6.4 Nature Conservation

6.4.1 Introduction

The CSG fields nature conservation study has been split into three parts; terrestrial flora, terrestrial fauna and aquatic ecology. The terrestrial ecology has been divided into two study areas (Northern and Southern CSG fields). This section addresses all areas and is supplemented by detailed appendix reports (Appendix N1).

In addition, the effect of the project's CSG field component on matters of national environmental significance (MNES) has also been assessed. This has been undertaken in accordance with the requirements of the Environmental Protection Biodiversity Conservation (EPBC) Act 1999 and is reported separately in Appendix G (EPBC Act Report). Appendix G includes a specific section on the CSG field (Section 4: Development of CSG Resources – EPBC 2008/4059) and includes a description of proposed actions, a description of environmental values (MNES) and potential impacts to MNES and mitigation measures.

6.4.2 Methodology

6.4.2.1 Terrestrial Ecology

The study methodology for the CSG fields ecological study involved a three stage approach (as detailed below) to ensure an appropriate level of biodiversity assessment was undertaken. This approach departs from previous traditional EIS ecological study methodologies to accommodate the large study area for the CSG fields. This methodology was developed in consultation with the EPA.

As an extensive field survey of the CSG fields study area was not practical, a robust literature review of all known data sources for the CSG fields was undertaken. For the reasonable foreseeable future (RFD) area (Fairview, Arcadia Valley and Roma) targeted field studies to assess biodiversity values were also undertaken. Field scoping studies were developed for further ongoing detailed impact assessment of each project element as their specific location becomes known within the RFD area. See Appendix N1 for a detailed methodology.

Stage 1 Literature Review

Stage 1 of the study involved a comprehensive literature review of all known data sources and previous ecological studies for the entire CSG fields study area. This review was undertaken to provide a background for targeted ground surveys and ensure that adequate knowledge of biodiversity values was acquired for CSG field areas not subject to targeted field surveys. Details on the literature review methodology and results are provided in Appendix N1.

Stage 2 Field Studies

Stage 2 involved a number of targeted field studies within the RFD area. The field surveys targeted the Roma, Arcadia Valley and Fairview CSG fields (Figures 6.4.1 and 6.4.2). Details of the field studies including: field survey design; study area and site selection; survey methodology and investigation results are provided in full detail in Appendix N1.

Survey Periods

The terrestrial ecology survey was undertaken in four stages during August to November 2008.

Survey Period 1:

- Four days in August 2008 (26th - 29th August).
- Location: Fairview CSG field.

Survey Period 2:

- Four days in September 2008 (23rd - 26th September).
- Location: Roma CSG field.

Survey Period 3:

- Four days in October 2008 (30th September - 3rd October).
- Location: Fairview CSG field.

Survey Period 4

- Five days in November 2008 (4th - 8th November).
- Location: Arcadia Valley CSG field.

Stage 3 Impact Assessment and Recommended Phase 2 Protocols

Stage 3 involved an assessment of potential ecological impacts from proposed RFD well field construction and operations. Assessment of potential ecological impacts and further biodiversity assessment protocols are detailed in Section 6.4.5 and in further detail in Appendix N1. This included the development of Phase 2 protocols for further biodiversity assessment, well field scoping and site selection processes (refer Section 6.1).

