



D5 | **Nature Conservation
and Land Access**

Environmental Constraints Mapping
and Field Management Protocols

EPBC Listed Fauna Species Habitat
Mapping

Potential Impacts Analysis and
Offsets Strategy



Report

GLNG CSG field

Supplementary Assessment of Potential Impact to
Ecological Values

NOVEMBER 2009

Prepared for
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1 Part 1: Introduction

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Reference: 42626459/1/C

Status: Final

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Part 2 - Environmental Constraints Mapping and Field Management Protocols

Appendix A Impact Avoidance and Mitigation

Appendix B Field Survey Methodology

Part 3 - EPBC Listed Fauna Species Habitat Mapping

Appendix A EPBC-listed fauna summary notes for each CSG field

Part 4 - Potential Impacts Analysis and Offsets Strategy

Appendix A EPBC-listed threatened communities and analogous REs

Abbreviations

Abbreviation	Description
CSG	Coal Seam Gas
Cwlth	Commonwealth
DERM	Queensland Department of Environment and Resource Management
DEWHA	Department of the Environment, Water, Heritage and the Arts
DME	Department of Mines and Energy
DNRW	Queensland Department of Natural Resources and Water (now part of DERM)
DPIF	Department of Primary Industries and Fisheries
EIS	Environmental Impact Statement
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERE	Endangered Regional Ecosystem
ESA	Environmentally Sensitive Areas
EVR	Endangered, Vulnerable or Rare species
FPC	Foliage Projection Cover
GLNG	Gladstone Liquefied Natural Gas
Ha	Hectares
IUCN	International Union for Conservation of Nature
LNG	Liquefied Natural Gas
M	Metres
Mm	Millimetres
MNES database	Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) Matters of National Environmental Significance database
NC Act	Queensland <i>Nature Conservation Act 1992</i>
NP	National Park
NSW	New South Wales
NT	Northern Territory
RE	Regional Ecosystems
RFDA	Reasonably Foreseeable Development Area
SF	State Forest
SPRAT	Species Profiles and Threats
Qld	Queensland
VM Act	Queensland <i>Vegetation Management Act 1999</i>
WA	Western Australia

Part 1: Introduction

1.1 Purpose

The purpose of this report is to outline the supplementary assessment of the potential impacts of the development on the ecological values of the CSG fields which has been undertaken in response to the submissions received on the EIS.

1.2 Background

The GLNG EIS indicates the large area intended for coal seam gas exploration (CSG fields). The CSG Fields will be developed for the production of approximately 5,300 petajoules (PJ) of CSG. This will involve the development of up to approximately 2,650 exploration and production wells. It is anticipated that up to 1,200 wells will be established prior to 2015, with potential for up to 1,450 or more additional wells after 2015. Additional supporting infrastructure including field gathering lines, nodal compressor stations, centralised compression and water treatment facilities, accommodation facilities, power generation and water management facilities will also be installed. The field development for the GLNG Project is initially expected to be within the RFD Area.

The detailed nature of the development of the CSG Fields is described in section 3.6.2 of the EIS. In summary, the development involves a rolling program of construction, operation and decommissioning of CSG infrastructure over a large area and a significant length of time. Because of the nature of the CSG exploration, the planning for field development, including the specific locations of exploration and development wells and associated infrastructure is determined incrementally based on the outcome of ongoing exploration programs.

Initial development in any one area will begin with a small number of wells increasing over time (several years). In addition, the road network will expand to provide access to each well and water and gas gathering lines will be established. Once sufficient wells are developed, nodal compressor stations will be established and the centralised compression and water treatment facilities developed. As the wells are utilised and become depleted, they are then decommissioned over time and the area rehabilitated.

The main potential impact on ecological values of from the development of the CSG Fields will arise from the clearing of vegetation and potential fauna habitat required for the wells and associated infrastructure. The clearing will progress incrementally over the life of the GLNG Project consistently with the expansion and contraction of the well and associated infrastructure network. Reduction of disturbance from CSG field development will be employed by a number of means, and in particular in situations where 'pad drilling' can be utilised by drilling multiple well holes from one pad utilising directional drilling techniques. The cleared areas will be rehabilitated as the well and infrastructure is decommissioned over time.

Due to the vast coverage and nature of CSG production within the CSG Fields, the precise location of the wells and associated infrastructure can not be known at this time. To enable initial identification of potential ecological values within the CSG fields and assessment of potential impacts, the EIS incorporated a desktop study of current ecological values with ground-truthing field surveys to produce an assessment of likely impacts from typical project elements (including wells, pipelines, gas processing facilities, water gathering pipelines and other associated infrastructure). The EIS contemplated undertaking a Phase 2 assessment which would include constraints mapping and site scouting procedures after the EIS and before construction of the individual wells commenced. Some

1 Part 1: Introduction

of the submissions received during public exhibition of the EIS requested further impact assessment are undertaken before the Coordinator-General Report is prepared.

In response to the public submissions, Santos has undertaken a supplementary assessment of the potential impact of the development of the CSG fields on ecological values of the area. The supplementary assessment has comprised the following key elements:

- **Constraints mapping** – a detailed analysis of the ecological values of the Reasonably Foreseeable Development Area (RFDA) within the CSG fields having regard to augmented desktop and field datasets;
- **Constraints classes** – identification and mapping of five classes of land within the RFDA with graduated levels of ecological sensitivity based on the constraints mapping;
- **Field Management Protocol** – development of a field management protocol which describes the nature of development which may be undertaken within each of the constraints classes, the process to settle the specific location of the development within each constraints class having regard to the ecological values of the area and mitigation measures. The field management protocol has also been developed for other environmental values;
- **Field Development Plan** – identification of a field development plan (FDP) for the RFDA with preliminary locations for the wells and associated infrastructure;
- **Supplementary Impact Assessment** - an evaluation of potential impacts on ecological values of the development of the CSG fields based on three scenarios derived from implementation of the field management protocol to the field development plan;
- **Mitigation Measures** – identification of mitigation measures additional to measures outlined in the EIS; and
- **Offset Strategy** – outlining the basis of an Environmental Offset Management Strategy to offset ecological values impacted by the GLNG Project by offsite measures (such as property acquisition, covenants and reserve dedications).

These key elements of the supplementary assessment are outlined in Figure 1-1 and the features of these elements are described below.

1.3 Constraints Mapping

1.3.1 Primary Constraints Maps

Santos has undertaken detailed constraints mapping of the RFDA within the CSG Fields (Part 2 of this report). The constraints mapping has used detailed datasets which have been collated and assessed as part of the EIS process for the GLNG Project. The datasets include both desktop and field data. The datasets used were:

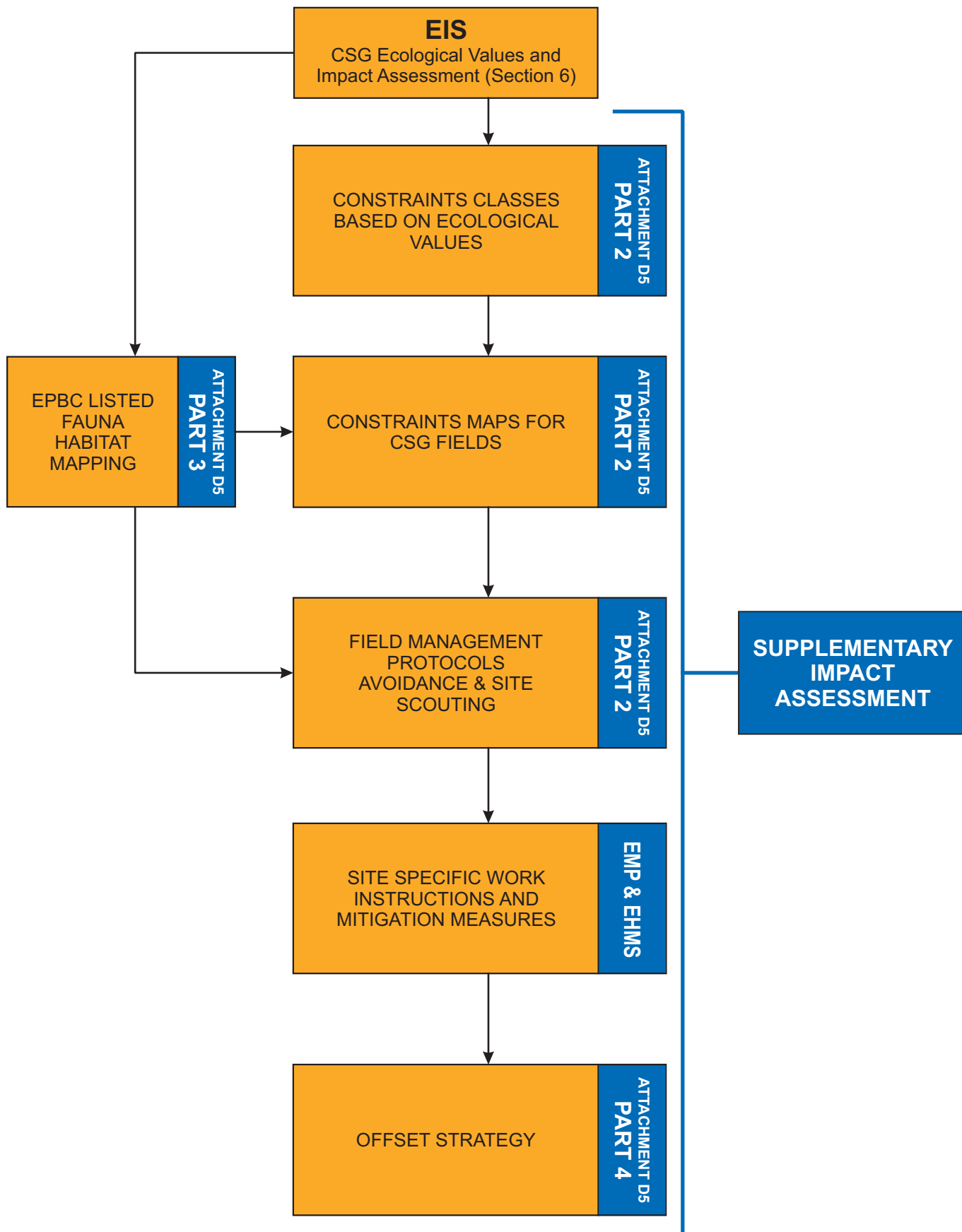
- Essential Environmentally Sensitive Areas (ESAs);
- Regional Ecosystem Mapping v5.2;
- EPBC-listed threatened ecological communities;
- Queensland Directory of Important Wetlands;
- Essential Habitat Mapping;
- Bioregional Corridors Mapping; and
- Field surveys undertaken for the EIS which survey representative areas of significant flora and fauna habitat within the RFDA Area (presented in Appendix N1 of the EIS).

1 Part 1: Introduction

The detail of the datasets used to derive the constraints mapping are presented in Part 2 of this report: Ecological Constraints Mapping & Field Management Protocols.

1.3.2 Fauna Habitat Maps

Santos has also developed a further layer of constraints mapping based on potential habitat for fauna species listed under the EPBC Act within the RFDA Area. The maps and process for developing the threatened fauna habitat constraints maps are detailed in Part 3 of this report: EPBC Listed Fauna Species Habitat Mapping.



Client 	Project GLADSTONE LNG PROJECT - EIS SUPPLEMENT ATTACHMENT D5 PART 1 SUPPLEMENTARY ASSESSMENT OF POTENTIAL IMPACTS TO CSG FIELD ECOLOGICAL VALUES	Title CSG FIELD SUMMARY OF SUPPLEMENTARY IMPACT ASSESSMENT		
	Drawn: LL	Approved: JB	Date: 09-11-2009	Figure: 1-1
	Job No.: 4262 6440 /6220	File No. 42626440-g-2179.cdr	Rev. B A4	

1 Part 1: Introduction

1.4 Constraints Classes

Santos has developed five classes of land within the RFDA with graduated levels of ecological sensitivity (constraints classes) based on the constraints mapping. The five classes of land are, in general terms:

- **Class A** – National parks and Wetlands of International Importance (there are no such wetlands in the RFDA);
- **Class B** – Environmentally sensitive areas categories B and C including state forests, “endangered” REs, EPBC listed communities and waterways and wetlands;
- **Class C** – “Of concern” REs and essential habitat;
- **Class D** – “Not of concern” REs; and
- **Class E** – Non-remnant vegetation - generally modified habitats such as agricultural lands, grazing lands, residential lands or regrowth vegetation.

The detail of the constraints classes are presented in Part 2 of this report.

1.5 Field Management Protocols

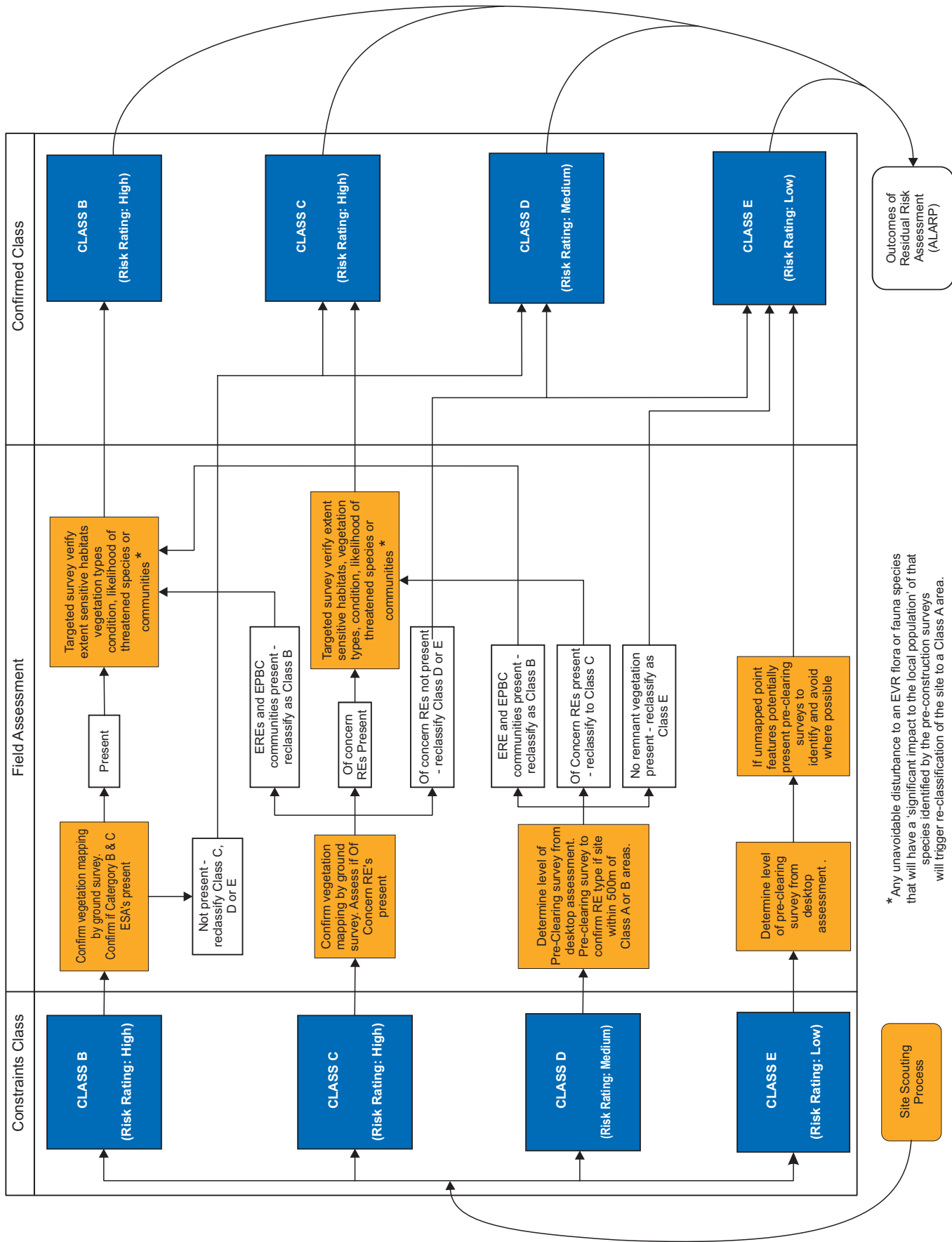
Santos has developed field management protocols for the management of ecological impacts within each of the five constraints classes. The field management protocols which will be implemented by Santos when undertaking the development of the CSG fields on land within each of the five constraints classes to reduce the impact of the GLNG Project on the ecological values of the CSG field.

The Field Management Protocols for each of the five constraints classes set out:

- a) The nature of the development which are proposed to be undertaken within each constraints class. (for example, development will not be carried out in Class A lands);
- b) The process to be undertaken to settle the specific location of the development within each constraints class having regard to the local ecological values of the area. (for example, undertaking pre-construction surveys); and
- c) The mitigation measures which will be implemented to minimise the impact of the development on the ecological values of the area (for example, selecting a specific site on land of a lower constraints class).

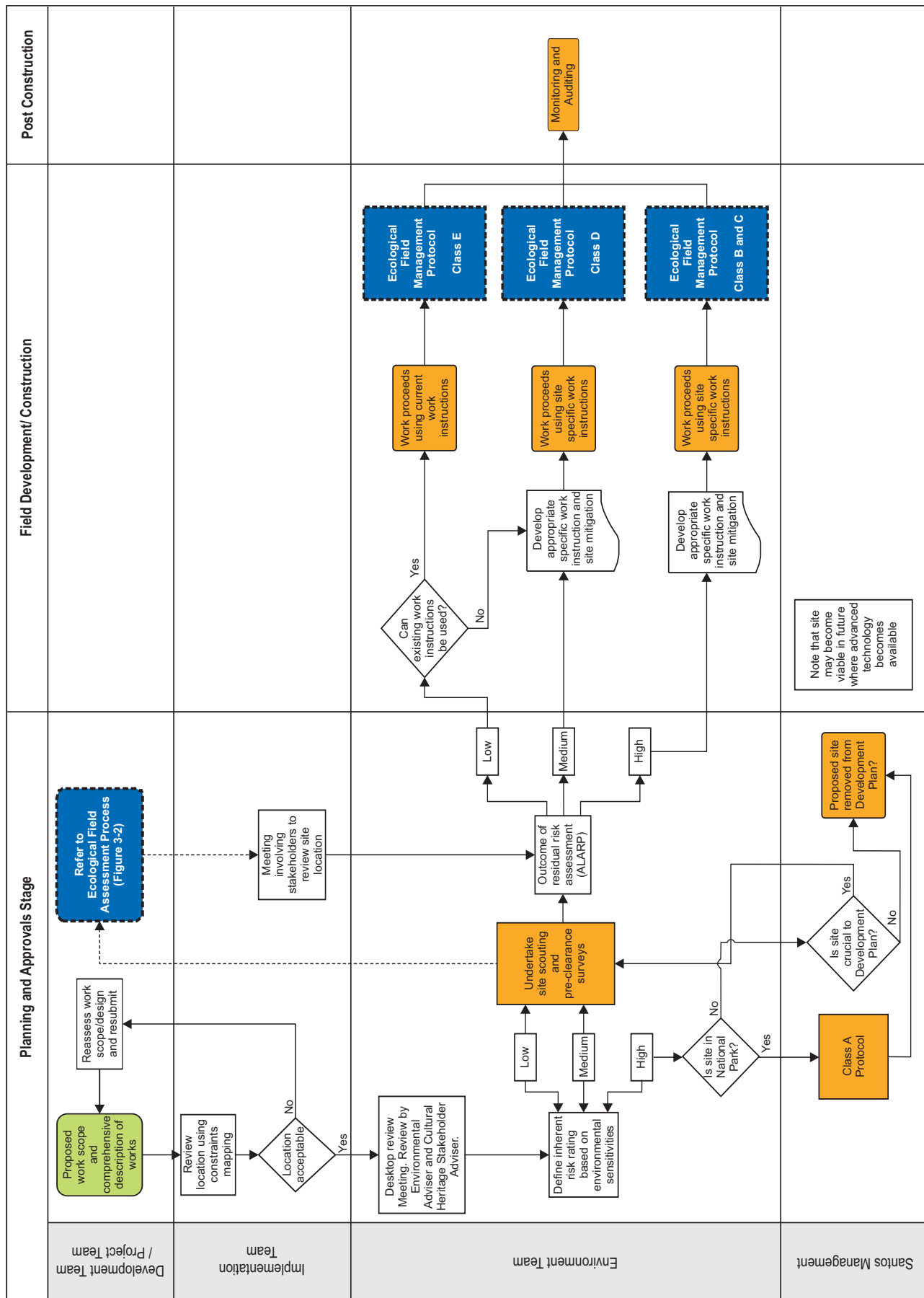
The field management protocols for each of the five constraints classes are presented in Part 2 of this report.

A flow chart of the ecological field management protocol is provided in Figure 1-2. The ecological field management protocol forms part of an overall environmental planning and field management protocol which has regard to other environmental values such as cultural heritage, soil and social values. A flow chart of the overall environmental planning field management protocol and relationship with the ecological field management protocol is Figure 1-3. A description of the field management protocol so far as it applies to other environmental values is presented in Part 5 of this report.



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Client 	Project GLADSTONE LNG PROJECT - EIS SUPPLEMENT ATTACHMENT D5 PART 1 SUPPLEMENTARY ASSESSMENT OF POTENTIAL IMPACTS TO CSG FIELD ECOLOGICAL VALUES	Title CSG ECOLOGICAL FIELD MANAGEMENT PROTOCOL	
	Drawn: VH Approved: JB Date: 09-11-2009 Job No.: 4262 6440 /6220 File No. 42626440-g-2181.cdr	Figure: 1-2 Rev. A A4	



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GLADSTONE LNG PROJECT - EIS SUPPLEMENT
ATTACHMENT D5 PART 1
SUPPLEMENTARY ASSESSMENT
OF POTENTIAL IMPACTS TO
CSG FIELD ECOLOGICAL VALUES

Drawn: VH

Approved: JB

Date: 09-11-2009

Job No.: 4262 6440 /6220

File No. 42626440-g-2180.cdr

Title

CSG FIELD
ENVIRONMENTAL PLANNING
AND MANAGEMENT PROTOCOL

Figure: 1-3

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1 Part 1: Introduction

1.6 Field Development Plan

Santos has prepared a proposed field development plan for the development of the CSG Fields within the Reasonably Foreseeable Development Area (RFDA). The field development plan outlines nominal locations for the development wells and associated infrastructure.

The field development plan represents Santos' currently proposed development within the RFDA but will change incrementally over the life of the GLNG Project within the RFDA as the gas field develops and from the implementation of the Field Management Protocols. The field development plan nonetheless presents a reasonable basis for undertaking an impact assessment of the GLNG Project.

1.7 Supplementary Impact Assessment

Santos has undertaken a supplementary assessment of potential impacts on ecological values of the development of the CSG fields. This has involved:

- Overlaying the proposed field development plan on the constraints maps;
- Assessing the extent of potential affectation on the ecological values of the CSG fields based on three scenarios; and
- Assessing the broader impacts of the development of the CSG fields on the ecological values in the RFDA including for example fragmentation effects.

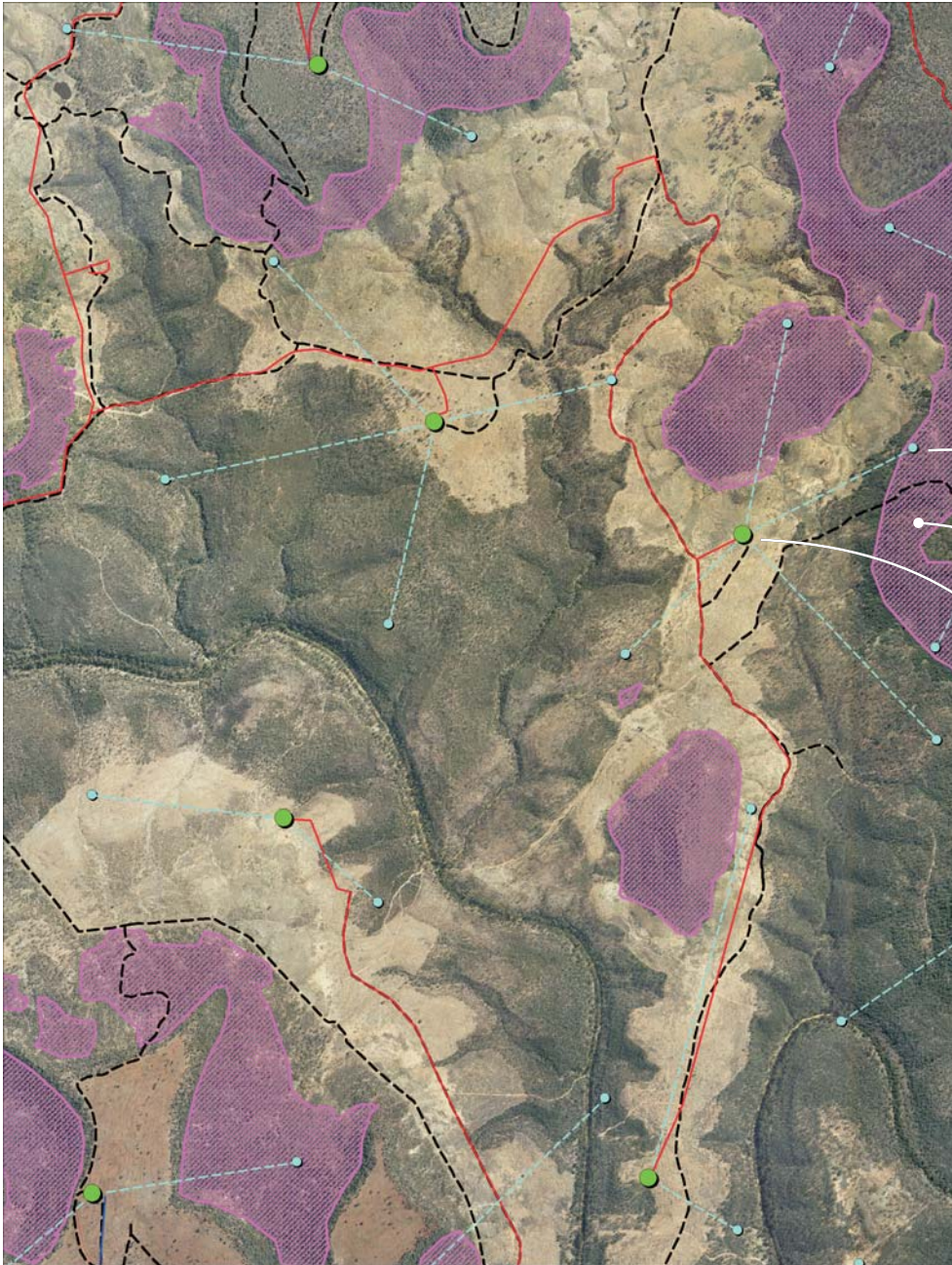
The three development scenarios considered in the impact assessment are:

- **Scenario 1 - Pre-Avoidance & Mitigation** – this scenario is based on a calculation for clearance of vegetation for development and associated infrastructure on the assumption that each well hole identified in the FDP will have an associated pad located on the surface. This scenario will not occur in practice because Santos proposes to incorporate multiple drill holes from single well pads (pad drilling) where technically feasible. This means that the amount of surface pads and associated infrastructure (such as roads) on the surface is significantly reduced. The pre-avoidance and mitigation scenario is presented for completeness;
- **Scenario 2 - Reasonable Worst Case** – this scenario is based on calculations for FDP well locations within the RFDA that can incorporate multiple drill holes from one pad (pad drilling). This calculation is projected over the FDP but takes into consideration pad drilling to be being undertaken where technically feasible. It is expected that pad drilling will be technically feasible in the majority of wells and only unavailable in a small minority of circumstances due to localised geological features. It is conservatively assumed for scenario two that pad drilling be technically feasible so as to reduce the surface area required by 75 % in the RFDA;
- **Scenario 3 - Reasonable Best Case** – this scenario is based on the calculations for Scenario 2, but also incorporates the consideration of opportunities for impact avoidance utilising the Field Management Protocol to identify specific locations to minimise vegetation clearing and habitat impact. It is conservatively assumed for scenario 3 and a reduction of impacts by up to 70 % of area of vegetation disturbance and impacts to EPBC listed flora and fauna habitats.

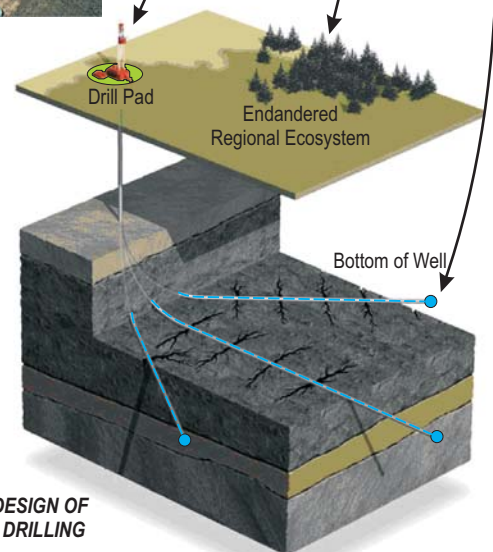
The assessment estimates the area of the different kinds of vegetation and threatened species which are likely to be impacted under each of the scenarios. A conceptual diagram of the three scenarios in practice is provided in Figure 1-4.

The supplementary impact assessment is detailed in Part 4 of this report: Impacts Analysis & Environmental Offset Strategy.

EXAMPLE AREA OF FAIRVIEW CSG PRELIMINARY FDP



- Drill Pad
- Bottom of Well
- Endangered Regional Ecosystem
- HDD Drill Hole
- Roads/Tracks
- Pipelines



CONCEPTUAL DESIGN OF
WELL PAD HDD DRILLING

Client



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GLADSTONE LNG PROJECT - EIS SUPPLEMENT
ATTACHMENT D5 PART 1
SUPPLEMENTARY ASSESSMENT
OF POTENTIAL IMPACTS TO
CSG FIELD ECOLOGICAL VALUES

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Approved: JB

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File No. 42626440-g-2182.cdr

Title

**EXAMPLE OF
IMPACT AVOIDANCE
EMPLOYING PAD DRILLING**

Figure: **1-4**

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1.7.1 Mitigation Measures

Santos proposes to employ mitigation measures to reduce the impact of the development of the CSG fields on ecological values. The mitigation strategies are outlined in EIS Section 6.4 and EIS Appendix N1 with specific measures detailed in the revised CSG EMP (Attachment B1).

1.7.2 Offset Strategy

A specific Environmental Offset Management Strategy for the whole of the GLNG Project is being developed by Santos in an iterative process with State and Commonwealth regulatory bodies and in conjunction with Ecofund Queensland (a state advisory service).

The purpose of the Environmental Offset Management Strategy is to outline the process by which Santos will facilitate the protection and enhancement of the ecological values impacted by the GLNG Project by offsite measures (such as property acquisition, covenants and reserve dedications).

The specific aims of the GLNG Offset Management Strategy include:

- Identification of suitable offset options;
- Landholder liaison and negotiation to secure required offsets;
- Assessment of properties;
- Offset validation and preparation of specific Biodiversity Offset Management Plan(s); and
- Liaison to finalise contractual arrangements and covenants.

The Offset Management Strategy being developed by Santos includes exploration of suitable offset options; examination of a number of options under both a 'traditional' approach to address legislative requirements, as well as options under a 'strategic' approach to maximise environmental gains and are further outlined in detail within the Gladstone LNG Environmental Offset Strategy (Ecofund, 2009). Further details of the CSG Offset Management Strategy are contained in Part 4 of this report.

Part 2: Environmental Constraints Mapping and Field Management Protocols



Report

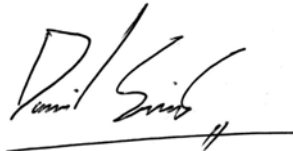
Part 2 Ecological Constraints Mapping and Field Management Protocols

NOVEMBER 2009

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Appendices

Appendix A Impact Avoidance and Mitigation

Appendix B Field Survey Methodology

Abbreviations

Abbreviation	Description
CSG	Coal Seam Gas
Cwlth	Commonwealth
DERM	Queensland Department of Environment and Resource Management
DME	Department of Mines and Energy
DNRW	Queensland Department of Natural Resources and Water (now part of DERM)
DPIF	Department of Primary Industries and Fisheries
EIS	Environmental Impact Statement
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERE	Endangered Regional Ecosystem
ESA	Environmentally Sensitive Areas
EVR	Endangered, Vulnerable or Rare species
FPC	Foliage Projection Cover
GLNG	Gladstone Liquefied Natural Gas
LNG	Liquefied Natural Gas
MNES database	Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) Matters of National Environmental Significance database
NC Act	Queensland <i>Nature Conservation Act 1992</i>
RE	Regional Ecosystems
RFDA	Reasonably Foreseeable Development Area
SF	State Forest
Qld	Queensland
VM Act	Queensland <i>Vegetation Management Act 1999</i>

Introduction

1.1 Background

The purpose of this report is to detail the broad-scale constraints mapping within the CSG fields which has been undertaken to supplement the ecological impact assessment of the CSG field component of the GLNG Project.

This report:

- (a) Describes the datasets which were used to identify and map five classes of land with different levels of ecological sensitivity (constraints classes). The datasets are described in Section 1;
- (b) Describes the five types of constraints classes for the CSG fields. The constraints classes are described in Section 2;
- (c) Maps the location of each of the constraints classes for the CSG fields. The maps are depicted in Section 2; and
- (d) Describes the field management protocols which will be implemented by Santos when undertaking the development of the CSG fields on land within each of the five constraints classes. The protocols are detailed in Section 3.

The supplementary assessment of the impact of the GLNG Project on the ecological values of the CSG field based on implementation of the protocols within the constraints classes is presented in, Part 4.

1.2 Approach

An approach was sought that utilised accessible, current, and reliable available data sources, to produce a practical and 'user friendly' product. An initial evaluation of available datasets was undertaken, scrutinising each dataset for suitability of use in isolation and combined with other layers (Section 1). Suitable datasets were then presented in combinations to formulate a series of constraints classes based on varying degrees of environmental values and sensitivities (Section 2). A number of management strategies have been formulated with practical prescriptions for on the ground management and confirmation of sensitive environmental values and constraints (Section 3).

1.3 Data Layers

A range of data layers and the results from field surveys (EIS Appendix N1) were used to compile the constraints classes (Section 2) used to formulate this mapping. The data layers utilised include:

- Environmentally Sensitive Areas (ESAs);
- Regional Ecosystem Mapping v5.2;
- EPBC-listed threatened communities;
- Queensland Directory of Important Wetlands;
- Essential Habitat Mapping; and
- Bioregional Corridors Mapping.

All datasets are products of the Queensland Department of Environment and Resource Management (DERM). Details of the datasets are explained below.

1 Introduction

1.3.1 Environmentally Sensitive Areas

Category A and B Environmentally Sensitive Areas (ESAs) are defined in the *Environmental Protection Regulation 2008*. These are displayed in Table 1-1 and Table 1-2 respectively, below. Category A and B ESAs were utilised as they are enshrined in Queensland Legislation and are easily applied as most are based on land tenure. The other classifications are areas mapped by the State Government. The classifications refer to designations of higher levels of protection and management and thus give an automatic and easily identifiable indication of the sensitivity of these areas.

Category C ESAs are defined in the DERM *Draft Code of Environmental Compliance for Level 2 Petroleum Activities*. These are displayed in Table 1-3, below. These are automatically inferred as having a lower sensitivity than Category A and B ESAs and can be used to apply a lesser level of management or monitoring.

In Queensland, petroleum activities can be undertaken in category B and C ESAs. Petroleum activities may not be undertaken in land comprising Category A ESAs such as national parks. National Parks cover a significant portion of the Fairview and Arcadia CSG fields.

Category A ESAs

Table 1-1 Category A Environmentally Sensitive Areas

LAND AREA CLASSIFICATION	ADMINISTERING LEGISLATION	ADMINISTRATING AUTHORITY
National Parks (Scientific); National Parks; National Parks (Aboriginal Land); National Parks (Torres Strait Islander Land); National Parks (Recovery); and Conservation Parks.	<i>Nature Conservation Act 1992.</i>	Department of Environment and Resource Management (DERM).
Wet Tropics Wet Tropics.	<i>World Heritage Protection and Management Act 1993.</i>	Wet Tropics Management Authority.
Restricted Areas (includes Constructed Water Reservoirs).	<i>Mineral Resources Act 198.9</i>	Department of Mines and Energy (DME).
Great Barrier Reef Marine Park Region.	<i>Great Barrier Reef Marine Park Act 1975 (Cwlth).</i>	Great Barrier Reef Marine Park Authority.
Marine Parks (other than general use zones).	<i>Marine Parks Act 1982 (Qld).</i>	DERM.

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Category B ESAs

Table 1-2 Category B Environmentally Sensitive Areas

LAND AREA CLASSIFICATION	ADMINISTERING LEGISLATION	ADMINISTRATING AUTHORITY
Coordinated Conservation Areas; Wilderness Areas; World Heritage Management Areas; International Agreement Areas; An area of Critical Habitat; or Major Interest identified under a Conservation Plan; Areas subject to an Interim Conservation Order; and Forest Reserves.	<i>Nature Conservation Act 1992.</i>	DERM.
An area subject to following conventions: (a) Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 23 June 1979); (b) Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar, 2 February 1971); and (c) Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 16 November 1972).	International Conventions.	DERM.
General Use Zones of a Marine Park	<i>Marine Parks Act 1982.</i>	DERM.
An Area to the Seaward Side of the Highest Astronomical Tide	Nil.	DERM.
Place of Cultural Heritage Significance; Protected Area; Registered Places; and Restricted Zone.	<i>Queensland Heritage Act 1992.</i>	DERM.
Designated Landscape Area (other than the area known as the 'Stanbroke Pastoral Holding').	<i>Cultural Record (Landscapes Queensland and Queensland Estate) Act 198.7</i>	.DERM.
Feature Protection Area, State Forest Park or a Scientific Area.	<i>Forestry Act 1959.</i>	Department of Natural Resources and Water (DNRW).
Fish Habitat Area; and A place in which a Marine Plant is situated.	<i>Fisheries Act 1994.</i>	Department of Primary Industries and Fisheries (DPIF).
Endangered Regional Ecosystems; and An area of High Nature Conservation Value.	Nil.	DERM.

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Category C ESAs

Table 1-3 Category C Environmentally Sensitive Areas

LAND AREA CLASSIFICATION	ADMINISTERING LEGISLATION	ADMINISTRATING AUTHORITY
Nature Refuges and Resource Reserves.	<i>Nature Conservation Act 1992.</i>	DERM.
Koala Habitat Area.	<i>Nature Conservation (Koala) Conservation Plan 2006.</i>	DERM.
An area identified as essential habitat by the DERM for a species of wildlife listed as endangered, vulnerable, near threatened or rare under the <i>Nature Conservation Act 1992</i> .	<i>Nature Conservation Act 1992.</i>	DERM.
Declared Catchment Areas.	<i>Water Act 2000.</i>	DNRW and/or Relevant Storage Operator or Board.
River Improvement Areas.	<i>River Improvement Trust Act 1940.</i>	DNRW and the Relevant River Trust.
Former Designated Landscape Area - Stanbroke Pastoral Holding.	<i>Aboriginal Cultural Heritage Act 2003.</i>	DERM.
Areas under Part 5 Division 2 of the Aboriginal Cultural Heritage Act 2003 and Torres Strait Islander Cultural Heritage Act 2003.	<i>Aboriginal Cultural Heritage Act 2003.</i> <i>Torres Strait Islander Cultural Heritage Act 2003.</i>	DNRW.
State Forest or Timber Reserves.	<i>Forestry Act 1959.</i>	DERM.
DPIF Research Sites.	Nil.	DPIF.
Areas of land occupied by the Bureau of Sugar Experiment Stations.	<i>Sugar Industry Act 1999.</i>	DPIF.
Coastal Management Districts.	<i>Coastal Protection and Management Act 1995.</i>	DERM.
Declared Areas.	<i>Vegetation Management Act 1999.</i>	DNRW.
An area shown as a wetland on a 'map of referable wetlands'.	<i>Environmental Protection Act 1994.</i>	DERM.
Reserves under the <i>Land Act 1994</i> .	<i>Land Act 1994.</i>	DNRW.
An 'of concern' regional ecosystem identified in the database maintained by the EPA called 'Regional ecosystem description database' containing regional ecosystem numbers and descriptions.	Nil.	DERM.

1.3.2 Regional Ecosystem Mapping

The Queensland Government has mapped the remnant vegetation in Queensland as Regional Ecosystems (REs). REs are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil (Sattler and Williams, 1999). REs were derived from a broad range of existing information sources including land system, vegetation and geology mapping and reports. REs (biodiversity status) are listed as 'Endangered', 'Of

1 Introduction

Concern' and 'Not of Concern' depending upon remaining extent of the particular RE and factors such as disturbance and biodiversity loss (DERM, 2007).

REs were utilised as they form the standard vegetation mapping data in Queensland. The three levels of status also allow for an immediate appreciation of the sensitivity of the vegetation community.

1.3.3 EPBC-listed Ecological Communities

The EPBC Act provides for the listing of nationally threatened native species and ecological communities, native migratory species and marine species. It does this by the:

- Identification and listing of species and ecological communities as threatened;
- Development of conservation advice and recovery plans for listed species and ecological communities;
- Development of a register of critical habitat;
- Recognition of key threatening processes; and
- Where appropriate, reducing the impacts of these processes through threat abatement plans.

The EPBC Act list of Threatened Ecological Communities uses the categories of Vulnerable, Endangered, and Critically Endangered.

The GLNG EIS identified the potential presence of four 'Endangered' ecological communities in the northern CSG fields and four 'Endangered' and one 'Critically Endangered' ecological communities within the southern CSG fields as sourced from the Matters of National Environmental Significance (MNES) Report. These are:

Northern CSG Fields

Endangered Ecological Communities

- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin;
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions; and
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.

Southern CSG Fields

Endangered Ecological Communities

- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin;
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions; and
- The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.

Critically Endangered Ecological Community

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

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As detailed mapping for each of the threatened communities is not available, potential presence and mapping for communities within the CSG fields was determined through the extrapolation of equivalent REs as presented on the Listing Advice or Community Profiles accessible on the EPBC threatened communities webpage. Table 1-4, below, details the equivalent REs for the threatened communities listed above.

Table 1-4 EPBC-listed threatened communities and their equivalent REs

EPBC-listed Threatened Community Status	Corresponding Regional Ecosystems (within Bioregion 11 – Brigalow Belt)
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant). Endangered.	RE 11.3.1- <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains; RE 11.4.3- <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains; RE 11.4.7-Open forest of <i>Eucalyptus populnea</i> with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on Cainozoic clay plains; RE 11.4.8- <i>Eucalyptus cambageana</i> open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains; RE 11.4.9- <i>Acacia harpophylla</i> shrubby open forest with <i>Terminalia oblongata</i> on Cainozoic clay plains; RE 11.4.10- <i>Eucalyptus populnea</i> or <i>E. pilligaensis</i> , <i>Acacia harpophylla</i> , <i>Casuarina cristata</i> open forest on margins of Cainozoic clay plains; RE 11.5.16- <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest in depressions on Cainozoic sand plains/remnant surfaces; RE 11.9.1- <i>Acacia harpophylla</i> - <i>Eucalyptus cambageana</i> open forest on Cainozoic fine-grained sedimentary rocks; RE 11.9.5- <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on Cainozoic fine-grained sedimentary rocks; RE 11.9.6- <i>Acacia melvillei</i> ± <i>A. harpophylla</i> open forest on Cainozoic fine-grained sedimentary rocks; RE 11.11.14- <i>Acacia harpophylla</i> open forest on deformed and metamorphosed sediments and interbedded volcanics; and RE 11.12.21- <i>Acacia harpophylla</i> open forest on igneous rocks; colluvial lower slopes.
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin. Endangered.	RE 11.3.21 <i>Dichanthium sericeum</i> and/or <i>Astrebla</i> spp. grassland on alluvial plains - Cracking clay soils; RE 11.4.4 <i>Dichanthium</i> spp., <i>Astrebla</i> spp. grassland on Cainozoic clay plains; RE 11.4.11 <i>Dichanthium sericeum</i> , <i>Astrebla</i> spp. and patchy <i>Acacia harpophylla</i> , <i>Eucalyptus coolabah</i> on Cainozoic clay plains; RE 11.8.11 <i>Dichanthium sericeum</i> grassland on Cainozoic igneous rocks; RE 11.9.3 <i>Dichanthium</i> spp., <i>Astrebla</i> spp. grassland on fine-grained sedimentary rocks; RE 11.9.12 <i>Dichanthium sericeum</i> grassland with clumps of <i>Acacia harpophylla</i> on fine-grained sedimentary rocks; and RE 11.11.17 <i>Dichanthium sericeum</i> grassland on old sedimentary rocks with varying degrees of metamorphism and folding.

