARROW'S STAGED APPROACH TO DELIVER OFFSETS

URS

OFFSET STRATEGY TECHNICAL REPORT

Figure: 9-1

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10 DEVELOPMENT OF OFFSET

Arrow will continue to develop their offset strategy and offset implementation plan in consultation with the relevant assessment agencies. This is particularly important as offset legislation and associated policies are expected to change, therefore flexibility is necessary.

Discussions will further define how the staged approach will be implemented effectively and offset requirements for Phase 1 will be finalised. This may include discussions with both federal and state agencies in order to determine the best outcome for the provision of offsets whilst meeting legislative requirements.

Further GIS analysis will be performed to identify the most suitable areas for offsets in accordance with Arrow's offset strategy as well as state and federal offset policies.

An Offset Implementation Plan will be developed for the Bowen Gas Project that provides further analysis on the Project's offset requirements and confirmation of Stage 1 offset requirements. The ability to co-locate offset values will be explored and identification of preferred offset sites. Assessments under the EPBC Act Environmental Offsets Policy applying the 'How to Use the Offsets Assessment Guide' for MNES will also be completed. The Bowen Gas Project Offset Implementation Plan will be finalised and submitted to regulators prior to Project commencement.

11 LIMITATIONS

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