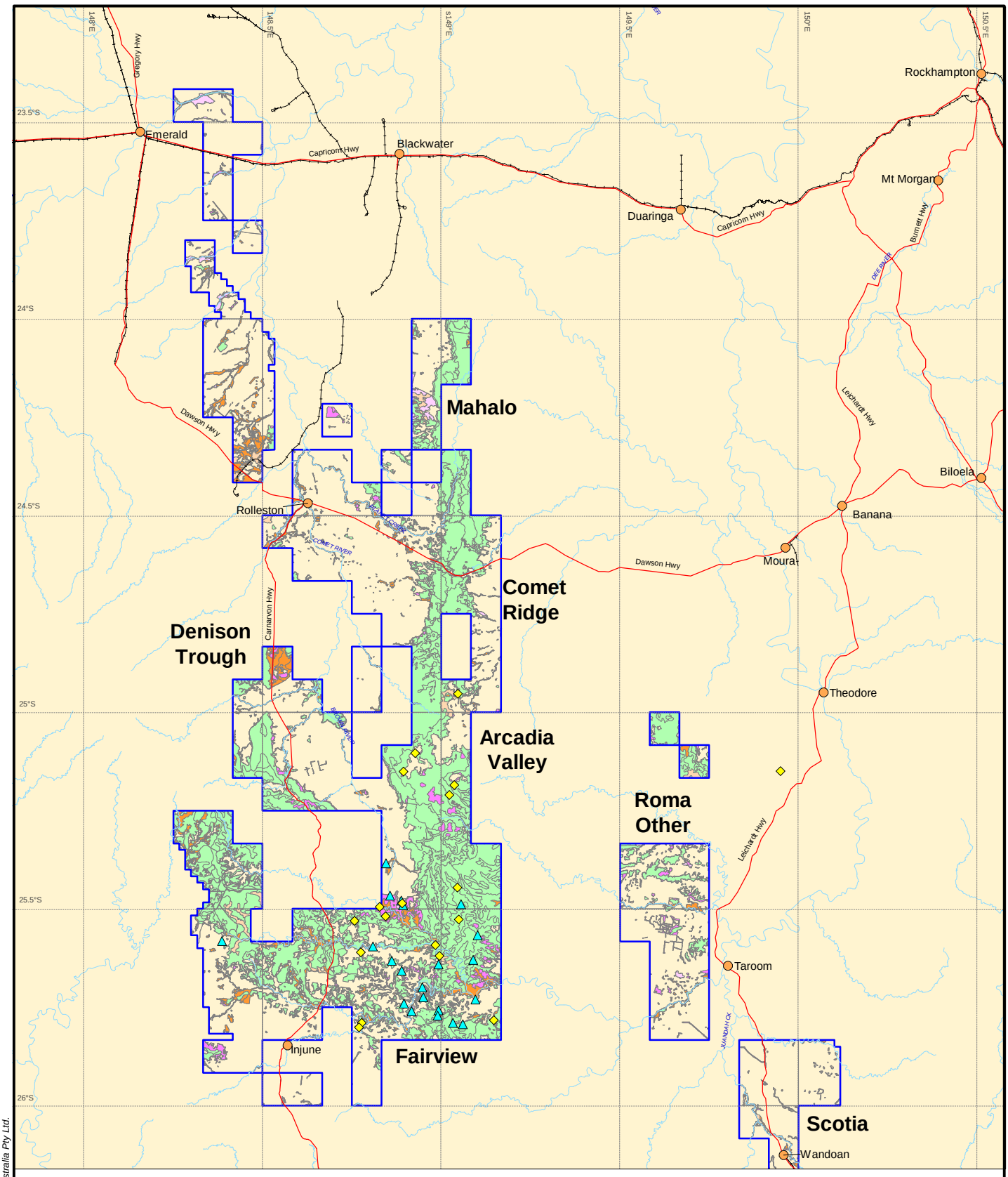
6.4.2.2 Aquatic Ecology

Aquatic floral and faunal surveys and collection of water quality data were undertaken between 23rd September and 3rd November 2008. Watercourse sites in each of the catchments were surveyed between 23rd September and 11th October. Artesian spring sites were surveyed between 29th October and 3rd November (Figure 6.4.3).

Thirty-two sites were surveyed, eleven from each of the Condamine – Upper Balonne and Upper Dawson Catchments, and ten from the Comet Catchment (Figures 6.4.4 to 6.4.6). Due to difficulties obtaining land access, all waterways were assessed at road crossing locations. Stream orders were determined for each creek at the survey site, following the Strahler method, as used in AusRivAS models. Sites were specifically selected to provide for a broad geographic spread of sampling locations in each of the catchments, and to allow for the survey of a range of stream sizes and adjacent land uses.

At all sites, the broad habitat type, channel pattern, water level and flow, substrate character and cover, bed and bank stability, and riparian cover were described using AusRivAS protocols (Appendix N4). Water was present at 28 of the sites surveyed; water quality measurements and aquatic flora (macrophyte) and fauna surveys were conducted at each of these sites.

See Appendix N4 for detailed methodology and survey results.



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

- Primary Road
- Major Drainage
- CSG Field
- Secondary Site
- Quaternary Site
- Not of concern RE
- Of concern sub-dominant RE
- Of concern dominant RE
- Endangered sub-dominant RE
- Endangered dominant RE

Client: LNG

URS

Project: GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

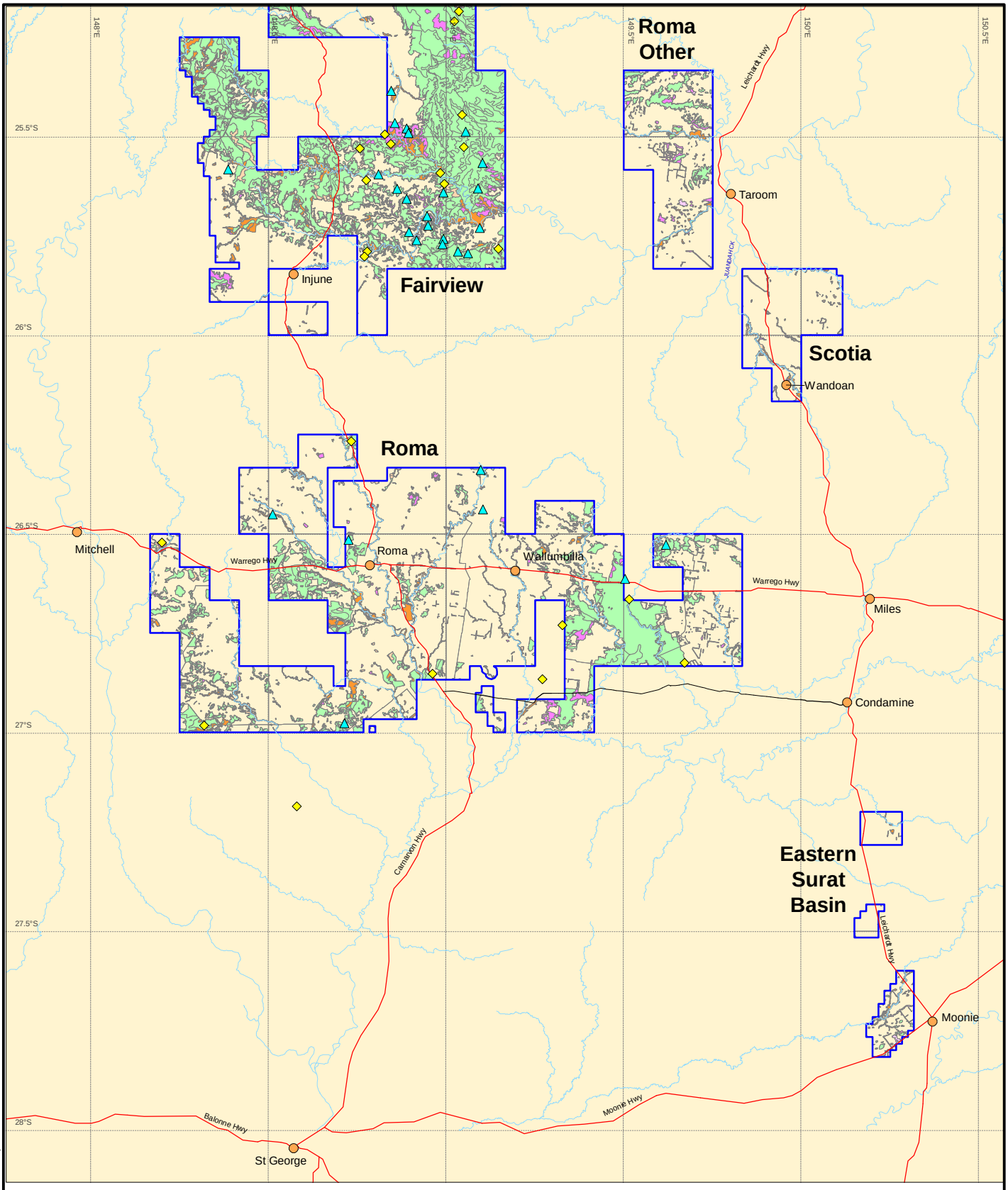
Title: **REGIONAL ECOSYSTEMS AND LOCATION OF URS FIELD INVESTIGATION SITES - NORTHERN CSG FIELD**