1 Introduction

EPBC-listed Threatened Community Status	Corresponding Regional Ecosystems (within Bioregion 11 – Brigalow Belt)
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions. Endangered.	RE 11.2.3-Microphyll vine forest ("beach scrub") on sandy beach ridges; RE 11.3.11-Semi-evergreen vine thicket on alluvial plains; RE 11.4.1-Semi-evergreen vine thicket ± <i>Casuarina cristata</i> 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- <i>Macropteranthes leichhardtii</i> 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- <i>Macropteranthes leichhardtii</i> 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.
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin. Endangered.	It should be noted that although this community was identified within the MNES, the only springs community mapped as an RE within the Brigalow Belt bioregion (RE 11.3.22 (Springs associated with recent alluvia) are <u>not</u> part of the listed ecological community.
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Critically Endangered.	In Queensland the ecological community is a primary component of the following REs within the Brigalow Belt bioregion: 11.8.2a- <i>Eucalyptus tereticornis</i> and <i>E. melliodora</i> occurring on low hills. Cainozoic igneous rocks; 11.8.8 <i>Eucalyptus albens</i> , <i>E. crebra</i> woodland on Cainozoic igneous rocks. Hillsides; and 11.9.9 <i>Eucalyptus crebra</i> woodland on fine-grained sedimentary rocks. It can also be a smaller component of the following regional ecosystem: 11.3.23, <i>Eucalyptus conica</i> , <i>E. nobilis</i> , <i>E. tereticornis</i> , <i>Angophora floribunda</i> on alluvial plains. Basalt derived soils.

The REs listed in Table 1-4, above, where present within the CSG fields, are used as surrogates for the EPBC-listed threatened communities.

1.3.4 Queensland Directory of Important Wetlands

Waterways and wetlands data has been used to map these important habitat features. As many of the streams within the CSG fields are ephemeral, only larger streams capable of retaining water for long have been mapped as these are most likely to support aquatic fauna such as the Murray Cod or birds such as the black-throated finch, whose range is constrained by the presence of permanent water. Data for waterways and wetlands has been sourced from the Queensland Directory of Important Wetlands.

1.3.5 Essential Habitat Mapping

Essential Habitat mapping identifies vegetation in which a species that is conservation significant has been known to occur or may potentially to utilise, based on known species range and distribution habitat. Essential Habitat mapping it has been utilised as a layer to make these locations obvious. It

1 Introduction

can be used as a trigger for a greater level of ground verification for conservation significant species, in particular the species for which the Essential Habitat mapping is centred on.

1.3.6 Bioregional Corridors

The Bioregional Corridors data is derived from Brigalow Belt Biodiversity Planning Assessment. The regional and state corridor data has been merged to form a single corridor layer. This has been applied over the CSG fields to indicate vegetation that is considered as significant for the movement of fauna and flora. It has been included as a guide to decision making where linear infrastructure such as tracks and pipelines may impact on the functionality of corridors.

1.4 Previous Survey Work

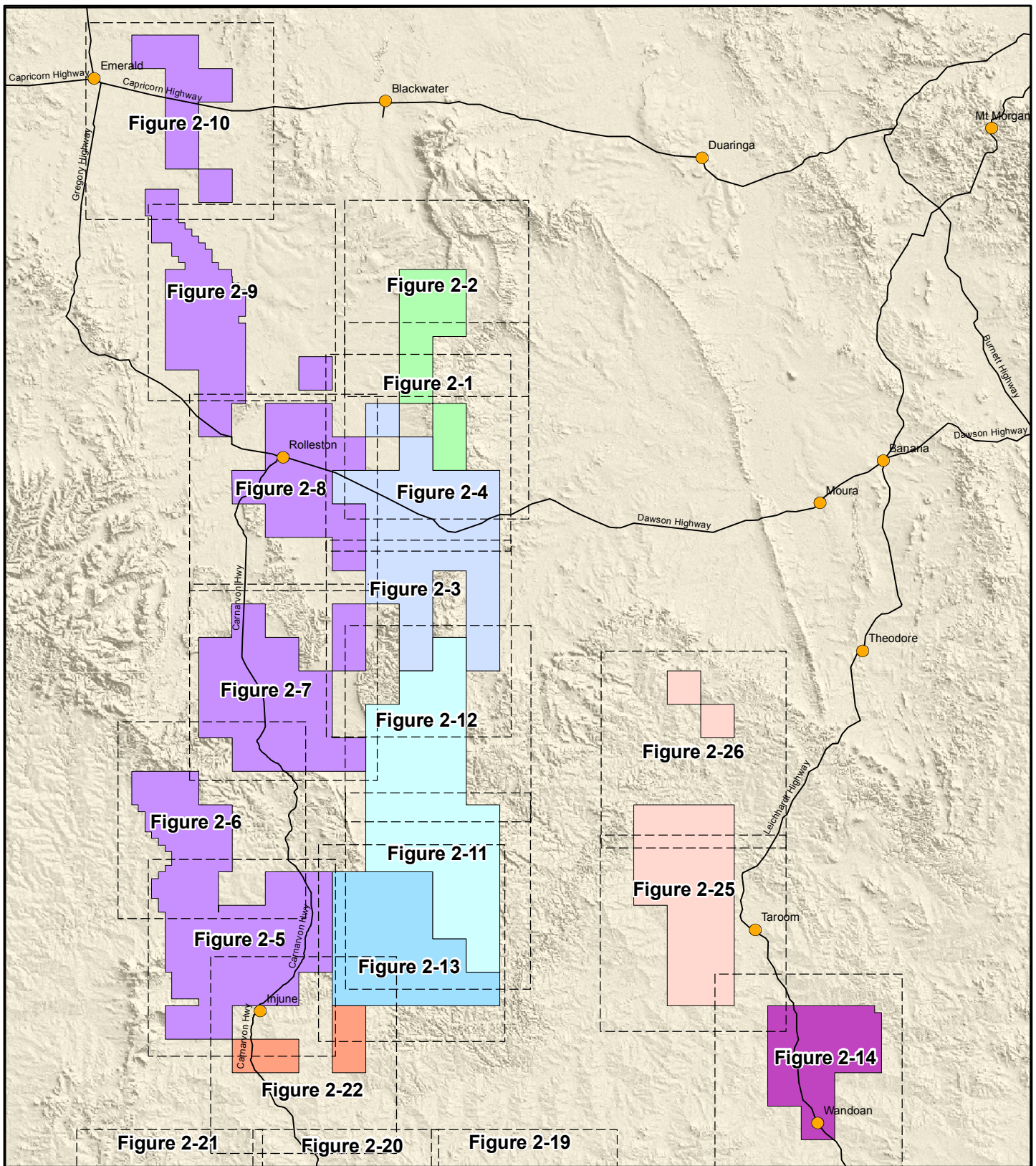
A series of flora and fauna habitat field surveys were conducted within targeted representative habitats of the Reasonably Foreseeable Development Area (RFDA) to characterise significant ecological values and verify the validity of current desktop data layers such as RE and Essential Habitat mapping (EIS Section 6 and EIS Appendix N1). A detailed description of habitat values for each of the individual CSG fields was then developed based on results from these survey results and a further detailed evaluation of desktop information and aerial photography (EIS Appendix N1, EIS Sections 4.2.6 and 4.2.7). Resulting habitat descriptions for each of the each of the CSG fields included a section detailing:

- Overall Description of landform;
- Diversity of habitat;
- Habitat Values for Fauna Assemblages;
- Corridor linkages;
- Previous Fauna records;
- Conservation Significant Species; and
- Pest species.

In addition, a summary of ecologically significant values for each individual CSG field based on results of field verification was also provided in table format in the EIS (EIS Appendix N1, EIS Sections 4.2.6 and 4.2.7) and included:

- Summaries of mapped REs; and
- Mapped significant REs and potentially present Endangered, Vulnerable and Rare (EVR) fauna and flora species.

A greater ecological understanding of the characteristic ecological values and conservation significant values of the RFDA was derived from these results and has been incorporated into the development of the ecological constraints classes (Section 2.1) and field protocols for constraints based management (Section 3.2). Figures 1-1 and 1-2 provide an overview of the constraints mapping in Section 2. The above references of field verified information will also be used as an additional reference tool when undertaking desktop review at the planning stage of the development of specific sites for CSG development (Section 3.2.1).



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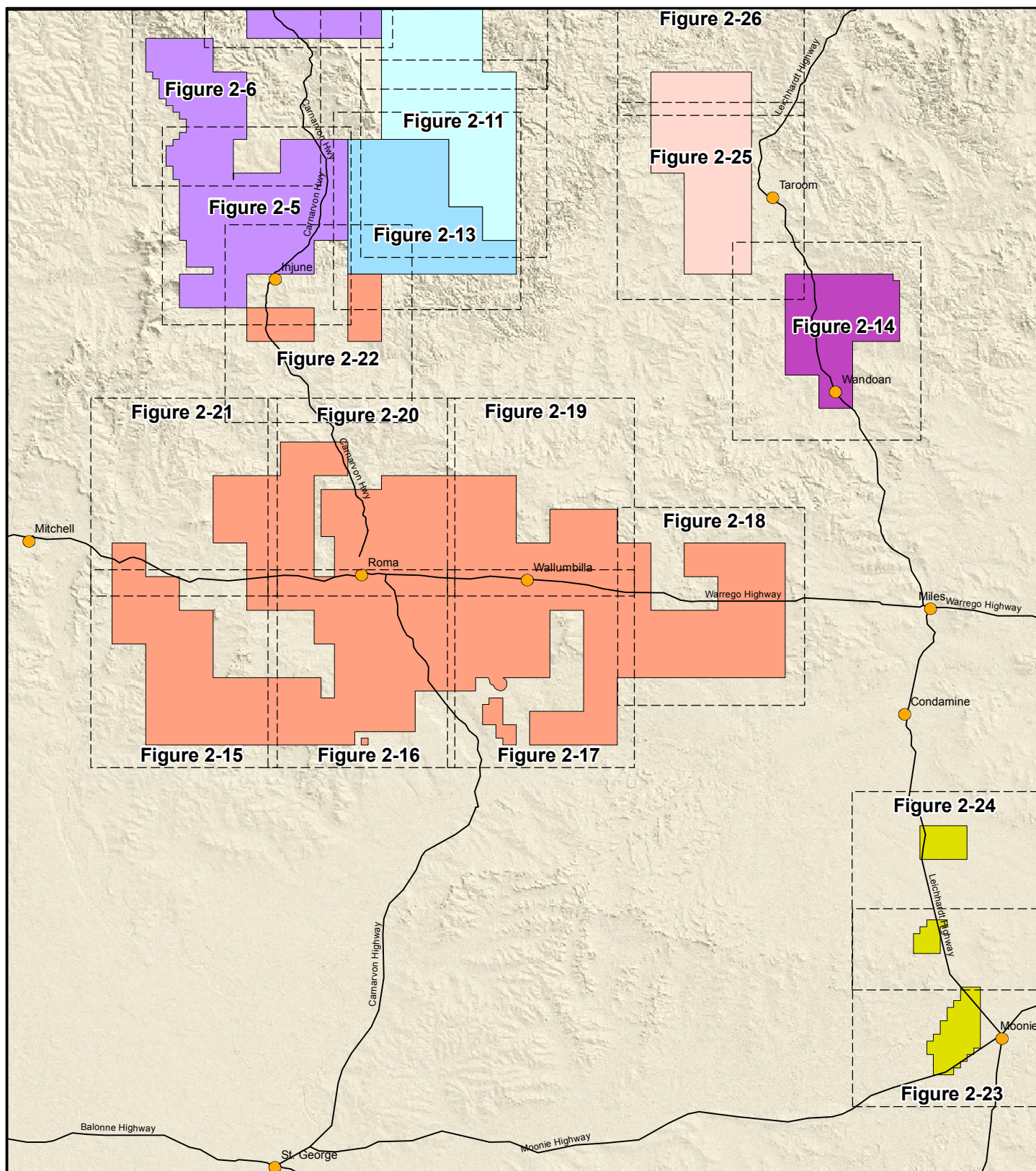
Legend

Arcadia Valley	Eastern Surat	Roma
Comet Ridge	Fairview	Roma Other
Denison Trough	Mahalo	Scotia

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING	Title NORTHERN CSG FIELD CONSTRAINT & EPBC POTENTIAL HABITAT FOR FAUNA OF THE CSG FIELD MAP INDEX LOCATIONS	
		Figure: 1-1	Rev.A A4

Drawn: CA Approved: JB Date: 23-10-2009
Job No: 4262 6440/6220 File: 42626440-g-2001.mxd



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Scale 1:1,500,000 (A4)
Datum: GDA94

Legend

Arcadia Valley	Eastern Surat	Roma
Comet Ridge	Fairview	Roma Other
Denison Trough	Mahalo	Scotia

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Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING	Title SOUTHERN CSG FIELD CONSTRAINT & EPBC POTENTIAL HABITAT FOR FAUNA OF THE CSG FIELD MAP INDEX LOCATIONS	
		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2001.mxd	Figure: 1-2 Rev.A A4

Constraints Classification

2.1 Constraints Classes

Five classes of constraints zoning have been developed for the CSG fields. These are based upon combinations of the data layers detailed above.

2.1.1 Class A

Class A areas are Category A ESAs such as the land comprising National Parks and RAMSAR wetlands. These areas are of very high conservation value and are designated as areas in which well and associated infrastructure development will not be undertaken.

2.1.2 Class B

Class B areas are:

- Category B and C Environmentally Sensitive Areas including:
 - State Forests;
 - 'Endangered' REs;
 - EPBC listed communities; and
 - Waterways and wetlands.

These areas are considered to be the most environmentally sensitive landscapes within which the GLNG Project will operate.

2.1.3 Class C

Class C areas are:

- 'Of Concern' REs; and
- Essential habitat.

These areas generally have a lower level of sensitivity than Class A or B. Although 'Of Concern' REs are considered less significant than 'Endangered', they are still considered to be potentially under threat.

2.1.4 Class D

Class D areas are 'Not of Concern' REs. These are generally areas of remnant vegetation with relatively low environmental sensitivity.

2.1.5 Class E

Class E areas are mapped as non-remnant vegetation. They are generally modified habitats such as agricultural lands, grazing lands or residential areas, or are comprised of regrowth vegetation. Although these areas have the lowest level of ecological constraints, they may contain microhabitat for native flora and fauna, including significant species.

2 Constraints Classification

2.1.6 Complementary Mapping Resources

To complement the Constraints Mapping, a separate series of maps depicting potential EPBC-listed fauna habitat within the CSG fields has been developed. The maps and rationale for use and method of application is presented in Part 3 of this report.

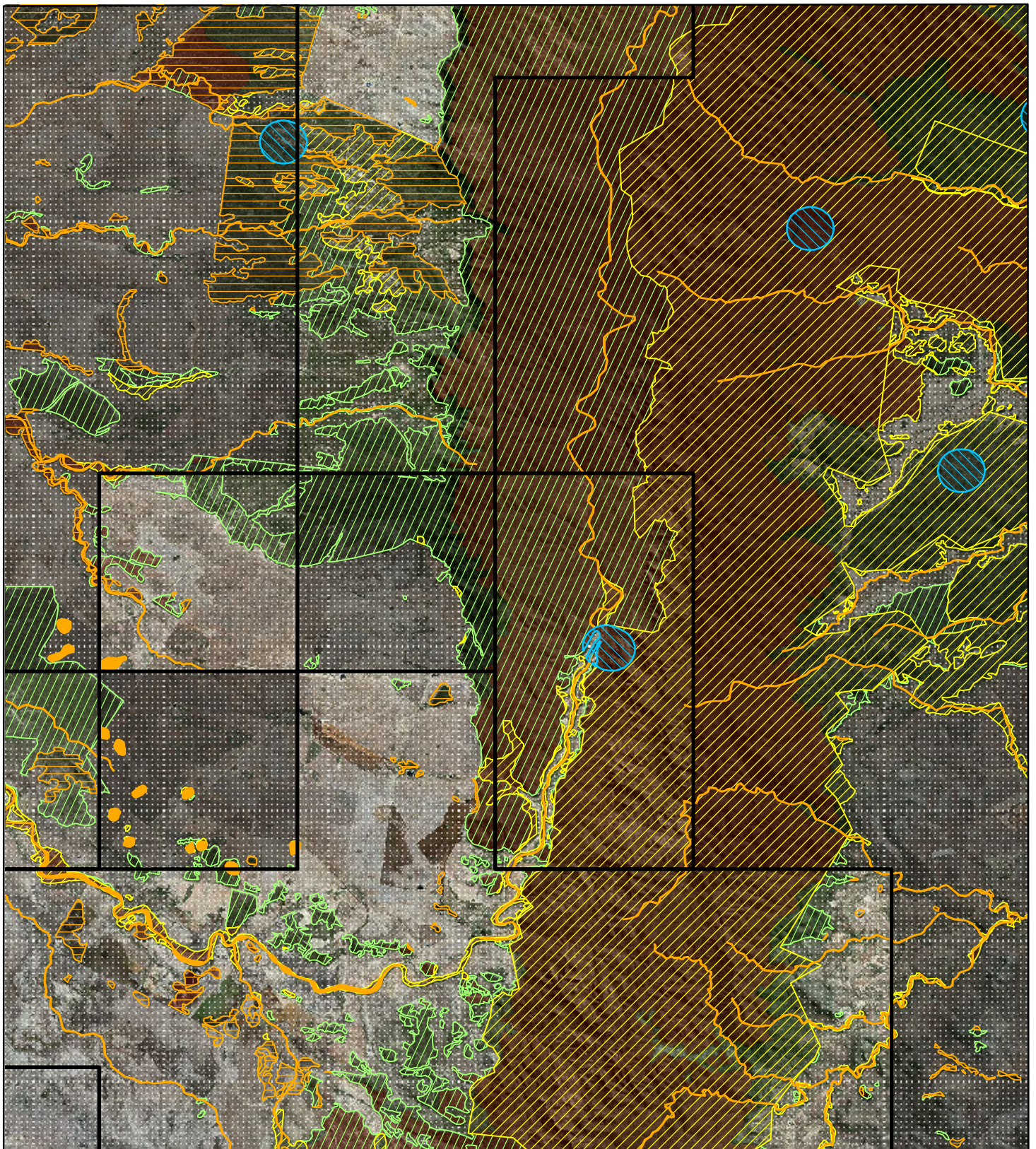
This mapping is designed to be used in conjunction with the five constraints classes. They have been designed to be used digitally in GIS platforms in combination to provide additional resources for environmental managers and technical specialists when designing CSG infrastructure layout and field scouting infrastructure locations.

2.1.7 Mapping Limitations

The constraints mapping overlays (Figures 2-1 to 2-26) provide an indication of the relative environmental sensitivity of certain areas based on mapped ecological features which have similar conservation values.

While these constraints generally apply, it should be noted that they are not uniform across each mapped unit. For example, Class B areas contain 'Endangered' REs, but they may not contain the same types of 'Endangered' REs. Additionally, field survey undertaken for the EIS in the CSG fields (EIS Appendix N1) to verify overall accuracy of REs and Essential Habitat mapping indicated microhabitats that are present within the CSG fields but not accounted for at the broader resolution of mapped REs data layers (Section 1.4).

Each Class includes a number of different vegetation units, and these individual units may require different management approaches. In addition, overlays of other parameters also apply, including Bioregional Wildlife Corridors; Essential Habitat, wetlands and waterways; EPBC listed vegetation communities; and EPBC listed fauna species potential habitat (Part 3). These are not necessarily correlated to the mapped major constraints classes. Greater resolution of local issues to avoid and minimise impact on microhabitats form part of the field management protocols described below.



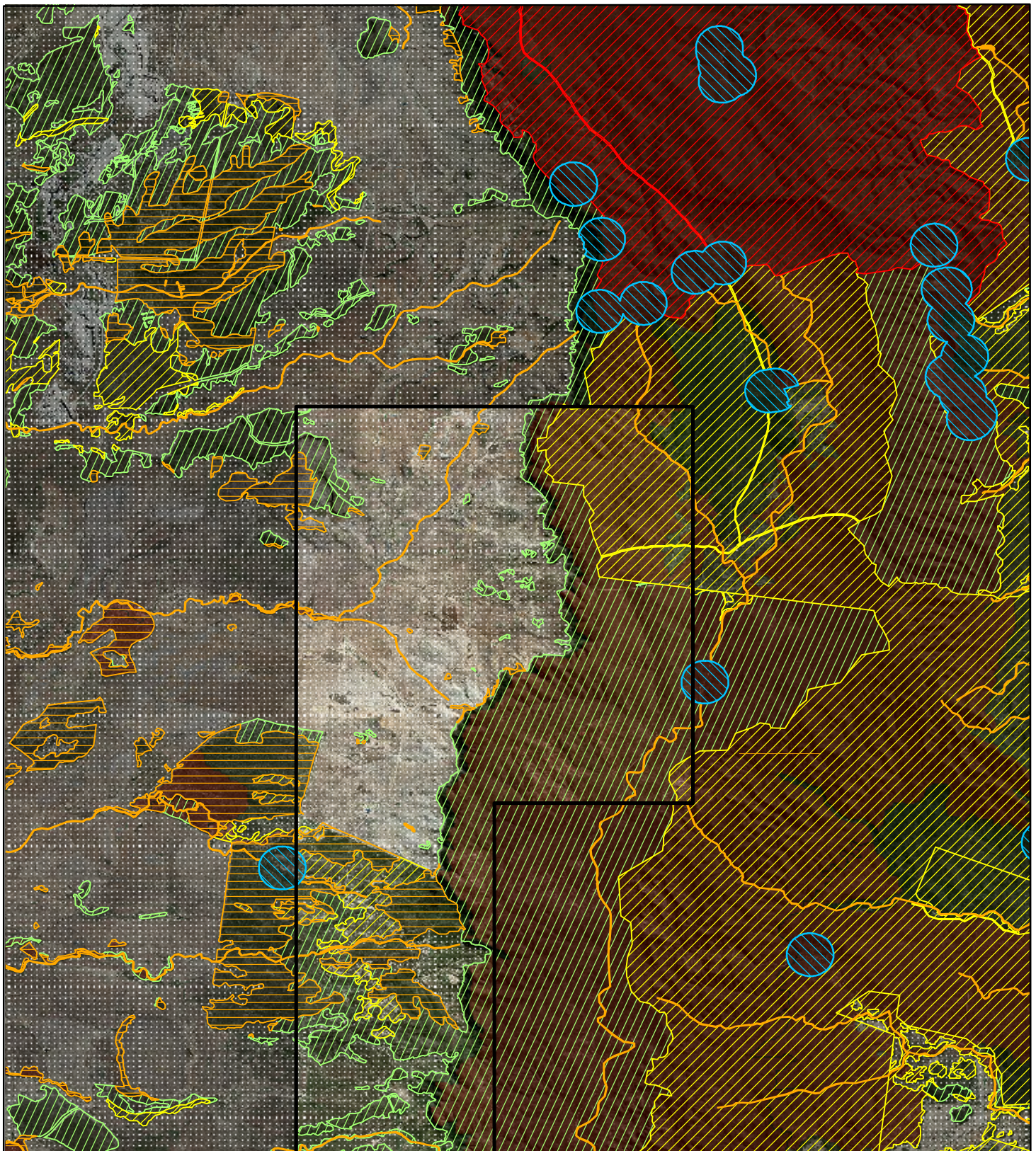
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING	Title ECOLOGICAL CONSTRAINTS MAPPING MAHALO SHEET 1 OF 2	
		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2002.mxd	Figure: 2-1 Rev.A A4



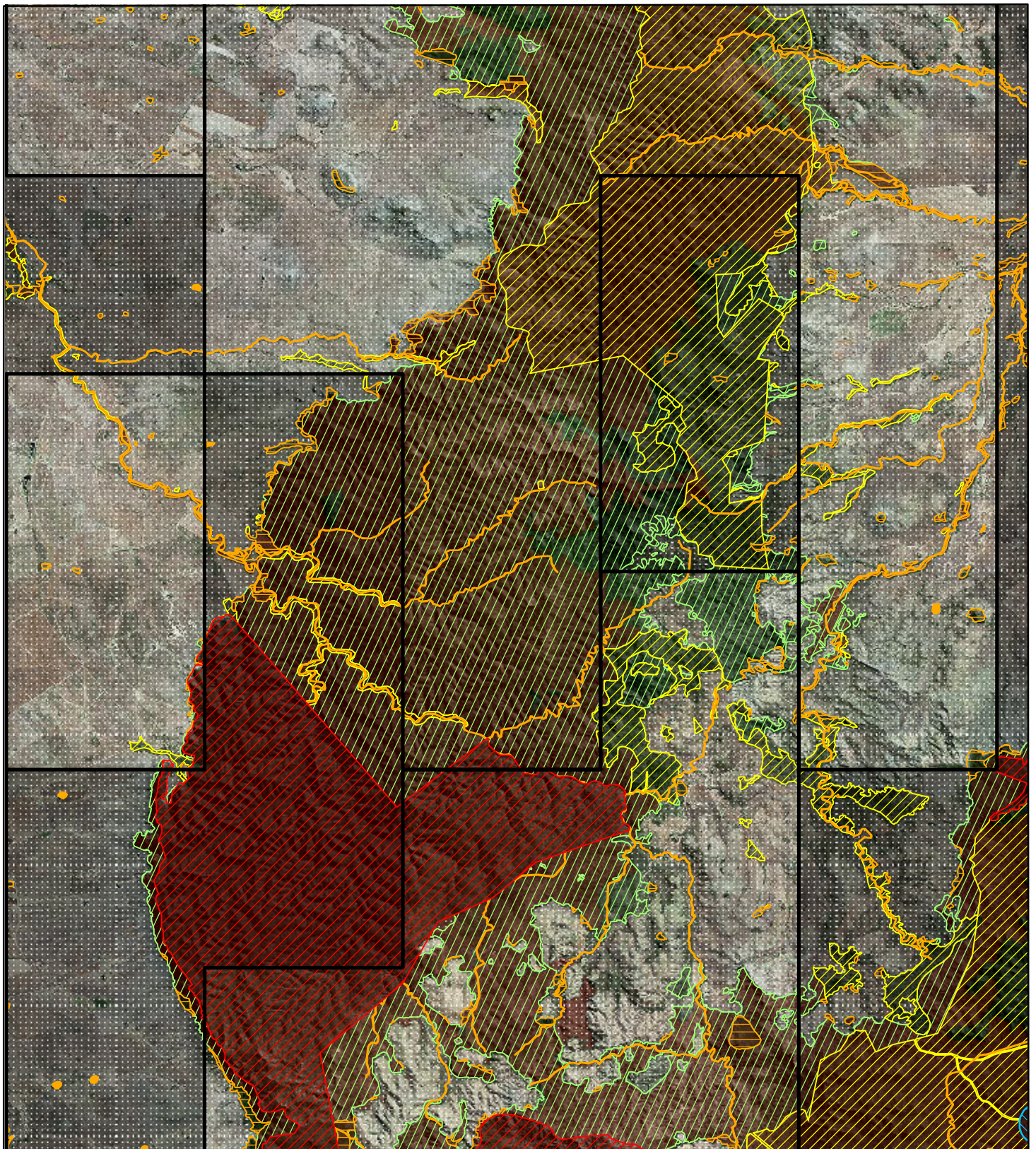
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Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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	Drawn: CA Job No: 4262 6440/6220	Approved: JB File: 42626440-g-2002.mxd	Date: 23-10-2009	Figure: 2-2	Rev.A A4



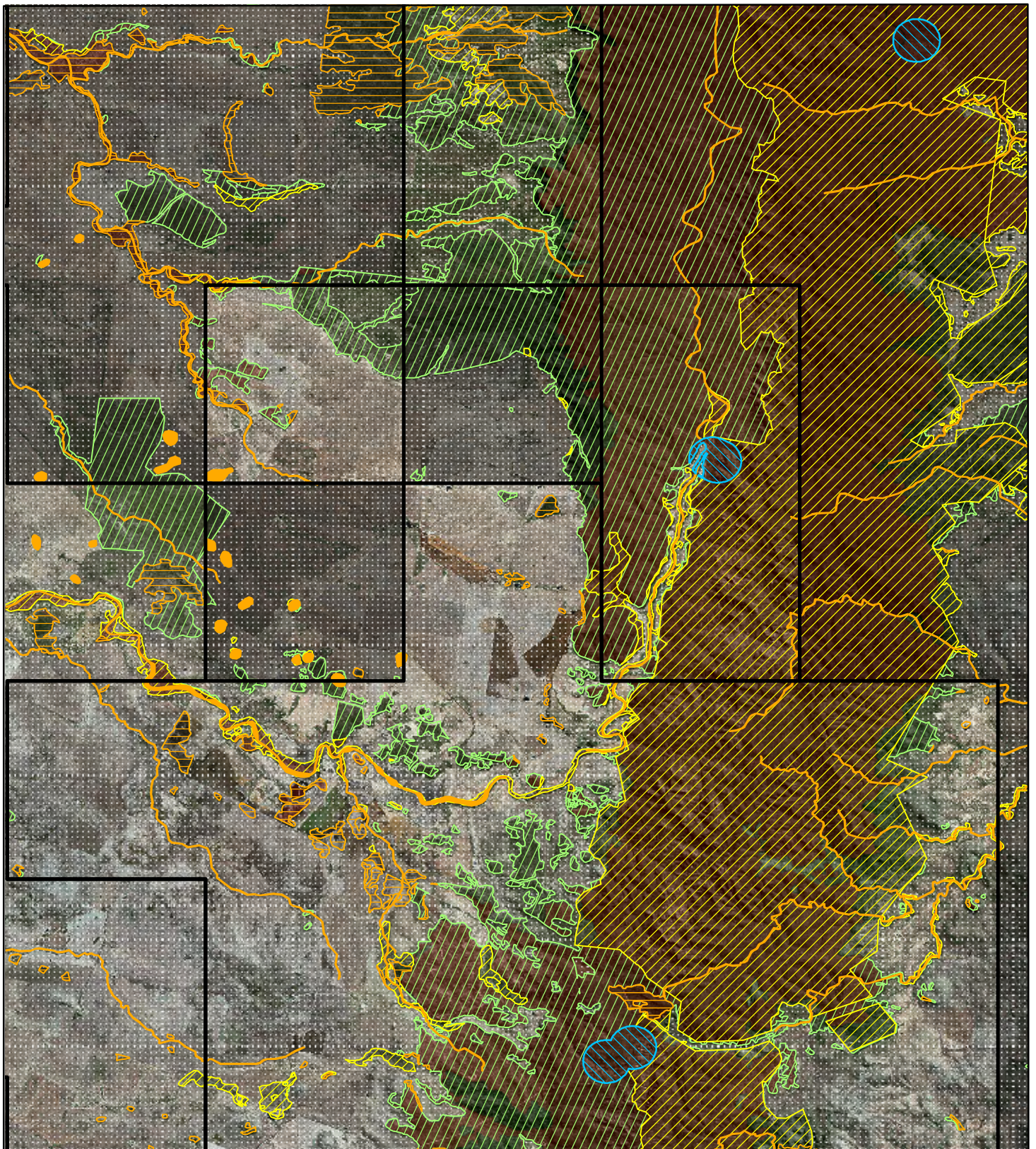
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

- | | |
|-------------------------------|---------|
| CSG Field | Class A |
| Bioregional Wildlife Corridor | Class B |
| Essential Habitat | Class C |
| | Class D |
| | Class E |

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Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING		Title ECOLOGICAL CONSTRAINTS MAPPING COMET RIDGE SHEET 1 OF 2	
	Drawn: CA	Approved: JB	Date: 23-10-2009	Figure: 2-3
	Job No: 4262 6440/6220	File: 42626440-g-2002.mxd	Rev.A A4	

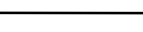


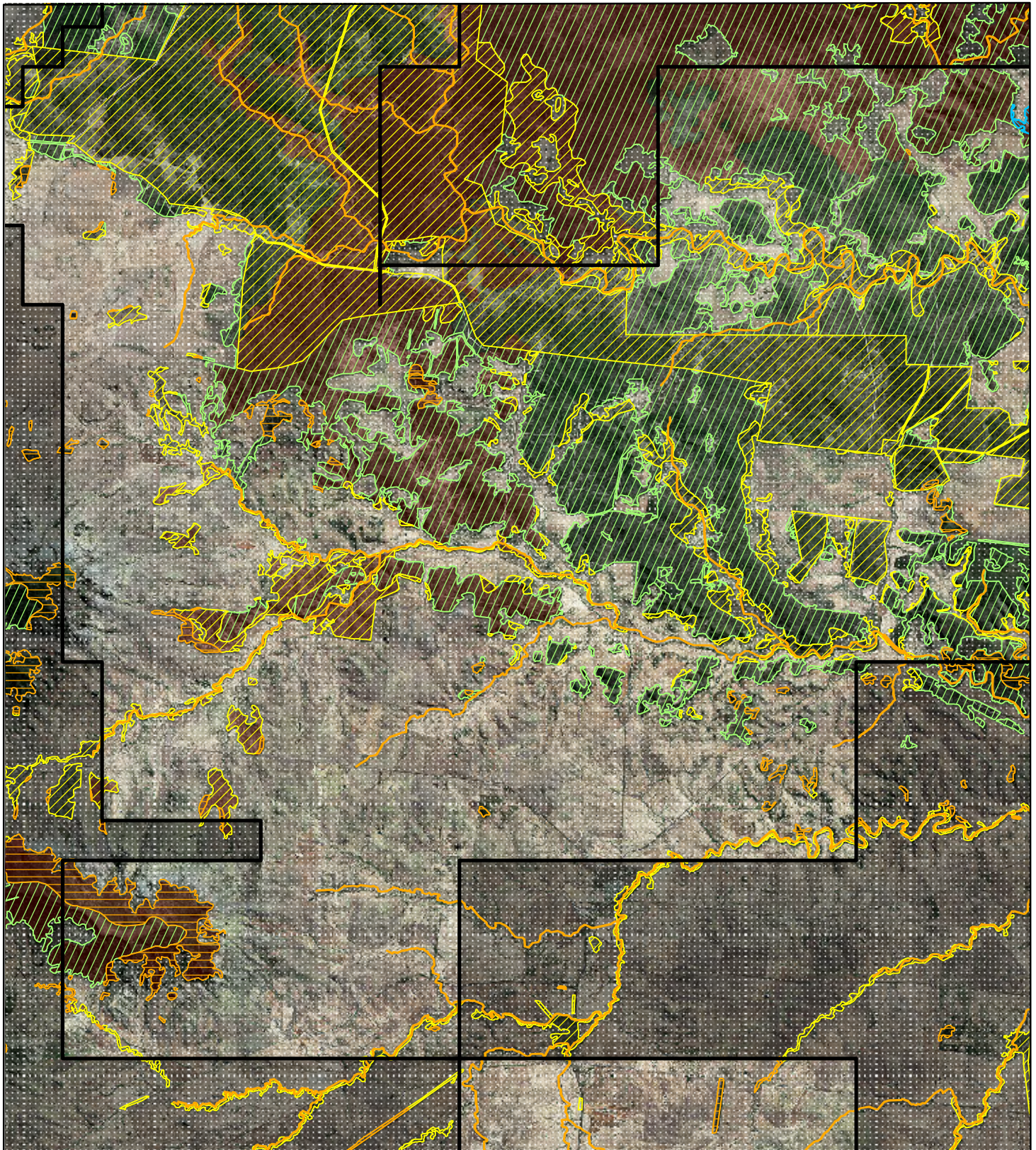
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client  	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING			Title ECOLOGICAL CONSTRAINTS MAPPING COMET RIDGE SHEET 2 OF 2		
	Drawn: CA		Approved: JB	Date: 23-10-2009		
	Job No: 4262 6440/6220		File: 42626440-g-2002.mxd		Figure: 2-4	
					Rev.A	A4



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
DENISON TROUGH
SHEET 1 OF 6**



Drawn: CA

Approved: JB

Date: 23-10-2009

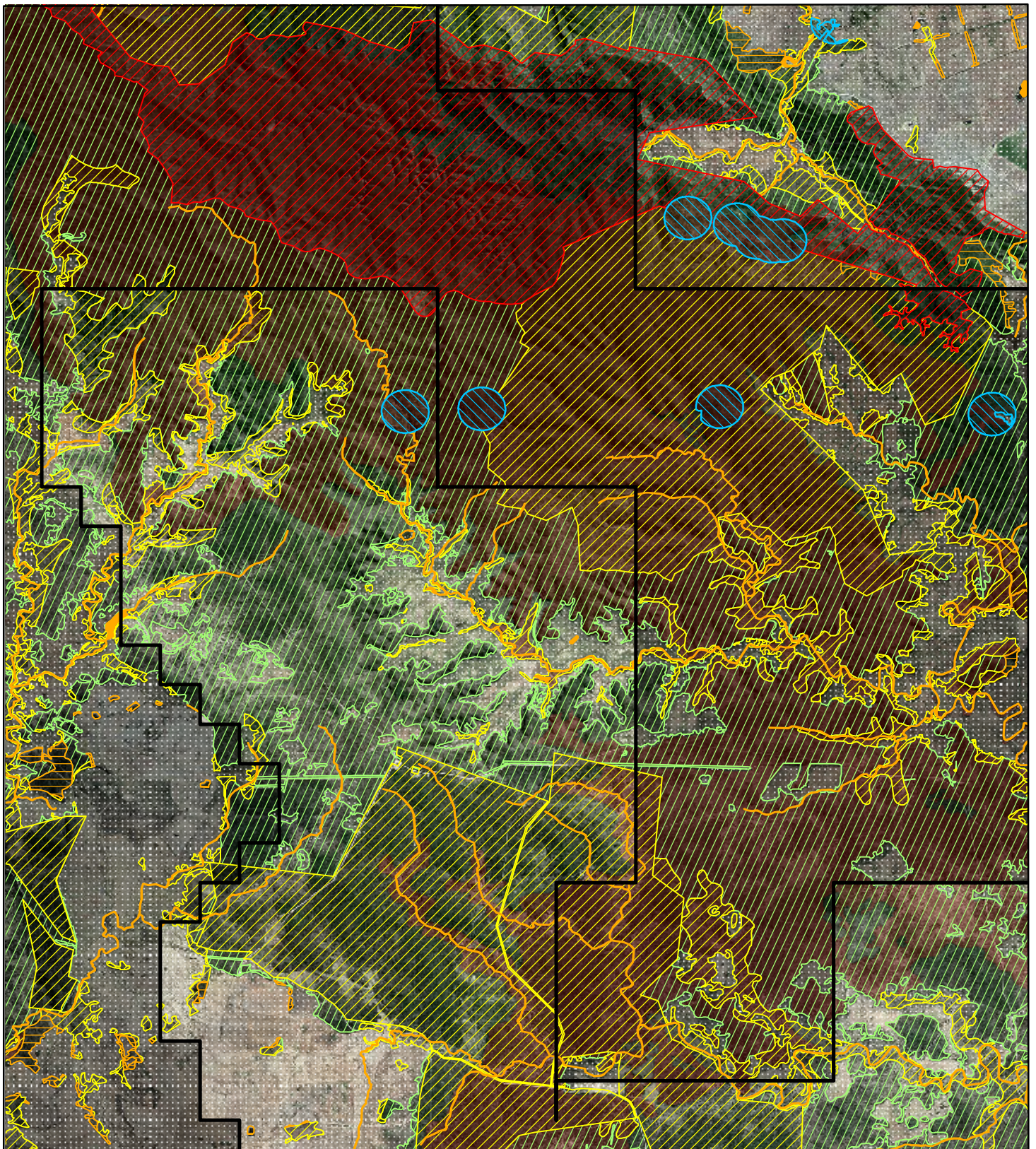
Job No: 4262 6440/6220

File: 42626440-g-2002.mxd

Figure: 2-5

Rev.A

A4



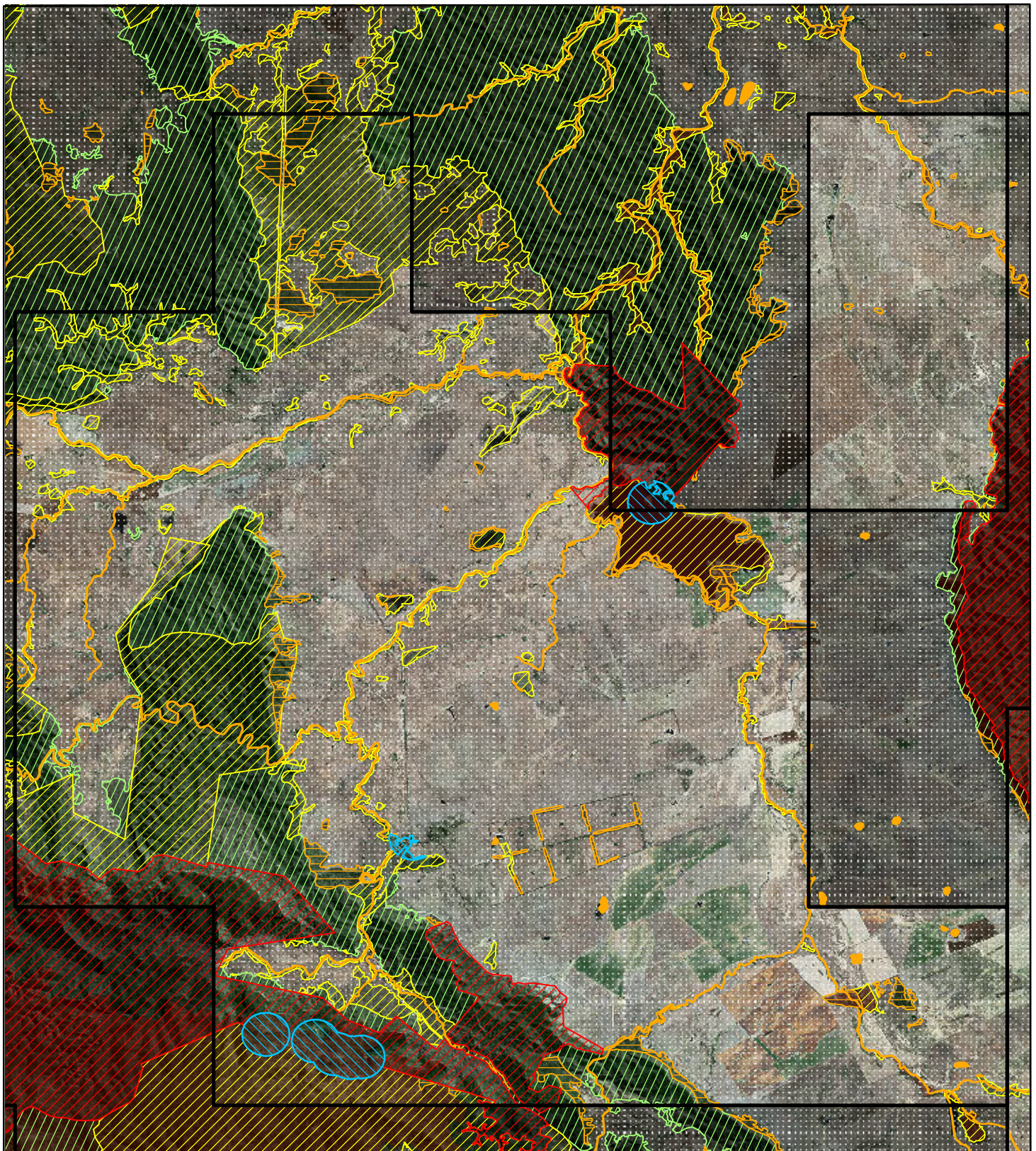
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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	Drawn: CA	Approved: JB	Date: 23-10-2009	Figure: 2-6	Rev.A A4
Job No: 4262 6440/6220			File: 42626440-g-2002.mxd		



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
DENISON TROUGH
SHEET 3 OF 6**