Drawn: RG	Approved: JB	Date: 18-02-2009
Job No: **4262 6220**	File No: 42626220-g-1003.wor	

Figure: **6.4.1**

Rev:A

A4

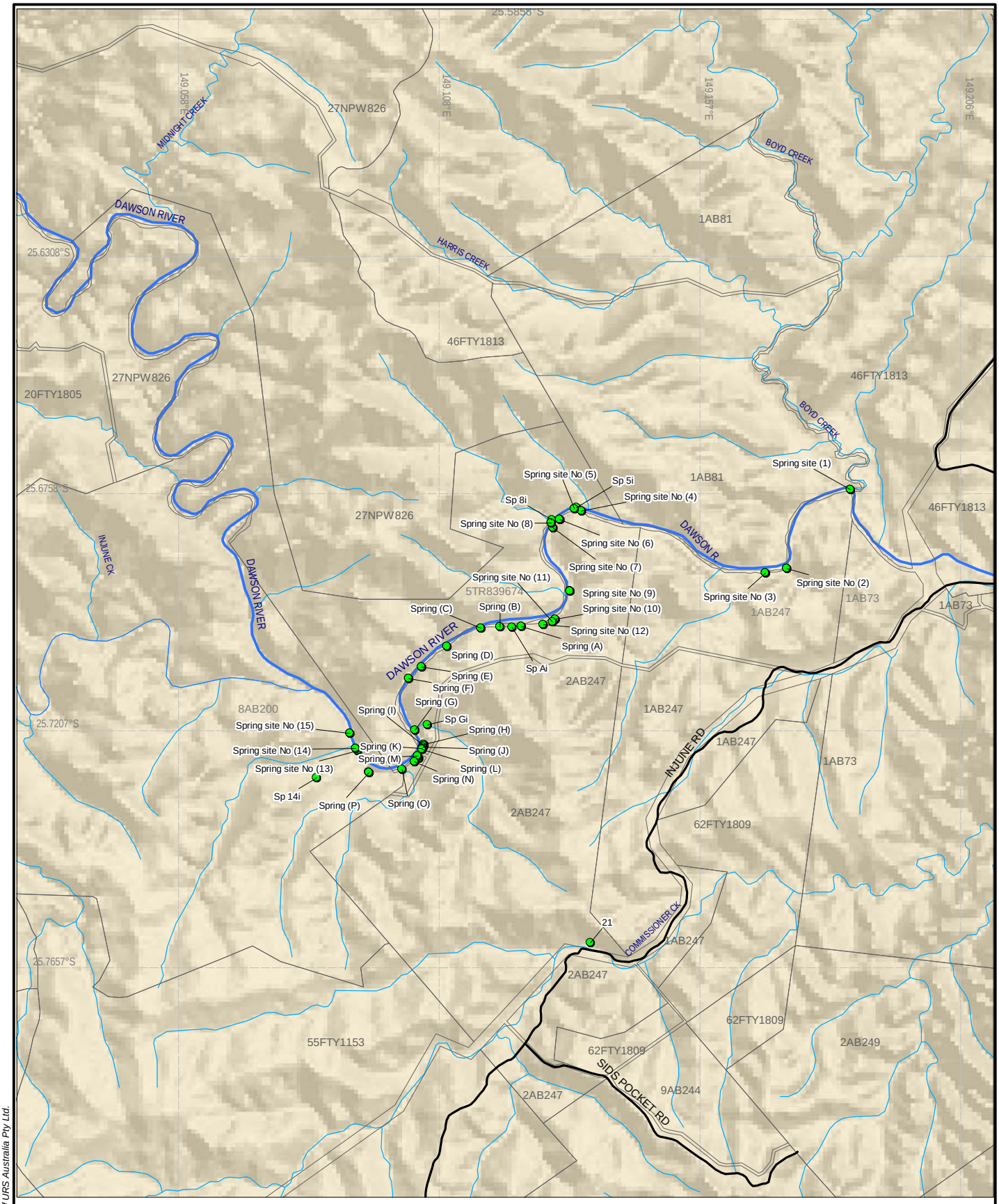


Client

Project
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title
REGIONAL ECOSYSTEMS AND LOCATION OF URS FIELD INVESTIGATION SITES - SOUTHERN CSG FIELD

Drawn: RG	Approved: JB	Date: 18-02-2009	Figure: **6.4.2**	Rev:A
Job No: **4262 6220**	File No: 42626220-g-1003.wor			**A4**



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

Client: LNG	Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	Title: **UPPER DAWSON CATCHMENT AQUATIC ECOLOGY SPRING SITE LOCATIONS CSG FIELD**
URS	Drawn: CA | Approved: JB | Date: 18-02-2009 Job No: **4262 6220** | File No: 42626220-g-1010.wor	Figure: **6.4.3** Rev:A A4