Drawn: CA

Approved: JB

Date: 23-10-2009

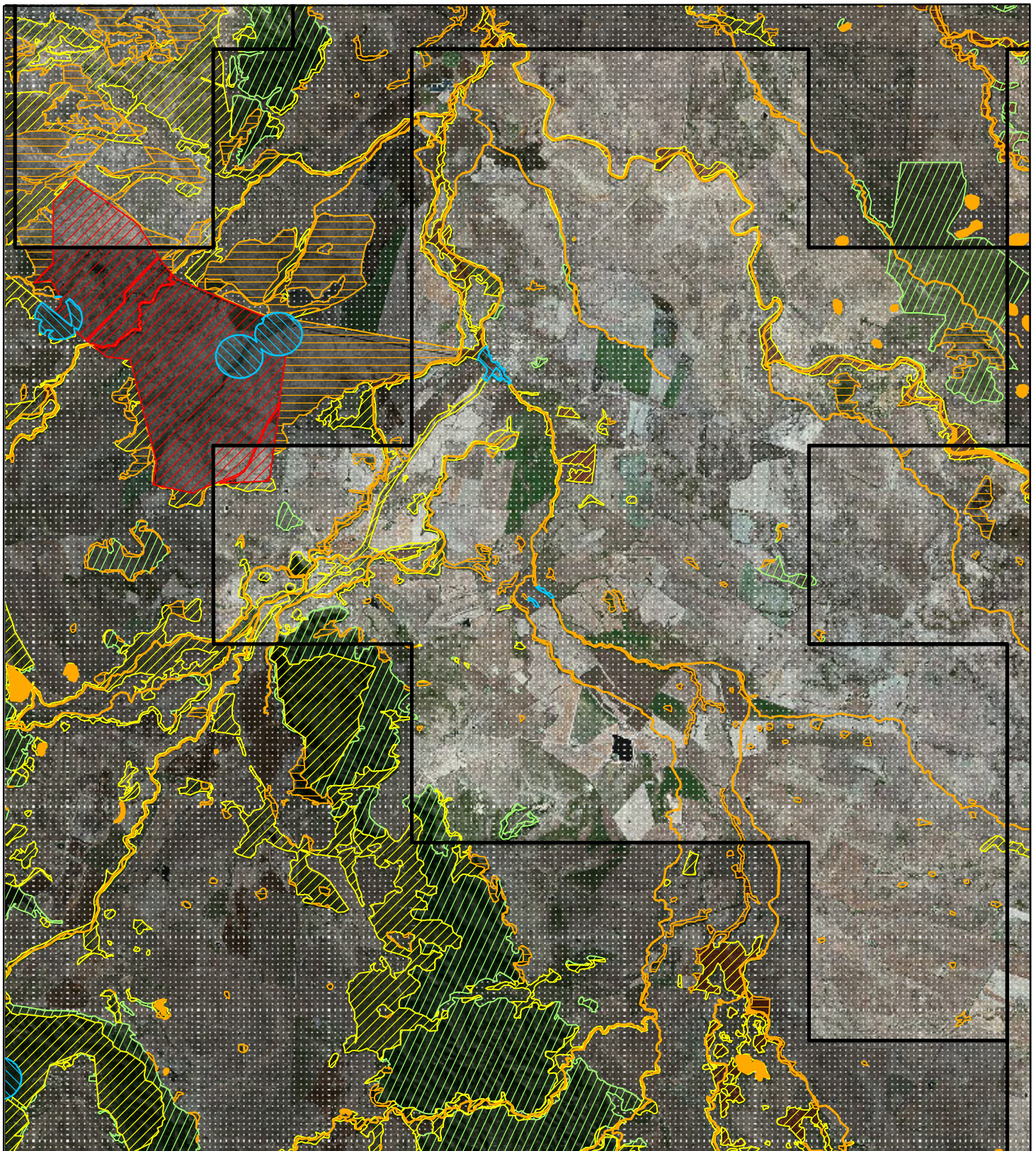
Job No: 4262 6440/6220

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Figure: 2-7

Rev.A

A4



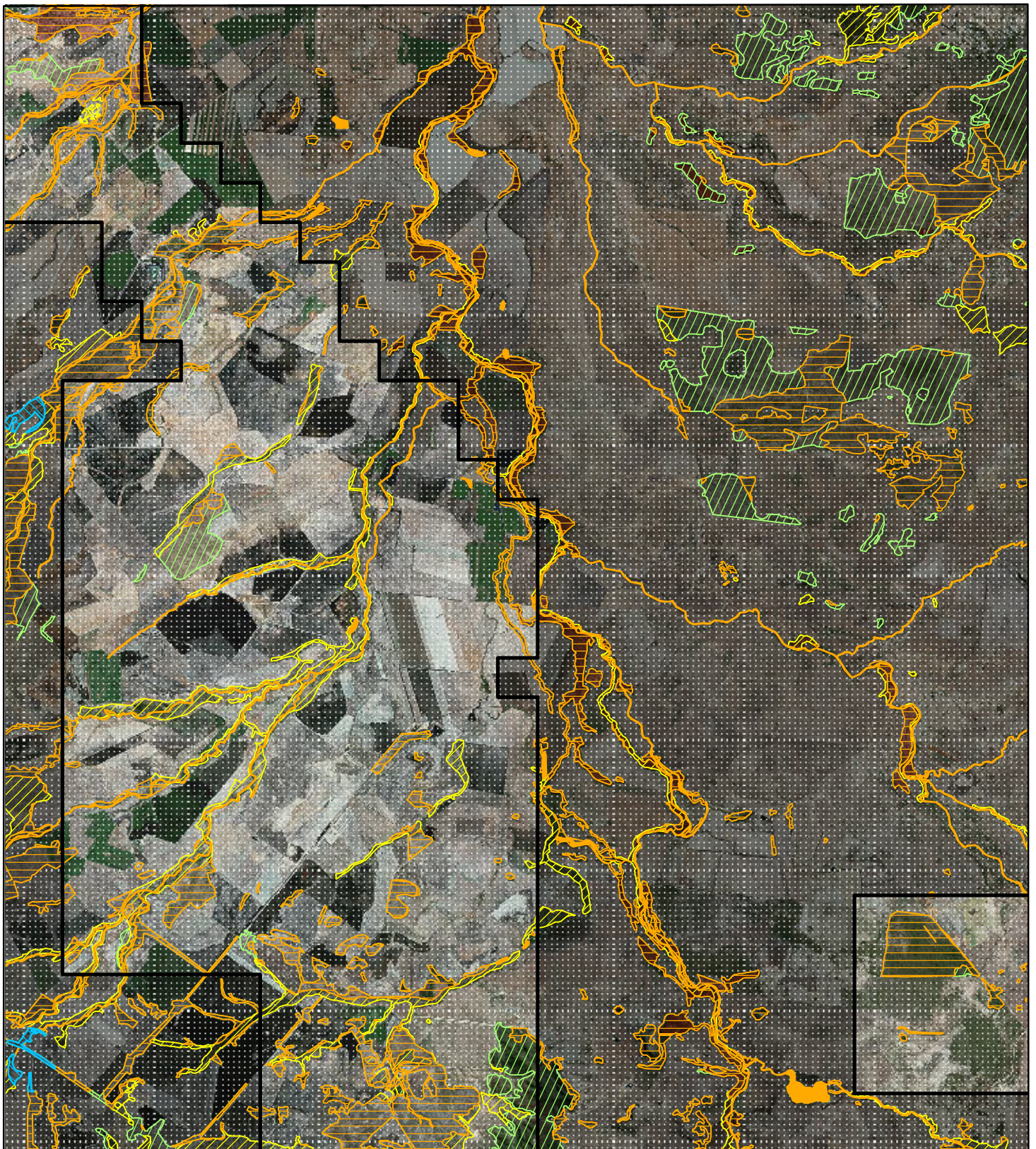
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING	Title ECOLOGICAL CONSTRAINTS MAPPING DENISON TROUGH SHEET 4 OF 6	
		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2002.mxd	Figure: 2-8 Rev.A A4



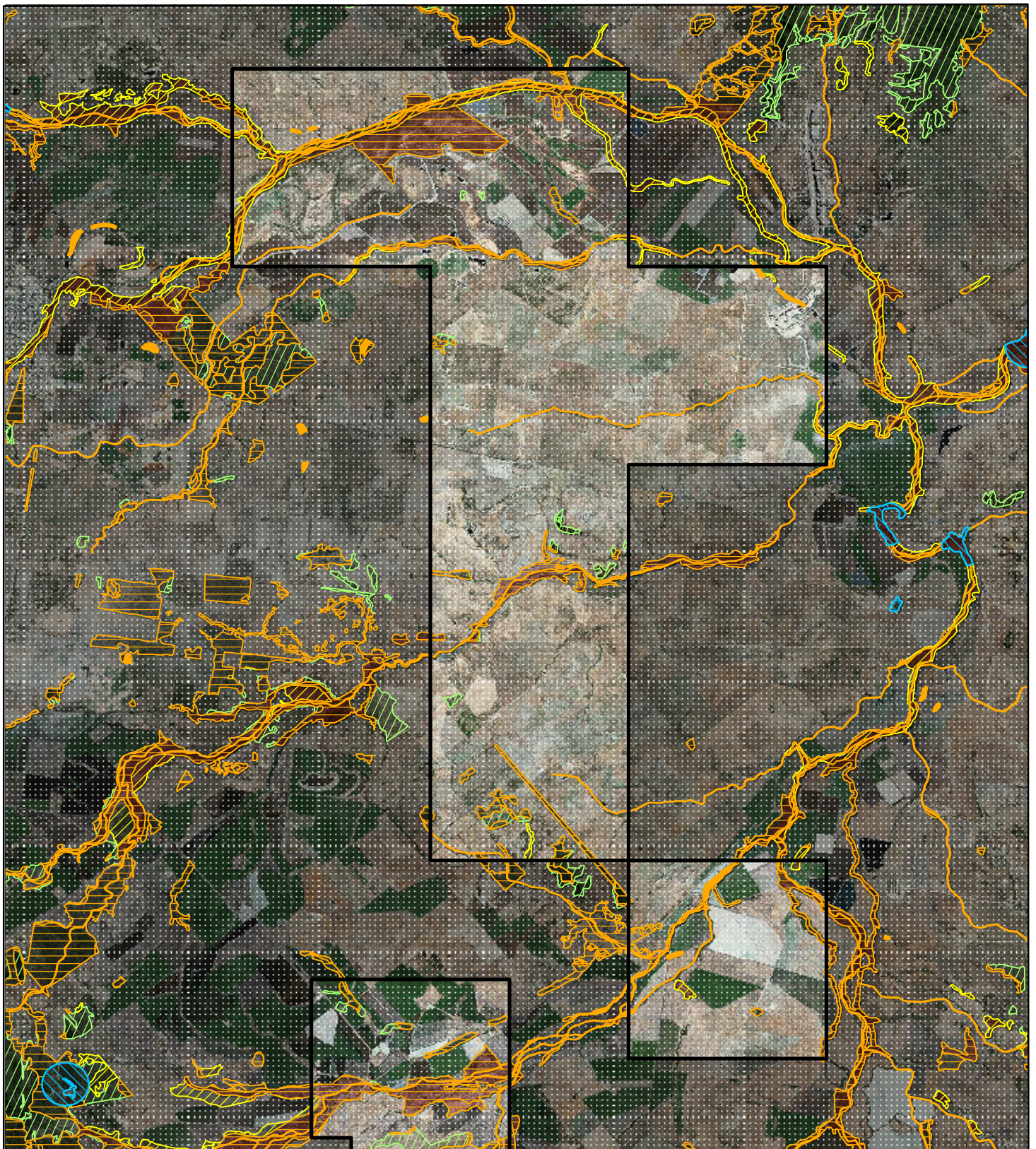
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2002.mxd	Figure: 2-9 Rev.A A4



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

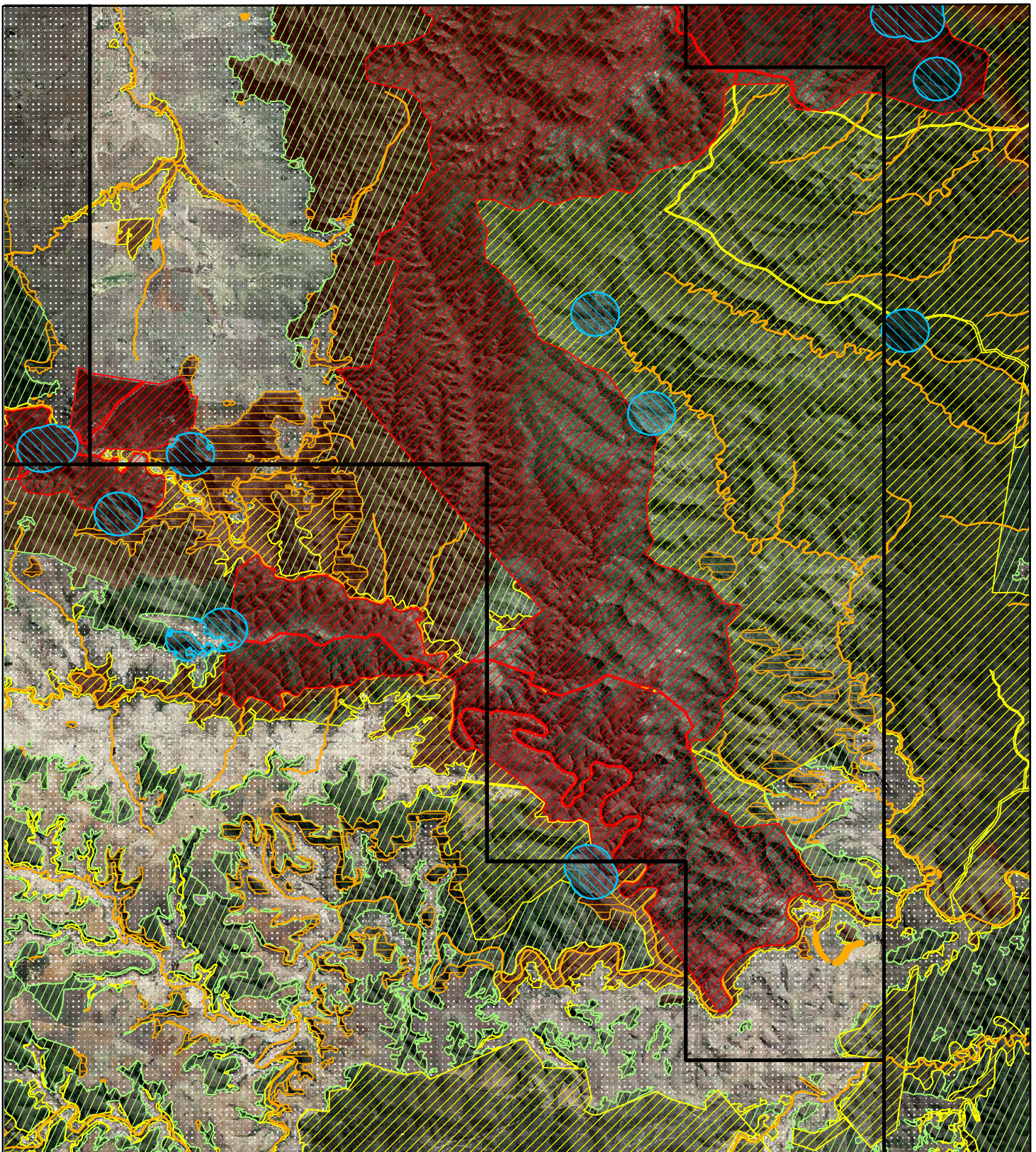
**ECOLOGICAL CONSTRAINTS MAPPING
DENISON TROUGH
SHEET 6 OF 6**



Drawn: CA Approved: JB Date: 23-10-2009
Job No: 4262 6440/6220 File: 42626440-g-2002.mxd

Figure: 2-10

Rev.A
A4



0 2.5 5 10
Km

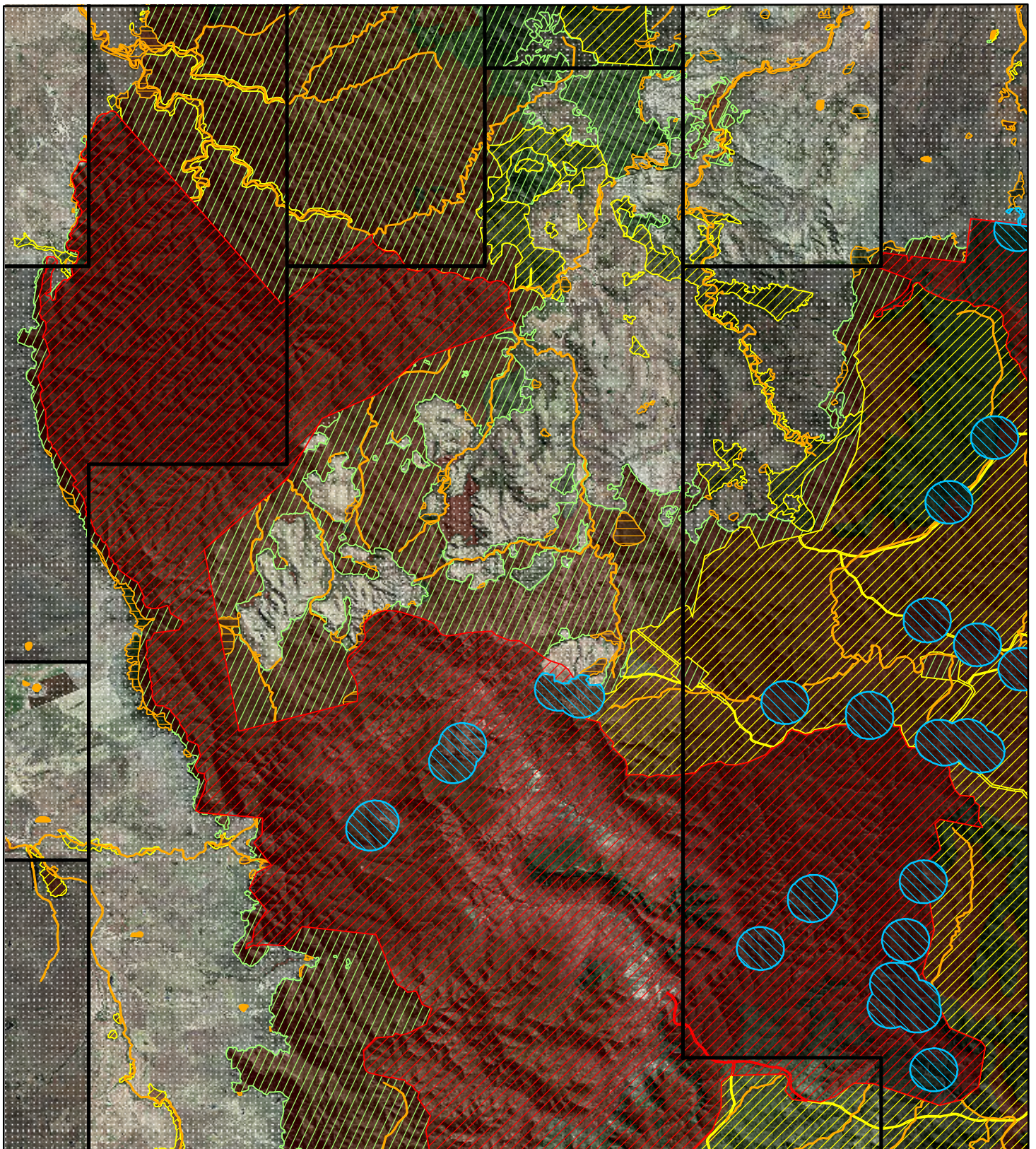
Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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Client  	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING		Title ECOLOGICAL CONSTRAINTS MAPPING ARCADIA VALLEY SHEET 1 OF 2	
	Drawn: CA	Approved: JB	Date: 23-10-2009	Rev.A
	Job No: 4262 6440/6220	File: 42626440-g-2002.mxd		A4

Figure: 2-11



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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ENVIRONMENTAL IMPACT STATEMENT
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Title

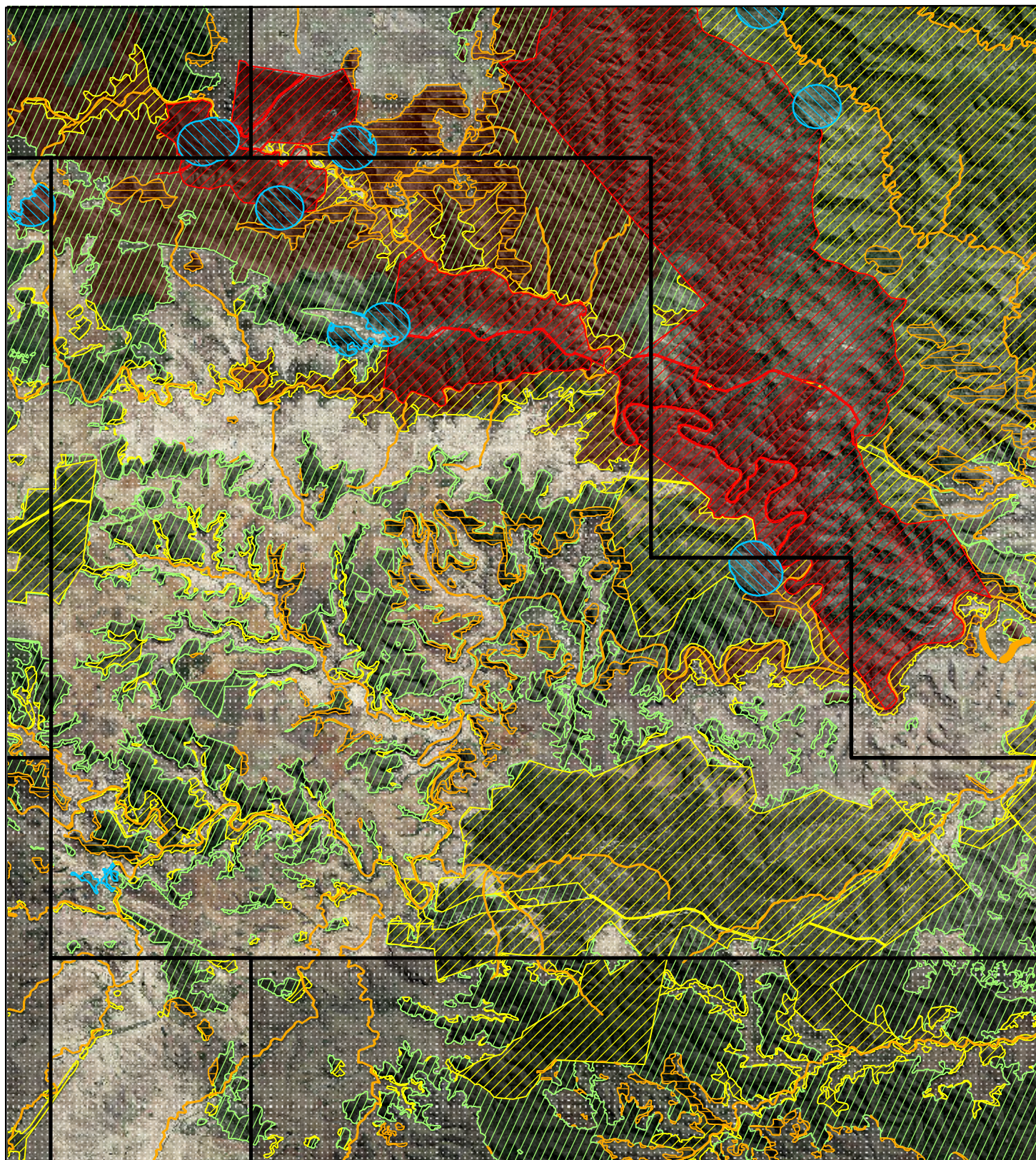
**ECOLOGICAL CONSTRAINTS MAPPING
ARCADIA VALLEY
SHEET 2 OF 2**

URS

Drawn: CA Approved: JB Date: 23-10-2009
Job No: 4262 6440/6220 File: 42626440-g-2002.mxd

Figure: 2-12

Rev.A
A4



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
FAIRVIEW
SHEET 1 OF 1**

URS

Drawn: CA

Approved: JB

Date: 23-10-2009

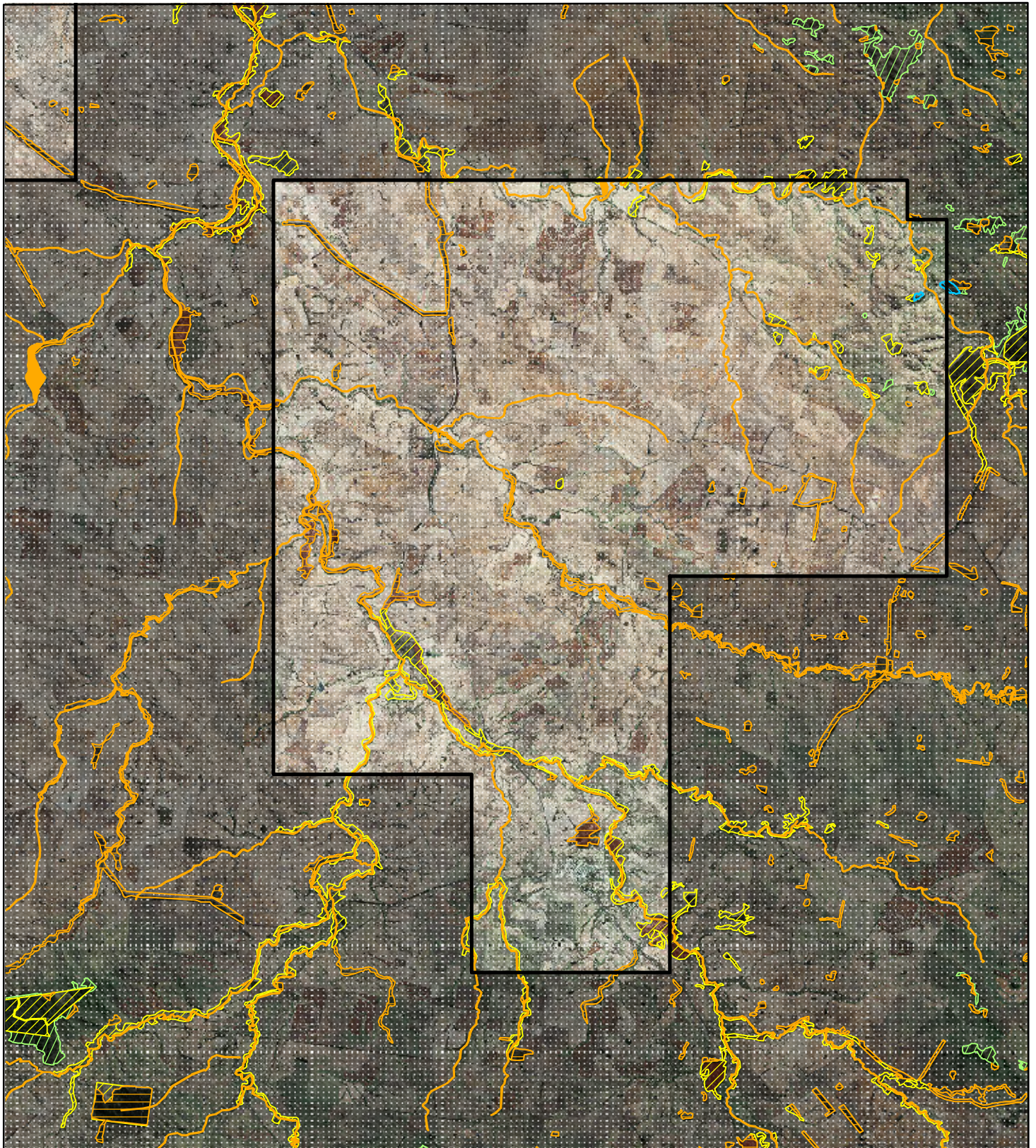
Job No: 4262 6440/6220

File: 42626440-g-2002.mxd

Figure: 2-13

Rev.A

A4



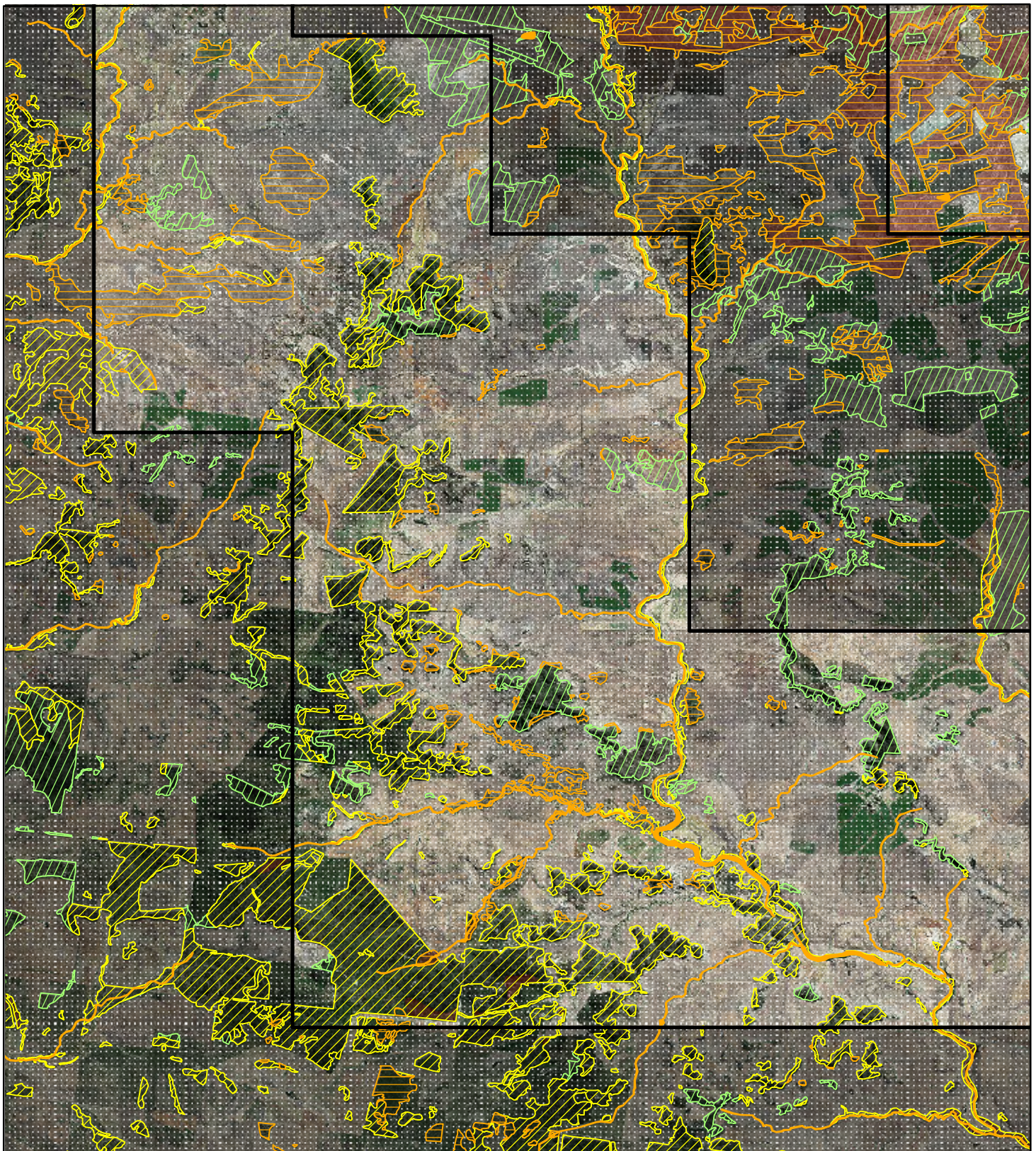
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING	Title ECOLOGICAL CONSTRAINTS MAPPING SCOTIA SHEET 1 OF 1	
		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2002.mxd	Figure: 2-14 Rev.A A4



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
ROMA
SHEET 1 OF 8**



Drawn: CA

Approved: JB

Date: 23-10-2009

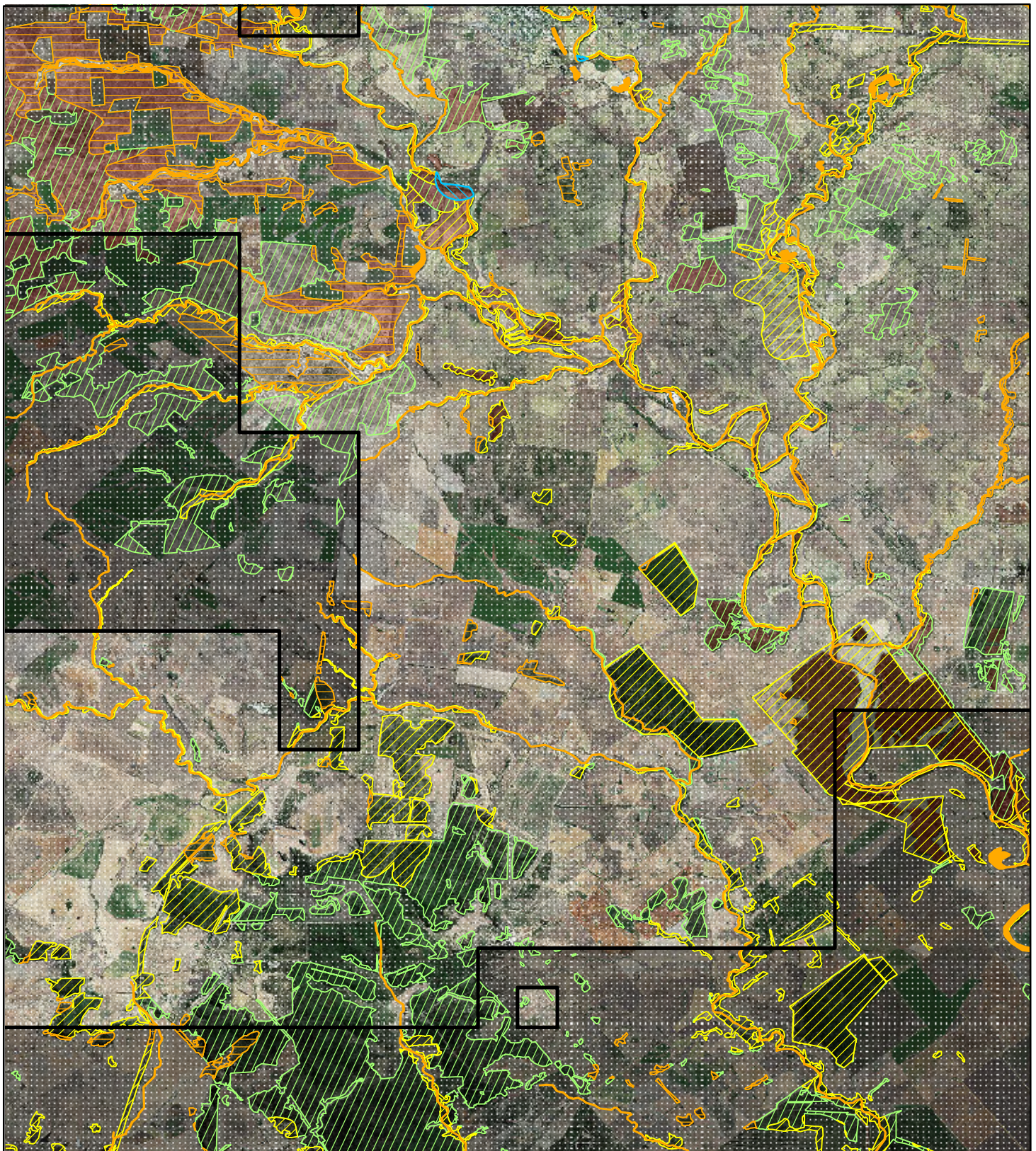
Job No: 4262 6440/6220

File: 42626440-g-2002.mxd

Figure: 2-15

Rev.A

A4



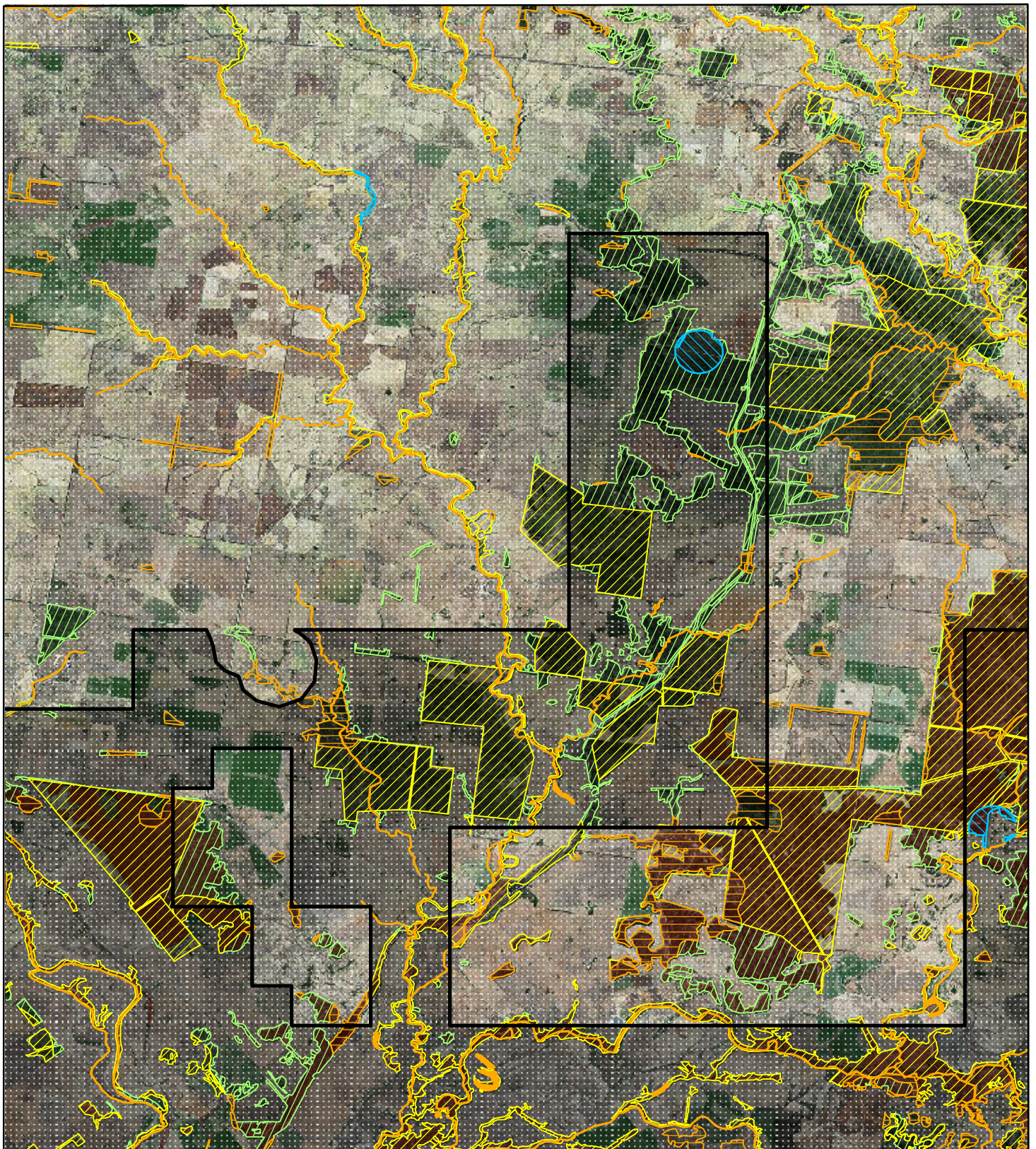
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING		Title ECOLOGICAL CONSTRAINTS MAPPING ROMA SHEET 2 OF 8	
	Drawn: CA Job No: 4262 6440/6220	Approved: JB File: 42626440-g-2002.mxd	Date: 23-10-2009 Figure: 2-16	Rev.A A4



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
ROMA
SHEET 3 OF 8**



Drawn: CA

Approved: JB

Date: 23-10-2009

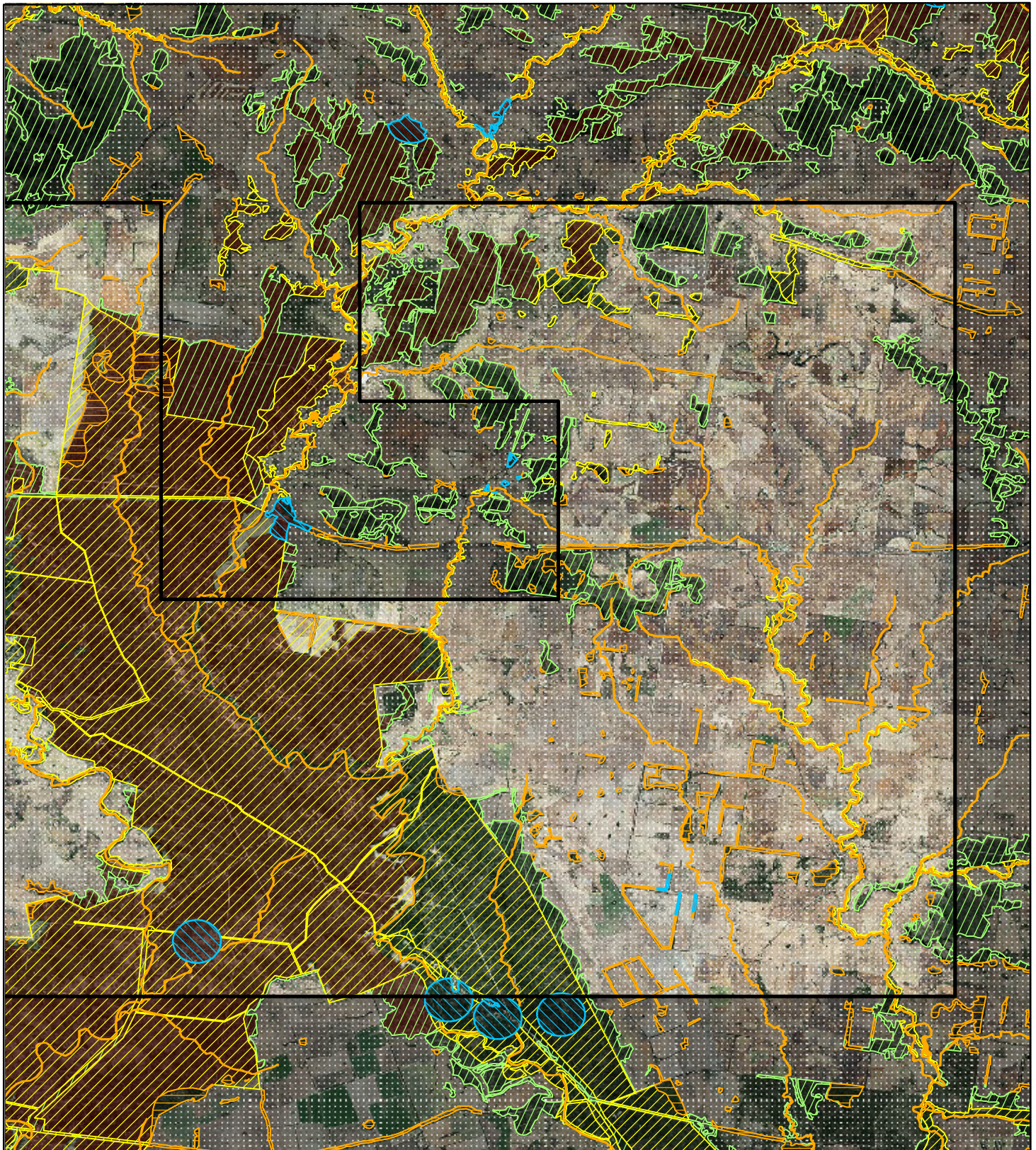
Job No: 4262 6440/6220

File: 42626440-g-2002.mxd

Figure: 2-17

Rev.A

A4



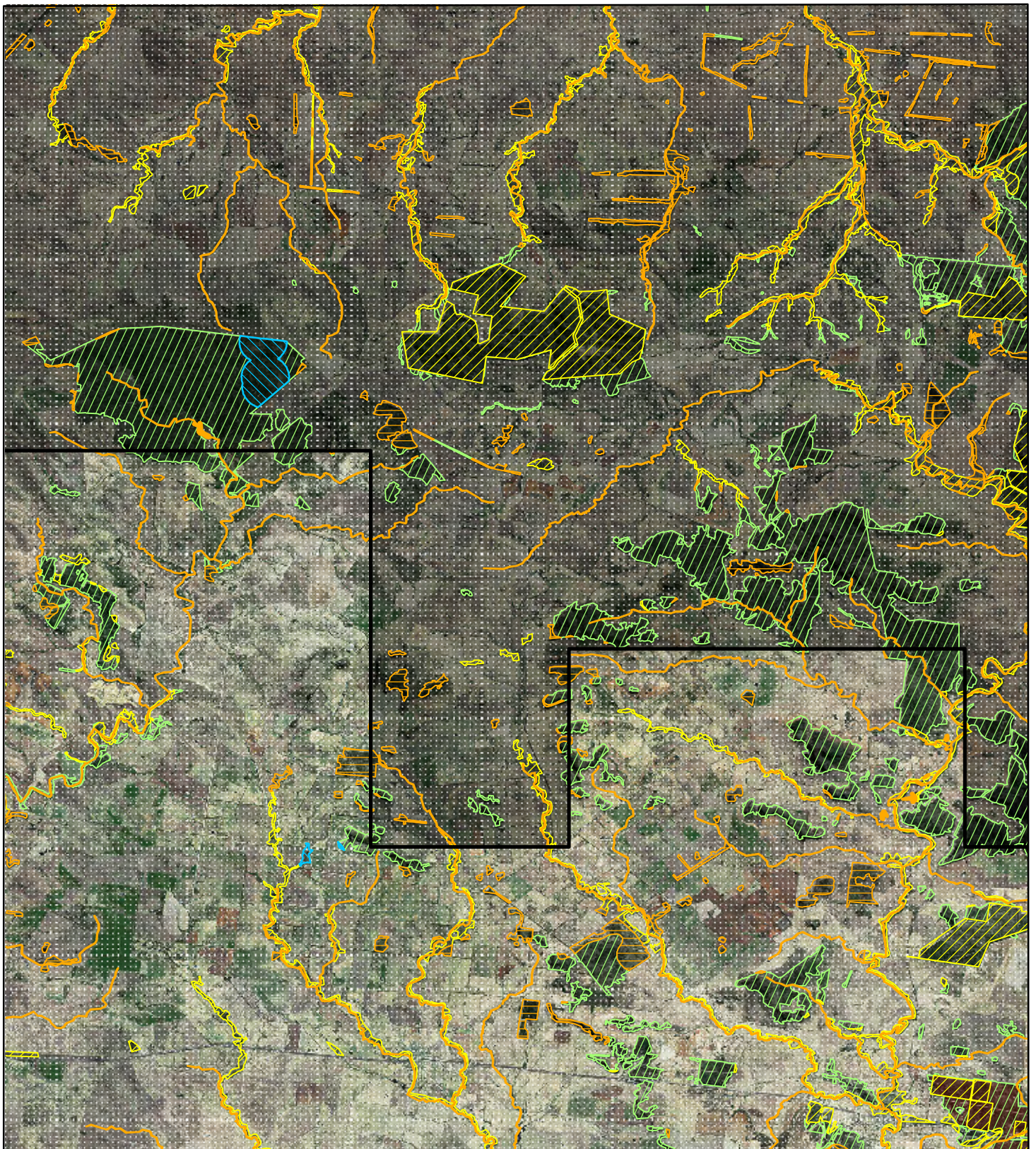
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

	CSG Field		Class A
	Bioregional Wildlife Corridor		Class B
	Essential Habitat		Class C
			Class D
			Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client		Project			Title	
		GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT ECOLOGICAL CONSTRAINTS MAPPING			ECOLOGICAL CONSTRAINTS MAPPING ROMA SHEET 4 OF 8	
		Drawn: CA	Approved: JB	Date: 23-10-2009	Figure: 2-18	Rev.A
Job No: 4262 6440/6220			File: 42626440-g-2002.mxd	A4		
						



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

	CSG Field		Class A
	Bioregional Wildlife Corridor		Class B
	Essential Habitat		Class C
			Class D
			Class E

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GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
ROMA
SHEET 5 OF 8**



Drawn: CA

Approved: JB

Date: 23-10-2009

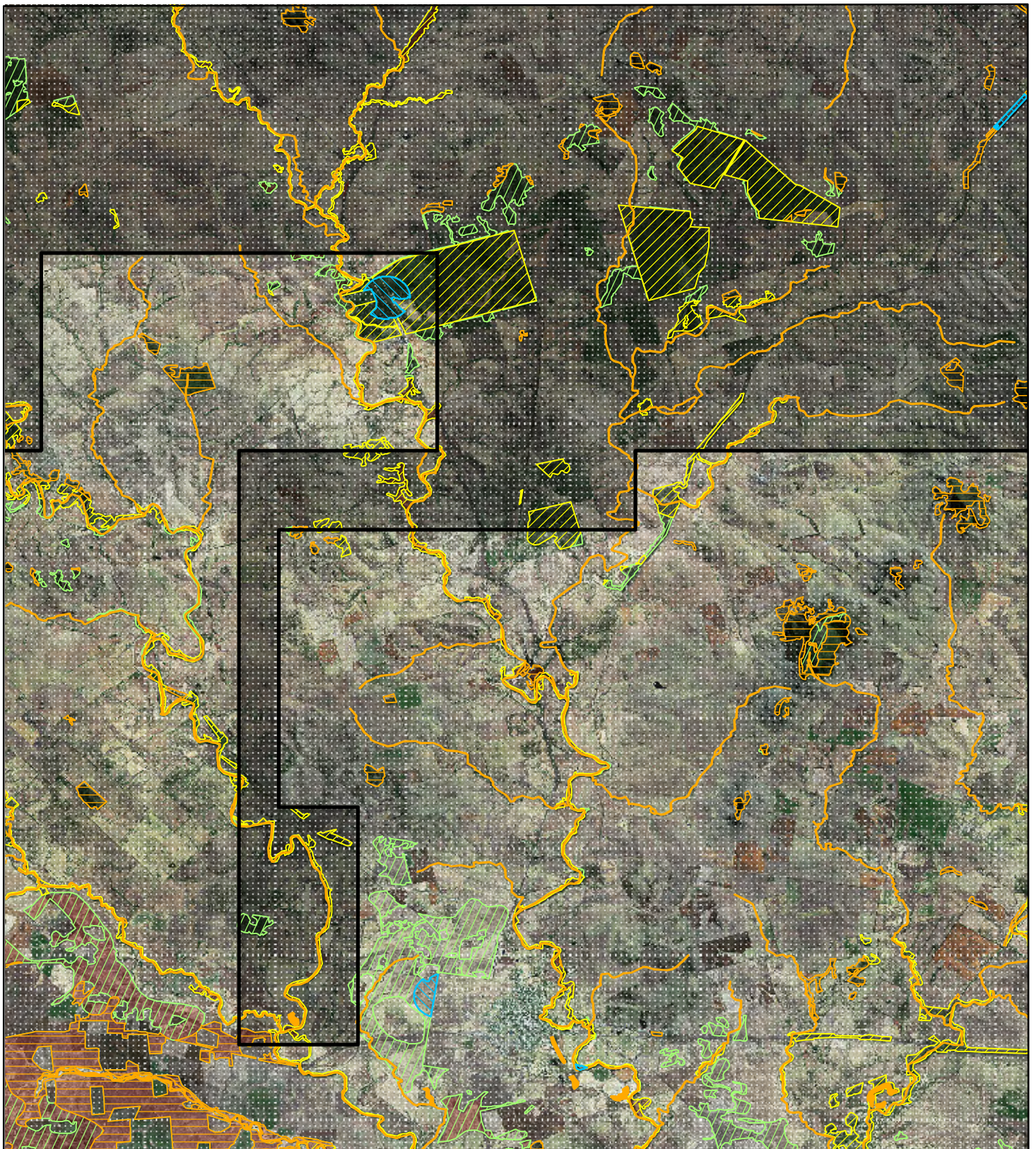
Job No: 4262 6440/6220

File: 42626440-g-2002.mxd

Figure: 2-19

Rev.A

A4



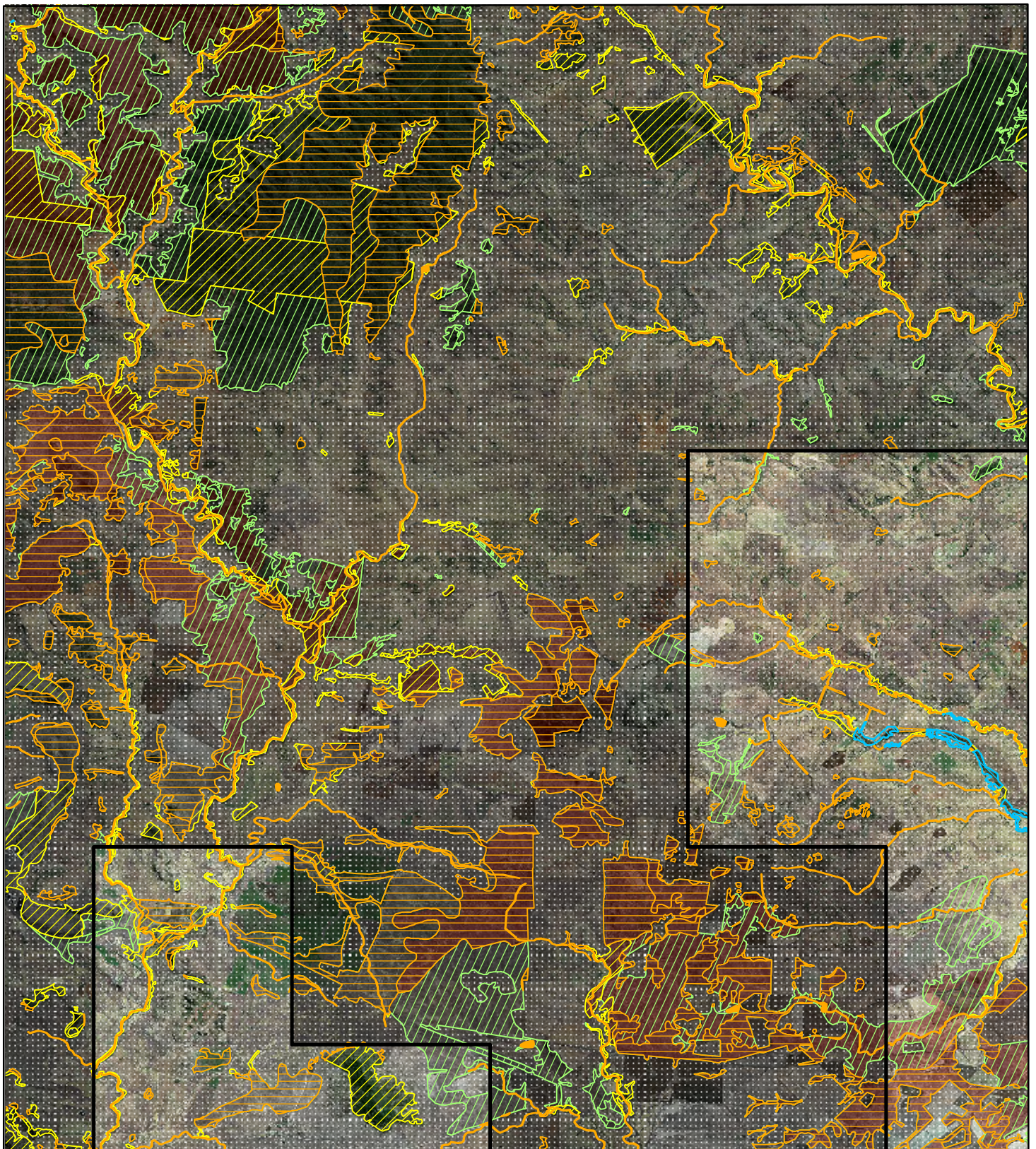
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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	Drawn: CA	Approved: JB	Date: 23-10-2009	Figure: 2-20	Rev.A A4
	Job No: 4262 6440/6220	File: 42626440-g-2002.mxd			



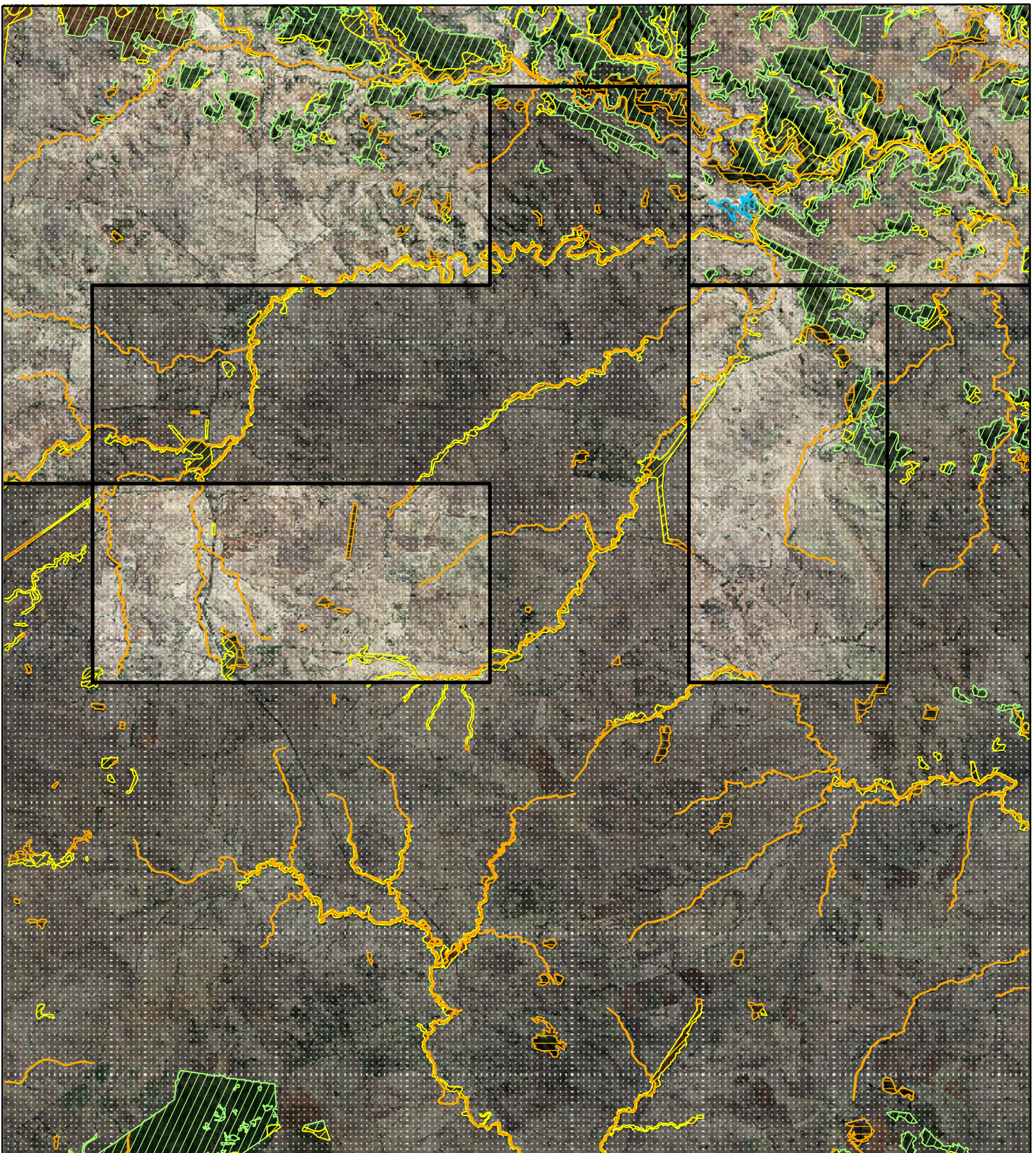
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2002.mxd	Figure: 2-21 Rev.A A4



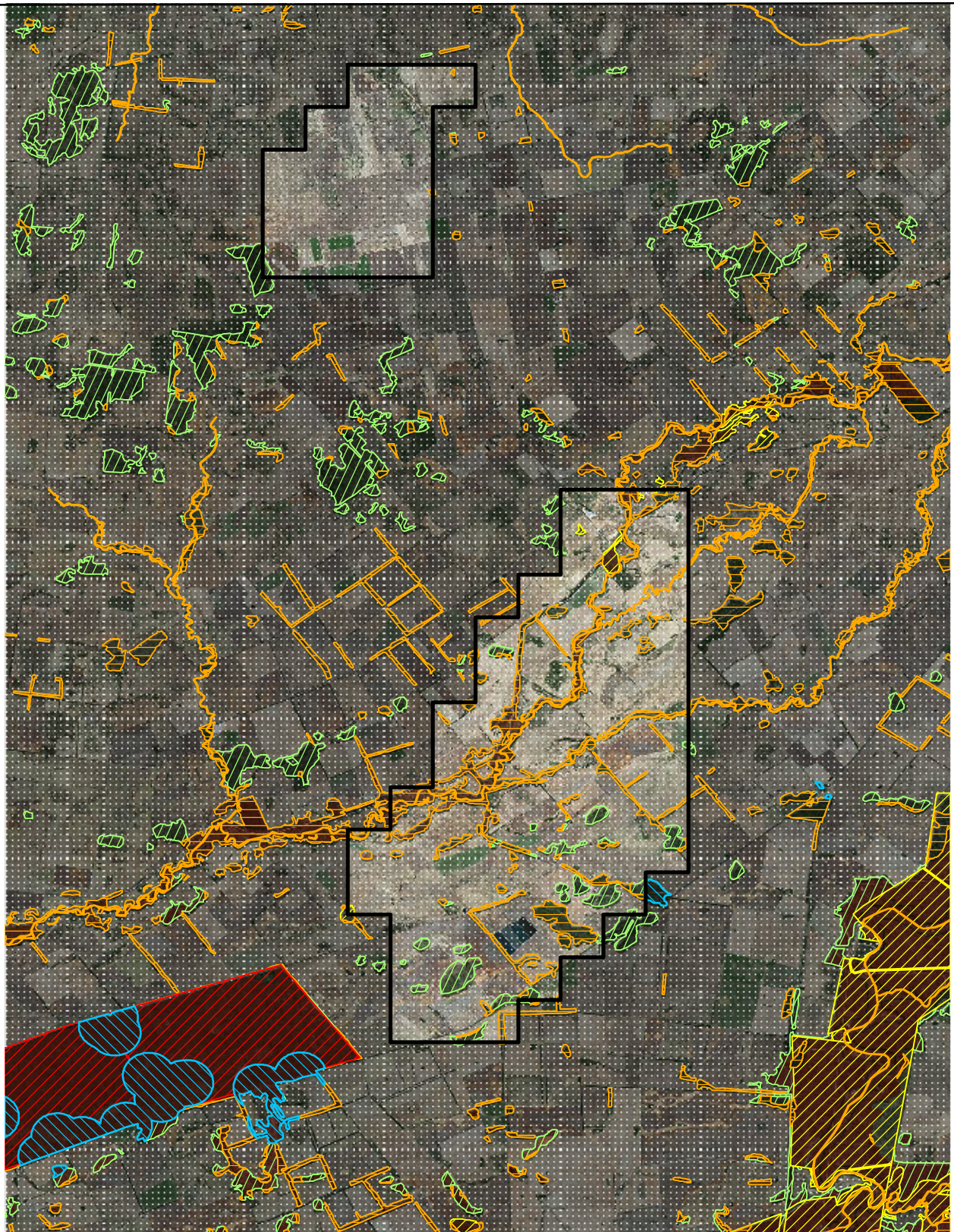
0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

	CSG Field		Class A
	Bioregional Wildlife Corridor		Class B
	Essential Habitat		Class C
			Class D
			Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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	Drawn: CA	Approved: JB	Date: 23-10-2009	Rev.A
	Job No: 4262 6440/6220	File: 42626440-g-2002.mxd		Figure: 2-22
				A4



0 2.5 5 10
Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

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Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
EASTERN SURAT
SHEET 1 OF 2**

URS

Drawn: CA

Approved: JB

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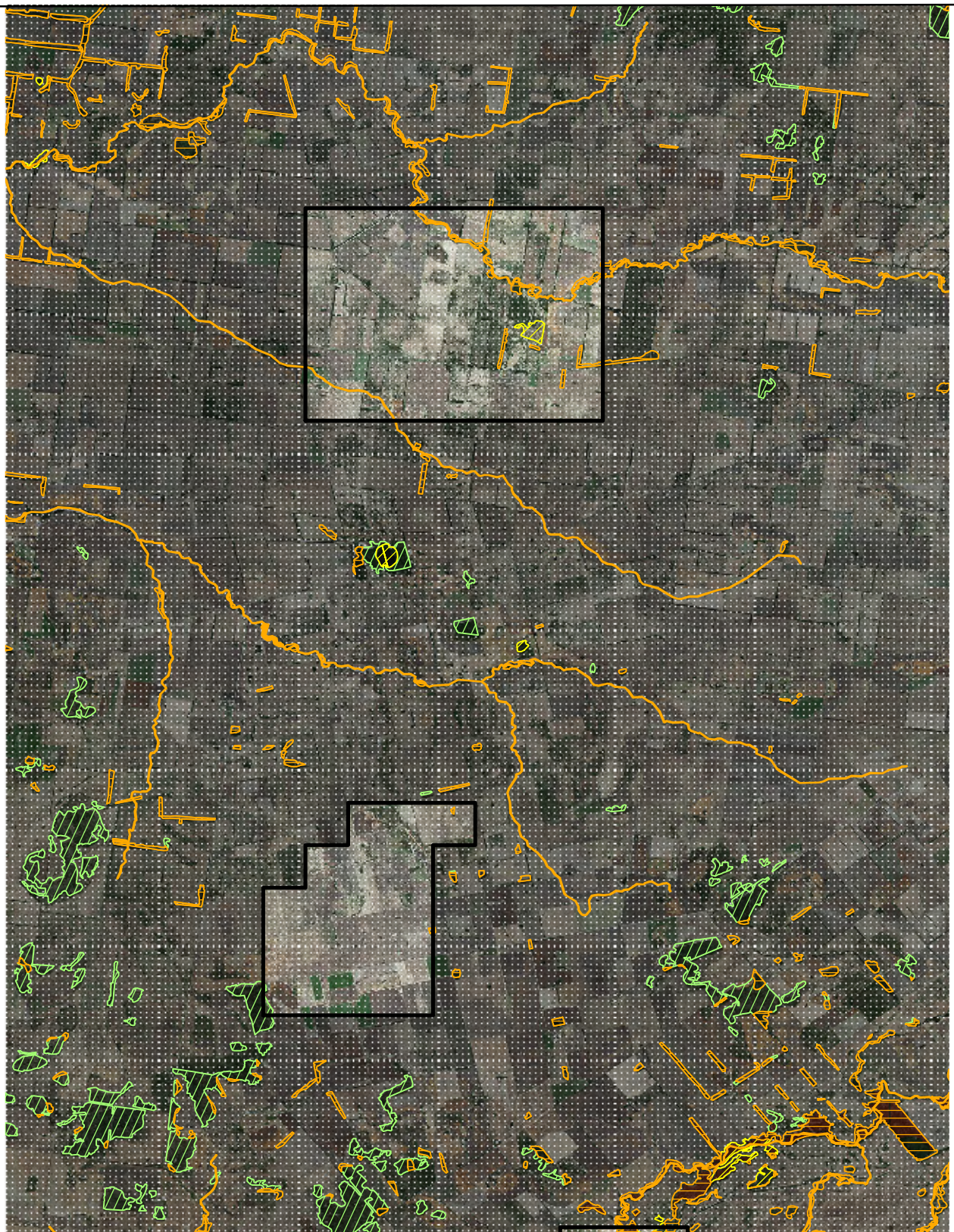
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Rev.A

A4



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Datum: GDA94

	CSG Field		Class A
	Bioregional Wildlife Corridor		Class B
	Essential Habitat		Class C
			Class D
			Class E

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Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
EASTERN SURAT
SHEET 2 OF 2**



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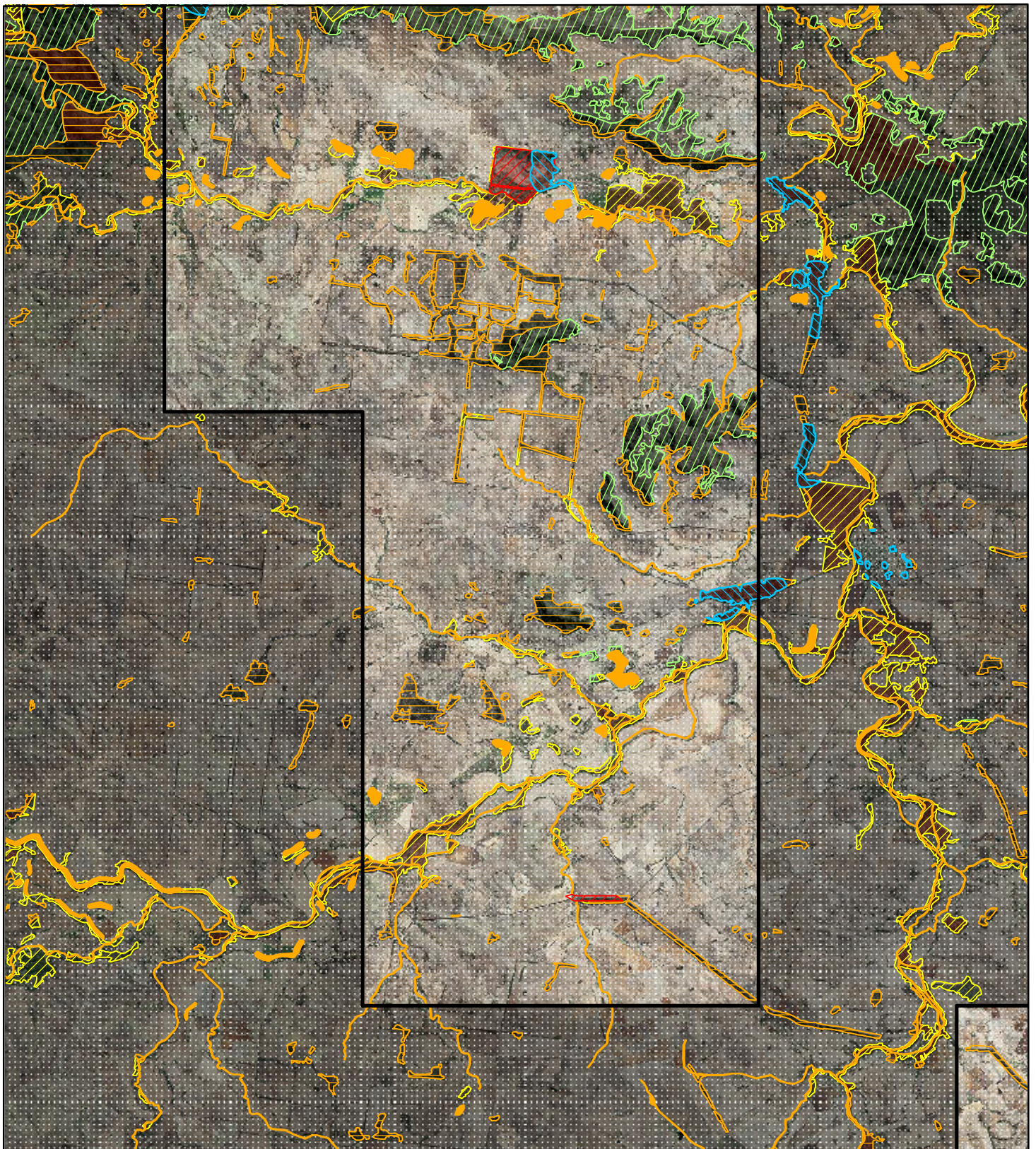
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Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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SUPPLEMENT
ECOLOGICAL CONSTRAINTS MAPPING

Title

**ECOLOGICAL CONSTRAINTS MAPPING
ROMA OTHER
SHEET 1 OF 2**



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Approved: JB

Date: 23-10-2009

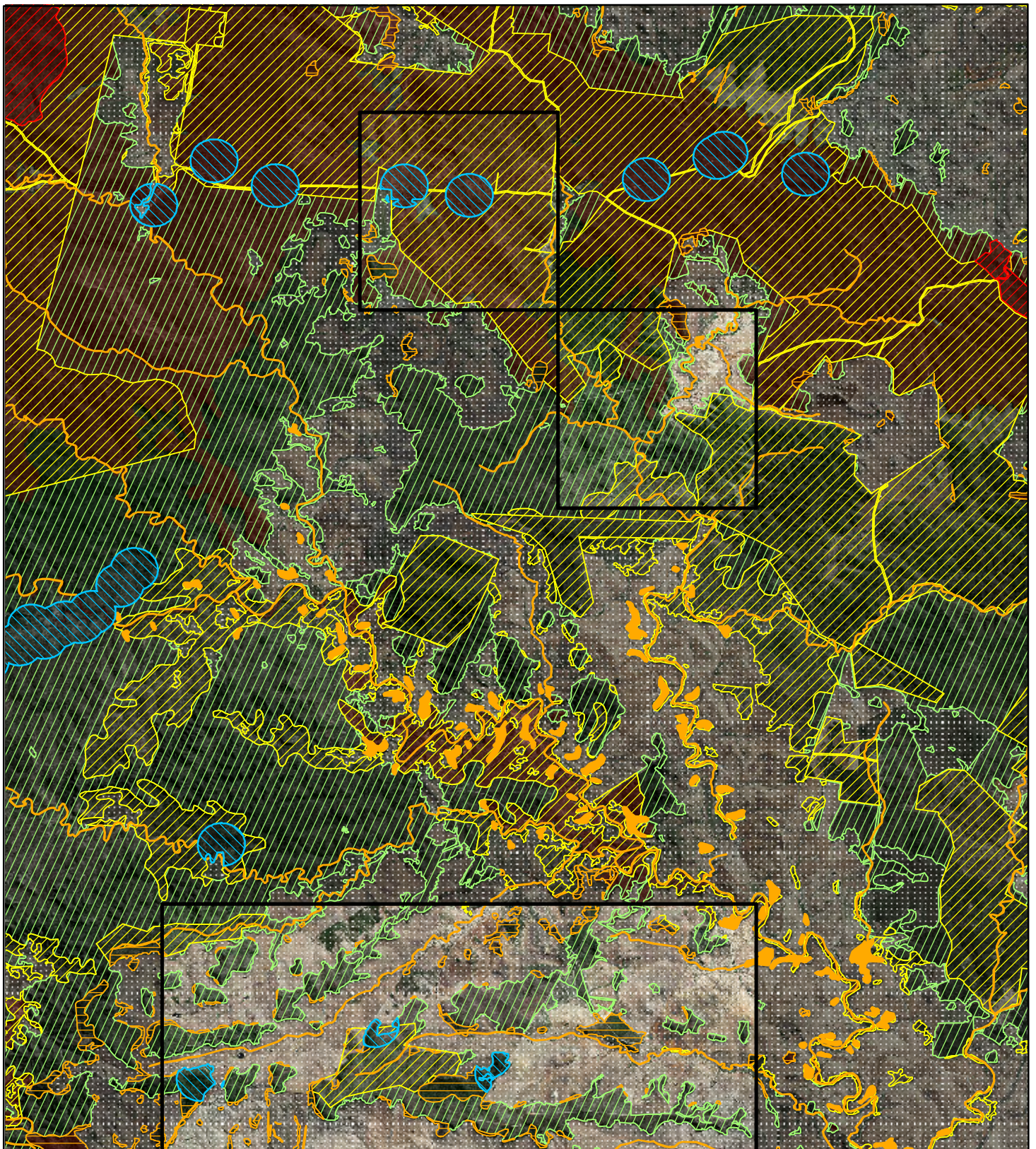
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Rev.A

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Km

Scale 1:250,000 (A4)
Datum: GDA94

CSG Field	Class A
Bioregional Wildlife Corridor	Class B
Essential Habitat	Class C
	Class D
	Class E

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		Drawn: CA Approved: JB Date: 23-10-2009 Job No: 4262 6440/6220 File: 42626440-g-2002.mxd	Figure: 2-26 Rev.A A4

Constraints-based Management of Ecological Impacts

3.1 Introduction

This section describes the field management protocols which will be implemented by Santos when undertaking the development of the CSG fields on land within each of the five constraints classes to reduce the impact of the GLNG Project on the ecological values of the CSG field.

The field management protocols presented in this report form part of the broader field management protocols which will be implemented by Santos when undertaking development of the GLNG Project to reduce the impact of the Project on other environmental values of the CSG field. The overall CSG field management protocol is outlined in Part 1 Figure 1-3. The specific ecological field management protocol process is outlined in Part 1 Figure 1-2.

3.2 Protocols for Constraints-Based Management

Field management protocols for constraints based management of ecological impacts are presented in this section. They cover protocols which apply to all classes of sensitivity. The protocols for each constraints class set out:

- (a) The nature of the development which may be undertaken within each constraints class;
- (b) The process to be undertaken to determine the specific location of the development within each constraints class; and
- (c) The mitigation measures which will be implemented to minimise the impact of the development on the ecological values of the area.

3.2.1 Desktop Review - All Classes

A desktop review will be undertaken at the planning stage of the development of the specific sites for locating wells, access roads and other associated infrastructure. The purpose of the desktop review is to update the constraints mapping having regard to any further available information, adjust the location of the proposed site to a lower constraints class where feasible and identify the specific actions for the pre-construction surveys. The desktop review will include the following procedures:

- Cross-check constraints maps with other data layers, including REs types, EPBC species habitat mapping, essential habitat mapping, wetlands mapping and Bioregional Wildlife Corridors, current aerial photography and results of previous survey work (EIS Appendix N1) as described above in Section 1.4 to ensure that any specific issues related to the site are identified.
- For each additional data layer, identify any significant species, sites or communities likely or known to be present, the likelihood of occurrence, and the listed threatening processes for those species or communities.
- Review available data on significant species/communities and threatening processes to confirm the level of pre-construction surveys required.
- Prepare detailed pre-clearance field survey actions that clearly define data collection, recording and reporting methodologies for pre-construction surveys within each constraint class. Identify clear actions required which may arise from the field results.
- Maintain a database of field records for every investigation, linked to a database of clearing operations.

3 Constraints-based Management of Ecological Impacts

- Where necessary, prepare site specific management plans for individual operations, which include low level assessments such as site and route selection, weed management, fire management, management of watercourse crossings, no-go zones and rehabilitation.

3.2.2 Field Management Protocols

The following section details the field management protocols for the ecological values of each constraints class. A summary of impact mitigation steps for each Class is also included in Appendix A.

3.2.3 Class A

Class A areas include Category A ESAs such as National Parks and RAMSAR wetlands.

These areas are of very high conservation value and are designated no-go areas. No-go areas are where petroleum activities will be prohibited from being undertaken. No project activities that have an impact on the environmental values of these areas are permitted in Class A zones.

3.2.4 Class B

Class B areas include Category B and C ESAs including State Forests; 'Endangered' REs; EPBC listed communities and Wetlands and waterways (Section 1.3.1).

These areas are considered to be the most environmentally sensitive landscapes within which the project will operate. As such they have the strictest management protocols. Protocols for management of activities in Class B sites are as per the following steps:

Avoidance

1. Class B areas will be avoided where possible at the planning stage for the siting of wells, access routes and associated infrastructure. If the Class B area can not be avoided through relocation at the planning stage, then well sites or associated infrastructure, will be sited in previously disturbed areas if possible, or in locations least likely to cause significant impacts based on the pre-construction surveys below.
2. No disturbance is proposed to occur in any areas within 50 m of waterways wherever feasible and within 200 m of mapped wetlands.

Pre-Construction Surveys

3. A pre-construction ground survey will be undertaken to confirm that vegetation mapping associated with the planned sites is accurate and to confirm the localised ecological values. The ground survey will identify specific locations of 'Endangered' REs and EPBC listed communities in the area of the proposed development.
4. If Category B and C ESAs (Section 1.3.1) are not present, the site will be re classified as constraints Class C, D or E accordingly.
5. Where Endangered REs or EPBC listed communities are confirmed, a more detailed ecological site survey will be undertaken by a suitably qualified person to ground truth boundaries of sensitive habitats, verify vegetation types, assess habitat condition and assess likelihood of presence of threatened species or communities. Survey design of targeted field assessment will be developed

3 Constraints-based Management of Ecological Impacts

by a suitably qualified person utilising standard methodologies such as those outlined in Appendix B) where applicable.

6. If the likely presence of threatened species is confirmed, then a targeted survey by a suitably qualified person will be undertaken to confirm presence and identify site specific microhabitat values. If threatened species are not likely no further surveys will be undertaken.

Mitigation

7. The specific sites for the wells, access routes and associated infrastructure will be selected to avoid sensitive areas confirmed by the pre-construction surveys where feasible.
8. If the proposed site is proximate to sensitive areas, specific management measures, such as minimising pad area or multiple pad drilling using HDD techniques, retention of buffer zones and specific placement of tracks and pipelines (e.g. co-location of pipelines and access tracks within the same corridor) will be implemented.
9. For clearing in proximity to identified significant fauna habitat a suitably qualified person will be present.
10. Any unavoidable disturbance to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species identified by the pre-construction surveys will trigger re-classification of the site to a Class A area and alternative options for operations will be explored to reduce impact on the EVR species population (e.g. pad drilling outside the habitat to extract CSG).
11. Progressive rehabilitation of disturbed areas will be undertaken using best practice techniques and to agreed standards in accordance with statutory approvals.
12. Produce a site specific work instruction and site mitigation plan for the development of each well site and associated infrastructure prior to construction commencing

Offsets

13. Any unavoidable disturbance to Class B sensitive areas for EREs or EPBC listed communities or EVR fauna habitat identified on site, and where there is a permanent loss of the environmental values, will be accounted for in the Part 4 of this report.

3.2.5 Class C

Class C areas are REs which are listed as 'Of Concern'. These areas generally have a lower level of sensitivity than Class A or B zones. Although 'Of Concern' REs are considered less significant than 'Endangered' REs, they are still considered to be under threat.

Protocols for management of activities in Class C mapped sites are as the following steps:

Pre-Construction Surveys

1. A pre-construction ground survey will be undertaken to confirm that vegetation mapping associated with the planned sites is accurate and to confirm the localised ecological values. The ground survey will identify locations of 'Endangered' REs and EPBC listed communities in the area of the proposed development.
2. If any 'Endangered' REs or EPBC listed communities are present site will be upgraded to a Class B area and the protocols for the Class B area above will apply. If 'Of Concern' REs are not present, the proposed site will be re-classified site as Class D or E accordingly.

3 Constraints-based Management of Ecological Impacts

3. Where 'Of Concern' REs are confirmed in the area of the proposed development, a more detailed ecological site survey will be undertaken by a suitably qualified person to ground truth the boundaries of sensitive habitats, verify vegetation types, assess habitat condition, and determine likelihood of presence of threatened species or communities (Methodology as per Appendix B). If the likely presence of threatened species is confirmed, then a targeted survey by a suitably qualified person will be undertaken to confirm the presence and minimise impact.

Mitigation

4. The specific sites for the wells, access routes and associated infrastructure will be selected to avoid sensitive areas confirmed by the pre-construction surveys where feasible
5. Any unavoidable disturbance to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species identified by the pre-construction surveys will trigger re-classification of the site to a Class A area and alternative options for operations will be explored to reduce impact on the EVR species population.
6. For clearing in proximity to identified significant fauna habitat a suitably qualified person will be present.
7. If the pre-construction survey has determined that there is a low risk to sensitive environments, then a suitably qualified person must be available at short notice to attend during clearing operations should any disturbance to sensitive vegetation or fauna occur.
8. Undertake progressive rehabilitation of disturbed areas using best practice techniques and to agreed standards in accordance with statutory approvals.
9. Produce a site specific work instruction and site mitigation plan for the development of each well site and associated infrastructure prior to construction commencing.

Offset

10. Any unavoidable disturbance to Class C sensitive areas such as 'Of Concern' communities, and where there is a permanent loss of the environmental values, will be accounted for in Part 4 of this report.

3.2.6 Class D

Class D areas are remnant REs which are classified as 'Not of Concern'. These are generally areas of low environmental sensitivity. Protocols for management of activities in Class D sites are as follows:

Pre-Construction Surveys

1. A suitably qualified person will determine whether a pre-construction survey is required based on results of the desktop assessment. If the proposed site is within 500 m proximity of Class A or B area then a pre-clearing survey to confirm RE types will be undertaken.
2. If any Category B and C ESAs (Section 1.3.1) are confirmed as present by the pre-construction survey, the site will be upgraded to a Class B area and the Class B protocol will apply. If 'Of Concern' REs are confirmed as present, the site will be re-classified as a Class C area. If there is no remnant vegetation present, then the site will be re-classified as Class E area.
3. Produce a site specific work instruction and site mitigation plan for the development of each well site and associated infrastructure prior to construction commencing.

3 Constraints-based Management of Ecological Impacts

Mitigation

4. Any unavoidable disturbance to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species identified by the pre-construction surveys will trigger re-classification of the site to a Class A area and alternative options for operations will be explored to reduce impact on the EVR species population.
5. If the pre-construction survey identifies any potential significant fauna habitat a suitably qualified person will be available during clearing at short notice to attend should any disturbance to sensitive vegetation or fauna occur.
6. Undertake progressive rehabilitation of disturbed areas using best practice techniques and to agreed standards in accordance with statutory approvals.

3.2.7 Class E

Class E areas are mapped as non-remnant vegetation. They are generally modified habitats such as agricultural lands, grazing lands or residential areas. Although these areas have the lowest level of ecological constraints, they may contain point features or microhabitat for significant flora and fauna species, including isolated hollow bearing trees, wetland sites (and artificial waterbodies), habitat connectivity along fence lines or road easements minor riparian corridors and cracking clay pans. Protocols for management of activities in Class E mapped sites are as follows:

Pre-Construction Surveys

1. A suitably qualified person will determine whether a pre-construction survey is required based on results of the desktop assessment. If unmapped habitats or point features (as listed above) are potentially present further field investigation is required by a suitably qualified person.

Mitigation

2. If point features or habitats are identified, field management steps will be taken to avoid these areas where possible, and a suitably qualified person must be available during clearing at short notice to attend should any disturbance to sensitive vegetation or fauna occur.
3. Any unavoidable disturbance to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species identified by the pre-construction surveys will trigger re-classification of the site to a Class A area and alternative options for operations will be explored to reduce impact on the EVR species population.
4. Undertake progressive rehabilitation of disturbed areas using best practice techniques and to agreed standards in accordance with statutory approvals.

Appendix A Impact Avoidance and Mitigation

Class	Avoidance and Mitigation
A	No project activities that have an impact on the environmental values of these areas are permitted in Class A zones.
B	- Configure well sites access routes and infrastructure to avoid sensitive areas identified by ground truthing and any targeted threatened species surveys. - Proximity to sensitive areas may trigger specific management such as minimising pad area, retention of buffer zones and specific placement of tracks and pipelines. - For all clearing operations, a suitably qualified person will be present on site at all times. - For clearing in proximity to identified significant fauna habitat a suitably qualified person shall also be present. - No disturbance shall occur in any areas within 50 m of waterways and within 200 m of mapped wetlands. - Any unavoidable disturbance (as determined on site) to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species (under legislative guidelines) will trigger re-classification of the site to a Class A zone and alternative options for operations will be explored to reduce impact on the EVR species population.
C	- Configure well sites access routes and infrastructure to avoid sensitive areas identified by ground truthing surveys. - If sensitive vegetation or habitats have been identified, a suitably qualified person must be present on site to oversee clearing operations - If the pre-clearing survey has determined that there is a low risk to sensitive environments, then a suitably qualified person must be available at short notice to attend during clearing operations should any disturbance to sensitive vegetation or fauna occur. - Any unavoidable disturbance (as determined on site) to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species (under legislative guidelines) will trigger re-classification of the site to a Class A zone and alternative options for operations will be explored to reduce impact on the EVR species population.
D	- If pre-clearing survey identifies any potential significant fauna habitat an on-call ecologist must be available during clearing at short notice to attend should any disturbance to sensitive vegetation or fauna occur. - Any unavoidable disturbance (as determined on site) to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species (under legislative guidelines) will trigger re-classification of the site to a Class A zone and alternative options for operations will be explored to reduce impact on the EVR species population.
E	- If point features or habitats are identified, field management steps will be taken to avoid these areas where possible, and an on-call ecologist must be available during clearing at short notice to attend should any disturbance to sensitive vegetation or fauna occur. - Any unavoidable disturbance (as determined on site) to an EVR flora or fauna species that will have a 'significant impact to the local population' of that species (under legislative guidelines) will trigger re-classification of the site to a Class A zone and alternative options for operations will be explored to reduce impact on the EVR species population.

Appendix B Field Survey Methodology

Detailed ecological site assessments should include the following flora and fauna survey methodologies where applicable.

Flora Field Survey Methodology

The flora survey will employ assessment of floral taxa and vegetation communities suitable for use in RE map amendment requests and in keeping with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al.*, 2005).