Client

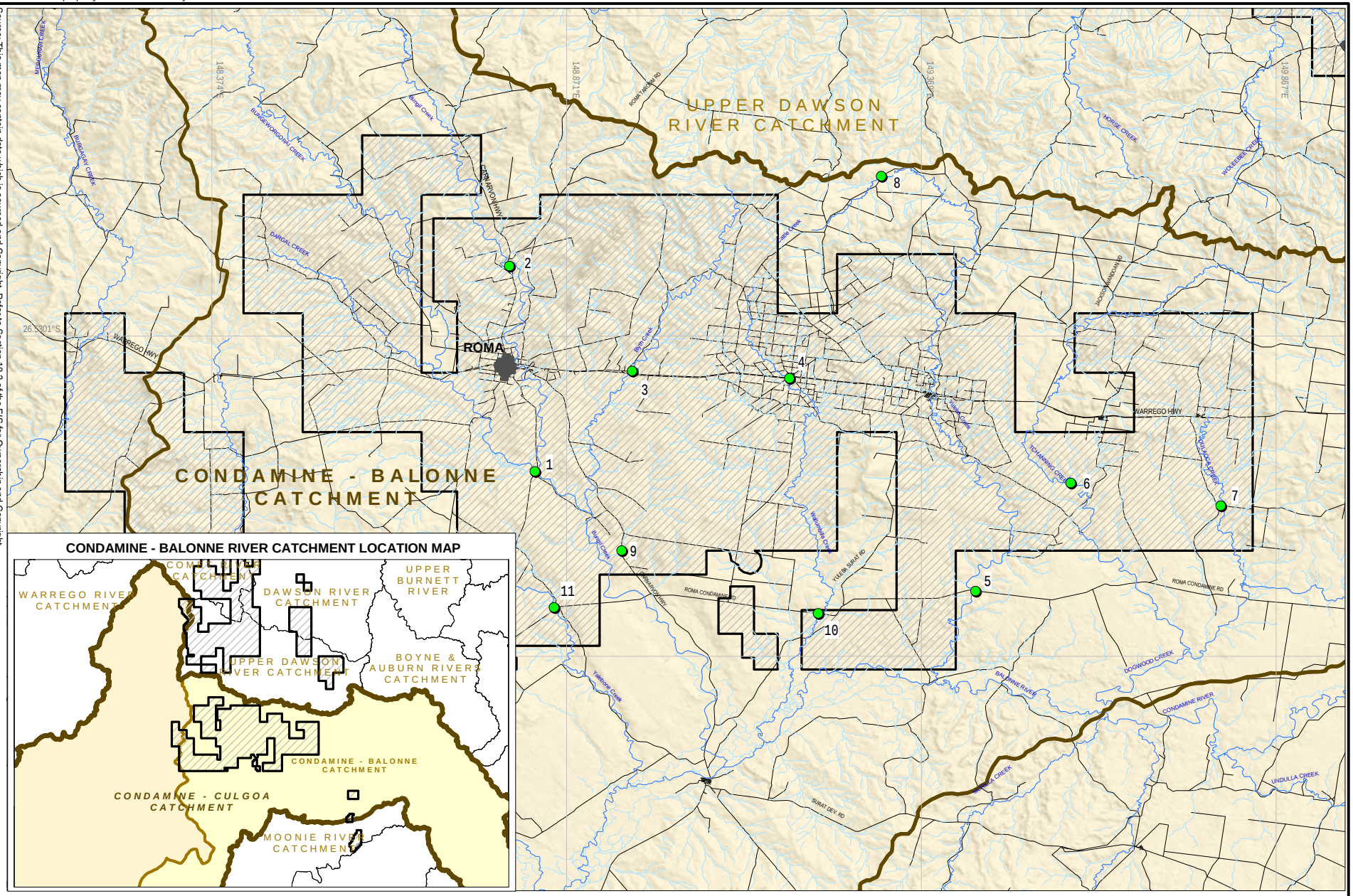
Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

CONDAMINE - BALONNE CATCHMENT
AQUATIC ECOLOGY
SURVEY SITE LOCATIONS
CSG FIELD

Drawn: CA	
Approved: JB	
Date: 18-02-2009	
Job No: **4262 6220**	
File No: 42626220-g-1007.wor	
Figure: **6.4.4**	
A4	Rev: A



Client

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Drawn: CA | Approved: JB | Date: 18-02-2009