Preliminary community definition (utilising colour aerial photography and interpretation of current DERM 1:100,000 RE mapping) will be used to identify locations for representative field survey sample plots to obtain floristic and structural data and ground truth communities. Field surveys will include botanical assessment at a number of representative sites within each vegetation community, employing a number of standard methods including: secondary survey sites; quaternary survey sites; and random meander search areas.

Secondary Survey Sites

Secondary survey sites comprise of 10 m x 50 m (500 m²) transects. Fieldwork within secondary survey sites will include floristic and structural analysis as detailed below.

Floristic analysis will include plant identification and species diversity characterisation of all flora present. Relative abundance will be assigned for all species recorded. Plant identification and estimation of relative abundance will be undertaken by an experienced botanist with previous survey experience of the bioregion.

Structural analysis will include recording the height class and life form of the dominant species within each strata present. Height of each strata will be recorded using a hand held Optilogic laser rangefinder. Foliage Projection Cover (FPC) of the canopy and mid strata (where applicable) should be calculated using the canopy intercept method. FPC of the ground layer will be determined using ocular estimation of cover within several 1 m subplots along the secondary transect.

Evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity will be compiled for each secondary survey site. A time encoded digital photograph will be taken at each plot as a reference. Locations of each secondary transect will be recorded using a GPS unit.

Quaternary Survey Sites

Quaternary survey sites will be utilised to ground truth vegetation units and confirm dominant characteristic species. Structural analysis included recording the height class and life form of the dominant species within the mid and canopy strata will be in accordance with Neldner *et al.* (2005).

Evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity will be compiled for each quaternary survey site. A time encoded digital photograph will be taken at each plot as a reference. Locations of each quaternary transect will be recorded using a GPS unit.

Meander Searches

Following assessment of each secondary survey site and selected quaternary sites, an area of approximately 1 ha surrounding each plot will be searched for 20 minutes utilising the random meander technique (Cropper, 1993). The aims of the random meander searches are to:

Appendix B

- Identify additional less abundant species not recorded within survey plots;
- Identify any potential significant threatened or species not identified within the survey plot;
- Confirm the representativeness of plot locations; and
- Confirm boundaries and ecotonal areas between vegetation communities.

Fauna Habitat Survey Methodology

Habitat suitability assessments will be conducted within vegetation communities to ascertain the suitability and extent of potential fauna habitat supported within the community. Habitat assessments will be designed to specifically target habitat of conservation significant species identified as potentially present from detailed literature reviews. Key characteristics assessed for habitat suitability will include:

- Structure and dominant floristics of woodland canopy;
- Presence of large mature trees for arboreal fauna, nesting bird species, insectivorous bats and perching raptors;
- Presence of faunal refugia such as hollow bearing trees, fallen timber and large woody debris;
- Diversity and density of the shrub layer and ground cover provided as habitat for ground dwelling mammals;
- Presence of rock outcrops and dry cracking clays as habitat for reptile and small ground dwelling mammal species; and
- Connectivity and linkages of riparian corridors, core habitat and major habitat units.

Active diurnal searches for reptiles, amphibians and mammals will involve searching for individuals active in targeted micro-habitat such as aquatic habitat, groundcover, trees/rock faces, fallen wood debris, decorticating bark and forest litter.

Searches for tracks and signs will involve both active and opportunistic observations of scats, scratchings, diggings and other signs of fauna activity. Where possible predator scats will also be collected for hair analysis for identification of prey species.

At each fauna sampling site habitat conditions will be recorded including dominant vegetation structure and floristics, level of fallen timber, hollow bearing trees, leaf litter, rocks, rank grasses or dense shrub layers, levels of disturbance and obvious signs of animal activity.

Separate targeted significant species surveys may also be employed within specific habitat types where appropriate to ascertain presence or absence of potential significant cryptic species if critical habitat for these species is identified at a sampling location.



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Part 3: EPBC Listed Fauna Species Habitat Mapping



Report

Part 3 EPBC Listed Fauna Species Habitat Mapping

NOVEMBER 2009

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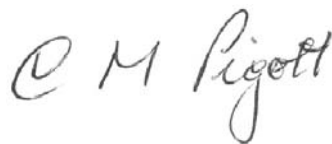


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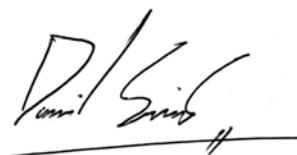
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Reference: 42626459/1/C
Status: Final

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Appendices

Appendix A EPBC-listed fauna summary notes for each CSG Field

Abbreviations

Abbreviation	Description
CSG	Coal Seam Gas
DERM	Queensland Department of Environment and Resource Management
DEWHA	Department of the Environment, Water, Heritage and the Arts
EIS	Environmental Impact Statement
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
GLNG	Gladstone Liquefied Natural Gas
ha	hectares
IUCN	International Union for Conservation of Nature
m	Metres
mm	Millimetres
MNES database	Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) Matters of National Environmental Significance database
NC Act	Queensland <i>Nature Conservation Act 1992</i>
NP	National Park
NSW	New South Wales
NT	Northern Territory
RE	Regional Ecosystems
SF	State Forest
SPRAT	Species Profiles and Threats
Qld	Queensland
VM Act	Queensland <i>Vegetation Management Act 1999</i>
WA	Western Australia

Introduction

1.1 Introduction

This report is provided in response to comments received from the Department of the Environment, Water, Heritage and the Arts (DEWHA) regarding the potential distribution of Threatened and Migratory species listed in the EPBC Act within the region of the CSG fields. EPBC listed threatened and migratory species are profiled, with information on their distribution, known habitat types, identified threats, and their known or potential distribution within the CSG fields. Maps displaying the potential distribution of each species on the CSG fields have been compiled using this information (Figures 2-1 to 2.9).

These EPBC listed species potential habitat distribution maps are complimentary to the CSG fields Ecological Constraints Maps (Part 2) to inform desktop field planning and field based site scouting.

The EPBC listed species potential habitat distribution maps also been utilised as a surrogate to project potential worst case impacts to EPBC listed species in order to estimate any potential offset requirements for CSG field development (Part 4).

1.2 Methodology

1.2.1 Initial Data Compilation and Mapping

A list of EPBC listed threatened and migratory species potentially present in the region was generated using the EPBC Protected Matters search tool. Details of the coordinates of the search are provided in the GLNG EIS Appendix N1 (Section 3.1.1). A total of 27 Threatened and 17 Migratory species were extracted from the database. Further examination of the list and known ecology of the species revealed that only 17 of the threatened fauna species and 15 of the migratory species are considered likely to occur on the CSG fields, with the remaining species considered either extinct in this region, or unlikely to be present based on known current distributions or habitat preferences.

1.2.2 Species Profile Summaries

Species profiles were generated for each of the threatened species. Included in each profile is summary information on:

- The current threat category at State (*Qld Nature Conservation Act 1992, & Regulations 2006*), Australian (*Environmental Protection and Biodiversity Conservation Act 1999*) and International (IUCN Red Listed) levels;
- Known distribution and habitat preferences;
- Identified threatening processes; and
- Known or potential occurrence within the CSG fields region.

General information on each of the species was summarised from information provided in the Commonwealth Government's online Species Profiles and Threats (SPRAT) database (DEWHA, 2009) or the various referenced documents for each species in the SPRAT profiles. Additional information was also sourced from species profiles on the Queensland Government's (DERM) online threatened species factsheets (DERM, 2009a), from IUCN Red List profiles (IUCN, 2009), museum records and from information provided in popular field guides. Known records of species from conservation areas in the region were also identified based on searches of the Qld EPA "Wildlife Online" database (DERM, 2009b).

1 Introduction

Searches were undertaken for the following regional national parks:

- Southwood; Nuga Nuga;
- Lake Murphy;
- Carnarvon;
- Isla Gorge;
- Minerva Hills;
- Blackdown Tableland;
- Erringibba;
- Expedition; and
- Palmgrove.

Information on the likelihood of occurrence of each species within the CSG fields is provided. This information is based on known occurrences of species as identified in the EIS (EIS Appendices N1 and N4) or database searches.

1.2.3 Species Distribution Analysis

Potential distribution of each species was assessed by matching known habitat preferences (as ascertained from the species profiles) to regional ecosystems (REs) or landzones as identified by Sattler & Williams (1999). There are 11 landzones identified for the Brigalow Belt bioregion, although not all of these are present on the CSG fields (for example, land zone 12 and Landzone 11). In some instances, it was possible to refine the mapping to individual REs, such as for the black-breasted button-quail. Species that have broader habitat preferences or that rely on particular microhabitat features were mapped at the landzone scale to illustrate the potential occurrence of habitat for these species across the CSG fields. A description of each Landzone with typical vegetation communities is presented in Table 1-1 below

Table 1-1 Landzones and Potential Vegetation Communities Present in the CSG fields

Landzone	Description
3	Primarily consist of woodlands and open forest on Quaternary alluviums on river and creek flats. Dominant systems include floodplains, alluvial plains, alluvial fans, terraces, levees, swamps, channels and closed depressions. Within the CSG fields, common canopy species on this landzone include <i>Eucalyptus tereticornis</i> , <i>Eucalyptus populnea</i> , <i>Acacia harpophylla</i> and <i>Eucalyptus melanophloia</i> . Cracking clays within this landzone are a significant microhabitat feature.
4	Comprises Cainozoic clay deposits, usually forming level to gently undulating plains above current alluvial systems. Typical vegetation communities present include woodlands to open forest of <i>Acacia harpophylla</i> , <i>Eucalyptus populnea</i> , <i>Eucalyptus cambageana</i> as well as semi-evergreen vine thickets. Cracking clays within this landzone are a significant microhabitat feature.
5	This landzone primarily consists of uniform near level or gently undulating Cainozoic plains with sandy or loamy soils and includes dissected remnants of these surfaces. Typical vegetation communities present include woodlands to open forests of <i>Eucalyptus crebra</i> , <i>Eucalyptus populnea</i> , <i>Eucalyptus melanophloia</i> , <i>Eucalyptus moluccana</i> as well as semi-evergreen vine thickets.
7	Primarily consist of Cainozoic duricrusts formed on a variety of rock types, usually forming mesas or scarps. They are often vegetated with woodland commonly dominated by <i>Acacia rhodoxylon</i> , <i>Acacia catenulata</i> or <i>Acacia shirleyi</i> .

1 Introduction

Landzone	Description
8	This landzone is primarily comprised of Cainozoic igneous rocks, predominantly flood basalts forming extensive plains and occasional low scarps. This landzone within the CSG fields can support woodlands of <i>Eucalyptus tereticornis</i> , <i>Eucalyptus melanophloia</i> and <i>Eucalyptus orgadophila</i> , as well as semi-evergreen vine thickets and native grasslands.
9	This landzone consists of fine-grained sedimentary rocks, generally with little or no deformation, forming undulating landscapes with a broad range of fine textured soils of moderate to high fertility. Communities present include woodlands of <i>Acacia harpophylla</i> , <i>Eucalyptus populnea</i> , <i>Eucalyptus cambageana</i> , <i>Eucalyptus crebra</i> as well as semi-evergreen vine thickets.
10	Medium to coarse-grained sedimentary rocks, with little or no deformation, forming plateaus, ledges and scarps. Common vegetation communities present on the landzone within the CSG Fields include woodlands to forests of <i>Corymbia citriodora</i> , <i>Acacia catenulata</i> , <i>Acacia shirleyi</i> , <i>Eucalyptus decorticans</i> , <i>Eucalyptus crebra</i> , <i>Callitris glaucophylla</i> and <i>Eucalyptus populnea</i> . Present primarily on the higher country of the Expedition and Carnarvon Ranges.
NR (Non-remnant)	The remainder of the mapped area not included as habitat comprises modified habitats such as regrowth vegetation, agricultural lands, grazing lands or residential areas.

1.2.4 Expert Review and Species' Distribution Refinement

Species distribution mapping was further refined through results from CSG field reconnaissance surveys (EIS Appendix N1) and detailed input from a recognised expert on the ecology of the Brigalow Belt Bioregion, with particular experience conducting flora and fauna surveys in the area of the CSG fields.

Local knowledge was applied to amend the potential distribution of each species within each CSG field. An estimation of the likelihood of presence was provided, with the following definitions used;

- **Known:** reliably recorded from the CSG field within the last 5 years; suitable habitat remains intact and populations still extent.
- **Likely:** >50 % chance that the species occurs in the CSG field based on the presence of suitable habitat and within the known distribution.
- **Possible:** <50 % chance that the species occurs in the CSG field based on known habitat preferences and distribution; no known confirmed records or the species may have formally occurred but the species have declined in numbers or extent of range (current status unknown).
- **Absent:** not known to currently occur in CSG field due to lack of suitable habitat or outside of known range. May have formerly occurred in CSG field but has declined to the point of local extinction.

Certain species, such as eastern long-eared bat, Dunmall's snake and collared delma, are known from only one or a few records in the CSG fields, hence accurate determination of preferred habitat and distribution is difficult without further targeted surveys. In addition, further examination determined that the Murray Cod (*Maccullochella peelii peelii*) was not present within the Roma CSG field. The updated mapping units for each species are detailed below in Table 2-1. Further information regarding habitat requirements, potential range and likelihood of presence within each CSG field for each species is presented in Appendix A. Final mapping of potential habitat for each species is shown on Figures 2-1 to 2-9.

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1.2.5 Limitations

It should be noted that the mapping generated within this report is a tool to indicate areas within which potential habitat for these species may exist. If present, most of the threatened or migratory species will have a very localised and scattered distribution within these areas, depending on a number of factors including, but not limited to:

- Seasonal distribution variation;
- Temporal and spatial migrational considerations;
- Presence of specific microhabitat conditions for each species;
- Presence of suitable foraging and breeding habitat requirements for each species;
- Localised climatic and micro-climatic conditions;
- Species population dynamics for each species such as abundance, density, fecundity, mortality and population health within each landscape and bio-geographical sub-region;
- Ecological integrity and condition of existing ecosystems and habitat;
- Impacts and disturbance to ecosystem function;
- Current and historical land management practices; and
- Predation, condition of connectivity for dispersal, fire regime historical disturbance.

Further refinement of potential habitat mapping for each of these species is outside of 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 to account for the above factors for each species.

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2.1 Threatened Species Profiles and Mapping Units

2.1.1 Species known or potentially present

The species profile development and expert review resulted in a final species list and modified mapping for each species. Table 2-1 below details EPBC listed fauna species potentially present within the CSG fields and the habitat in which they may utilise.

Table 2-1 EPBC Listed Fauna Species Habitat Mapping Units

Species	Mapping Units	Habitat and Range Comments
Mammals		
<i>Dasyurus hallucatus</i> northern quoll.	Landzone 10 with the addition of 11.9.4 and 11.9.5 in all northern CSG fields only.	Has declined dramatically from region primarily due to cane toads. Any remaining populations are not considered likely to occupy any more than 10 % of mapped potential habitat given low densities and numbers known for the CSG area, absent from southern CSG fields
<i>Chalinolobus dwyeri</i> Large-eared pied bat, large pied bat.	All remnant vegetation on landzone 10. All remnant vegetation adjoining any RE on landzone 10.	Not known to occur in study area away from landzone 10. Will forage in adjoining woodlands as well as clearings. Known from the Expedition Range; likely to be widespread but in low numbers.
<i>Nyctophilus timoriensis</i> Eastern long-eared bat (South-eastern form).	Landzones 3, 4, 5, 7, 8, 9 and 10.	Occurs in wide range of remnant woodland types but in very low numbers. Recently recorded from Lonesome Holding in southern Arcadia Valley; also known from Carnarvon Range through to Moonie area (e.g. Alton NP). May also occur in adjoining non-remnant depending on un-mappable micro site features (i.e. availability of hollows).
Birds		
<i>Geophaps scripta scripta</i> Squatter pigeon (southern).	All remnant vegetation on landzone 3, 4, 5, 7 and 10 in northern CSG fields. All non-remnant vegetation on landzone 3 in all northern CSG fields. All remnant vegetation within Yuleba SF only in Roma CSG field.	Throughout northern area in most vegetation except the densest types (e.g. brigalow/vine thicket). Occurrence usually dependant on water especially in non-remnant areas. Will also live in high disturbed sites close to water (e.g. cattle yards). Virtually absent south of Injune except for small population in Yuleba SF.
<i>Erythrotriorchis radiatus</i> Red goshawk.	Landzones 3, 8 and 10 in northern gas fields only and mapped wetlands.	Could potentially overfly anywhere in all of northern CSG fields including non-remnant areas. Focus areas most likely to be around Lake Nuga Nuga and Palm Tree/Robinson Creek wetlands.

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Species	Mapping Units	Habitat and Range Comments
<i>Turnix melanogaster</i> Black-breasted button-quail.	RE 11.9.4 in Arcadia Valley, Comet, Fairview and Roma Other only.	Known from 11.9.4 immediately adjoining the Comet CSG field. >90 % probability in largest 11.9.4 patches in Arcadia but almost all of these are within NP. <30 % confidence of presence in Fairview and Roma Other due to smaller patch size and higher surrounding fragmentation of habitat.
<i>Rostratula australis</i> Australian painted snipe.	11.3.2, 11.3.3, 11.3.4, 11.3.25, 11.3.27 and wetlands.	Potentially any wetland (usually shallow and temporary types); also farm dams with suitable vegetative cover. Potentially on other REs that form gilgais e.g. 11.4.3 and 11.9.5 but mapping these communities would over-estimate habitat. Likely to occur anywhere with suitable habitat across CSG fields but difficult to detect being a cryptic species.
Reptiles		
<i>Egernia rugosa</i> Yakka Skink.	Any remnant on landzones 3, 4, 5, 7 and 9 in all CSG fields with the exception of 11.3.3. Include non-remnant of 11.3.2 only.	Found in most vegetation and substrate types except landzone 10 and also avoids coolabah (11.3.3). Able to live in clearings providing there are suitable shelter sites (e.g. tunnel erosion) which most frequently occurs on 11.3.2. Patchy distribution but can be difficult to detect - likely to be more widespread than records indicate; recorded from Arcadia Valley, Lonesome Holding, Mt. Hutton, Womblebank Road, Cobbadah, Moonie area, Yuleba-Surat Rd and Roma area.
<i>Furina dunmalli</i> Dunmall's snake.	All remnant vegetation on landzone 4, 5, 7, 9 and 10.	Extremely sparsely distributed throughout entire study area. Recorded from Expedition Range and Taroom town area; very poorly known species which is difficult to detect; likely to be more widespread than records indicate but in very low densities.
<i>Paradelma orientalis</i> Brigalow Scaly-foot.	All remnant vegetation on landzones 4, 5, 7, 9 and 10 in all CSG fields. Include only regrowth on landzones 4 and 9 (i.e. any endangered community regrowth).	Occurs in a wide variety of substrates and vegetation types throughout. Lives in brigalow/vine thicket regrowth but not tolerant of clearings. Known from Expedition Range, Fairview, Carnarvon Range and Grafton Range near Roma; likely to be throughout the northern CSG fields wherever there is intact vegetation and suitable microhabitat.

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Species	Mapping Units	Habitat and Range Comments
<i>Denisonia maculata</i> Ornamental snake.	Landzones 3, 4 and 9 in Denison, Mahalo, Comet and Arcadia Valley CSG fields (remnant and non-remnant vegetation). Landzone 3 only in Fairview and Roma Other (remnant and non-remnant vegetation).	Dawson, Fitzroy and Comet River catchments only [i.e. on northern side of Great Dividing Range only). Preference for alluvial and clay substrates with tolerance of clearing. No confirmed records from Fairview and Roma Other so <50 % confident this species occurs in those two fields. Recorded from Lake Nuga Nuga; likely along watercourses with clay substrates within Dawson-Fitzroy drainage.
<i>Delma torquata</i> Collared delma.	All remnant vegetation on Landzone 10 in Arcadia, Mahalo, Comet and Roma Other. All remnant RE 11.3.2 in Roma.	Known from land zone 10 in Expedition Range. Known from remnant 11.3.2 along stock routes west of Roma.
Molluscs		
<i>Adclarkia dawsonensis</i> Boggomoss Snail.	11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.22, 11.3.25 and 11.3.27 in Roma Other only.	In addition to boggomosses, this species also occurs in remnant coolabah, poplar box and gilgaied brigalow along major watercourses (e.g. Dawson River), although population numbers are not as high as in boggomosses. Core populations occur at Mt. Rose Station and Isla Delusion Rd; recently detected in very low numbers along Dawson River near Theodore. May not be present within the Roma Other CSG field.

For each species listed within above, a profile was developed. These are presented below along with profiles for those species listed in the MNES but not expected to be found within the CSG fields. Further information regarding habitat requirements, potential range and likelihood of presence within each CSG field for each species is presented in Appendix A.

2.1.2 Species profiles – species known or likely to be present

Northern Quoll (Dasyurus hallucatus)

Status: Endangered (EPBC); Common (NCA); Endangered (IUCN).

The northern quoll is a carnivorous marsupial and is the smallest of four quoll species found in Australia. Northern quoll are grey-brown or reddish above with white spots on the body and a brownish, unspotted tail, a pointed snout and large eyes and ears.

This is a chiefly nocturnal species, which dens in rock crevices or tree hollows. The species occurs in a range of woodland habitats, but is most abundant in rocky areas. The species was formerly found across coastal and subcoastal northern and eastern Australia as far south as Brisbane, but the range has contracted and distribution is now patchy. It is generally sedentary, and establishes small local territories.

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Identified threats to the northern quoll include inappropriate fire regimes, predation following fire and lethal toxic ingestion of cane toad toxin. The recent expansion of cane toads across northern Australia is thought to pose a particular threat, although some quoll populations still persist in toad-infested areas.

Within the region of the CSG field, the northern quoll is historically known from Carnarvon, Expedition, Palmgrove and Minerva Hills national parks. Carnarvon NP was, until recently, a stronghold for the species in the Central Queensland Sandstone Belt. However, populations are known to have declined markedly following invasion of cane toads (C. Eddie, M. Oakwood pers. obs.). It may still occur within isolated pockets of the CSG fields, especially in rocky range areas in the northern and eastern fields within Landzone 10, however, targeted surveys are required to confirm their presence.

Large-eared pied bat (Chalinolobus dwyeri)

Status: Vulnerable (EPBC); Rare (NCA); Near Threatened (IUCN).

The large-eared pied bat is a medium sized (hb 45-49 mm) insectivorous microbat which is generally a uniform glossy black colour, lighter underneath and with white variable strips along the flanks.

This is a generally uncommon species which is distributed in dry and wet sclerophyll forests in eastern Australia, from the Blackdown Tablelands to the south coast of NSW. The species ranges in a wide variety of woodland and forest habitats, and is likely to traverse both remnant vegetation and agricultural lands, especially where watering points occur. Critical roosting habitat is restricted to rocky areas or old mine shafts. It is not known how far the species ranges from its roosting habitat although habitat in proximity to sandstone ranges is thought to be most important. It has been classified as Vulnerable based on the low number of mature individuals and the likelihood of a substantial further reduction in numbers. The primary identified threat is destruction of cave or mine shaft roost sites.

In the region of the CSG fields, it has been recorded from Carnarvon, Blackdown Tablelands and Expedition national parks. It is therefore considered potentially present on the CSG fields. Based on the known ecology of this species, it is likely that critical habitat is confined to Landzone 10 areas, with suitable feeding and watering habitat within foraging range of these sites.

Eastern long-eared bat (Nyctophilus timoriensis) (South-eastern form)

Status: Vulnerable (EPBC); Vulnerable (NCA); Data deficient (IUCN).

The eastern long-eared bat is a medium large (hb 50-70 mm) insectivorous microbat, dark grey above with slightly paler underparts. The south-eastern form is distributed through southern central Queensland, central western New South Wales, north-western Victoria and South Australia, and there is no clear evidence that it has suffered a contraction of its previous range. It generally occurs in semi arid areas of tall eucalyptus open forest and woodland. The species roosts in tree hollows or under bark.

The principal identified threat is from loss of habitat due to land clearance for agriculture. Timber harvesting, grazing and changed fire regimes may also be threats.

Within the region, the species is known to occur in Carnarvon and Expedition national parks, and has been recorded from Lonesome Holding within the Fairview and Arcadia CSG fields. It potentially may occur sparsely and in low numbers in all remnant habitat containing suitable roost sites as well as in agricultural areas where sufficient woodland remains, such as along riparian corridors.

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Squatter pigeon (southern) (Geophaps scripta scripta)

Status: Vulnerable (EPBC); Vulnerable (NCA); Least Concern (IUCN).

The squatter pigeon is a medium sized, ground dwelling pigeon, predominantly grey-brown, with black and white facial markings. Squatter pigeons are usually seen in pairs or small groups, and usually breed in solitary pairs.

Squatter pigeons are found along the inland slopes of the Great Dividing Range, from about the Burdekin-Lynd region, west to Charleville and Longreach, and east to the Gladstone area. Their distribution in central southern Qld is patchy, and there have been no records further south in NSW since the 1970's. It is thought that the Queensland population is stable, and no recent decline in the extent of occurrence has been recorded. The total population size is estimated at about 40,000 birds.

The squatter pigeon occurs in a variety of grassy woodland and eucalypt open forest habitats. It has also been frequently seen in disturbed areas including road and rail line verges, stockyards, and around settlements. It is also found in grazed areas. The species is most often encountered in proximity to water bodies such as intermittent streams, isolated pools, bores and farm dams.

Breeding occurs from late winter into summer. The nest is grass-lined, and built into a depression in the soil beneath a grass tussock. Two eggs are laid. Squatter pigeons are predominantly seed eaters, with a diet of various grass, legume, forb and herb seeds. They also eat some insects. The species is locally nomadic, and does not undertake long distance movements.

Identified threats to the viability of squatter pigeon populations include: loss of habitat from clearing for agriculture or industry; degradation of habitat by sheep, cattle and rabbits; and predation, especially by cats and foxes.

Within the region of the CSG fields, squatter pigeons have been recorded from Blackdown Tablelands, Carnarvon and Expedition national parks. To date it has been recorded from all northern CSG fields and the Roma field in the south. It occurs in eucalypt open forest and woodland remnants, and in grazing lands in proximity to natural and artificial water bodies. Landzones where this species occurs include 3, 4, 5, 7, 9 and 10.

Red goshawk (Erythrorhynchus radiatus)

Status: Vulnerable (EPBC); Endangered (NCA); Vulnerable (IUCN).

The red goshawk is a large reddish-brown raptor, with females much larger than the males. The species is endemic to Australia, and occurs sparsely in subcoastal forests and woodlands of northern WA, NT, Queensland and northern NSW, where it is now considered possibly extinct. There is evidence of a recent coastal contraction of the population in eastern Australia.

Habitat for this species includes tall eucalypt woodland and open forest, with a mixture of vegetation types, and usually in proximity to permanent water. Nests are in tall trees, usually within 1 km of water. This species is predominantly a predator of smaller birds. Movements are poorly known, but it is thought that the species is generally resident year round.

Identified threats to this species include: habitat loss and fragmentation; egg collecting; pesticides; overgrazing (causing reduction in prey items); fire; shooting by property owners; disease; genetic bottlenecks; secondary poisoning and disturbance by birdwatchers.

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Within the region of the CSG fields, red goshawk has been recorded at Blackdown Tableland National Park and the Springsure-Rolleston area (Birds Aust Atlas). There is no known resident population within the CSG fields. Much of the CSG fields would be unoccupied due to the lack of suitable habitat, but it could be present in the more northerly fields such as Denison, Mahalo, Arcadia, Roma Other and Comet, where they may occur in proximity to the major permanent rivers in Landzones 3 and 10 (e.g. Dawson, Nogoia and Comet Rivers, as well as Lake Nuga Nuga).

Black-breasted button-quail (Turnix melanogaster)

Status: Vulnerable (EPBC) Vulnerable (NCA); Vulnerable (IUCN).

The black-breasted button-quail is a large, darkish species with white eye, grey bill and yellow legs. The species is endemic to eastern Australia, where it occurs in coastal and near coastal areas of southern Queensland and northern NSW. It was once widespread in the Dawson and Fitzroy catchments but has contracted from these areas, and a major decline in the extent of occurrence has been observed.

This species is mainly restricted to rainforests and dry closed forests such as vine thickets, Acacia thickets and beach vegetation. It has also been recorded from brigalow and associated vegetation. It is generally considered to be a sedentary species, and nests on the ground.

Identified threats to this species include: habitat clearance for agriculture and forestry; grazing; fire; predation by cats, foxes and pigs; and urban development.

Within the region of the CGS fields, this species has been recorded only from Palmgrove National Park. It is highly likely that it occurs in the large vine thicket patches within Expedition NP (Amphitheatre section) in the Arcadia CSG field. It may also occur within suitable habitat within the easternmost fields (Mahalo, Comet, Arcadia and Roma Other) in areas where good quality habitat, such as vine thicket or dense brigalow, is present. It may occur in these microhabitats within Landzones 3,4,5,8,9,10 and 11.

Australian Painted Snipe (Rostratula australis)

Status: Vulnerable (EPBC) Vulnerable (NCA); Unlisted (IUCN).

The painted snipe is a stocky wading bird with a long pinkish bill. It has been recorded in all Australian states, but the main area of distribution is in eastern, northern and inland Australia. Population numbers are low and the species has a scattered distribution pattern. There has been an apparent decline in the Australian population since the 1950's. This species is a wetland bird, and inhabits a variety of freshwater and brackish wetlands including temporary and permanent lakes, swamps and claypans. It may also occur on dams, waterlogged grasslands, rice fields, sewerage farms and bore drains.

The species is believed to be dispersive or migratory. The identified threats include loss or degradation of habitat, decline in water quality, changed wetland conditions and reduction in frequency of flooding. Nest predation by feral animals is also likely.

This species has not been reported from national parks in the region of the CSG fields, but it is known from wetlands in the Roma and Taroom areas. Based on its known distribution, it is possible that the species may be occasionally present on any suitable wetlands in the region.

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Yakka Skink (Egernia rugosa)

Status: Vulnerable (EPBC) Vulnerable (NCA); Unlisted (IUCN).

The yakka skink is a large, heavily built lizard which is brownish above with a darker mid dorsal zone and pale fawn stripes. It occurs in a broad area of coastal and subcoastal Queensland, but records are widely scattered. It occurs in areas of dry Eucalyptus forest or woodland, especially in the brigalow belt bioregion. It has been found in areas of dense vegetation and hides under fallen logs, in hollow logs, beneath rocks, or in soil burrows. It is diurnal in habit and feeds on plants, fruit and insects.

Identified threat to this species include: habitat reduction and degradation; agricultural and urban development; removal of woody debris and rock microhabitat; ripping of rabbit warrens; and predation by cats and foxes.

Within the region of the CSG fields, yakka skinks have been recorded at Expedition National Park. There are museum records from sites within the Denison and Arcadia fields and sightings from the Roma and Injune areas. Given that much of the region has suitable habitat, it is considered likely that isolated populations may be present within the other fields also. The most likely landzone (based on occurrence of brigalow communities) where this species may occur are 3, 4, 5, 7, and 9. Additionally, it could occur in non-remnant areas if suitable microhabitat, such as large logs, rock piles and tunnel erosion, is present.

Dunmall's snake (Furina dunmalli)

Status: Vulnerable (EPBC) Vulnerable (NCA); Vulnerable (IUCN).

Dunmall's snake is a small to medium sized elapid which is uniformly dark grey/brown. Its range is restricted to the brigalow belt bioregion. It has been recorded from brigalow (*Acacia harpophylla*), bulloak (*Allocasuarina luehmannii*) and white cypress pine (*Callitris glaucophylla*) forest and woodland over black cracking clays, clay loam and sandy soils.

The identified threats include: habitat loss, land clear and thinning; inappropriate road side management; habitat degradation from grazing activities; and feral predation from cats and foxes.

Within the region of the CSG fields, Dunmall's snake has been recorded at Taroom, Expedition National Park and within the Arcadia field. Potentially suitable habitat is widespread in the study area, and includes Landzones 3, 4, 5, 7 and 9.

Brigalow scaly-foot (Paradelma orientalis)

Status: Vulnerable (EPBC) Vulnerable (NCA); Vulnerable (IUCN).

The brigalow scalyfoot is a medium sized legless lizard which is a glossy brown or dark grey and lighter underneath. The core range of the species is within the southern brigalow belt of Queensland. It is found in a variety of open forest habitats and on various soil types. It has been observed in brigalow (*Acacia harpophylla*) woodland, over tussock grass and cracking clays, in Eucalyptus forests on sandy clay, and in Acacia closed forest. It has also been collected from dry sclerophyll forest on sandstone, open woodland with spinifex cover, and low gidgee on cracking clays. It generally shelters on the ground under bark, logs sandstone slabs or other surface debris. It is generally a nocturnal species.

The identified threats include: habitat loss due to land clearing and thinning operations, inappropriate road side management, and predation by feral animals such as cats. Habitat degradation from

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overgrazing and accidental deaths on roads and from misidentification with snakes, may pose additional threats.

Within the region of the CSG fields, this species has been recorded from Carnarvon, Expedition and Blackdown Tableland national parks. Additional records are known from the Arcadia, Fairview and Roma CSG fields. Most of the CSG fields are within the known range of this species and because it has such a wide habitat range, it could be expected within intact habitat anywhere in the region. The most likely landzones are expected to be: 3, 4, 5, 7, 9 and 10.

Ornamental Snake (*Denisonia maculatus*)

Status: Vulnerable (EPBC) Vulnerable (NCA); Vulnerable (IUCN).

This is a small, dark-coloured elapid snake with cream and white spots and markings on the lips. It is endemic to the Brigalow belt in central Queensland, centred around an area south-west of Rockhampton (Dawson-Fitzroy catchment). It is known to have specialist habitat preferences, being restricted to Brigalow woodland growing on clay and sandy soils, alluvial woodlands, and open forest of levee banks. It generally occurs in moist habitats subject to flooding.

Identified threats include: habitat clearing and thinning, grazing pressure and poisoning by cane toads.

The ornamental snake is found within Nuga Nuga national park, with additional records from areas such as Emerald and Moura. It may be more widespread than current records indicate, so there is a possibility of occurrence particularly in the most north-easterly CSG fields. It would be expected to occur primarily in Landzones 3 and 4, but could also occur in non-remnant areas, particularly along the major streams.

Collared delma (*Delma torquata*)

Status: Vulnerable (EPBC) Vulnerable (NCA); Vulnerable (IUCN).

The collared delma is a small species of legless lizard, brownish with a dark head and lighter banding on the head. It has been recorded from scattered localities around southeast Queensland from west of Gladstone, to the outer western suburbs of Brisbane. However, the species is only reported with regularity from the Bunya Mountains and Mt. Crosby areas. Habitat for this species is reported to be rocky hillsides on basalt and lateritic soils. It is usually associated with eucalypt or acacia woodland, or vine thicket over a sparse understory or tussock grasses.

The primary identified threats are human disturbance or modification to habitat, fire and weeds.

Within the region of the CSG fields, this species is known from Blackdown Tableland and Expedition national parks. It is also known from poplar box woodland on stock routes west of Roma. Based on known habitat preferences, it may occur in Landzones 3, 7, 8 and 10, and has been recorded in RE 11.7.2 and 11.3.2.

Boggomoss Snail (*Adclarkia dawsonensis*)

Status: Critically Endangered (EPBC) Unlisted (NCA); Unlisted (IUCN).

The boggomoss snail is a medium sized snail characterised by a thin semi-transparent shell. The species is restricted to small peat bogs in alluvial flats and riparian environments (e.g. Brigalow woodland with gilgais). It is currently known only from two locations in the Taroom area on the upper

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Dawson River. It occurs in mound spring habitat at Mt. Rose Station, and in Queensland blue gum/*Livistona nitida* woodland at the Isla-Delusion crossing of the Dawson River between Taroom and Theodore.

Identified threats include land clearing, pigs, fire, cattle grazing, weeds, earthworks, interrupted water flow and inundation.

The known sites for this species are located about 30 km to the east of the Roma Other field. Searches of suitable habitat for boggomoss snail were conducted as part of the GLNG EIS (Appendix N4), but none were found on the CSG fields. The possibility that undiscovered populations of this species occurs in the Roma Other field, cannot be completely discounted.

2.1.3 Species Profiles – Species unlikely to be present

Western Quoll (*Dasyurus geoffroii geoffroii*)

Status: Vulnerable (EPBC); Extinct (NCA); Near Threatened (IUCN).

This species formerly ranged into western Queensland but is now confined to the sclerophyll and mallee remnants in the southwest of Western Australia. It is considered extinct in the region of the CSG fields.

Spot-tailed Quoll – southern subspecies (*Dasyurus maculatus maculatus*)

Status: Endangered (EPBC); Vulnerable (NCA); Near Threatened (IUCN).

The spot-tailed quoll is a large reddish quoll with white spotting on both the body and tail. All quoll species are nocturnal carnivores. This species is distributed in eastern Australia and in Queensland is restricted to the south-east, from about Bundaberg south, and inland. It has been recorded from the brigalow belt, and there is a single unconfirmed and doubtful record from Carnarvon Gorge National Park, in the region of the CSG study area.

The habitat preference is for mature wet forest, but it has been observed in a variety of other habitats including woodlands, riparian eucalypt forest, coastal heaths and rocky areas. It usually dens in hollow trees or rocky areas, and has a home range of up to 2,560 ha for males and 650 ha for females. A number of threats have been identified for this species. They include: habitat loss; fox and dingo predation; fire; direct killing (regarded as pest to livestock); road mortality, cane toad poisoning and 1080 bait poisoning.

The occurrence of this species in the CSG fields region is considered unlikely,

Northern hairy-nosed wombat (*Lasiorhinus krefftii*)

Status: Endangered (EPBC); Endangered (NCA); Critically Endangered (IUCN).

This species formerly occurred through south-central Queensland and NSW, but currently, the only known remaining population occurs at Epping Forest National Park, west of Clermont.

This species occurs in semi-arid woodlands and brigalow habitats and such habitats are present on the CGS fields. However, given that this is a fairly conspicuous species, it is considered extremely unlikely that an extant, undiscovered population may be located within the CSG fields.

2 Results

Bilby (Macrotis lagotis)

Status: Vulnerable (EPBC); Endangered (NCA); Vulnerable (IUCN)

The Bilby is a rabbit-sized bandicoot which was formerly distributed across much of inland Australia, including the brigalow belt of central Queensland, where it has not been seen since the 1930s. It is now chiefly restricted to the Tanami Desert in the Northern Territory, where significant recovery effort is being undertaken to ensure its survival. In Queensland, the bilby still occurs in the Diamantina River area in the far south-west of the state.

Bilbies occur in a range of habitats such as Mitchell grass plains, sandstone ridges, gibber plains, rocky soils with little ground cover, hummock and tussock grasslands, and acacia shrublands. Although some of these habitats do occur within the CSG fields, it is considered extremely unlikely that the species still persists in these areas.

Bridled nailtail wallaby (Onychogalea fraenata)

Status: Endangered (EPBC); Endangered (NCA); Endangered (IUCN).

The bridled nailtail wallaby is a small grey or light tan coloured wallaby with a distinctive white stripe, or bridle behind the forelimbs. It occurs in dense acacia shrubland and grassy woodland, particularly where both habitats occur in proximity. It was identified as previously occurring in brigalow, poplar box woodland, and grassland interfaces. The species was believed extinct but was rediscovered in 1973 near Dingo, Qld. It is now thought to be restricted to the Taunton National Park, near Dingo and Idalia National Park, near Longreach. It has also been re-introduced to Avocet Nature Refuge. The occurrence of this species in any of the CSG fields is considered to be extremely unlikely.

Star Finch (eastern), star finch (southern) (Neochmia ruficauda ruficauda)

Status: Endangered (EPBC) Endangered (NCA); Near Threatened (IUCN).

The star finch is a small species of finch, with an olive back and red markings on the face. The eastern (or southern) race formerly occurred primarily in eastern Queensland, from about Bowen south to far northern NSW. It is now thought to be restricted to near-coastal central Queensland. There are thought to be four sub-populations. The star finch occurs chiefly in grasslands and grassy woodlands in proximity to water bodies. It has also been observed in the streets and gardens of small towns. The species is considered sedentary, but may undertake local movements.

Threats to this species are not fully understood. However, habitat degradation from overgrazing, invasion of weeds, contamination of habitat from mining activities, prolonged drought, and capture for the bird trade are considered potential or past threats.

The CSG fields are within the historical range of the star finch, It was recorded from Robinson Creek near Taroom in 1844 (Holmes, 1996) and Roma in 1932 (Holmes, 1998). There have been no subsequent sightings of wild birds and it is considered locally extinct, despite the presence of potentially suitable habitat across the region.

Black-throated finch (white-rumped subspecies) (Poephila cincta cincta)

Status: Endangered (EPBC) Vulnerable (NCA); Near Threatened (IUCN).

The black-throated finch is a small granivorous bird, brownish above with a grey head and black throat. The subspecies *cincta* has a white rump. The species was formerly distributed from the

2 Results

Atherton Tablelands through eastern Queensland to northern NSW. It is now restricted to the northern part of that former range. It is thought to have contracted up to 80 % of its former range in the last 20 years.

This species inhabits grassy woodlands with eucalyptus, acacias and melaleucas. It is also thought to be associated with riparian habitats. It feeds on grass seeds. It is generally sedentary, but may undertake local movements in response to seeding habitat.

Identified threats to this species are: clearing and fragmentation of habitats; degradation of habitat from overgrazing by stock and rabbits; fire regimes which alter habitat; weeds and exotic grasses; trapping; predation by introduced predators; and hybridisation with the northern subspecies.

The CSG fields are within the historical range of the species. There are no known recent records of wild birds and it is considered to be locally extinct, despite the presence of apparently suitable habitat.

Swift parrot (*Lathamus discolor*)

Status: Endangered (EPBC); Endangered (NCA); Endangered (IUCN).

The swift parrot is a mostly green coloured species with red facial markings and dark blue patches on the crown and wings. It is endemic to south-eastern Australia, including Tasmania, Victoria, NSW and south-eastern Queensland. In Queensland, recent records are from Gold Coast, Noosa, Toowoomba, Warwick and Lockyer Valley. There are no recent records from the region of the CSG fields and the species has not been recorded in any of the region's national parks.

This is a migratory species, with the southern populations wintering in Victoria and NSW, rarely into southern Queensland. This species breeds only in Tasmania. The wintering habitat on mainland Australia is box-ironbark forests and woodlands. The CSG field area is considered to be too far north of the known wintering populations for this species, and therefore it is not considered to be present.

Plains-wanderer (*Pedionomus torquatus*)

Status: Vulnerable (EPBC); Vulnerable (NCA); Endangered (IUCN).

The plains wanderer is a small, brownish, quail-like bird, now thought to be more closely allied to the waders. It occurs in scattered locations in southern Queensland, NSW, Victoria and SA. In Queensland, the species is now thought restricted to the channel country of the far south-west. It has not been recorded on any of the reserves in the region of the CSG fields. The probability of its occurrence on the CSG fields is considered unlikely.

Superb parrot (*Polytelis swainsonii*)

Status: Vulnerable (EPBC) Unlisted (NCA); Vulnerable (IUCN).

The superb parrot is a medium sized green parrot usually occurring in small flocks. The species occurs only in south-eastern Australia and it has been recorded as a vagrant in far southern Queensland at Eulo and Goondiwindi. It has not been recorded in any of the national parks in the region of the CSG fields. The probability of its occurrence on the CSG fields is considered very low.

Paradise parrot (*Psephotus pulcherrimus*)

Status: Extinct (EPBC) Extinct (NCA); Extinct (IUCN).

2 Results

The paradise parrot is a small, long tailed species. It formerly occurred across southern Queensland, including the region of the CSG fields. There are historical records from Palmgrove National Park in the study region. The species has not been recorded since 1927 and is presumed extinct.

Fitzroy Tortoise (*Rheodytes leukops*)

Status: Vulnerable (EPBC) Vulnerable (NCA); Vulnerable (IUCN).

The Fitzroy turtle is a medium large brownish freshwater turtle. It is restricted to the Fitzroy river system of central Queensland, where it prefers fast flowing clear water habitats. It generally occurs in pool-riffle sections where waters are well oxygenated and aquatic plant growth is present. Known localities for this species include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango. This species moves only short distances within its preferred habitats.

Identified threats include egg predation, habitat modification (e.g. stream obstructions), increased turbidity or pollution, and weed infestation.

The only CSG fields within the catchment of the Fitzroy River are the Denison fields, which are traversed by an upper tributary, the Comet River. No Fitzroy River turtles were recorded in these areas during aquatic surveys for the EIS (Appendix N4). There is a very low potential for this species to occur in the middle and upper Comet River catchment, since no areas of suitable habitat have been identified.

Five-clawed worm-skink (*Anomalopus mackayi*)

Status: Vulnerable (EPBC) Endangered (NCA); Vulnerable (IUCN).

This is a small, slender skink with reduced limbs. It has a small area of distribution in the extreme southern portion of the Queensland brigalow belt, centred around the Darling Downs and extending into northern NSW. It is known to occur in grassland and open eucalyptus and cypress pine woodland habitats. It prefers a grassy understory on cracking clay or loam soils and lives under logs and leaf litter, in loose soil or earth cracks.

Identified threats include: disturbance to soil layer by grazing animals, clearing or cropping; burning of fallen timber; crop production, erosion; irrigation.

This species has not been recorded from the CSG fields and it is considered unlikely to occur due to a lack of suitable habitat and being outside of its accepted range.

Murray cod (*Maccullochella peelii peelii*)

Status: Vulnerable (EPBC) Unlisted (NCA); Critically Endangered (IUCN).

The Murray cod is Australia's largest freshwater fish. It is distributed only on the Murray-Darling River system, occurring in Queensland, NSW and SA. Murray cod are distributed throughout the system, and occur in a variety of habitats, from small clear upland streams to lowland waterholes and river reaches. The species is known to migrate for significant distances during flood conditions. In Queensland, this fish has been translocated into the Dawson and Mary River systems.

The principle identified threats are overfishing and river regulation. Degradation of aquatic habitats by cattle is another threat.

2 Results

Within the region of the CSG fields, this species has not been recorded from the Dawson-Comet catchments. It has been previously recorded in the upper Condamine-Balonne system but is unlikely to be present in the Roma CSG field through which the upper part of this system traverses.

2.1.4 Migratory Species

Results of the EPBC Protected Matters search produced a list of 17 migratory species, all birds, as potentially occurring on the CSG fields. These species fall into three broad categories: aerial species; small “bush” birds; and wetland and watercourse species. Only one species, painted snipe, is also listed as an EPBC threatened species.

Generally, the aerial species are widely distributed across Australia, and may occur within the CSG fields as a part of their range. These are all summer migrants to Australia, with the exception of the rainbow bee-eater, which in Queensland may be present year round. These species could range over a variety of habitats including remnant and non-remnant vegetation and none are really restricted by ground habitats. For this reason, their potential distribution within the CSG fields cannot be reliably mapped.

The identified “bush bird” species include four species of flycatchers and fantails that are generally migratory only in the southern part of their range, or else undertake a winter migration to northern Australia and New Guinea. These species all favour moist habitats such as rainforest, mangroves and wet gullies, so in the generally dry habitats on the CSG fields, their distribution is likely to be extremely patchy and confined to moist gullies or gorges in the range country if they occur at all. The distribution of these species cannot be mapped within the CSG.

The wetland and watercourse birds represent a group which is largely dependent on waterbodies. Wading birds, such as painted snipe, little curlew and Latham’s snipe undertake large-scale international migrations on a seasonal basis, while the egrets undertake local migrations only. The Australian cotton pygmy goose is a species which generally prefers deep, still waterbodies, and is generally sedentary or locally nomadic. The white-bellied sea-eagle is a generally coastal species which undertakes local migrations inland by following the major river systems. The remaining two species (little tern and southern giant petrel) are marine species which do not occur in the CSG fields.

The distribution of wetland and watercourse bird species correlates directly to the availability of surface water resources in the region. Significant wetlands within the CSG fields include Lake Murphy and Nuga Nuga National Park. The distribution of these and other wetlands and major watercourses on the CSG fields where these species may occur is shown in Figures 2-8 and 2-9.

2.1.5 EPBC-listed Species Habitat Mapping

Mapping of threatened and migratory species potential habitat has been undertaken based mapping of the region based on land zone distribution is shown in Figures 2-1 to 2-9 and Table 2-2. The mapping is presented at two scales. The large scale mapping provides an overview of the extent of habitats across the region, while the small scale mapping provides a finer resolution for individual fields. The potential distribution of terrestrial threatened species habitat is displayed in Figures 2-2 to 2-7 while the potential distribution of aquatic threatened species and migratory waterbirds is shown in Figures 2-8 to 2-9.



Landzone 3 - All CSG Fields
 Landzone 3 - Northern CSG Fields
 Landzone 3 without RE 11.3.3

Primarily consist of woodlands and open forest on Quaternary alluviums on river and creek flats. Dominant systems include floodplains, alluvial plains, alluvial fans, terraces, levees, swamps, channels and closed depressions. Within the CSG Fields, common canopy species on this landzone include *Eucalyptus tereticornis*, *Eucalyptus populnea*, *Acacia harpophylla* and *Eucalyptus melanophloia*. Cracking clays within this landzone are a significant microhabitat feature.



Landzone 4 - All CSG Fields
 Landzone 4 - Northern CSG Fields
 Landzone 4 - Denison, Mahalo, Comet and Arcadia CSG fields

Comprises Cainozoic clay deposits, usually forming level to gently undulating plains above current alluvial systems. Typical vegetation communities present include woodlands to open forest of *Acacia harpophylla*, *Eucalyptus populnea*, *Eucalyptus cambageana* as well as semi-evergreen vine thickets. Cracking clays within this landzone are a significant microhabitat feature.



Landzone 5 - All CSG Fields
 Landzone 5 - Northern CSG Fields

This landzone primarily consists of uniform near level or gently undulating Cainozoic plains with sandy or loamy soils and includes dissected remnants of these surfaces. Typical vegetation communities present include woodlands to open forests of *Eucalyptus crebra*, *Eucalyptus populnea*, *Eucalyptus melanophloia*, *Eucalyptus moluccana* as well as semi-evergreen vine thickets.



Landzone 7 - All CSG Fields
 Landzone 7 - Northern CSG Fields

Primarily consist of Cainozoic duricrusts formed on a variety of rock types, usually forming mesas or scarps. They are often vegetated with woodland commonly dominated by *Acacia rhodoxylon*, *Acacia catenulata* or *Acacia shirleyi*.



Landzone 8 - All CSG Fields
 Landzone 8 - Northern CSG Fields

This landzone is primarily comprised of Cainozoic igneous rocks, predominantly flood basalts forming extensive plains and occasional low scarps. This landzone within the CSG Fields can support woodlands of *Eucalyptus tereticornis*, *Eucalyptus melanophloia* and *Eucalyptus orgadophila*, as well as semi-evergreen vine thickets and native grasslands.



Landzone 9 - All CSG Fields
 Landzone 9 - Within Denison, Mahalo, Comet and Arcadia CSG Fields

This landzone consists of fine-grained sedimentary rocks, generally with little or no deformation, forming undulating landscapes with a broad range of fine textured soils of moderate to high fertility. Communities present include woodlands of *Acacia harpophylla*, *Eucalyptus populnea*, *Eucalyptus cambageana*, *Eucalyptus crebra* as well as semi-evergreen vine thickets.



Landzone 10 - All CSG Fields
 Landzone 10 - Northern CSG Fields
 Landzone 10 - Mahalo, Comet, Arcadia and Roma-Other CSG Fields

Medium to coarse-grained sedimentary rocks, with little or no deformation, forming plateaus, ledges and scarps. Common vegetation communities present on the landzone within the CSG Fields include woodlands to forests of *Corymbia citriodora*, *Acacia catenulata*, *Acacia shirleyi*, *Eucalyptus decorticans*, *Eucalyptus crebra*, *Callitris glaucophylla* and *Eucalyptus populnea*. Present primarily on the plateau country of the Expedition and Camarvon Ranges.



Wetlands



Remnant Vegetation in Yuleba State Forest



REs 11.3.1, 11.3.2, 11.3.3, 11.3.4, 11.3.22, 11.3.25, 11.3.27 in Roma-Other CSG Field



RE 11.3.2, 11.3.3, 11.3.4, 11.3.25, 11.3.27



RE 11.3.2 in Roma CSG Field



RE 11.9.4 in Comet, Arcadia, Fairview and Roma-Other CSG Fields



RE 11.9.4 in Northern CSG Fields



RE 11.9.5 in Northern CSG fields

NOTE: This Figure 2-1 must be viewed with Figures 2-2 to 2-7.

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING	Title FAUNA HABITAT KEY AND LANDZONE DESCRIPTION	
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2006.mxd	Figure: 2-1	Rev.B A4

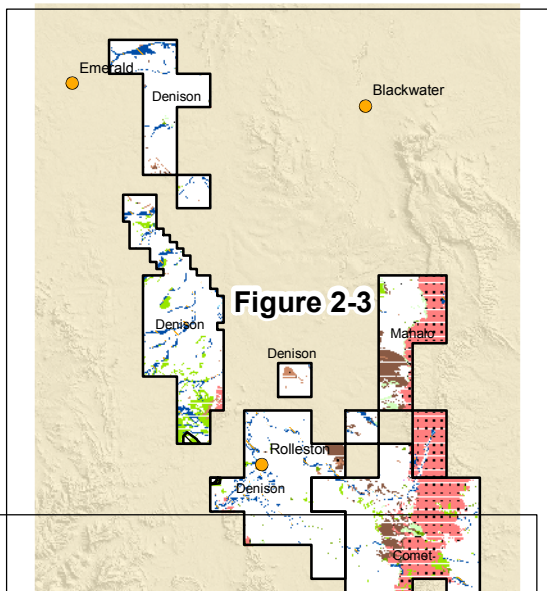


Figure 2-3

FAUNA KEY

For EPBC Fauna Mapping Key, Refer to Figure 2-1

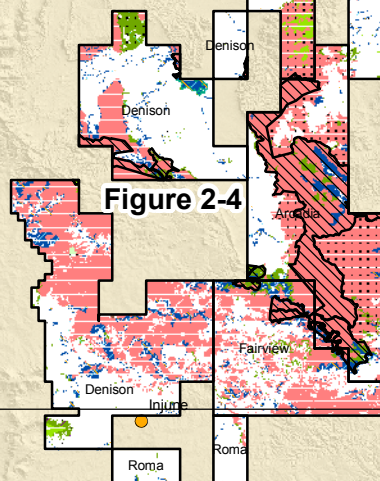


Figure 2-4

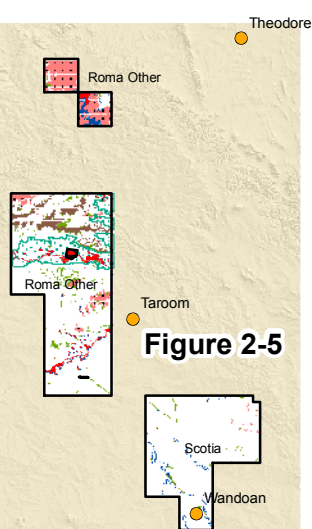


Figure 2-5

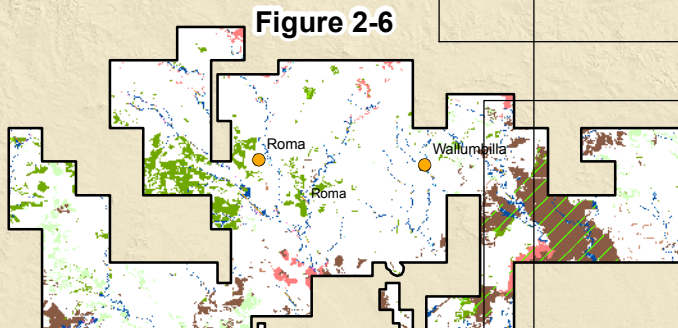


Figure 2-6

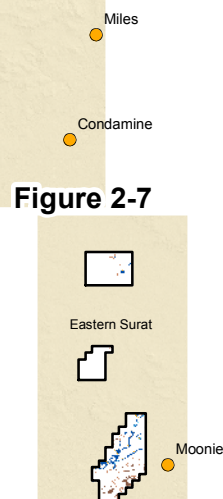
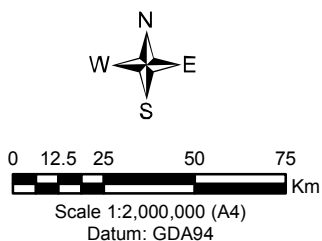
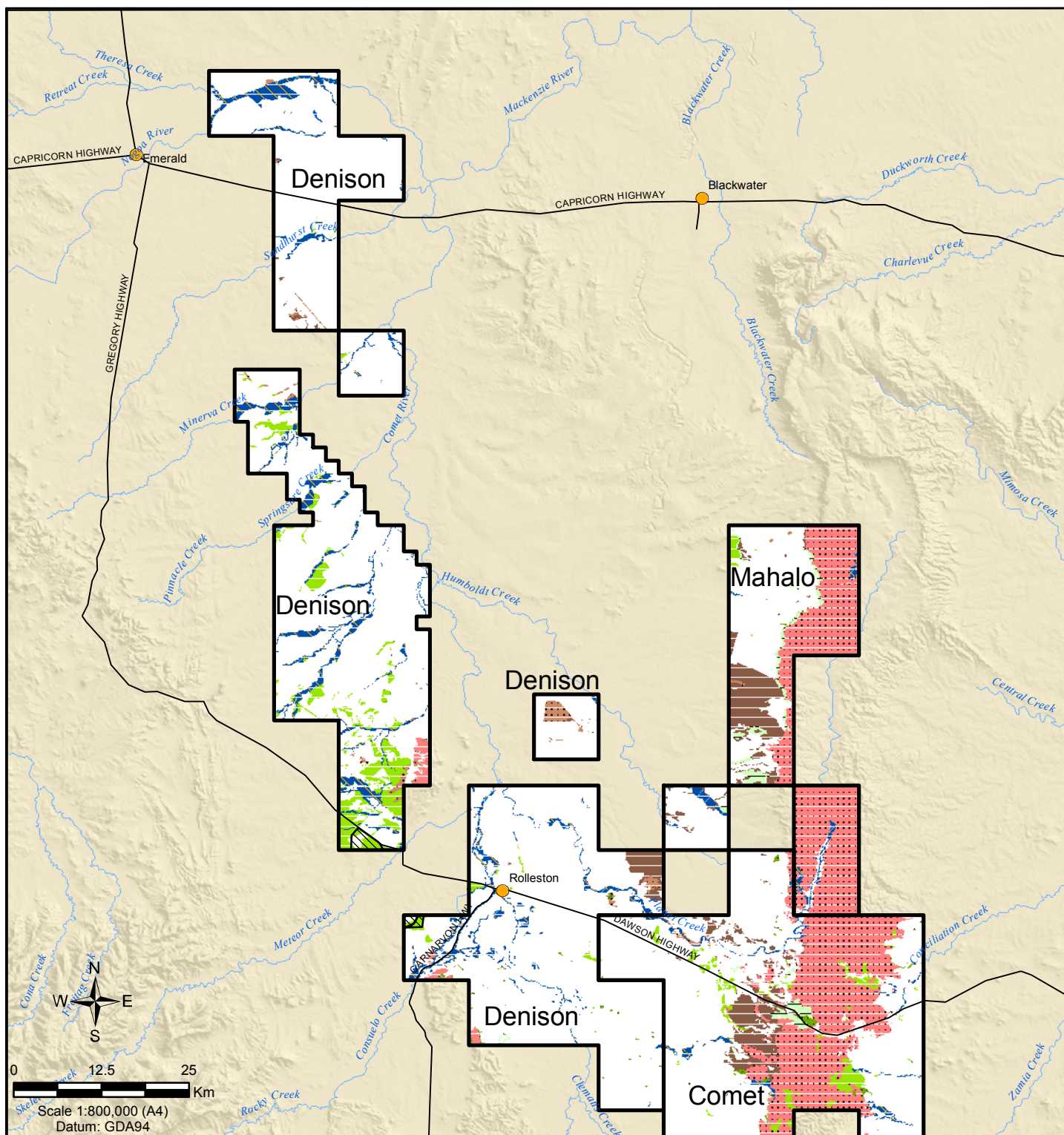


Figure 2-7



Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA MAPPING	Title CSG FIELDS POTENTIAL HABITAT FOR EPBC LISTED FAUNA SPECIES MAP SHEET LAYOUTS
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2003.mxd	Figure: 2-2 Rev.B A4



NOTE: This Figure must be viewed with Figure 2-1 which has a detailed Map Unit Key.

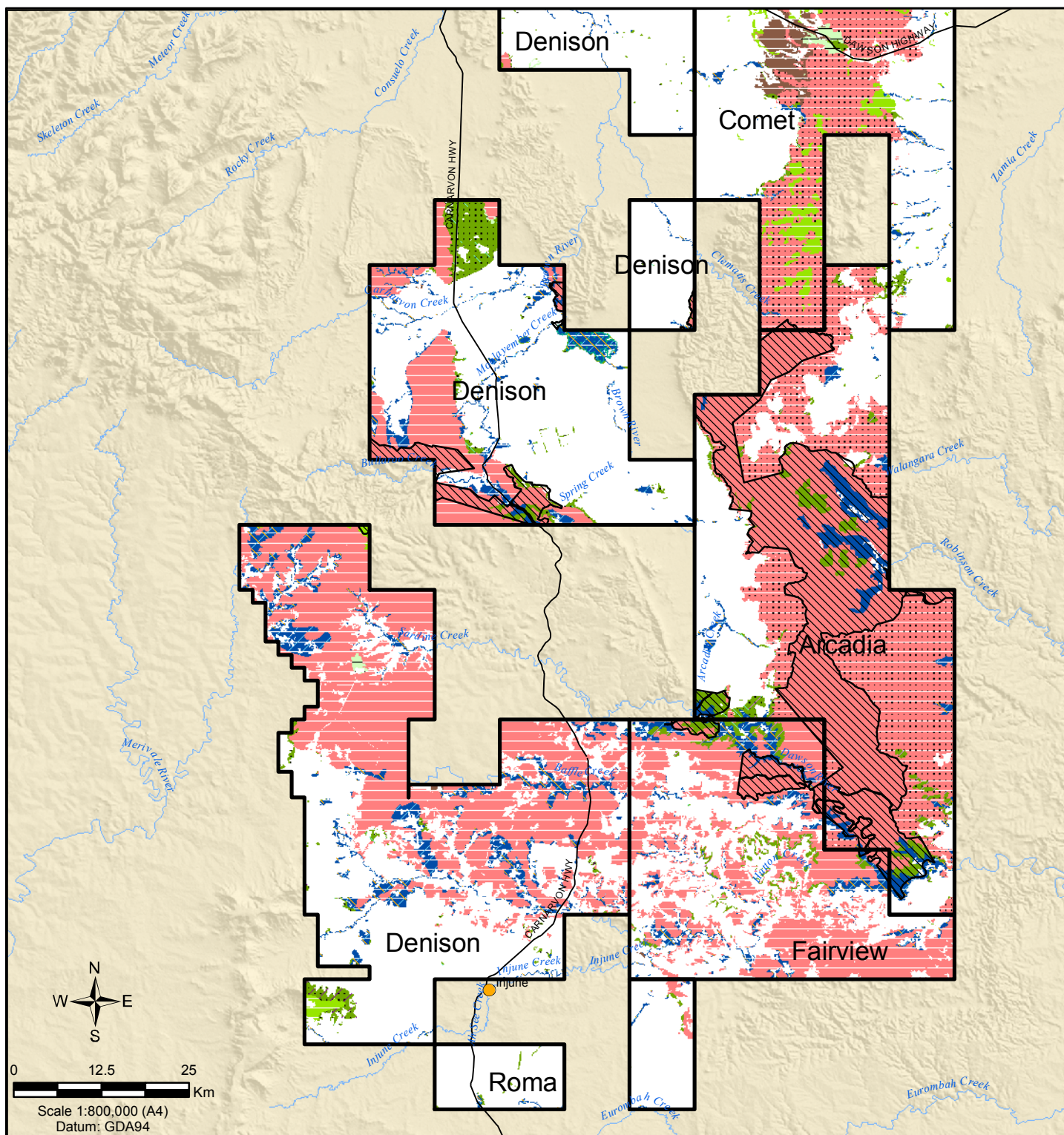
National Park  (Over-rides any other hatching)

- Northern Quoll 
- Large-eared pied bat 
- Eastern long-eared bat 
- Squatter pigeon (southern) 
- Red goshawk 
- Black-breasted button-quail 
- Australian Painted Snipe 

- Yakka skink 
- Dunmall's snake 
- Brigalow scaly-foot 
- Ornamental snake 
- Collared delma 
- Boggomoss Snail 

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING		Title DENISON AND MAHALO CSG FIELD POTENTIAL HABITAT FOR EPBC LISTED FAUNA SPECIES	
	Drawn: CA	Approved: JB	Date: 10-11-2009	Figure: 2-3
	Job No: 4262 6440/6220	File: 42626440-g-2004.mxd	Rev.B A4	



NOTE: This Figure must be viewed with Figure 2-1 which has a detailed Map Unit Key.

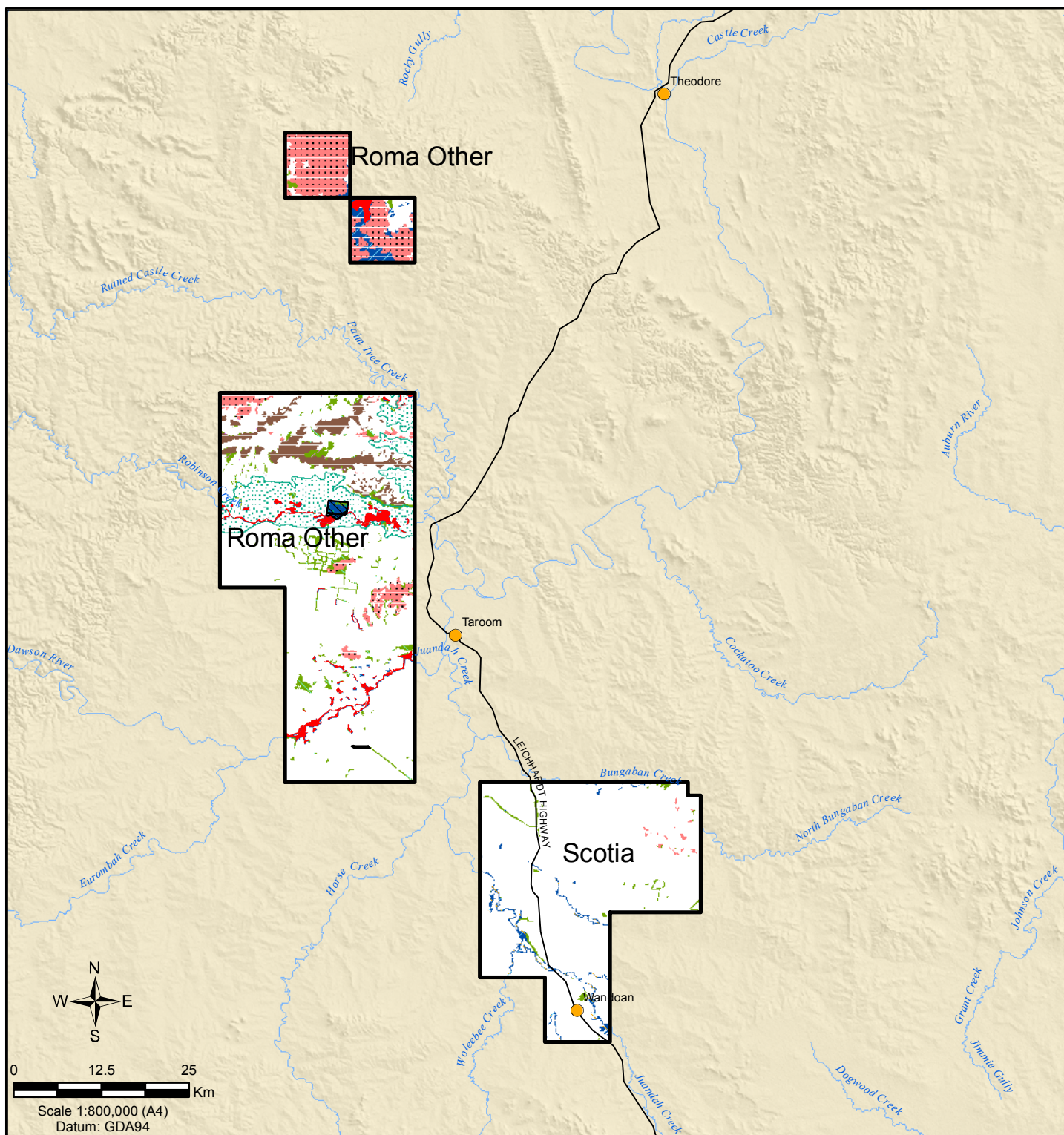
National Park  (Over-rides any other hatching)

- Northern Quoll 
- Large-eared pied bat 
- Eastern long-eared bat 
- Squatter pigeon (southern) 
- Red goshawk 
- Black-breasted button-quail 
- Australian Painted Snipe 

- Yakka skink 
- Dunmall's snake 
- Brigalow scaly-foot 
- Ornamental snake 
- Collared delma 
- Boggomoss Snail 

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING	Title DENISON, COMET, ARCADIA FAIRVIEW POTENTIAL HABITAT FOR EPBC LISTED FAUNA SPECIES
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2004.mxd	Figure: 2-4 Rev.B A4



NOTE: This Figure must be viewed with Figure 2-1 which has a detailed Map Unit Key.

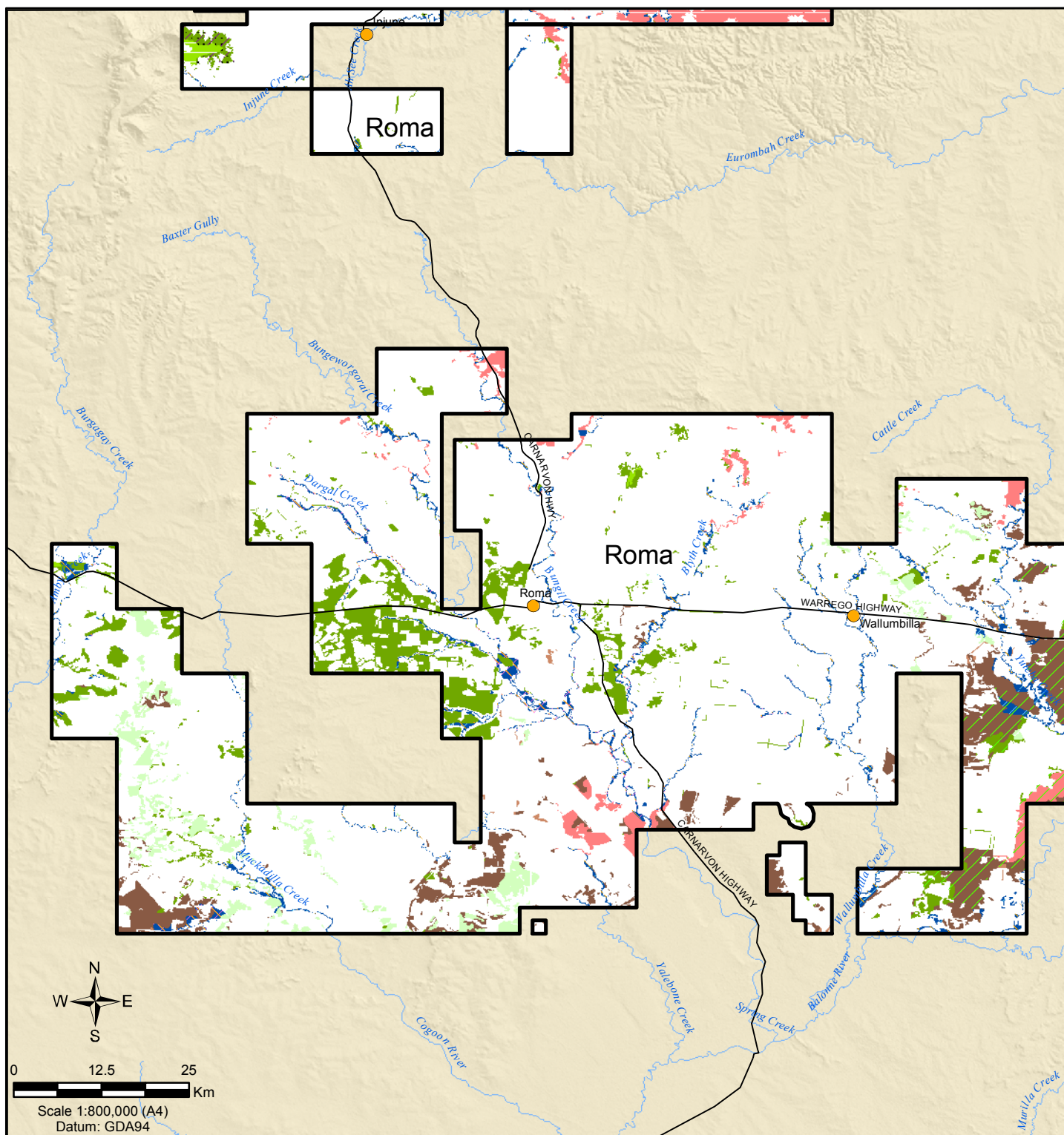
National Park  (Over-rides any other hatching)

- Northern Quoll      
- Large-eared pied bat 
- Eastern long-eared bat      
- Squatter pigeon (southern)       
- Red goshawk    
- Black-breasted button-quail  
- Australian Painted Snipe  

- Yakka skink     
- Dunmall's snake     
- Brigalow scaly-foot     
- Ornamental snake     
- Collared delma     
- Boggomoss Snail 

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client		Project			Title	
		GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING			ROMA OTHER & SCOTIA CSG FIELD POTENTIAL HABITAT FOR EPBC LISTED FAUNA SPECIES	
	Drawn: CA		Approved: JB		Date: 10-11-2009	
	Job No: 4262 6440/6220		File: 42626440-g-2004.mxd		Figure: 2-5	
						Rev.B A4



National Park  (Over-rides any other hatching)

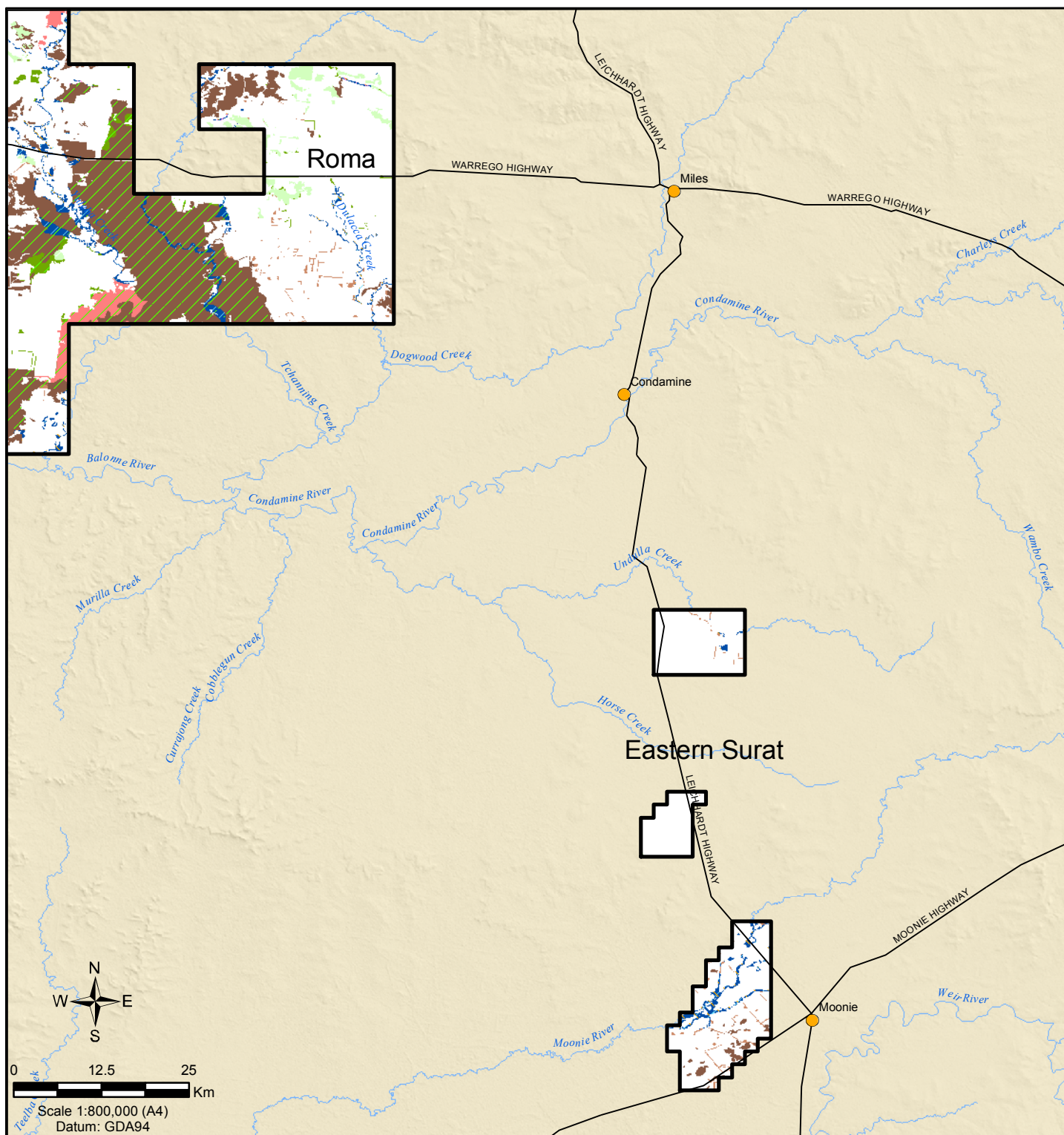
- Northern Quoll 
- Large-eared pied bat 
- Eastern long-eared bat 
- Squatter pigeon (southern) 
- Red goshawk 
- Black-breasted button-quail 
- Australian Painted Snipe 

- Yakka skink 
- Dunmall's snake 
- Brigalow scaly-foot 
- Ornamental snake 
- Collared delma 
- Boggomoss Snail 

NOTE: This Figure must be viewed with Figure 2-1 which has a detailed Map Unit Key.

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING	Title ROMA CSG FIELD POTENTIAL HABITAT FOR EPBC LISTED FAUNA SPECIES
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2004.mxd	Figure: 2-6 Rev.B A4



NOTE: This Figure must be viewed with Figure 2-1 which has a detailed Map Unit Key.

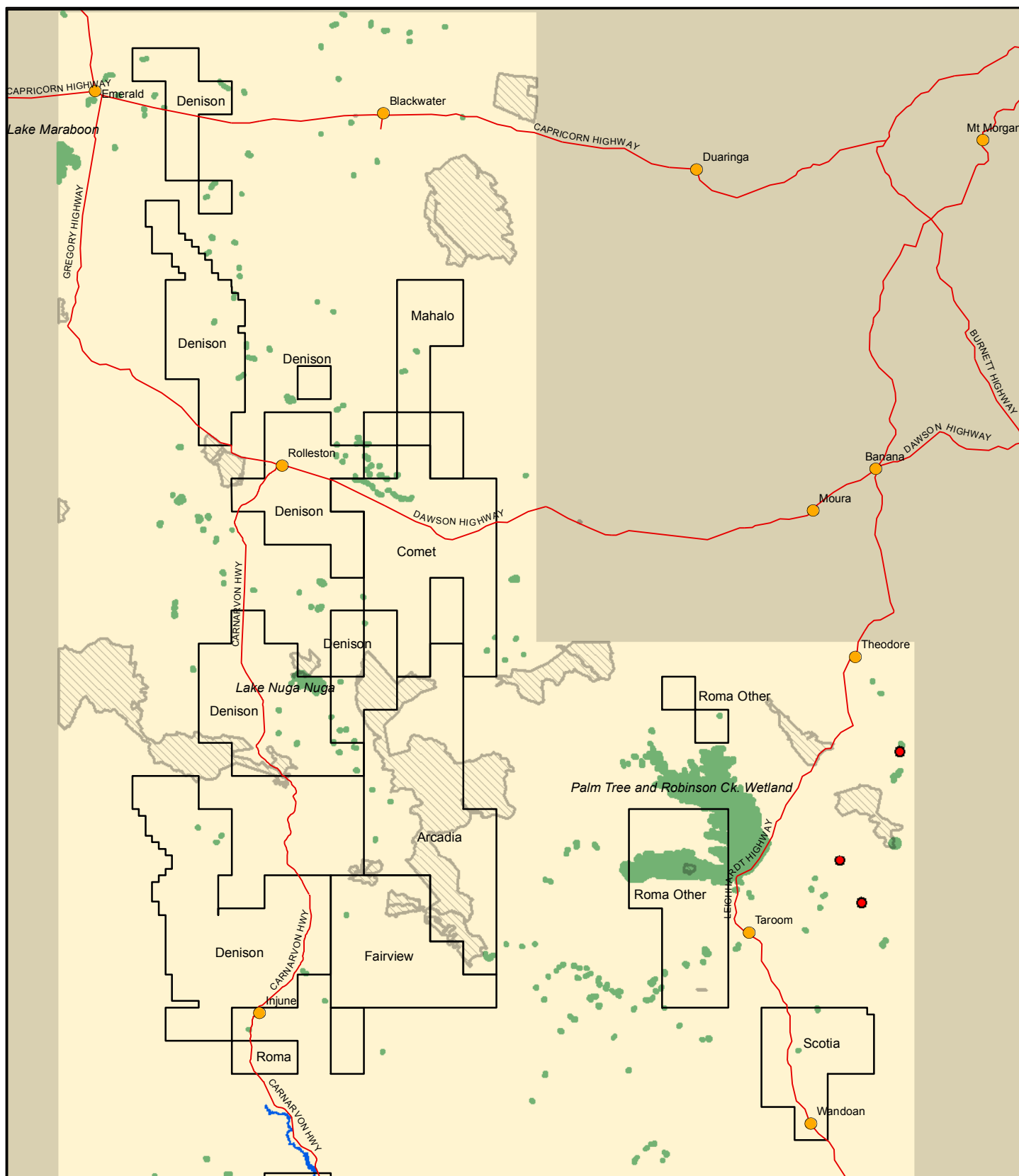
National Park  (Over-rides any other hatching)

- Northern Quoll 
- Large-eared pied bat 
- Eastern long-eared bat 
- Squatter pigeon (southern) 
- Red goshawk 
- Black-breasted button-quail 
- Australian Painted Snipe 

- Yakka skink 
- Dunmall's snake 
- Brigalow scaly-foot 
- Ornamental snake 
- Collared delma 
- Boggomoss Snail 

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING	Title ROMA AND EASTERN SURAT CSG FIELD POTENTIAL HABITAT FOR EPBC LISTED FAUNA SPECIES
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2004.mxd	Figure: 2-7 Rev.B A4



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Scale 1:1,500,000 (A4)
Datum: GDA94

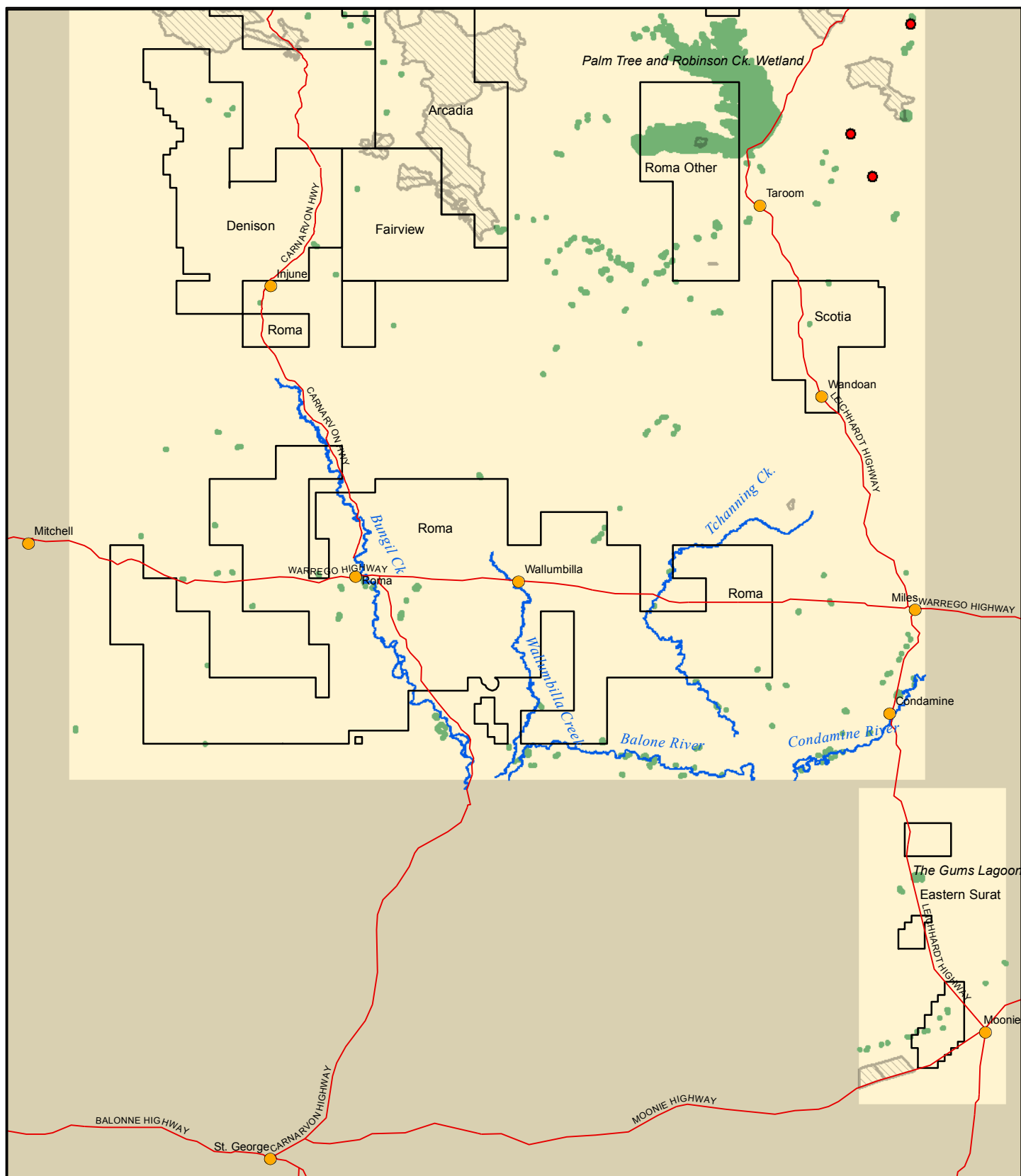
LEGEND

- **Boggomoss Snail**
- Murray Cod** (unconfirmed potential distribution)
- Migratory Wetland Birds** (Wetlands, Lakes, Lagoons, Waterholes)

- National Park
- CSG Field

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING	Title NORTHERN CSG FIELD POTENTIAL HABITAT FOR EPBC LISTED THREATENED AQUATIC SPECIES AND MIGRATORY WADERS
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2005.mxd	Figure: 2-8 Rev.B A4



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Scale 1:1,500,000 (A4)
Datum: GDA94

LEGEND

- Boggomoss Snail
- Murray Cod (unconfirmed potential distribution)
- Migratory Wetland Birds (Wetlands, Lakes, Lagoons, Waterholes)

- National Park
- CSG Field

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright.