Job No: **4262 6220** | File No: 42626220-g-1008.wor

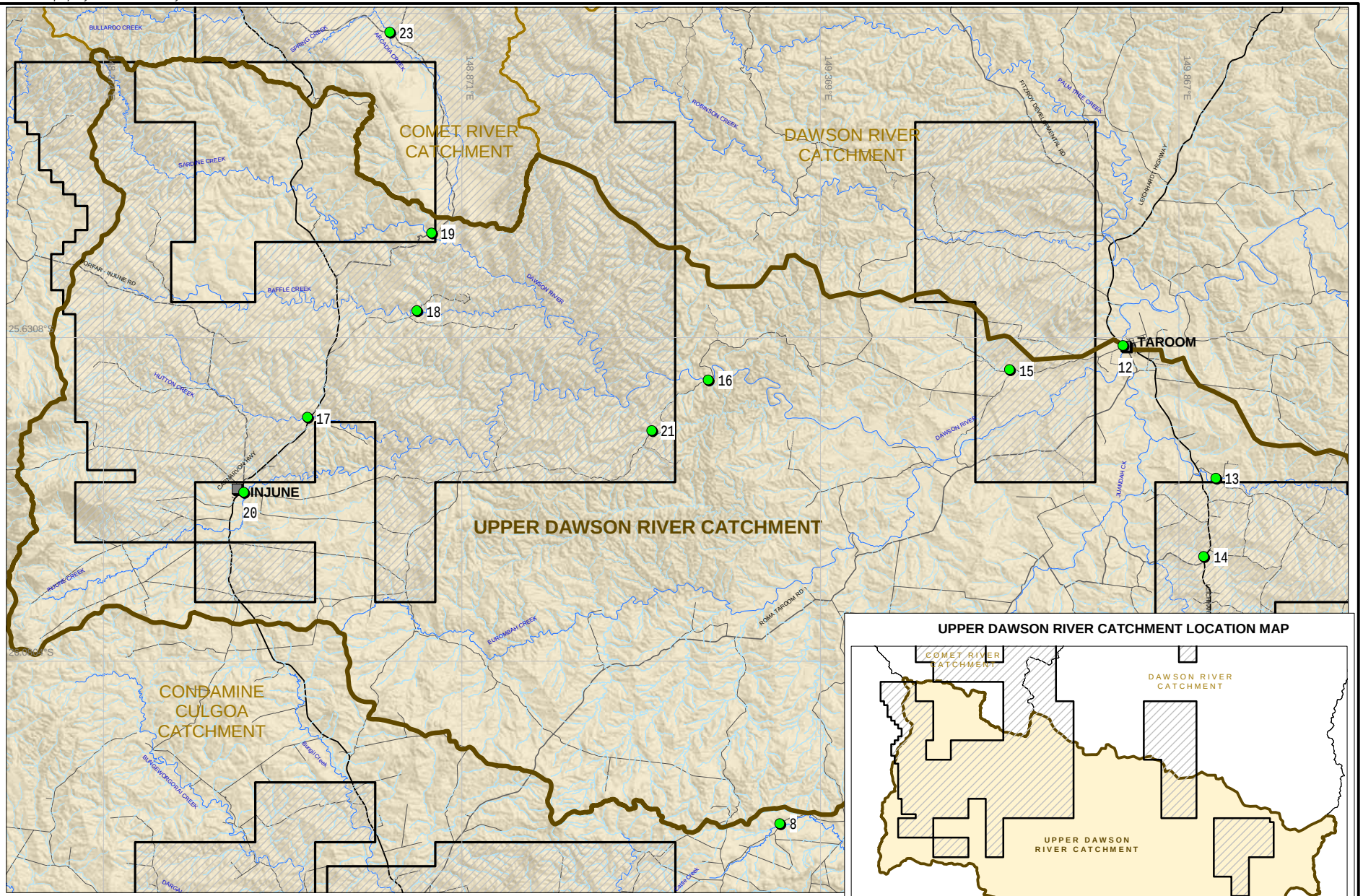
Title

UPPER DAWSON RIVER CATCHMENT
AQUATIC ECOLOGY
SURVEY SITE LOCATIONS
CSG FIELD

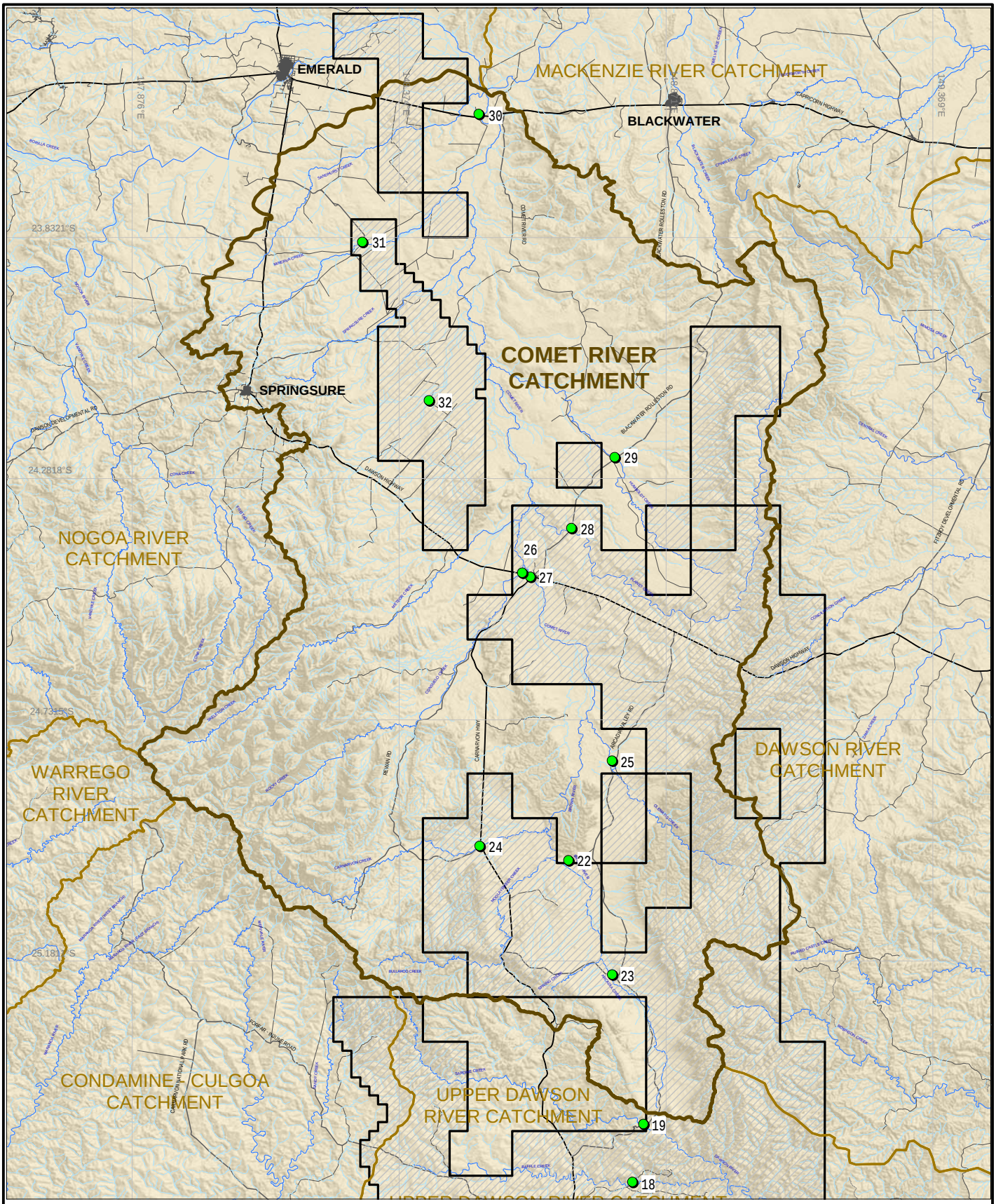
Figure: **6.4.5**

Rev: A

A4



UPPER DAWSON RIVER CATCHMENT LOCATION MAP



Client

Project
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title
COMET CATCHMENT
AQUATIC ECOLOGY
SURVEY SITE LOCATIONS
CSG FIELD

Drawn: CA	Approved: JB	Date: 18-02-2009
Job No: **4262 6220**	File No: 42626220-g-1009.wor	

Figure: **6.4.6**

Rev:A

A4

6.4.3 Regulatory Framework

Key legislation governing nature conservation identified with regards to the proposed CSG fields of the GLNG Project includes:

- *Environmental Protection Act, 1994 (Qld);*
- *Environment Protection and Biodiversity Conservation Act 1999, Commonwealth;*
- *Nature Conservation Act 1992 (Qld);*
- *Lands Protection Act 2002 (Qld);*
- *Vegetation Management Act 1999 (Qld);*
- *Water Act 2000 (Qld); and*
- *Fisheries Act 1994 (Qld).*

6.4.3.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) aims to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (being ecologically sustainable development).