Client 	Project GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT EPBC LISTED FAUNA SPECIES MAPPING	Title SOUTHERN CSG FIELD POTENTIAL HABITAT FOR EPBC LISTED THREATENED AQUATIC SPECIES AND MIGRATORY WADERS
	Drawn: CA Approved: JB Date: 10-11-2009 Job No: 4262 6440/6220 File: 42626440-g-2005.mxd	Figure: 2-9 Rev.B A4

2 Results

Table 2-1 Distribution, Habitat Preference and Migratory Habits of EPBC-Listed Migratory Species Potentially Present within the CSG Fields

Common Name	Scientific Name	Aust. Distribution	Habitat	Migratory Habits
Aerial Species				
White-throated needletail.	<i>Hirundapus caudacutus.</i>	Eastern and south-eastern coastal and inland Australia.	Aerial species; at heights to cloud level. In Australia, wide variety of habitats ranging from heavily treed forests to open habitats, such as farmland, heathland or mudflats.	Breeds in north Asia, Siberia; non-breeding population in Australia September-March.
Barn swallow.	<i>Hirundo rustica.</i>	Northern Australia, coastal and subcoastal.	Aerial species; generally ranges over open areas, often near water.	Summer migrant to Australia.
Rainbow bee-eater.	<i>Merops ornatus.</i>	Australia wide.	Open forests, woodlands, shrublands, cleared areas, often in proximity to water.	Southern populations migrate to north Australia in winter; northern populations may remain year round. Some migration to Indonesia and New Guinea.
Fork-tailed swift.	<i>Apus pacificus.</i>	Australia wide.	Aerial species ranging over all habitats.	Summer migrant to Australia.
Bush Birds				
Black-faced monarch.	<i>Monarcha melanopsis.</i>	Eastern Australia.	Mangroves, rainforest, eucalypt forest, woodlands.	Southern Australia breeding population migrates north, may reach New Guinea.
Spectacled monarch.	<i>Monarcha trivirgatus.</i>	North-eastern Australia, to central NSW.	Rainforest, mangroves, moist gullies in Eucalyptus forest.	Southern race <i>gouldii</i> migrates to northth Australia and New Guinea in winter.
Satin flycatcher.	<i>Myiagra cyanoleuca.</i>	Eastern Australia.	Forest, woodlands, mangroves, coastal heath.	Winter migration to north Australia and New Guinea.
Rufous fantail.	<i>Rhipidura rufifrons.</i>	East and SE Australia, coastal and subcoastal.	Rainforest, wet monsoon forest, paperbarks, mangroves, riparian.	Breeding summer migrant.
Wetland and Watercourse Species				
Great egret.	<i>Ardea alba.</i>	Australia wide.	Freshwater and marine wetlands, all types.	Probably local movements within Australia, depending on water availability. Migrates to and from breeding sites.
Cattle egret.	<i>Ardea ibis.</i>	Australia wide, except south-western deserts.	Wetlands, pastures, grazing lands, mudflats.	Local migrations within Australia. Mainland populations may seasonally migrate to Tasmania or New Zealand.

2 Results

Common Name	Scientific Name	Aust. Distribution	Habitat	Migratory Habits
Latham's snipe, Japanese snipe.	<i>Gallinago hardwickii</i> .	Eastern Australia.	All permanent and ephemeral wetland types.	Summer non-breeding migrant to Australia from North Asia and Japan.
Australian Cotton Pygmy-goose.	<i>Nettapus coromandelianus albipennis</i> .	Eastern Qld.	Generally freshwater lakes and wetlands with deep open water and fringing aquatic vegetation.	Sedentary or locally nomadic.
Little curlew.	<i>Numenius minutus</i> .	Northern, eastern and inland Australia.	Swamps, billabongs, floodplains, artificial waterbodies.	Summer migrant to Australia from northern hemisphere.
Painted snipe.	<i>Rostratula australis</i> .	Eastern and northern Australia, coastal and inland.	Freshwater and brackish wetlands including temporary and permanent lakes, swamps and claypans. Also on artificial waterbodies.	Dispersive or migratory within Australia.
Southern giant-petrel.	<i>Macronectes giganteus</i> .	Marine species.	Marine species not in CSG fields.	Migrates into sub-Antarctic region.
Little tern.	<i>Sterna albifrons</i> .	Coastal northth and east Australia.	Coastal environments - not in CSG fields.	Various migratory patterns.
White-bellied sea-eagle.	<i>Haliaeetus leucogaster</i> .	Australia wide except western interior.	Coastal habitats, inland rivers and terrestrial wetlands.	Breeding resident but undertakes local migrations.

Management Protocols

3.1 Management Protocols for Development within Areas Mapped as Fauna Habitat

The following protocols have been developed to ensure development within mapped habitat areas considers the EPBC listed fauna species described in this report. These protocols have been established in conjunction with those presented within Part 2. The below protocols share the same aims and objectives as the generic protocols for the all management classes identified within the Constraints Mapping. This ensures that the management protocols for both the EPBC listed species habitat mapping and the Constraints Class Mapping are complimentary and one does not trigger a management protocol in contradiction to the other.

3.1.1 Desktop Assessments and Pre-development Checks

- Cross-check Habitat Maps with other data layers, including REs, Constraints Mapping, essential habitat mapping, wetlands mapping and Bioregional Wildlife Corridors to ensure that any specific issues relating to the site are identified.
- For each additional data layer, identify any significant species, sites or communities likely or known to be present, the likelihood of occurrence, and the listed threatening processes for those species or communities.
- Review available data on significant species/communities and threatening processes to assess the level of field investigation required. Depending on the results, pre-clearing field surveys may be as minimal as brief ground-truthing exercises to confirm mapping and identify any non-mapped point features, or as complex as quantitative vegetation surveys or targeted fauna trapping/observation studies to identify presence of significant species.
- Prepare detailed pre-clearance field survey protocols that clearly define data collection, Recording and reporting methodologies for field investigations within each constraint class. Identify clear actions required which may arise from the field results.

3.1.2 Field Assessments

- Confirm by ground survey that landzone mapping associated with the planned sites is accurate. A detailed site assessment by a qualified suitably qualified person will be required to ground truth boundaries of sensitive habitats, verify vegetation types, assess habitat condition, and assess likelihood of presence of threatened species or communities.
- Depending on results of desktop and ground truthing surveys, more detailed targeted survey work may be required. Ensure that all field surveys are conducted using standard methods that are, to the extent possible, consistent between sites.
- Search methods utilised should be specific for the species indicated as potentially present.
- Maintain a database of field records for every investigation, linked to a database of clearing operations.
- Although non-remnant tracts are generally highly modified, some areas may have potential as habitat for significant species. These areas may include wetland sites (including artificial waterbodies), road verges, minor riparian corridors and clay pans. Therefore, pre-clearing overview surveys are recommended to ensure that potential habitats or point features which are unmapped are identified in the field and management steps taken to avoid these areas.

3 Management Protocols

3.1.3 Site Specific Design and on-ground Management

- Where necessary, prepare site specific management plans for individual operations, which include low level assessments such as site and route selection, weed management, fire management, management of watercourse crossings, no-go zones, and rehabilitation.
- Access tracks and other linear infrastructure to support well sites should be located along existing tracks, in previously disturbed areas, or in the least sensitive ecosystems if possible.
- Proximity to sensitive areas may trigger specific management such as minimising pad area, retention of buffer zones and specific placement of tracks and pipelines.
- To reduce the potential for impacts to significant species, ensure no disturbance occurs in any areas within 50 m of waterways and within 200 m of mapped wetlands.
- For all clearing operations, a suitably qualified person will be available if required to oversee the operation.
- Important microhabitat features, such as large hollow logs, should be carefully removed from sites to be cleared and placed in adjoining habitat or stock-piled for use in rehabilitation.
- Checking of open trenches for entrapped fauna and removal by experienced ecologist.

Appendix A

Appendix A EPBC-listed fauna summary notes for each CSG Field

Species	Denison	Mahalo	Comet	Arcadia*	Fairview*	Roma Other	Scotia	Roma*	Eastern Surat	Known REs of importance	Other REs likely to be important in CSG fields	General Distribution Notes	Important Microhabitat Features
Mammals													
<i>Dasyurus hallucatus</i> northern quoll.	L	L	L	L	L	P	A	A	A	11.8.3 11.9.4 11.9.5 11.10.1 11.10.2 11.10.3 11.10.4 11.10.13	11.7.1 11.7.2 11.7.4 11.7.6 11.7.7 11.9.8 11.10.7 11.10.8 11.10.9 11.10.10 11.10.11	Recorded within last 10-30 years from Carnarvon, Bigge and Expedition Ranges and Mt. Zamia (Minerva Hills); Known to have undergone marked decline in Carnarvon Range over past 5-10 years due primarily to cane toad invasion; no confirmed records within Expedition Range within past 10 years but no targeted or systematic surveys have been undertaken.	Cliffs and rock faces with cavities and holes; rock outcrops.
<i>Chalinolobus dwyeri</i> large-eared pied bat, large pied bat.	L	L	L	K	L	P	A	A	A	11.10.1 11.10.2 11.10.3 11.10.4 11.10.13	Other woodland types adjoining key REs including watercourse s and clearings.	Known from Expedition Range; likely to be widespread but in low numbers.	Cliffs and rock faces with cavities and holes; mine shafts.

Appendix A

Species	Denison	Mahalo	Comet	Arcadia*	Fairview*	Roma Other	Scotia	Roma*	Eastern Surat	Known REs of importance	Other REs likely to be important in CSG fields	General Distribution Notes	Important Microhabitat Features
<i>Nyctophilus timoriensis</i> eastern long-eared bat (South-eastern form).	L	L	L	K	K	L	P	L	L	11.5.1 11.10.9	Potentially all woodland types containing trees that form hollows.	Recently recorded from Lonesome Holding in southern Arcadia Valley; also known from Carnarvon Range through to Moonie area (e.g. Alton NP).	Tree hollows.
Birds													
<i>Geophaps scripta scripta</i> squatter pigeon (southern).	K	K	K	K	K	K	P	K	A	11.3.2 11.3.3 11.3.4 11.3.14 11.3.18 11.3.19 11.3.25 11.3.27 11.3.39 11.10.1 11.10.6 11.10.7 11.10.9 11.10.10 11.10.11	11.3.21 11.4.4 11.5.1 11.5.4 11.9.3	Resident populations occur throughout northern CSG fields (north of Injune-Wandoan); outlying population in Yuleba SF (Roma CSG field).	Access to water; relatively open and grassy habitat; seeds of grasses and forbs including weeds; absence/low abundance of foxes and cats.
<i>Erythrotriorchis radiatus</i> red goshawk.	P	P	P	P	P	P	P	A	A		Potentially all REs on land zone 3, 4, 5, 7, 8, 9, 10 and 11.	RAOU bird atlas record from Springsure-Rolleston area; nearby records from Chesterton Range and Chinchilla area; transients P along major watercourses and wetlands e.g. Dawson, Brown,	Habitat complexity/diversity at landscape scale; wetlands/major watercourses; abundant prey (birds).

Appendix A

Species	Denison	Mahalo	Comet	Arcadia*	Fairview*	Roma Other	Scotia	Roma*	Eastern Surat	Known REs of importance	Other REs likely to be important in CSG fields	General Distribution Notes	Important Microhabitat Features
												Comet, Nogoia Rivers, Robinson, Palm Tree and Moolayember Creeks + Lake Nuga Nuga and Lake Murphy; no resident populations known.	
<i>Turnix melanogaster</i> black-breasted button-quail.	P	P	P	L	P	P	A	A	A	11.9.4	11.3.11 11.8.3 11.9.5 11.9.8	Known immediately adjacent to CSG fields from Palmgrove NP; highly likely (>90% probability) of occurrence in large SEVT patches of Amphitheatre section of Expedition NP (Arcadia CSG field); also possible in SEVT patches in Fairview CSG field (e.g. Yebna, Expedition Resource Reserve) but no surveys undertaken.	Closed canopy vegetation communities; vine thickets with low shrubs and dense ground cover; abundant invertebrate prey particularly in leaf litter.
<i>Rostratula australis</i> Australian painted snipe.	P	P	P	P	P	P	P	K	P	11.3.25 11.3.2 11.3.3 11.3.4 11.3.22 11.3.27	11.3.17, 11.4.3, 11.4.7, 11.4.8, 11.9.1, 11.9.5	Known from wetlands in Roma town area, 45km N of Roma, Springsure and Taroom area; Likely to occur anywhere with suitable habitat across CSG fields but difficult to detect being a cryptic species	Wetlands with dense cover; REs on clay plains with gilgais.

Appendix A

Species	Denison	Mahalo	Comet	Arcadia*	Fairview*	Roma Other	Scotia	Roma*	Eastern Surat	Known REs of importance	Other REs likely to be important in CSG fields	General Distribution Notes	Important Microhabitat Features
Reptiles													
<i>Egernia rugosa</i> yakka Skink	L	L	L	K	K	L	L	K	L	11.3.2 11.4.3 11.4.10 11.4.12 11.5.1 11.5.4 11.5.5 11.7.1 11.7.2 11.7.4 11.7.6 11.7.7 11.9.5 11.9.7 11.10.9	11.3.6 11.3.14 11.3.17 11.3.18 11.3.19 11.3.39 11.9.1 11.9.2 11.9.13	Patchy distribution but can be difficult to detect - Likely to be more widespread than records indicate; recorded from Arcadia Valley, Lonesome Holding, Mt. Hutton, Womblebank Road, Cobbadah, Moonie area, Yuleba-Surat Rd and Roma area.	Large hollow logs, log and debris piles; rock piles; gullies with cavities and rock ledges; tunnel erosion and holes; abandoned rabbit warrens; low numbers of predators; abundant food (invertebrates and plant material).
<i>Furina dunmalli</i> Dunmall's snake	P	P	P	K	P	P	P	P	P	11.5.1 11.9.5 11.10.1	11.3.2 11.3.14 11.3.17 11.3.18 11.3.19 11.3.39 11.4.3 11.4.10 11.4.12 11.5.4 11.5.5 11.7.1 11.7.2 11.7.4 11.7.6 11.7.7 11.9.7 11.10.9	Recorded from Expedition Range and Taroom town area; very poorly known species which is difficult to detect; Likely to be more widespread than records indicate but in very low densities.	Intact vegetation; rocks, logs, fallen bark; reptile prey; possibly termite mounds.

Appendix A

Species	Denison	Mahalo	Comet	Arcadia*	Fairview*	Roma Other	Scotia	Roma*	Eastern Surat	Known REs of importance	Other REs likely to be important in CSG fields	General Distribution Notes	Important Microhabitat Features
<i>Paradelma orientalis</i> brigalow Scaly-foot	L	L	L	K	K	L	P	K	A	11.9.4 11.9.5 11.10.1 11.10.2 11.10.4 11.10.10	11.3.1 11.3.14 11.3.17 11.3.18 11.3.19 11.3.39 11.4.3 11.4.10 11.4.12 11.5.4 11.5.5 11.7.1 11.7.2 11.7.4 11.7.6 11.7.7 11.9.7 11.10.6 11.10.7 11.10.9 11.10.11	Known from Expedition Range, Fairview, Carnarvon Range and Grafton Range near Roma; likely to be throughout the northern CSG fields wherever there is intact vegetation and suitable microhabitat.	Intact vegetation; rocks, logs, fallen bark; trees with furrowed bark; invertebrate prey and sap resources.
<i>Denisonia maculata</i> ornamental snake	K	L	L	L	P	P	P	A	A	11.3.25 11.3.27	11.3.2 11.3.3 11.3.4 11.3.21 11.3.22 11.3.27 11.3.17 11.4.3 11.4.7 11.4.8 11.9.1 11.9.5 11.4.4	Recorded from Lake Nuga Nuga; Likely along watercourses with clay substrates within Dawson-Fitzroy drainage.	Rocks, logs, clay substrate; low numbers of predators; abundance of prey particularly frogs.

Appendix A

Species	Denison	Mahalo	Comet	Arcadia*	Fairview*	Roma Other	Scotia	Roma*	Eastern Surat	Known REs of importance	Other REs likely to be important in CSG fields	General Distribution Notes	Important Microhabitat Features
											11.9.3		
<i>Delma torquata</i> Collared delma	P	P	P	K	L	P	P	P	A	11.3.2 11.10.1 11.10.4	11.10.2 11.10.7 11.10.10 11.10.11	Known from Expedition Range and from stock routes west of Mitchell; difficult to detect.	Rocks; logs; tussock grasses; invertebrate prey.
Molluscs													
<i>Adclarkia dawsonensis</i> Boggomoss snail	A	A	A	A	A	L	A	A	A	11.3.1 11.3.2 11.3.3 11.3.4 11.3.22 11.3.25 11.3.27		Core populations occur at Mt. Rose Station and Isla Delusion Rd; recently detected in very low numbers along Dawson River near Theodore.	Logs; intact vegetation; clay substrate; low abundance of predators; low fire risk.

¹ CSS Fields within the RFDA to calculate impacts from the preliminary FDP include: Roma, Fairview and Arcadia

Key to Table

K = Known; L = Likely; P = Possible; A = Absent

Known: reliably recorded from the CSG field within the last 5 years; suitable habitat remains intact and populations still extant.

Likely: >50% chance that the species occurs in the CSG field based on the presence of suitable habitat and within the known distribution.

Possible: <50% chance that the species occurs in the CSG field based on known habitat preferences and distribution; no known confirmed records or the species may have formally occurred but the species have declined in numbers or extent of range (current status unknown).

Absent: not known to currently occur in CSG field due to lack of suitable habitat or outside of known range. May have formerly occurred in CSG field but has declined to the point of local extinction.



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Part 4: Potential Impacts Analysis and Offsets Strategy



Report

Part 4 Impact Analysis & Environmental Offset Strategy

NOVEMBER 2009

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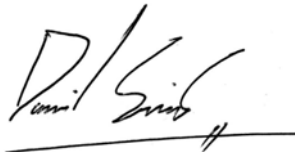
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Reference: 42626459/1/E
Status: Final

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Appendices

Appendix A

Introduction

1.1 Background

The purpose of this document is to present a supplementary assessment of potential impacts of the GLNG Project on the ecological values of the CSG Fields.

This report:

- assesses the extent of potential affectation on the ecological values of the CSG Fields based on three scenarios for the development of the RFDA;
- assess the broader impacts of the development of the CSG Fields on the ecological values of the RFDA; and
- outlines the basis of the proposed environmental offsets package to facilitate the protection and enhancement of the ecological values impacted by the GLNG Project by offsite measures.

An analysis of potential requirements for environmental offsets is also discussed and (Section 3) and includes:

- Options available for avoiding and minimising impacts to significant values;
- Extent and size of values potentially required for offsetting;
- Ecological values required to be offset; and
- Options for securing appropriate offset outcomes.

The offset assessment and analysis includes the co-ordination of multiple offset requirements and is being carried out according to the legislative requirements of the following policies,

- Biodiversity offsets under the *Draft Policy for Biodiversity Offsets 2008* (Qld);
- Vegetation management offsets under the *Vegetation Management Act, 1999* (Qld); and
- Environmental offsets under the *Environmental Protection and Biodiversity Conservation Act, 1999* (Cwth).

This report should be read in conjunction with Part 1: CSG field, Summary of Supplementary Assessment of Potential Impacts to Ecological Values.

1.2 CSG Future Development Plan

An analysis of potential impacts from development of the CSG fields has been undertaken by producing a preliminary Field Development Plan (FDP) to provide a projected impact footprint. Santos has developed the preliminary FDP based on a forecasted development program for the CSG RFDA. The field development plan represents Santos' currently proposed development within the RFDA but will change incrementally over the life of the GLNG Project within the RFDA as the gas field develops and from the implementation of the Field Management Protocols. The field development plan nonetheless presents a reasonable basis for undertaking an impact assessment of the GLNG Project.

The production of the preliminary FDP has been undertaken in a GIS platform to project the planned locations of primary CSG elements (including wells, pipelines, roads and compressors) across the RFDA. The planning process to establish locations for the CSG field elements takes consideration of a number of factors including geological features, topographic limitations, sensitive receptors (i.e.

1 Introduction

homesteads), inundation areas and environmental constraints. The FDP will be refined and updated as more information is obtained on CSG resources or with changes in technology or engineering best practice and from implementation of the Field Management Protocol.

1.3 Minimising Impacts on Environmental Values within the CSG Fields

Best practice environmental management entails implementing or undertaking activities that avoid or minimise impacts on environmentally sensitive areas. Santos will adopt the following management philosophy when planning for, and implementing, petroleum activities within the CSG fields based on following management hierarchy and the preliminary FDP:

- **Avoidance:** Avoiding potential impacts on environmentally sensitive areas;
- **Minimise:** Minimise potential impacts on environmentally sensitive areas;
- **Mitigate:** Implement mitigation to reduce impacts where operating in environmentally sensitive areas cannot be avoided; and
- **Offset:** Where impacts are unavoidable and result in a permanent loss of an environmental value provide secured offsets.

Where ecologically sensitive areas such as Endangered Regional Ecosystems (ERE's) and remnant vegetation are identified by environmental constraints mapping (as detailed in Part 2) impact avoidance and reduction strategies are implemented when planning for the location of field infrastructure through the Field Management Protocol. Examples of this include:

Avoidance

By relocating well leases outside of EREs. This can be done in approximately 25 % of cases where sites are initially located in ERE's. This is determined by looking at the proposed development to assess how many sites are on the edge of mapped ERE's and can be accessed by relocating the well lease or by directional drilling from a less sensitive environment.

Implementing appropriate Field Management Protocols (Part 2) including the assessment and remapping of remnant vegetation may further reduce the potential impacts on "Endangered" or "Of Concern" vegetation communities which are likely to have higher environmental values than "Not of Concern" communities.

Reduction of disturbance will be employed in situations where 'pad drilling' can be utilised by drilling multiple well holes from one pad utilising directional drilling techniques. This reduces the impacts of traditional drilling where previously a single drill pad would be employed for every well. Well pads used for directional drilling are slightly larger than a standard well lease and are in the order of approximately 1.2 ha. In addition, there will be significant reduction in the area disturbed by roads, access tracks, pipelines for the gas and water reticulation systems needed to service each well. Reduction of impacts using 'pad drilling' is projected to be approximately 75 % to 88 % less impact in ERE's and other environmentally sensitive areas across the Fairview, Arcadia and Roma CSG fields.

Minimisation

Reducing site impacts (e.g. well lease reduction) by reducing the size of a standard lease from approximately 10,000 m² in disturbed land to approximately 6,400 m² in remnant vegetation will reduce impacts to significant remnant vegetation by approximately 35 %. The reduction in well lease

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size may be restricted by physical constraints (e.g. such as sloping lands) and health and safety considerations, particularly in relation to the safe operation of drilling rigs, plant and equipment.

Mitigation

Implementation of appropriate field management protocols as outlined in Part 4 of this report, include issuing specific work instructions and site management plans for well lease developments or related infrastructure, can further reduce the potential impacts on essential habitat of a EVR flora or fauna species. Based on existing field experience it is estimated that impacts on habitat values for EVR species could be reduced by up to 70 %. This is considered to be a conservative estimate as each site is assessed by suitably qualified persons to determine environmental values prior to any physical disturbance being authorised.

Rehabilitation is an integral part of minimising impacts and restoring environmental values. Rehabilitation will be in accordance with the CSG rehabilitation strategy outlined in the EIS (Section 6.16).

Santos will develop a comprehensive rehabilitation plan that incorporates monitoring and benchmark reference sites to guide on-going environmental management and rehabilitation activities. Santos commits to progressively rehabilitating land over the life of the project. Santos will implement a rehabilitation program on all land significantly disturbed by the project to:

- Investigate and remediate any contaminated land caused by the authorised petroleum activities;
- Take all reasonable and practicable measures to:
 - Re-establish surface drainage lines;
 - Reinstatement the top layer of the soil profile; and
 - Promote the re-establishment of vegetation.
- Take all reasonable and practicable measures to rehabilitate disturbed areas to:
 - A stable landform and with a self-sustaining vegetation cover and species that are similar to adjoining undisturbed areas;
 - Ensure that all land is reinstated to the pre-disturbed land use and suitability class;
 - Ensure that the maintenance requirements for rehabilitated land is no greater than that required for the land prior to its disturbance by petroleum activities; and
 - Ensure that the water quality of any residual void or water bodies constructed by petroleum activities meets criteria for subsequent uses and does not have potential to cause environmental harm.
- Maintain rehabilitated areas to ensure and demonstrate the:
 - Stability of landforms;
 - Erosion control measures remain effective;
 - Stormwater runoff and seepage from rehabilitated areas does not negatively affect the environmental values of any waters;
 - Plants show healthy growth and recruitment is occurring; and
 - Rehabilitated areas are free of any declared pest plants.
- Monitoring of rehabilitated sites will be undertaken to ensure natural or assisted regeneration is progressing, weeds are appropriately managed and soil erosion is minimised.

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- Rehabilitation will be considered successful when the site can be managed for its designated land-use (either similar to that of surrounding undisturbed areas, a representative analogue sites or as otherwise agreed in a written document with the landowner/holder and administering authority) without any greater management input than for other land in the area being used for a similar purpose and there is evidence that the rehabilitation has been successful for at least three years.

Impact Analysis

2.1 Vegetation and Habitat Clearing

An assessment has been undertaken of the extent of potential affectation on vegetation and habitat clearance arising from implementation of the FDP. This has involved:

- Overlaying the proposed field development plan on the constraints maps presented in Part 2 – GLNG CSG Field Ecological Constraints Mapping & Field Management Protocol; and
- Estimating the extent of potential affectation on the ecological values of the CSG Fields based on three scenarios.

Results of the following analysis of potential clearing impacts are based on vegetation and habitat clearance for the projected CSG RFDA (as outlined above Section 1.2). Potential impacts have been calculated for both well locations and infrastructure elements separately. Three different scenarios are presented for well locations.

- **Scenario 1 - Pre-Avoidance & Mitigation** – this scenario is based on a calculation for clearance of vegetation for development and associated infrastructure on the assumption that each well hole identified in the FDP will have an associated pad located on the surface. This scenario will not occur in practice because Santos proposes to incorporate multiple drill holes from single well pads (pad drilling) where technically feasible. This means that the amount of surface pads and associated infrastructure (such as roads) on the surface is significantly reduced. The pre-avoidance and mitigation scenario is presented for completeness;
- **Scenario 2 - Reasonable Worst Case** -this scenario is based on calculations for FDP well locations within the RFDA that can incorporate multiple drill holes from one pad (pad drilling). This calculation is projected over the FDP but takes into consideration pad drilling to being undertaken where technically feasible. It is expected that pad drilling will be technically feasible in the majority of wells and only unavailable in a small minority of circumstances due to localised geological features. It is conservatively assumed for scenario two that pad drilling to be technically feasible so as to reduce the surface area required by 75% in the RFDA; and
- **Scenario 3 - Reasonable Best Case** –this scenario is based on the calculations for Scenario 2, but also incorporates the consideration of opportunities for impact avoidance utilising the Field Management Protocol to identify specific locations to minimise vegetation clearing and habitat impact. It is conservatively assumed for scenario 3 that a reduction of impacts by up to 70% of the area of vegetation disturbance and impacts to EPBC listed flora and fauna habitats; (as assessed in Part 3).

The above field development scenarios do not take into account rehabilitation of disturbed areas and the restoration of habitat values as outlined in Section 1.3. The potential impacts or permanent loss of environmental values are also likely to be significantly reduced by implementing a progressive rehabilitation program. Offset analysis is presented below in a number of tables for values broken down into the three scenarios for both well locations and infrastructure elements.

2.1.1 Potential Impacts to Significant Regional Ecosystems

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The estimate of areas of significant REs which are likely to be directly impacted by clearing for each of the three scenarios is presented in the tables below. The estimate is based on overlay of the projected CSG FDP with Queensland state government RE mapping v.5.0 for the CSG (as presented in the EIS, Section 11).

- A summary of significant REs potentially impacted by well development in the CSG RFDA are summarised in Table 2-1;
- A summary of significant REs potentially impacted by infrastructure elements in the CSG RFDA area are summarised in Table 2-2;
- A full listing of each RE potentially impacted by well development is provided in Table 2-3; and
- A full listing of each RE potentially impacted by infrastructure elements is provided in Table 2-4.

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Table 2-1 Summary of Potential Areas likely to be directly impacted from projected Well Locations on Significant REs

Conservation Significant REs	No of RE types in CSG RFDA	Area of Impact (~ha)		
		Scenario 1 Pre-Avoidance	Scenario 2 Reasonable Worst Case	Scenario 3 Reasonable Best Case
Endangered REs	3	100.8	0	0
Of Concern REs	4	84	28.8	8.6

Table 2-2 Summary of Areas likely to be directly impacted from projected Infrastructure Elements on Significant REs

Conservation Significant REs	No of RE types in CSG RFDA	Area of Impact (~ha)	
		Pipelines & Pipelines ¹	Compressors
Endangered REs	3	20.4	0
Of Concern REs	4	91.8	2.2

¹ where impacts occur in ERES, infrastructure has been located within existing infrastructure easements (i.e. roads, tracks and fence lines) wherever possible. As such, this number will be significantly reduced.

Table 2-3 Breakdown of Areas likely to be directly impacted from projected Well Locations on Significant REs

Regional Ecosystem	Description	VM Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	Of Concern	68.4	28.8	8.6
11.3.17	<i>Eucalyptus populnea</i> woodland with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on alluvial plains	Of Concern	8.4	0.0	0.0
11.4.3	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains	Endangered	1.2	0.0	0.0

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Regional Ecosystem	Description	VM Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
11.9.4	Semi-evergreen vine thicket or <i>Acacia harpophylla</i> with a semi-evergreen vine thicket understorey on fine grained sedimentary rocks	Endangered	68.4	0.0	0.0
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on fine-grained sedimentary rocks	Endangered	31.2	0.0	0.0
11.9.7	<i>Eucalyptus populnea</i> , <i>Eremophila mitchellii</i> shrubby woodland on fine-grained sedimentary rocks	Of Concern	1.2	0.0	0.0
11.9.10	<i>Acacia harpophylla</i> , <i>Eucalyptus populnea</i> open forest on fine-grained sedimentary rocks	Of Concern	6.0	0.0	0.0

Table 2-4 Areas likely to be directly impact from projected Infrastructure Elements for CSG FDP on Significant REs

Regional Ecosystem	Description	Biodiversity Status	Area of Impact (~ha)	
			Pipelines & Roads ¹ (~ha)	Compressors (~ha)
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains	Of Concern	77.9	2.2
11.4.3	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains	Endangered	3.3	0.0
11.9.4	Semi-evergreen vine thicket or <i>Acacia harpophylla</i> with a semi-evergreen vine thicket understorey on fine grained sedimentary rocks	Endangered	0.8	0.0
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on fine-grained sedimentary rocks	Endangered	16.3	0.0
11.9.7	<i>Eucalyptus populnea</i> , <i>Eremophila mitchellii</i> shrubby woodland on fine-grained sedimentary rocks	Of Concern	1.3	0.0
11.9.10	<i>Acacia harpophylla</i> , <i>Eucalyptus populnea</i> open forest on fine-grained sedimentary rocks	Of Concern	0.0	0.0

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Regional Ecosystem	Description	Biodiversity Status	Area of Impact (~ha)	
			Pipelines & Roads ¹ (~ha)	Compressors (~ha)
11.3.17	<i>Eucalyptus populnea</i> woodland with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on alluvial plains	Of Concern	12.6	0.0

¹ where impacts occur in EREs, infrastructure has been located within existing infrastructure easements (i.e. roads, tracks and fence lines) wherever possible. As such, this number will be significantly reduced.

2.1.2 EPBC Listed Species

An analysis of the potential impacts on ecological values in the CSG FEED area under the requirements of the *Environmental Protection & Biodiversity Conservation Act, 1999* (Cwth) is presented in a series of tables below.

The estimate of areas of potential fauna habitat for species listed under the EPBC Act likely to be directly impacted by clearing for each of the three scenarios is presented in the tables below. The estimate is based on overlay of the projected CSG FEED FDP with potential fauna habitat for the CSG area as determined by the CSG EPBC Listed Fauna Species Habitat Mapping (Part 2).

- A full listing of potential areas of direct impact for each EPBC listed Species impacted by well development is provided in Table 2-5.
- A full listing of potential areas of direct impact for EPBC listed Species impacted by infrastructure elements are provided in Table 2-6.

Table 2-5 Areas likely to be directly impacted from Well Development for projected FDP on EPBC listed Species

Species	Habitat and Range within CSG	EPBC Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance (bottom of Well)	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
Mammals					
<i>Dasyurus hallucatus</i> northern quoll.	Has declined dramatically from region primarily due to cane toads. Any remaining populations would probably occupy <10 % of available habitat. Absent from southern CSG fields.	Endangered.	535.2	120	36

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Species	Habitat and Range within CSG	EPBC Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance (bottom of Well)	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
<i>Chalinolobus dwyeri</i> large-eared pied bat, large pied bat.	Not known to occur in study area away from landzone 10. Will forage in adjoining woodlands as well as clearings. Known from the Expedition Range; likely to be widespread but in low numbers.	Vulnerable.	498	133.2	40
<i>Nyctophilus timoriensis</i> eastern long-eared bat (South-eastern form).	Occurs in wide range of remnant woodland types but in very low numbers. Recently recorded from Lonesome Holding in southern Arcadia Valley; also known from Carnarvon Range through to Moonie area (e.g. Alton NP). May also occur in adjoining non-remnant depending on unmappable micro site features (i.e. availability of hollows).	Vulnerable.	800.4	188.4	56.5
Birds					
<i>Geophaps scripta scripta</i> squatter pigeon (southern).	Throughout northern area in most vegetation except the densest types (e.g. brigalow/vine thicket). Occurrence usually dependant on water especially in non-remnant areas. Will also live in high disturbed sites close to water (e.g. cattle yards). Virtually absent south of Injune except for small population in Yuleba SF.	Vulnerable.	542.4	153.6	41.6
<i>Erythrotriorchis radiatus</i> red goshawk.	Could potentially overfly anywhere in all of northern gas fields including non-remnant. Focus areas most likely to be around Lake Nuga Nuga & Palm Tree/Robinson Creek wetlands.	Vulnerable.	540	153.6	46.1

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Species	Habitat and Range within CSG	EPBC Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance (bottom of Well)	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
<i>Turnix melanogaster</i> black-breasted button-quail.	Known from 11.9.4 immediately adjoining the Comet CSG field. >90 % probability in largest 11.9.4 patches in Arcadia but almost all of these are within NP. <30 % confidence of presence in Fairview & Roma Other due to smaller patch size & higher surrounding fragmentation of habitat.	Vulnerable.	55.2	0.0	0.0
<i>Rostratula australis</i> Australian painted snipe.	Potentially any wetland (usually shallow & temporary types); also farm dams with suitable vegetative cover. Potentially on other REs that form gilgais e.g. 11.4.3 & 11.9.5 but mapping these communities would over-estimate habitat. Likely to occur anywhere with suitable habitat across CSG fields but difficult to detect being a cryptic species.	Vulnerable.	106.8	37.2	11.2
Reptiles					
<i>Egernia rugosa</i> yakka skink.	Found in most vegetation & substrate types except landzone 10 & also avoids coolabah (11.3.3). Able to live in clearings providing there are suitable shelter sites (e.g. tunnel erosion) which most frequently occurs on 11.3.2. Patchy distribution but can be difficult to detect - likely to be more widespread than records indicate; recorded from Arcadia Valley, Lonesome Holding, Mt. Hutton, Womblebank Road, Cobbadah, Moonie area, Yuleba-Surat Rd & Roma area.	Vulnerable.	298.8	54	16.2

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Species	Habitat and Range within CSG	EPBC Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance (bottom of Well)	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
<i>Furina dunmali</i> Dunmall's snake.	Extremely sparsely distributed throughout entire study area. Recorded from Expedition Range & Taroom town area; very poorly known species which is difficult to detect; likely to be more widespread than records indicate but in very low densities.	Vulnerable.	672	142.8	42.8
<i>Paradelma orientalis</i> brigalow scaly-foot.	Occurs in a wide variety of substrates & veg types throughout. Lives in brigalow/vine thicket regrowth but not tolerant of clearings. Known from Expedition Range, Fairview, Carnarvon Range & Grafton Range near Roma; likely to be throughout the northern CSG fields wherever there is intact vegetation & suitable microhabitat.	Vulnerable.	672	142.8	42.8
<i>Denisonia maculata</i> ornamental snake.	Dawson, Fitzroy & Comet River catchments only [i.e. on northern side of Great Dividing Range only). Preference for alluvial & clay substrates with tolerance of clearing. No confirmed records from Fairview & Roma Other so <50 % confident this species occurs in those 2 fields. recorded from Lake Nuga Nuga; likely along watercourses with clay substrates within Dawson-Fitzroy drainage.	Vulnerable.	126	36	10.8
<i>Delma torquata</i> collared delma.	Known from landzone 10 in Expedition Range. Known from remnant 11.3.2 along stock routes west of Roma.	Vulnerable.	246	36	10.8

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Table 2-6 Areas of likely direct impact from Infrastructure Elements for the projected RFDA on EPBC listed species

Species	Habitat and Range within CSG	EPBC Act Status	Pipelines & Roads ¹ (~ha)	Compressors (~ha)
Mammals				
<i>Dasyurus hallucatus</i> northern quoll.	Has declined dramatically from region primarily due to cane toads. Any remaining populations would probably occupy <10 % of available habitat. Absent from southern CSG fields.	Endangered.	334.8	22.0
<i>Chalinolobus dwyeri</i> large-eared pied bat, large pied bat.	not known to occur in study area away from landzone 10 Will forage in adjoining woodlands as well as clearings. Known from the Expedition Range; likely to be widespread but in low numbers.	Vulnerable.	359.6	22.0
<i>Nyctophilus timoriensis</i> eastern long-eared bat (South-eastern form).	Occurs in wide range of remnant woodland types but in very low numbers. Recently recorded from Lonesome Holding in southern Arcadia Valley; also known from Carnarvon Range through to Moonie area (e.g. Alton NP). May also occur in adjoining non-remnant depending on unmappable micro site features (i.e. availability of hollows).	Vulnerable.	551.4	178.3
Birds				
<i>Geophaps scripta scripta</i> squatter pigeon (southern).	Throughout northern area in most vegetation except the densest types (e.g. brigalow/vine thicket). Occurrence usually dependant on water especially in non-remnant areas. Will also live in high disturbed sites close to water (e.g. cattle yards). Virtually absent south of Injune except for small population in Yuleba SF.	Vulnerable.	444.2	66.1
<i>Erythroriornis radiatus</i> red goshawk.	Could potentially overfly anywhere in all of northern gas fields including non-remnant. Focus areas most likely to be around Lake Nuga Nuga & Palm Tree/Robinson Creek wetlands.	Vulnerable.	444.2	66.1

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Species	Habitat and Range within CSG	EPBC Act Status	Pipelines & Roads ¹ (~ha)	Compressors (~ha)
<i>Turnix melanogaster</i> black-breasted button-quail.	Known from 11.9.4 immediately adjoining the Comet CSG Field. >90 % probability in largest 11.9.4 patches in Arcadia but almost all of these are within NP. <30 % confidence of presence in Fairview & Roma Other due to smaller patch size & higher surrounding fragmentation of habitat.	Vulnerable.	0.5	0
<i>Rostratula australis</i> Australian painted snipe.	Potentially any wetland (usually shallow & temporary types); also farm dams with suitable vegetative cover. Potentially on other REs that form gilgais e.g. 11.4.3 & 11.9.5 but mapping these communities would over-estimate habitat. Likely to occur anywhere with suitable habitat across CSG fields but difficult to detect being a cryptic species.	Vulnerable.	99.3	22.0
Reptiles				
<i>Egernia rugosa</i> yakka skink	Found in most vegetation & substrate types except landzone 10 & also avoids coolabah (11.3.3). Able to live in clearings providing there are suitable shelter sites (e.g. tunnel erosion) which most frequently occurs on 11.3.2. Patchy distribution but can be difficult to detect - likely to be more widespread than records indicate; recorded from Arcadia Valley, Lonesome Holding, Mt. Hutton, Womblebank Road, Cobbadah, Moonie area, Yuleba-Surat Rd & Roma area.	Vulnerable.	189.4	156.2
<i>Furina dunmalli</i> Dunmall's snake.	Extremely sparsely distributed throughout entire study area. Recorded from Expedition Range & Taroom town area; very poorly known species which is difficult to detect; likely to be more widespread than records indicate but in very low densities.	Vulnerable.	407.4	134.2
<i>Paradelma orientalis</i> brigalow scaly-foot.	Occurs in a wide variety of substrates & veg types throughout Lives in brigalow/vine thicket regrowth but not tolerant of clearings Known from Expedition Range, Fairview, Carnarvon Range & Grafton Range near Roma; likely to be throughout the northern CSG fields wherever there is intact vegetation & suitable microhabitat	Vulnerable.	407.4	134.2

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Species	Habitat and Range within CSG	EPBC Act Status	Pipelines & Roads ¹ (~ha)	Compressors (~ha)
<i>Denisonia maculata</i> ornamental snake.	Dawson, Fitzroy & Comet River catchments only [i.e. on northern side of Great Dividing Range only]. Preference for alluvial & clay substrates with tolerance of clearing. No confirmed records from Fairview & Roma Other so <50 % confident this species occurs in those two fields. Recorded from Lake Nuga Nuga; likely along watercourses with clay substrates within Dawson-Fitzroy drainage.	Vulnerable.	129.2	44.1
<i>Delma torquata</i> collared delma.	Known from land zone 10 in Expedition Range. Known from remnant 11.3.2 along stock routes west of Roma.	Vulnerable.	102.7	0

¹ where impacts occur in EREs, infrastructure has will be located within existing infrastructure easements (i.e. roads, tracks and fence lines) wherever possible. As such, this number will be significantly reduced.

2.1.3 EPBC Listed Ecological Communities

An analysis of the potential impact on EPBC listed ecological communities in the CSG RFDA under the requirements of the *Environmental Protection & Biodiversity Conservation Act, 1999* (Cwth) is presented in a series of tables below.

The estimate of areas of potential EPBC listed ecological communities likely to be directly impacted by clearing for each of the three scenarios is presented in the tables below. The estimate is based on is based on overlay of the projected CSG FEED FDP with an extrapolation of equivalent RE mapping in accordance with the latest information provided by the EPBC threatened Communities profiles.

Appendix A, defines the REs employed as surrogates for the EPBC listed ecological communities per each specific EPBC ecological community profile (presented in EIS Section 11).

- A full listing of likely areas of direct impact for each listed EPBC Ecological Community impacted by well development is provided below in Table 2-7; and
- A full listing of likely areas of direct impact for each EPBC Ecological Community impacted by infrastructure elements is provided below in Table 2-8.

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Table 2-7 Areas of likely direct impact from Well Development in FDP on EPBC Ecological Communities

Ecological Communities	Description	EPBC Act Status	Area of Impact (~ha)		
			Scenario 1 Pre-Avoidance (bottom of Well)	Scenario 2 Reasonable Worst Case (pad drilling)	Scenario 3 Reasonable Best Case (impact reduction)
Brigalow ecological community.	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) ecological communities.	Endangered.	32.4	0	0
Semi-Evergreen Vine Thicket.	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.	Endangered.	68.4	0	0
Bluegrass ecological community.	Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.	Endangered.	2.4	0	0
Sub-total			103.2	0	0

Table 2-8 Potential impact from Infrastructure Elements of FDP on EPBC Ecological Communities

Ecological Communities	Description	EPBC Act Status	Area of Impact (~ha)	
			Pipelines & Roads (ha)	Compressors (ha)
Brigalow ecological community.	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) ecological communities.	Endangered.	19.6	0
Semi-Evergreen Vine Thicket.	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.	Endangered.	0.8	0
Bluegrass ecological community.	Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.	Endangered.	5.2	0
Sub-total			25.6¹	0

1: The impact analysis reports 25.6 ha of threatened ecological communities as potentially impacted by the proposed development of linear infrastructure. It should be noted that infrastructure projected by the preliminary FDP has been located along existing roads, tracks and fence lines where they exist within these areas. Therefore, the estimate of real impact has been overestimated for the purposes of this report and impacts to these areas would be considered to be significantly less than reported.

2.1.4 Summary of Values

A sum total of the estimate of areas of significant vegetation likely to be directly impacted by clearing is presented below in the Table 2-9. These totals are based on the values above for the reasonable

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worse case for well site clearing (pad drilling), linear infrastructure (pipelines and roads) and compressors.

Table 2-9 Summary of Potential Impact FDP on Significant Vegetation Values

Significant Values	Area of Potential Impact	
	Count	~ha
Endangered REs	1 RE	20.4
Of Concern REs	3 REs	122.8
EPBC Act listed communities	3 ecological communities	128.8

2.2 Bioregional Context of Potential Clearing Impacts

Further to presentation of potential clearing impacts to ecological values outlined above (Section 2.1), an analysis of vegetation clearing in the context of bioregional impacts for significant REs and EPBC listed communities is presented below as a percentage of the extent of each community represented within the Brigalow belt bioregion. The tables include the relative proportion of vegetation clearance in the bioregional context based on the reasonable worst case scenario. A presentation of clearing impacts in the bioregional context is not presented for mapped EPBC listed fauna species habitat (Part 3) as this is not useful analogous surrogate for potential bioregional impacts to EPBC listed species populations in the brigalow belt.

2.2.1 Significant Regional Ecosystems

- A full listing clearing impact in the bioregional context for each Significant RE impacted by well development is provided below in Table 2-9; and
- A full listing clearing impact in the bioregional context for each Significant RE impacted by infrastructure elements is provided below in Table 2-10.