6.4.3.2 Environment Protection and Biodiversity Conservation Act 1999

The *Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999* provides for the protection of the environment and heritage, especially matters of national environmental significance. The Act promotes biodiversity conservation, heritage protection and recognises the role of Indigenous people in the conservation of Australia's biodiversity. It is designed to provide for the conservation of biodiversity through the protection of threatened species and ecological communities, migratory, marine and other protected species listed under the Act.

In general, the EPBC Act requires approval from the Commonwealth for actions which will, or are likely to have, a significant impact on listed threatened species and communities, listed migratory species and other matters of national environmental significance. The Act is administered by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA). The proposal has been declared a "controlled action" under the EPBC Act and requires the approval of the Commonwealth under the EPBC Act.

6.4.3.3 Nature Conservation Act 1992

The Queensland *Nature Conservation* (NC) *Act, 1992* is administered by the Environmental Protection Agency (EPA) and is the principal legislation for the conservation and management of the State's native flora and fauna. The primary objective of the NC Act is the conservation of nature which includes the preservation of protected areas, protected plants and protected wildlife as listed under relevant regulations, including the *Nature Conservation (Wildlife) Regulation, 2006*.

6.4.3.4 Lands Protection Act *2002*

The Queensland *Lands Protection (Pest and Stock Route Management) (LP) Act, 2002* provides pest management for agricultural lands. The LPA lists several species of flora and fauna that are considered Class 1, 2 or 3 pests under the Act.

6.4.3.5 Vegetation Management Act 1999

The purpose of the Queensland *Vegetation Management* (VM) *Act, 1999* is to regulate the clearing of native vegetation, i.e. Remnant Regional Ecosystems (REs), to prevent the loss of biodiversity or any increase in land degradation from vegetation clearing, to maintain ecological processes, reduce greenhouse gas emissions, and to manage the effects of clearing. Additionally, areas of remnant

vegetation specific to conservation significant species (listed under the NC Act) are further classified as Essential Habitat.

The Department of Natural Resources and Water (DNRW) uses certified mapping of Remnant Vegetation and Essential Habitat to administer the VM Act. Clearing of native vegetation mapped as REs and/or Essential Habitat is subject to assessment by the DNRW against the applicable Regional Vegetation Management Code for the Brigalow Belt and New England Tableland Bioregions (DNRW, 2008).

Remnant Vegetation Conservation Status

The Regional Ecosystem Description Database (REDD) (EPA, 2009) lists the status of regional ecosystems as gazetted under the VM Act (Vegetation Management Status) and their Biodiversity Status as determined by the EPA.

The VM Act Status is based on an assessment of the pre-clearing and remnant extent of regional ecosystems. The VM Act sets out criteria that must be satisfied before a regulation is made declaring a regional ecosystem to be classed as "endangered", "of concern" or "not of concern". The Biodiversity Status is based on the EPA's assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of regional ecosystems.

The Biodiversity Status of affected communities is listed in this EIS as required by the Terms of Reference (ToR). However, the VM Act Status (given its statutory basis) is the primary classification considered in this EIS.

Vegetation Clearing

The following information describes the circumstances in which the GLNG Project must comply with the VM Act in regards to vegetation clearing (as per conversations with representatives of the Department of Mines and Energy).

The holder of a petroleum authority is authorised to undertake vegetation clearing when it is regarded as an 'incidental activity' for the following:

- Exploration or testing (Section 32 Exploration and testing (1) and 152 Petroleum production or storage testing (1));
- Pipeline construction or operation; or
- Construction or operation of the petroleum facility.

The clearing of native vegetation for the purpose of an 'incidental activity' is limited to that which is reasonably necessary for the authorised activity. For example, clearing to enable the construction and operation of a petroleum well, natural underground reservoir for petroleum storage, pipeline or a petroleum facility. 'Reasonably necessary' clearing of vegetation may include activities such as:

- Clearing within the infrastructure or building envelope to enable construction and operation; and
- Clearing for safety or maintenance purposes (e.g. fire break).

Petroleum activities[1] (including the GLNG Project) do not require a development approval to clear native vegetation. This is a specified activity and is listed as an exemption in Schedule 8 Table 4 of the IP Act. However, any conditions contained in the Environmental Authority (under EP Act) regarding vegetation management must be complied with. In situations where the GLNG Project is operating in areas which are not subject to a petroleum authority, the VM Act and the IP Act apply and a development approval will be required to clear native vegetation unless an exemption applies.

[1] As defined by the *Petroleum and Gas Act 2004* and the *Environmental Protection Act (EP Act) 1994*

By reason of changes made to Section 89 of the *Nature Conservation Act 1992* and amendments to the Nature Conservation (Protected Plants) Conservation Plan 2006, a clearing permit will now be required from the EPA to clear any native plant. This will not apply however, in the case of a least concern plant on private land and the person taking the plant is the landholder of the land.

6.4.3.6 Water Act 2000

The *Water Act 2000* (Water Act) provides a framework for the sustainable management of water and related resources. It regulates the taking, use and allocation of water through (among other things) water resource plans and resource operations plans. Relevantly, it sets out permitting and licensing requirements for taking or interfering with water and other resources.

Where water used for, or during, surface water activities is not associated water under the *Petroleum and Gas (Production and Safety) Act 200*4 (P&G (PS) Act), or is not water necessarily produced as a result of the carrying out authorised activities under the *Petroleum Act 1923* (Qld), a water licence, which regulates the taking or interfering with water from a watercourse or overland flowwater, will be required for those activities.

6.4.3.7 Fisheries Act 1994

The *Fisheries Act 1994* (Qld) (Fisheries Act) ensures that Queensland fisheries resources are managed and utilised in an ecologically sustainable way, as well as providing for management of fish habitats and ensuring that there is equity in access to the resources by commercial, recreational and Indigenous fishers.

All waters of the state are protected against degradation by direct or indirect impact under Section 125 of the *Fisheries Act, 1994* (Fisheries Act). If litter, soil, a noxious substance, refuse or other polluting matter is on land (including the foreshore and non-tidal land), in waters, or in a fish habitat, and it appears to the Chief Executive that the polluting matter is likely to adversely affect fisheries resources or a fish habitat, the Chief Executive of the Department of Primary Industries & Fisheries (DPI&F) may issue a notice requiring the person suspected of causing the pollution to take action to redress the situation.

Under Division 8 of the Fisheries Act, a waterway barrier works approval is needed to build any structure across a freshwater waterway. The purpose of this part of the Act is to provide a balance between the need to construct dams and weirs and the need to maintain fish movement. Such structures include culverts and road crossings, which may need to be constructed to develop access roads in the CSG Fields. If approval is given, the Chief Executive, DPI&F may direct the building of a specified fishway for the barrier if required.

Fishways are not expected to be a requirement for this project, and have not been considered further although more detailed information on the approval process is located in Appendix N4. Potential Impacts of the development of the CSG fields on fish passage are addressed in Appendix N4.

6.4.4 Existing Environmental Values

6.4.4.1 Literature Review

Existing data sources and literature on the ecology of the CSG fields study area was compiled through investigation of key references including:

- Spot 5 2.5 m Colour Satellite Imagery (Geoimage Pty Ltd, 2008);
- Queensland Environmental Protection Agency (EPA) Herbarium flora database (HERBRECS);
- Queensland EPA fauna and flora record database (Wildlife Online);
- Queensland Museum fauna record database;
- Queensland EPA 1:100,000 Regional Ecosystems Version 5.2 (EPA, 2008);
- Queensland EPA Ecomap environmentally sensitive areas database;

- Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) 'Matters of National Environmental Significance (MNES)' database;
- Current distribution texts for vascular flora and vertebrate fauna taxa;
- Queensland Environmental Protection Agency Essential Habitat mapping; and
- Species distribution maps from current field guides.

These references were reviewed and an assessment was undertaken to identify the potential presence of significant[2] fauna and flora species, and significant vegetation communities as listed under state and commonwealth legislation, including threatened floral and faunal taxa as per:

- The Queensland *Nature Conservation (Wildlife) Regulation 2006*, under the provisions of the NC Act;
- The Commonwealth EPBC Act; and
- Significant vegetation communities as described by the Queensland VM Act and the Commonwealth EPBC Act.

The review of existing data aided in the identification of the range of species and habitats that may be present within the study area. The study area coordinates utilised for the above information sources are provided in Appendix N1.

Previous Ecological Reports

The following 16 ecological reports discuss the flora, fauna and habitat values of areas within the CSG fields and include several Santos specific well inspections. These reports were reviewed and the main findings of each documented.

- Boobook (2002), Rare and Threatened Plant Survey, Sardine Creek Well Lease Site.
- Boobook (2005), Humboldt 1 Preliminary Fauna and Flora Assessment.
- Boobook (2006a), Comet Ridge Field Pilot Program Environmental Constraints Preliminary and Final Reports.
- Boobook (2006b), Preliminary Assessment of Flora and Fauna Impacts for Proposed Wells: Comet Ridge Project Area, Fairview Gas Field.
- Boobook (2006c), Rare and Threatened Flora and Fauna lists.
- Boobook (2008a), Well Site Inspection Report; Strathblane 1C.
- Boobook (2008b), Drill Site Inspection Report, FV 87, 88 and 89, Comet Ridge Pilot Program.
- Boobook (2008c), Drill Site Inspection Report, FV 161, Comet Ridge Pilot Program.
- Boobook (2008d), Drill Site Inspection Report; Arcadia Branch 2C & 3, Comet Ridge Pilot Program.
- Boobook (2008e), Proposed Dawson River Crossing (Comet Ridge): Preliminary Site Inspection Report.
- Boobook (2008f), Well Site Inspection Report (2008); Ironbark Gully 2.
- Boobook (2008g), Well Site Inspection Report; Emu Nest 1C.
- Connell Wagner (2008), Upgrade of Hutton and Moonah Creek, Fairview Platypus Survey Eastern Queensland Gas Fields.

[2] Significant species are those threatened species listed as either "Critically Endangered", "Endangered", "Vulnerable" or "Rare" under the NC Act and EPBC Act, and other note worthy species that carry significance other than legislative status occurring at the extent of their natural geographic range, or those that carry cultural heritage significance.

Significant vegetation communities are communities listed as "Critically Endangered", "Endangered", "Of Concern" or "Vulnerable" under the VM Act or EPBC Act.

- URS (2008), Environmental Management Plan for Fairview Project Area Section 3, Description of Environmental Values and Potential Impacts.
- HLA-Envirosciences (2006), Flora and Fauna Study Report for the Proposed Comet Ridge to Wallumbilla Gas Pipeline.
- J. W. Woinarski *et al*. (2006). Monitoring change in the vertebrate fauna of central Queensland, Australia, over a period of broad-scale vegetation clearance, 1973–2002.

As a result of the literature review 49 conservation significant terrestrial fauna species (23 birds, 2 frogs, 14 reptiles and 10 mammals) listed under both state and commonwealth legislation were identified as potentially occurring within the study area. Habitat for these species was targeted for identification during the field survey. A list of the target species and ecological notes for each are provided in Appendix N1.

Significant species identified include any Critically Endangered, Endangered, Vulnerable or Rare taxa listed under:

- The Queensland *Nature Conservation (Wildlife) Regulation 2006* under the provisions of the Queensland NC Act; and
- The Commonwealth EPBC Act.

Summary of Significant Biodiversity Values from Previous Ecological Reports

These reports include flora and fauna studies of well leases and Queensland herbarium RE mapping within the CSG study area. The reviewed literature primarily covered Fairview and Arcadia Valley regions, but also incorporates studies undertaken in the northern CSG fields including the Denison Trough CSG field. The flora reports included assessment of REs, vegetation communities, endangered flora species and introduced weeds, essential habitats and nationally important wetlands.