As shown in Table 2-109 and Table 2-11 below, *Eucalyptus populnea* woodland on alluvial plains (RE 11.3.2) is to be subjected to the majority of proposed disturbance (~77.9 ha) for pipeline and road development. This disturbance represents 0.015 % of this community within the bioregion. This vegetation community is listed as 'Of Concern' (VM status).

Vegetation communities being subjected to the second greatest area of clearance is *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks (RE 11.9.5), for pipeline and road development. It is estimated that approximately 16.3 ha of this RE is proposed to be cleared. This disturbance represents 0.010 % of this RE within the bioregion. RE 11.9.5 is listed as 'Endangered' (VM status) and 'Endangered' under the EPBC Act.

The vegetation community of *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains (RE 11.3.17) is subject to the greatest disturbance when viewed as a percentage of the bioregional extent (0.035 %). Approximately 12.6 ha of this RE is proposed to be cleared. This vegetation community is listed as 'Of Concern' (VM status) and 'Endangered' (biodiversity status) under the VM Act. It is not listed under commonwealth legislation.

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The development aspect considered to have the greatest impact on vegetation communities is pipeline and road development (~112.2 ha). The impacts from CSG well development is the next greatest at approximately 28.8 ha. Compressor station development will have the least impact at approximately 2.2 ha.

Table 2-10 Potential vegetation clearing impact on Significant REs from projected CSG Wells and % of Bioregional Extent

Regional Ecosystem	Description	VM Act Status	Area within Bioregion (~ha)	Scenario 2 Reasonable Worst Case (pad drilling) (~ha)	% of Bioregional Extent ¹
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains.	Of Concern.	528,081	28.8	0.005
11.3.17	<i>Eucalyptus populnea</i> woodland with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on alluvial plains.	Of Concern.	36,294	0.0	0.0
11.4.3	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains.	Endangered.	77,389	0.0	0.0
11.9.4	Semi-evergreen vine thicket or <i>Acacia harpophylla</i> with a semi-evergreen vine thicket understorey on fine grained sedimentary rocks.	Endangered.	33,883	0.0	0.0
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on fine-grained sedimentary rocks.	Endangered.	168,841	0.0	0.0
11.9.7	<i>Eucalyptus populnea</i> , <i>Eremophila mitchellii</i> shrubby woodland on fine-grained sedimentary rocks.	Of Concern.	109,286	0.0	0.0
11.9.10	<i>Acacia harpophylla</i> , <i>Eucalyptus populnea</i> open forest on fine-grained sedimentary rocks.	Of Concern.	83,507	0.0	0.0
Total			1,037,281	28.8	0.005

¹ Indicates disturbed % of vegetation community within the Brigalow Belt bioregion as per Accad *et. al.* (2008)

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Table 2-11 Potential vegetation clearing impact on significant REs from projected Infrastructure Elements for CSG FEED FDP and % of Bioregional Extent

Regional Ecosystem	Description	Area within Bioregion (~ha)	Pipelines & Roads (~ha) ¹	% of Bioregional Extent ¹	Compressors (~ha)	% of Bioregional Extent ¹
11.3.2	<i>Eucalyptus populnea</i> woodland on alluvial plains.	52,8081	77.9	0.015	2.2	0.0004
11.4.3	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains.	77,389	3.3	0.004	0.0	0.0
11.9.4	Semi-evergreen vine thicket or <i>Acacia harpophylla</i> with a semi-evergreen vine thicket understorey on fine grained sedimentary rocks.	33,883	0.8	0.002	0.0	0.0
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on fine-grained sedimentary rocks.	168,841	16.3	0.010	0.0	0.0
11.9.7	<i>Eucalyptus populnea</i> , <i>Eremophila mitchellii</i> shrubby woodland on fine-grained sedimentary rocks.	109,286	1.3	0.001	0.0	0.0
11.9.10	<i>Acacia harpophylla</i> , <i>Eucalyptus populnea</i> open forest on fine-grained sedimentary rocks.	83,507	0.0	0.000	0.0	0.0

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Regional Ecosystem	Description	Area within Bioregion (~ha)	Pipelines & Roads (~ha) ¹	% of Bioregional Extent ¹	Compressors (~ha)	% of Bioregional Extent ¹
11.3.17	<i>Eucalyptus populnea</i> woodland with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on alluvial plains.	36,294	12.6	0.035	0.0	0.0
Total		1,037,281	112.2	0.067	2.2	0.0004

¹ Indicates disturbed % of vegetation community within the Brigalow Belt bioregion as per Accad *et. al.* (2008)

2.2.2 EPBC Listed Ecological Communities

A full listing clearing impact in the bioregional context for each Significant EPBC Communities impacted by well development is provided below in Table 2-12.

A full listing clearing impact in the bioregional context for each Significant EPBC Communities impacted by infrastructure elements is provided below in Table 2-13.

The tables include the relative proportion of vegetation clearance in the bioregional context based on the reasonable worst case scenario.

The community subject to the greatest proposed disturbance for the construction of pipelines and roads is Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological communities (~19.6 ha). This community is listed as 'Endangered' under the EPBC Act. This disturbance is also the greatest when viewing the community in a bioregional context (0.008 %).

The community subject to the second greatest proposed disturbance is the 'Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin' (~5.2 ha). This community is listed as 'Endangered' under the EPBC Act. This disturbance is the second greatest when viewing the community in a bioregional context (0.003 %).

The community of 'Semi-Evergreen Vine Thicket' is subject to the least proposed disturbance (~0.8 ha). This community is listed as 'Endangered' under the EPBC Act. This disturbance equates to 0.002 % of this community when viewed in a bioregional context.

Table 2-12 Potential impact from Well Development in the RFDA on EPBC Ecological Communities and % of Bioregional Extent

Ecological Communities	Description	EPBC Act Status	Area within Bioregion (~ha)	Scenario 2 Reasonable Worst Case (pad drilling) (~ha) ¹	% of Bioregional Extent ²
Brigalow ecological community.	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) ecological communities.	Endangered.	246,230	0.0	0.0

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Ecological Communities	Description	EPBC Act Status	Area within Bioregion (~ha)	Scenario 2 Reasonable Worst Case (pad drilling) (~ha) ¹	% of Bioregional Extent ²
Semi-Evergreen Vine Thicket.	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.	Endangered.	33,883	0.0	0.0
Bluegrass ecological community.	Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.	Endangered.	160,830	0.0	0.0
Total			440,943	0.0	0.0

¹ The areas for each EPBC listed community have been based on the analogous REs to be cleared. These are: Brigalow Ecological Community; RE 11.4.3; RE11.9.5. Semi-Evergreen Vine Thicket; RE 11.9.4. Bluegrass ecological community; 11.9.3.

² Indicates disturbed % of vegetation community within the Brigalow Belt bioregion as per Accad *et. al.* (2008).

Table 2-13 Potential impact from Infrastructure Elements of RFDA on EPBC Ecological Communities and % of Bioregional Extent

Ecological Communities	Description	EPBC Act Status	Area within Bioregion ¹ (~ha)	Pipelines & Roads (~ha)	% of Bioregional Extent ²	Compressors (~ha)	% of Bioregional Extent ²
Brigalow ecological community.	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) ecological communities.	Endangered.	246,230	19.6	0.008	0.0	0.0
Semi-Evergreen Vine Thicket.	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.	Endangered.	33,883	0.8	0.002	0.0	0.0
Bluegrass ecological community.	Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.	Endangered.	160,830	5.2	0.003	0.0	0.0
Total			440,943	25.6	0.013	0.0	0.0

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¹ The areas for each EPBC listed community have been based on the analogous REs to be cleared. These are: Brigalow Ecological Community; RE 11.4.3; RE11.9.5. Semi-Evergreen Vine Thicket; RE 11.9.4. Bluegrass ecological community; 11.9.3.

² Indicates disturbed % of vegetation community within the Brigalow Belt bioregion as per Accad *et. al.* (2008).

The community subject to the greatest proposed disturbance for the construction of pipelines and roads is Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological communities (~19.6 ha). This community is listed as 'Endangered' under the EPBC Act. This disturbance is also the greatest when viewing the community in a bioregional context (0.008 %).

The community subject to the second greatest proposed disturbance is the 'Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin' (~5.2 ha). This community is listed as 'Endangered' under the EPBC Act. This disturbance is the second greatest when viewing the community in a bioregional context (0.003 %).

The community of 'Semi-Evergreen Vine Thicket' is subject to the least proposed disturbance (~0.8 ha). This community is listed as 'Endangered' under the EPBC Act. This disturbance equates to 0.002 % of this community when viewed in a bioregional context.

2.3 Description of Impacts

The development stages of each CSG fields include exploration, construction, operation, rehabilitation and decommissioning activities which will have direct and indirect impacts. Through the different stages of the CSG field activities the disturbances created vary. A comprehensive description and assessment of potential impacts and mitigation strategies for each of the different development stages is detailed within the EIS Section 6.4 and Appendix N1. The direct and indirect impacts of the GLNG Project within the CSG Fields are summarised in the following sections.

The local disturbance area generated for each well site is progressively reduced and rehabilitated throughout the stages of CSG field development (EIS Section 3.6). For example, the area required for a drilling a well pad lease is approximately 1.2 ha in the initial 3 week development period. This area is then reduced when the flare pit, drilling sumps and turkey's nest are rehabilitated and removed. Following on from these activities the drilling lease is again reduced and rehabilitated to an area of approximately 0.1 ha when operational (for a 5 to 10 year lifespan), reducing both the overall localised and regional impact.

Potential impacts from well development and associated infrastructure on the regional scale would only be realised over time as well sites are established across the landscape in sequence over a number of years. The progressive nature of continual rehabilitation of each site (as described above) across the landscape means that potential impacts on the regional scale are lessened over the time frame of the overall field development. As rehabilitation of individual sites continues concurrently with the continuing development of other sites over the extended life span of the CSG field the overall net impacts of the development are lessened.

Localised Potential Impact

The installation of both temporary and permanent CSG infrastructure will result in the need to clear vegetation from specific areas. For well leases this may involve the potential clearing of up to 1.2 ha of vegetation initially in worst case situations where well location cannot avoid vegetation. In many cases there will be minimal vegetation clearing because Santos will be locating wells and

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infrastructure within previously cleared areas in accordance with the field management protocols (Part 2).

Regional Impact

The degree of potential vegetation removal and clearing for infrastructure is considered unlikely to have a significant impact to the ecological integrity and biodiversity values of the lowland grazing areas of the northern CSG fields of the Mahalo, Denison Trough, Scotia, Arcadia Valley and 'Roma Other'. These landscapes predominantly consist of grazing and agricultural land with isolated patches of habitat exhibiting very limited connectivity across the region, as detailed in EIS Sections 6.4.4.2 and Appendix N1 (Section 4.2.2 and 4.2.6). The northern CSG fields of Fairview and Arcadia do present some habitat of higher biodiversity value in the elevated areas associated with the Shotover, Expedition and Carnarvon Ranges. A significant proportion of these areas are held within state forests and national parks (approximately 29 %) and development activity is not expected to be significant within these areas of protected national estate. Where development activities are anticipated in areas of higher biodiversity value a number of mitigation strategies, in accordance with field management protocols (Part 2), such as initial constraints and risk identification and environmentally sensitive placement of infrastructure will be employed to manage potential impacts.

Similarly to the northern CSG fields, the degree of potential vegetation removal and clearing for infrastructure is unlikely to have a significant impact to the ecological integrity and biodiversity values of the southern CSG fields of Roma and the Eastern Surat Basin. This landscape predominantly consists of grazing and agricultural land with isolated patches of habitat exhibiting very limited connectivity across the region, as detailed in EIS Section 6.4.4.3 and Sections 4.2.3 and 4.2.7 of Appendix N1. Strategies outlined within the field management protocol (Part 2) will mitigate potential impacts to the remaining isolated pockets of habitat and riparian corridors with biodiversity value in the southern CSG fields.

A quantification of the areas of REs likely to be directly affected by the GLNG Project in the RFDA is presented in section 2.2 above.

2.3.2 Fragmentation of Communities

Localised Potential Impact

The placement of roads and pipelines such that locally important vegetation corridors are traversed resulting in the communities being fragmented and loss of habitat connectivity. The impact of fragmentation of habitat from road networks and pipelines will vary and is dependant on the extent, size shape and integrity of the adjacent habitat. Generally, fragmentation of core habitat from road and pipeline easements has a relatively lower degree of impact than fragmentation from clearing large extents of vegetation for agriculture or infrastructure.

Regional Impact

Habitat removal for road and pipeline placement has the potential for Regional fragmentation impacts if removal of habitat were not to take account of local ecological constraints, and any important pathway of connectivity. Potential impacts will be avoided by implementation of sensitive planning and avoidance of important pathways of connectivity, such as those found in along riparian corridors, the

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elevated scarps and other areas of core habitat and regional connectivity (such as the landscape link of Lonesome Holdings NP).

2.3.3 Loss of Fauna Habitat

Localised Potential Impact

Individual well development may result in the removal of a relatively small amount of vegetation and microhabitat within the area of disturbance (up to 1.2 ha). For example, the area around a corehole drilling lease (60 m x 60 m) may be slashed, and not entirely cleared, to reduce any potential for erosion and to improve rehabilitation. Impacts to fauna as a result of these activities will generally be slight, with a small chance of fauna mortality in affected areas. Given that much of the clearing will only involve the removal of selected trees and shrubs and the lopping of tree branches to allow vehicle and equipment access, potential impacts to fauna are generally considered to be relatively low.

Regional Impact

Potential loss of fauna habitat on a regional scale is not considered likely to be significant due to the relatively small and localised areas of potential habitat loss from well field development. Well field management protocols (Part 2) will ensure location of wells and associated infrastructure will be in locations of the least potential impact to fauna habitat. Where appropriate specialist ecological investigations will be undertaken during the Phase 2 scouting protocol to ensure no species of conservation significance are impacted by habitat disturbance from well field development (Part 1, EIS Appendix N1 and Section 6.4.5.5).

2.3.4 Fauna Mortality

Localised Potential Impact

Much of the CSG field study area is highly altered and is devoid of significant habitat. However, the development of a road network through vegetated areas of core fauna habitat will place fauna at a greater risk of being struck by vehicles. Marker pegs and open shotholes remaining from the exploration phase may offer a physical hazard to fauna and stock if left unattended. Other potential risks are fauna becoming entrapped in open excavations or pipeline trenches. Santos will implement appropriate management measures to minimise potential fauna mortalities during exploration programs or during the construction phase of any new pipelines.

Regional Impact

The potential for fauna mortality is likely in localised areas as outlined above, however impacts on ground dwelling fauna populations across the CSG fields are not considered likely to be significant in the regional context.

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2.3.5 Weed Species

Localised Potential Impact

The increased potential for weed seed spread in localised areas of construction and operation for the development of the CSG field has the potential to reduce viability of agricultural land and ecological value of habitat where infestations are unmitigated.

Regional Impact

Desktop and field studies have confirmed the presence of the declared weeds *Parthenium hysterophorus** (parthenium), *Opuntia tomentosa** (velvety tree pear), *O. stricta** (prickly pear) and *Lantana camara** (lantana) within or near a number of CSG fields. Of these species, parthenium has the greatest potential to significantly impact upon grazing and ecological values. Many of the CSG fields remain free of parthenium. However, the weed could easily be introduced to new areas through poor weed hygiene practices. Introduction to areas previously free of infestations could result in major issues with loss of grazing potential, reduction in habitat value and increase in risk to human health.

Potential impacts from weed dispersal on a regional scale would include broad scale spread of significant agricultural weeds such as parthenium. Regional impacts will be mitigated by the implementation of measures at the local scale, to avoid spread of weed species between properties and infested areas. Mitigation measures for potential weed impacts are detailed in within Attachment B1, EIS Sections 6 and 11 and EIS Appendix N1.

2.3.6 Dust

Localised Potential Impact

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.

Control measures will be implemented to minimise dust generation during the all phases of the CSG field development program, and it is not expected that potential effects of dust deposition on vegetation will be significant. The construction of wells and associated infrastructure and use of dirt tracks and roads within the CSG fields will generate dust. Further Detail on Mitigation strategies for potential impacts to flora and fauna from excessive dust are detailed within EIS Section 11 and Sections 5.2 to 5.4 of EIS Appendix N1.

Regional Impact

Potential impacts from dust in the regional context are not expected to be significant. The nature of dust impacts are primarily at a localised scale and will be mitigated with a number of strategies including those outlined below and in EIS Section 11 and Sections 5.2 to 5.4 of EIS Appendix N1.

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2.3.7 Noise & Vibration

Fauna may be affected in the short-term by noise and vibration stemming from activities such as road construction, excavation and seismic testing. Fauna will generally move away from the source to avoid these impacts and will return to the area when disturbances cease. Where the impact is low-level but continuous, acclimatisation by some species will occur over the longer term. It is not expected that noise impacts will cause significant impacts to fauna during CSG development or operational activities.

Regional Impact

The potential for fauna disturbance from noise and vibration is likely in localised areas as outlined above however significant impacts on ground fauna populations across the CSG fields are not considered likely to be significant in the regional context.

Offset Management Strategy

3.1 GLNG Offset Management Strategy

In addition to the objectives outlined above (Section 1.1) and previously stated within the EIS (Sections 6.4 and Appendices N1), a specific Environmental Offset Management Strategy for the whole of the GLNG project is being developed by Santos in an iterative process with State and Commonwealth regulatory bodies and in conjunction with Ecofund Queensland (a state advisory service). Specific aims of the GLNG Offset Management Strategy include:

- Identification of environmental offset requirements; Identification of suitable offset options;
- Landholder liaison and negotiation to secure required offsets;
- Assessment of properties;
- Offset validation and preparation of specific Biodiversity Offset Management Plan(s); and
- Liaison to finalise contractual arrangements and covenants.

The offset strategy is proposed to be based on the estimated areas of clearing for the GLNG Project within the CSG Fields.

Exploration of suitable offset options includes examination of a number of options under both a 'traditional' approach to address legislative requirements, as well as options under a 'strategic' approach to maximise environmental gains.

Offsetting outcomes from either the traditional or strategic approach as outlined below will result in maximising net biodiversity gains for a number of significant ecosystems that represent a range of endangered REs, EPBC listed communities and present habitat values for a number of niche specific EVR species for the bioregion.

As an example, current projected impacts for brigalow communities under the reasonable best case scenario (Section 2.1) will potentially result in the loss of 10.9 ha of currently unprotected brigalow in the bio-region (representing 0.008 % of brigalow within the bio-region¹). Secure offsetting for the loss of these communities under the final offsetting option will ensure an increase of brigalow within the protected estate for the bio-region. As an arbitrary example, an offset ratio of 3:1 for brigalow would result in an increase of 58.8 ha to the protected estate², representing an increase of 0.22 % of brigalow within the protected estate within the bio-region.

3.1.1 Traditional offset strategy approach

The 'traditional' approach involves addressing each offset policy individually and applying multipliers or ratios of impact to offset where the policies specifically refer to them, such as the Policy for Vegetation Management Offsets under the *Vegetation Management Act 1999*. Once the offset requirements are established under each policy, multiple-offset coordination has been applied to identify where offset values can be co-located to reduce the total offset area required. A summary of objectives for offsetting impacts under the traditional offset approach include:

- Identification of suitable potential offset areas with ecological values analogous to impacted ecological communities;
- Assessment of the ecological value and equivalence of offsets to ensure suitable offset extent, species assemblage, floristic structure and ecological integrity utilising an appropriate biometric field methodology;

¹ As per Accad et. al. (2008)

² Protected estate including all National Parks, Scientific Conservation Reserves, and Conservation Parks within the Brigalow Belt Bioregion

3 Offset Management Strategy

- Development of appropriate management prescriptions to ensure long term viability of offsets (such as pest control, livestock management, access exclusion, ameliorative plantings and fire regime management);
- Placement of appropriate covenants for future conservation and management of offsets; and
- Development of appropriate monitoring and maintenance activities and performance review processes to ensure long term viability of the offsets.

3.1.2 Strategic Offset Strategy approach

The 'strategic approach' consolidates the environmental values likely to be impacted by the Gladstone LNG Project and identifies potential offset properties that comply with the principles of the Queensland Government Environmental Offset Policy. The 'strategic approach' proposes offsets which will deliver a significant environmental benefit, are of a larger more viable size, strategically located and contribute to expanding protected areas in Queensland. This approach is likely to deliver greater conservation outcomes, assist the Queensland Government to expand protected areas and be more cost-effective. Objectives of the proposed strategic approach are to ensure that larger less fragmented offset areas with significant ecological values are secured to maximise biodiversity gains while still meeting the principles of biodiversity offsetting legislative requirements.

3.1.3 Projected Impacts vs Real Impacts

In addition to determining projected offset requirements under the different CSG development scenario's in this report, a field based inventory will be undertaken under the field management protocol (Part 2) to account for actual impacts to significant ecological values as the CSG field is explored and developed. Actual impacts that require offsetting during CSG development may differ from those presented in the scenario's above, and it is expected that real impacts will be either in the order of the reasonable best case scenario presented in this report or even less so. It is proposed that the inventory of impacts that will be undertaken in the field will be monitored and reconciled against the projected potential offset requirements outlined in this report to provide a realistic outcome for determining final offset requirements.

Santos proposes to provide an initial offset calculation and report to the relevant administering authorities on a regular basis to enable reconciliation of the initial offset calculation with the monitored extent of clearing which has been undertaken. Alternative options for the implementation of offset requirements are being investigated with Ecofund and the most appropriate option will be outlined in the final GLNG Offset Management Plan for the CSG fields.

3.1.4 Development of an Environmental Offsets Package

Santos will work with Ecofund Queensland to prepare an Environmental Offsets Package that will deliver the environmental outcomes outlined in Section 3.1 and 3.1.2. The package will be developed to deliver the offset requirement in way that minimise the time lag between the potential impact and the achievement of the environmental outcome. The package will be developed in consultation with State and Commonwealth agencies.

Appendix A

EPBC-listed threatened communities and analogous REs

EPBC-listed Threatened Community Status	Corresponding Regional Ecosystems (within Bioregion 11 – Brigalow Belt)
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant). Endangered.	RE 11.3.1-<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains; RE 11.4.3-<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> shrubby open forest on Cainozoic clay plains; RE 11.4.7-Open forest of <i>Eucalyptus populnea</i> with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on Cainozoic clay plains; RE 11.4.8-<i>Eucalyptus cambageana</i> open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains; RE 11.4.9-<i>Acacia harpophylla</i> shrubby open forest with <i>Terminalia oblongata</i> on Cainozoic clay plains; RE 11.4.10-<i>Eucalyptus populnea</i> or <i>E. pilligaensis</i>, <i>Acacia harpophylla</i>, <i>Casuarina cristata</i> open forest on margins of Cainozoic clay plains; RE 11.5.16-<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest in depressions on Cainozoic sand plains/remnant surfaces; RE 11.9.1-<i>Acacia harpophylla</i>-<i>Eucalyptus cambageana</i> open forest on Cainozoic fine-grained sedimentary rocks; RE 11.9.5-<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on Cainozoic fine-grained sedimentary rocks; RE 11.9.6-<i>Acacia melvillei</i> ± <i>A. harpophylla</i> open forest on Cainozoic fine-grained sedimentary rocks; RE 11.11.14-<i>Acacia harpophylla</i> open forest on deformed and metamorphosed sediments and interbedded volcanics; and RE 11.12.21-<i>Acacia harpophylla</i> open forest on igneous rocks; colluvial lower slopes.
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin. Endangered.	RE 11.3.21 <i>Dichanthium sericeum</i> and/or <i>Astrebla</i> spp. grassland on alluvial plains - Cracking clay soils; RE 11.4.4 <i>Dichanthium</i> spp., <i>Astrebla</i> spp. grassland on Cainozoic clay plains; RE 11.4.11 <i>Dichanthium sericeum</i>, <i>Astrebla</i> spp. and patchy <i>Acacia harpophylla</i>, <i>Eucalyptus coolabah</i> on Cainozoic clay plains; RE 11.8.11 <i>Dichanthium sericeum</i> grassland on Cainozoic igneous rocks; RE 11.9.3 <i>Dichanthium</i> spp., <i>Astrebla</i> spp. grassland on fine-grained sedimentary rocks; RE 11.9.12 <i>Dichanthium sericeum</i> grassland with clumps of <i>Acacia harpophylla</i> on fine-grained sedimentary rocks; and RE 11.11.17 <i>Dichanthium sericeum</i> grassland on old sedimentary rocks with varying degrees of metamorphism and folding.

Appendix A

EPBC-listed Threatened Community Status	Corresponding Regional Ecosystems (within Bioregion 11 – Brigalow Belt)
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions. Endangered.	RE 11.2.3-Microphyll vine forest ("beach scrub") on sandy beach ridges; RE 11.3.11-Semi-evergreen vine thicket on alluvial plains; RE 11.4.1-Semi-evergreen vine thicket ± <i>Casuarina cristata</i> 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-<i>Macropteranthes leichhardtii</i> 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-<i>Macropteranthes leichhardtii</i> 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.
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin. Endangered.	It should be noted that although this community was identified within the MNES, the only springs community mapped as an RE within the Brigalow Belt bioregion (RE 11.3.22 (Springs associated with recent alluvia) are <u>not</u> part of the listed ecological community.
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Critically Endangered.	In Queensland the ecological community is a primary component of the following Regional Ecosystems within the Brigalow Belt bioregion: 11.8.2a-<i>Eucalyptus tereticornis</i> and <i>E. melliodora</i> occurring on low hills. Cainozoic igneous rocks; 11.8.8 <i>Eucalyptus albens</i>, <i>E. crebra</i> woodland on Cainozoic igneous rocks. Hillsides; and 11.9.9 <i>Eucalyptus crebra</i> woodland on fine-grained sedimentary rocks. It can also be a smaller component of the following regional ecosystem: 11.3.23, <i>Eucalyptus conica</i>, <i>E. nobilis</i>, <i>E. tereticornis</i>, <i>Angophora floribunda</i> on alluvial plains. Basalt derived soils.



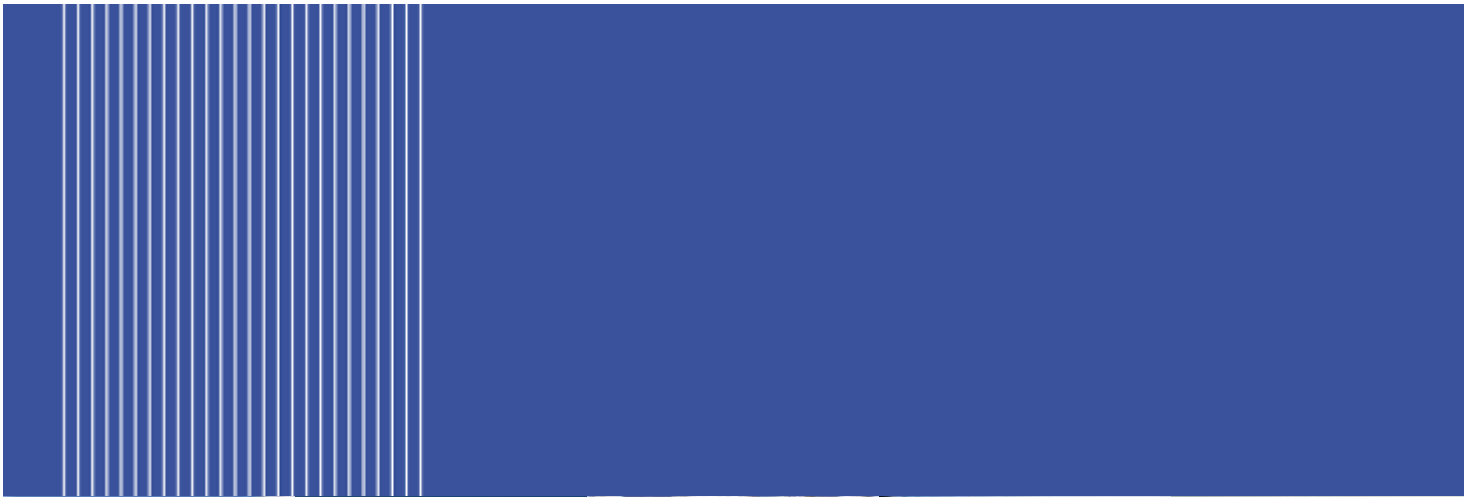
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Part 5: Field Management Protocol – Other Environmental Values



Report

Part 5 - CSG Field Management Protocol

NOVEMBER 2009

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CSG Field Management Protocol

1.1 Purpose

Attachment D5 describes the ecological constraints mapping and the ecological field management protocols in place for the development the CSG fields. Other environmental constraints identified in the EIS will also be applied by Santos in the selection of specific locations for the wells and associated infrastructure as part of an overall field management protocol for the CSG fields development.

The overall field management protocol is depicted in Figure X. The purpose of this document is to:

- Provide an overview of the site selection criteria which will be applied by Santos in determining the final specific locations for wells and associated infrastructure having regard to the other environmental constraints arising from the EIS; and
- Describe the desktop review process and pre-construction site surveys identified in Figure X which will be undertaken by Santos as part of the overall field management protocol to locate wells and associated infrastructure so as to minimise impacts on the environmental values of the CSG fields.

1.2 CSG Environmental Management Plan

This document should be read in conjunction with the CSG EMP. The CSG EMP provides details of the actions that will be undertaken to avoid or minimise environmental impacts from activities in specific locations in the CSG fields. These actions include criteria for selecting appropriate sites together with measures which will be employed when undertaking the development of wells and associated infrastructure to minimise impact on the environment.

Set out below is the approach that will be adopted by Santos to consider non-ecological constraints in the selection of locations for CSG fields development including:

- Identification of the site constraints for each environmental value arising from environmental impact assessment undertaken for the EIS;
- A description of the desktop review to confirm the environmental constraints in the area initially proposed for the well or associated infrastructure having regard to the EIS and updated information;
- Identification of pre-construction surveys to confirm the on ground location of potential ecological constraints which will contribute to the overall selection of specific sites; and
- Mitigation measures that will inform the selection of the site.

This document sets out the site selection criteria, desktop review methodology and pre-construction surveys proposed having regard to each key environmental constraint identified as part of the EIS.

Environmental Constraints

2.1 Land

EIS

An assessment of the land impacts from the development of the CSG fields is contained in section 6.3 of the EIS. The assessment included terrain mapping primarily from the interpretation of aerial photographs with reference to existing geological, topographical and soils information and background data sources followed by a site reconnaissance inspection to provide the basis for identifying terrain units which occur within the study area. Detailed soil maps are provided in EIS Appendices L1. Land classes were also identified for Good Quality Agricultural Lands (QCAL) in the Central West Region of Queensland – NRW (2004).

Site Selection Constraints

- Avoid problem areas where possible for locating wells and associated infrastructure;
- Avoid clearing on dispersible soils or highly erodible soils;
- Avoid good agricultural land where possible;
- Avoid where possible smaller parcels of land where the relative impact will be greater;
- Locate gathering pipelines and access roads along fencelines and property boundaries where practicable;
- Locate development activities away from more intensely used areas of the property and site specific areas identified during consultation with landowner where possible;
- No clearing on slopes greater than 6 degrees (10 %); and
- Water storage areas to be located to avoid class A QCAL.

Desktop Review

Conduct a review of the proposed location of the specific development of the CSG fields for the purposes of determining:

- Whether it is likely to fall within a problem soil area as identified on the overall soil maps; and
- The level of agricultural suitability of soils based on the Land Management Field Manuals for the Roma, Wandoan and Dawson/Callide Districts as appropriate; and
- The potential for application of the other constraints identified above.

If feasible and practical, relocating the site to avoid the site constraint.

Pre-Construction Survey

Field check for problem soil areas, higher quality agricultural land, slope of land and other site constraints relative to proposed location of wells and associated infrastructure.

Mitigation Measures

The proposed environmental mitigation measures for land contamination are set out in section 11.16.18 of the CSG EMP.

2 Environmental Constraints

2.2 Groundwater

EIS

An assessment of the potential groundwater impacts from the development of the CSG fields is contained in section 6.6 of the EIS. The assessment included a review of the geological units mapped to outcrop within the CSG fields and the registered bores within these units.

Site Constraints

- No drilling proposed within 50 metres of streams;
- Storage and loading/decanting areas for fuels and chemicals located outside of the floodplain of the stream channels (ie. approximately 50 metres away from the top bank);
- Water storage areas and ponds will be located to avoid areas with a high connectivity with groundwater;
- Ponds and water treatment facilities will be located above the 1 in 100 year flood level and away from remnant vegetation and other environmentally sensitive areas; and
- Wells will be constructed (and decommissioned) to avoid interconnection between aquifers.

Desktop Review

Review of available information to confirm locations of streams and bores relative to the proposed location of the wells and associated infrastructure.

Pre-Construction Survey

Field check to ensure proximity of proposed wells and associated infrastructure to environmental constraints.

In Fitzroy River area, conduct pre-construction surveys for nesting sites for Fitzroy River turtles at any major waterways where the species is considered potentially present which may be impacted by construction and operations and adjust site to minimise impacts [check application to CSG]

Mitigation Measures

The proposed environmental mitigation measures for groundwater are set out in section 11.16.16 of the CSG EMP.

2.3 Surface Water

EIS

An assessment of the potential surface water impacts from the development of the CSG fields is contained in section 6.5 of the EIS. The assessment included a baseline water quality assessment based on available data from the Department of Natural Resources and Mines supplemented by targeted and spatially dense samples.

2 Environmental Constraints

Site Constraints

- No drilling proposed within 50 m of streams;
- No clearing within any natural wetland, within 100 m from any natural wetland, in any natural significant wetland or within 200 m from any natural significant wetland;
- No clearing or drilling in, or within, 50 m of, the high bank of a watercourse;
- No clearing or drilling in, or within 100 m of a wetland or spring; and
- Plan infrastructure locations to avoid artesian springs.

Desktop Review

Review available information to identify location of any watercourses relative to the proposed location of the wells and associated infrastructure.

Pre-Construction Survey

Field check to confirm proposed location meets site constraints

Mitigation Measures

The proposed environmental mitigation measures for surface water are set out in section 11.16.17 of the CSG EMP.

2.4 Indigenous Cultural Heritage

EIS

An assessment of the potential indigenous cultural heritage impacts from the development of the CSG fields is contained in section 6.13.1 of the EIS. Santos has developed cultural heritage management plans with Aboriginal Parties over the CSG field area.

Site Selection Constraints

Cultural Heritage Management Plans under the *Aboriginal Cultural Heritage Act 2003*.

Desktop Review

Review proposed site against terms of Cultural Heritage Management Plans and other available information on cultural heritage.

Pre-construction Survey

As required by the Cultural Heritage Management Plans

Mitigation Measures

The proposed environmental mitigation measures for indigenous cultural heritage are set out in section 11.16.25 of the CSG EMP.

2 Environmental Constraints

2.5 Non-Indigenous Cultural Heritage

EIS

An assessment of the potential non-indigenous cultural heritage impacts from the development of the CSG fields is contained in section 6.13.2 of the EIS. The assessment included:

- A desktop review of the CSG fields study area including register searches to determine the presence of registered heritage sites; and
- A general reconnaissance and targeted field investigation of sites identified as part of the desktop review as being of potential heritage significance.

Site Selection Constraints

No disturbance of any place on the Queensland Heritage Register in accordance with the requirements of the *Queensland Heritage Act 1992*.

Desktop Review

Review of available information to confirm the locations of registered heritage sites.

Pre-Construction Survey

Field check for non-indigenous heritage items in area of proposed development which are not listed and adjust location where possible.

Mitigation Measures

A project specific conservation management plan will be prepared to establish mitigation, management and approval procedures. The proposed environmental mitigation measures for non-indigenous cultural heritage are set out in section 11.16.25 of the CSG EMP. Where potential non-indigenous material is identified and likely to be disturbed, Santos will determine the significance of the site in consultation with DERM and undertake relocation/preservation of the material.

2.6 Noise

EIS

An assessment of the potential noise impacts from the development of the CSG fields is contained in section 6.10 of the EIS. The assessment included noise monitoring at representative areas and development of operational noise criteria for the development of the CSG fields.

Site Constraints

Construction – evening and night time construction noise will be the night time sleep disturbance criteria of LAMax50dBA; and

Operation – based on DERM's Ecoaccess Guideline: Planning for Noise Control being background creep criteria for general CSG field activities noise, low frequency noise criteria for low frequency noise sources and specific noise level criteria for flares. Where existing ambient noise levels are

2 Environmental Constraints

already above the recommended noise levels, noise generated by the CSG development will be maintained at approximately 8 or 10 dB(A) below the existing ambient noise levels.

To achieve this criteria, Santos proposes to select facility locations in accordance with guidelines in the table below. The guidelines set out the offset distance from sensitive receptors which is required to meet the proposed noise criteria.

Stage	Activity	Noise Criteria ¹ (dBA)	Predicted Noise Level at Buffer Distance (dBA)							Minimum Required Buffer (m)
			Buffer Distance (m)							
			50	100	250	500	1,000	2,000	5,000	
Stage 1	Clear and grade	50	76	68	57	47	39	29	15	425
Stage 2	Setup of temporary facilities	50	68	61	48	37	26	16	0	225
Stage 3	Cellar and surface conductor pipe	50	66	59	47	37	28	18	4	225
Stage 4	Drilling	50	70	63	51	42	33	24	9	275
Stage 5	Casings and completions rig	50	74	66	55	46	37	27	12	400
Stage 6	Wellhead valves	50	69	62	51	42	33	23	8	275

Note: 1. Sleep disturbance noise criteria.

In cases where this buffer distance is unable to be achieved, noise mitigation measures will be incorporated. Where compressor stations are located within 1,000 metres of a noise sensitive receptor, noise mitigation measures will be implemented.

Desktop review

Review the proposed location of the specific development of the CSG Field for the purposes of applying the offset distance guidelines and where possible adjusting the location of the development to comply with the guidelines.

Pre-Construction Survey

Conduct a field check of the proximity of the proposed site to sensitive receptors for the purposes of applying the offset distance guidelines and where possible adjusting the location of the development to comply with the guidelines.

The proposed environmental mitigation measures for noise are set out in section 11.16.21 of the CSG EMP.

2.7 Air Quality

EIS

An assessment of the potential air quality impacts from the development of the CSG fields is contained in section 6.8 of the EIS. The assessment included air quality monitoring at sensitive receptors representative areas. The air quality performance criteria identified in the CSG EMP are:

- No excessive dust emissions;
- Any complaints from landholders responded to within two working days; and

2 Environmental Constraints

- Compliance with environmental authority conditions.

Site Constraints

Santos will consult with and advise any landholders who may potentially be impacted by construction dust emissions prior to the commencement of activities.

Desktop Review

Santos proposes to review the proposed location of the specific sites during the desktop review stage having regard to potential local air quality impacts.

Pre-Construction Survey

Nil

Mitigation Measures

The proposed environmental mitigation measures for air quality are set out in section 11.16.22 of the CSG EMP.

2.8 Relationship with landholders

Many of the non-ecological constraints associated with the location of infrastructure in the CSG fields relates to the impact on landholders. To gain entry, Santos is required to enter into access agreements with the relevant landholders. During negotiations of these agreements, Santos will identify further constraints such as locations that disturb cultivation practices or stock movements and will seek to avoid these impacts. Consultation will occur with the landowners as part of the desktop review and pre-construction survey work undertaken in conjunction with the access agreement process. Field scouting will be carried out prior to the acceptance of a site for a new activity, and all activities associated with land disturbance will be discussed with the relevant landholder prior to commencement.

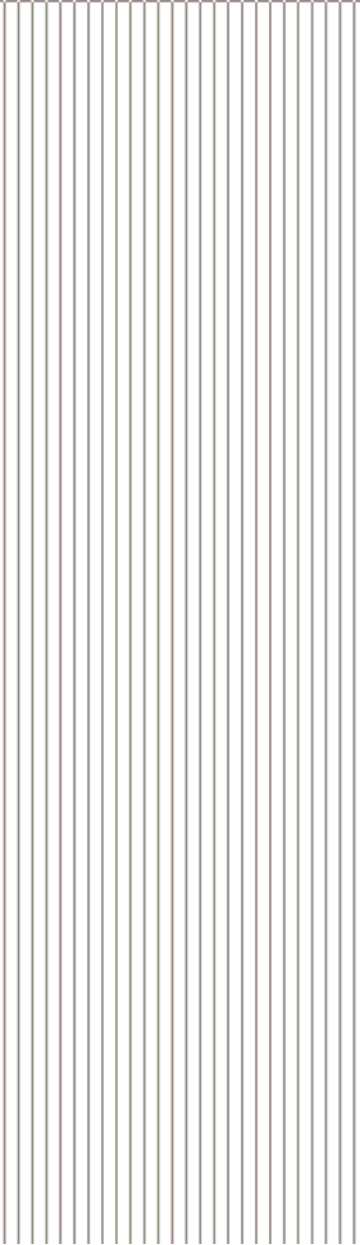
Desktop Review

The desktop review in each case will involve reviewing relevant available information including:

- EIS and SEIS;
- Ecological constraints mapping
- GIS constraints layer
- EA granted by DERM
- Site photos
- Location Map
- CSG EMP
- Other documents specified in the field management protocol.



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Glossary

Alluvium is material deposited by a river or other running water typically made up of a variety of materials, including fine particles of silt, clay, articles of sand and gravel.

Alluvial relating to, composed of, or found in alluvium or alluvial soil.

Biodiversity The number and variety of organisms found within a specified geographic region or within a given ecosystem.

Bioregion a landscape pattern that reflect changes in geology and climate, as well as major changes in floral and faunal assemblages at a broad scale.

Brigalow Belt is a Bioregion that spans inland and eastern Queensland from Townsville in the north to northern New South Wales, covering an area of about six million hectares.

Ecosystem is an interdependent system of interacting plants, animals and other organisms together with the non-living (physical and chemical) components of their surroundings.

Ecology scientific study of abundance, distribution and interactions between organisms and their natural environment.

EVR a term for a plant or animal species listed as critically endangered, endangered, vulnerable or rare under either state or commonwealth threatened species legislation.

Habitat The area or natural environment in which an organism or population normally lives. A habitat is made up of physical factors such as soil, moisture, range of temperature, and availability of light as well as biotic factors such as the availability of food resources and the presence of predators.

Herbarium Institution where a collection of dried plants are mounted, labelled, and systematically arranged for use in scientific study as reference material for describing plant taxa.

Quaternary sample plots - is a standardised flora study to collect data to verify regional ecosystem and vegetation mapping. Data from these sites are generally collected throughout the field survey and entered on spreadsheets or databases. Quaternary sites may be collected at regular intervals along a traverse, and/or made where REs/vegetation communities change.

Ramsar wetlands of international significance the Ramsar Convention is an inter-governmental treaty adopted on 2 February 1971 in the Iranian city of Ramsar and is focussed on the conservation and sustainable use of wetlands as important ecosystems. The addition of a site to the 'List of Wetlands of International Importance' (the "Ramsar List") expresses the relevant government's commitment to take all steps necessary to ensure the maintenance of the ecological character of the site.

Regional Ecosystems (REs) Describes the relationships between major floral species and the environment at the regional scale. They are mostly derived from linking vegetation mapping units based on dominant canopy species, recognised at a scale of 1:100,000 to land zones that represent major environmental variables, in particular geology, rainfall and landform. Under the VM Act REs are assigned a conservation status based on an assessment of the pre-clearing and remnant extent of a RE.

Remnant Vegetation Vegetation is identified as 'remnant' under the VM Act where the predominant canopy of the vegetation: covers more than 50 % of the equivalent undisturbed canopy;

6 Glossary

averages more than 70 % of the vegetations undisturbed height and is composed of species characteristic of the vegetations undisturbed predominant canopy.

Secondary sample plots Secondary sample plots are standardised transects used for classification and detailed descriptions of REs and vegetation communities. Data collected include all location, environmental and overall floristic and structural information as well as a list of all species present and basal area, percentage cover and stem density measures of abundance.

Weeds are plant species that invade native ecosystems and can adversely affect the survival of indigenous flora and fauna, often competing with indigenous plants for resources such as nutrients, moisture and light. They can prevent natural regeneration, reduce wildlife habitat, alter water flows, increase soil erosion, introduce poisons into the soil or poison animals, change fire behaviour and may introduce foreign genes into local plant populations. Weed species are not necessarily exotic non-indigenous species, but can also be non-endemic natives that are naturalised to areas outside of their natural distribution.

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Limitations

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The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

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