Results from field studies undertaken within the Fairview and Arcadia Valley CSG fields highlight several discrepancies between the current RE mapping and the actual vegetation communities. A number of 'Endangered' and 'Of Concern' REs were however identified during these studies and include RE 11.3.2 (alluvial poplar box woodland) (Boobook, 2006a), RE 11.3.17 (poplar box woodland) (Boobook, 2006b), RE 11.9.5 (brigalow open forest) (Boobook, 2008g), RE 11.9.4 (semi-evergreen vine thicket) and RE 11.9.5 (brigalow woodland) (Boobook, 2008c; HLA-Envirosciences, 2006).

These studies identified the potential presence of a significant number of introduced flora species within the Fairview CSG field, and include *Parthenium hysterophorus** which is both a 'Weed of National Significance' and a 'Class 2' declared pest under the *Queensland Land Protection Pest and Stock Management Route Management Act 2002.* Five 'Class 2' fauna pests, which are listed under the *Land Protection (Pest and Stock Route) Act 2002,* were identified at Comet Ridge (Boobook, 2008b; 2008c; 2008e).

A total of six Essential Habitat areas were identified (as defined under the NC Act in the Fairview CSG field and the importance of several Environmentally Sensitive Areas noted within Robinson Gorge, Lonesome Holdings, and Beilba. The Environmental Management Plan (EMP) for the Fairview project area (2008) identified the potential for 22 threatened species (8 plants, 5 birds, 3 mammals, 1 ray-finned fish, 5 reptiles) and 13 migratory species (6 birds, 7 wetland/marine birds), as listed in the MNES database, as potentially occurring within the Fairview CSG field. Additionally, in Hutton Creek the presence of four adult platypuses was confirmed and suitable habitat identified within a 2.5 km section of the creek (Connell Wagner, 2008).

Desktop review for the Roma CSG field identified 17 flora species listed as conservation significant under either the EPBC Act or the NC Act that are known to have ranges that overlap the region from Fairview to Wallumbilla (Fairview and Roma CSG fields) (HLA-Envirosciences, 2006). The Regional Ecosystems recorded as 'Of concern' (VM Act) included RE 11.10.1 (Boobook, 2006b), RE 11.3.2 and RE 11.9.7 (poplar box woodlands) (HLA-Envirosciences, 2006).

Studies from the northern Denison CSG field revealed a total of 223 fauna species recorded and expected within the Emerald region. Previous surveys within the region identified an additional two

vulnerable reptile species, namely the ornamental snake (*Denisonia maculata*) and yakka skink (*Egernia rugosa*) (Woinarski *et al*., 2006). From these studies it is evident that both seasonal variations and habitat modifications have impacted the distribution of fauna species within the region. Flora surveys for the Denison CSG field are limited, although a significant population (100 + individuals) of the native bluebell *Wahlenbergia islensis* (as listed under the NC Act) was recorded within the area (Boobook, 2002).

Results from studies undertaken in the Mahalo CSG field area revealed an absence of rare or threatened flora species or other plants of conservation significance. Nonetheless, the desktop fauna study recorded a potential for seven rare and threatened fauna likely to be present in the study area (Boobook, 2005). Field investigation of vegetation communities within a section of the Mahalo CSG field identified the Endangered RE 11.4.9 Brigalow/Dawson gum woodland (as listed under the EPBC Act) as being present (Boobook, 2005).

It is evident from these studies that the biodiversity values of the CSG fields appear to be greater within the more vegetated northern gas fields of the Arcadia Valley, Fairview and the northern Denison CSG fields. A number of environmentally sensitive areas and conservation significant vegetation communities exist within these areas. The potential presence of a number of conservation significant flora and fauna species across the CSG fields highlights the need to ensure that potential impacts to these species are mitigated prior to CSG field development.

Summary of Significant Values from Database Searches

The review of the databases listed in Section 6.4.4 indicates that the CSG fields potentially support a number of significant ecological values including:

- 130 significant flora species identified by searches; 21 of these species are potentially occurring based upon resources and habitat;
- 51 significant fauna species identified by searches; 28 of these species are potentially occurring based upon resources and habitat;
- Four REs that are also listed as ‘Endangered’ communities, and one RE listed as ‘Critically Endangered’ under the EPBC Act (see Section 3.2.3.4 of Appendix N1 for further details); and
- A number of Regional Ecosystems mapped by state government RE mapping (DNRM&W, 2005) that are described as significant under the VM Act.

Northern CSG Fields:

- Arcadia Valley: six significant Regional Ecosystems mapped. This includes three ‘Of Concern’ REs and three ‘Endangered’ REs;
- Fairview: seven significant Regional Ecosystems mapped. This includes four ‘Of Concern’ REs and three ‘Endangered’ REs;
- Mahalo: ten significant Regional Ecosystems mapped. This includes four ‘Of Concern’ REs and six ‘Endangered’ REs;
- Comet Ridge: 14 significant Regional Ecosystems mapped. This includes six ‘Of Concern’ REs and eight ‘Endangered’ REs;
- Denison: 23 significant Regional Ecosystems mapped. This includes 13 ‘Of Concern’ REs and 10 ‘Endangered’ REs; and
- Scotia: eight significant Regional Ecosystems mapped. This includes four ‘Of Concern’ REs and four ‘Endangered’ REs.

Southern CSG Fields:

- Roma: 19 significant Regional Ecosystems. This includes 12 ‘Of Concern’ REs and seven ‘Endangered’ REs; and

- Eastern Surat Basin: seven significant Regional Ecosystems. This includes three 'Of Concern' REs and four 'Endangered' REs.

Regional Context

Bioregion

The CSG fields study area is situated within the Brigalow Belt bioregion. The bioregions of Queensland are based on landscape patterns that reflect changes in geology and climate, as well as major changes in floral and faunal assemblages at a broad scale and are used as the fundamental framework for the planning and conservation of biodiversity.

Nature conservation of the Northern Brigalow Belt bioregion has received increasing attention due to the rapid and extensive loss of habitat that has occurred. Major impacts upon vegetation of the Brigalow Belt include tree clearing, high grazing pressure and the proliferation of exotic species such as the prickly pear (Young *et al.*, 1999). As a consequence of habitat modification many flora and fauna species have undergone severe range reductions and localised extinctions have occurred for several fauna species.

Vegetation clearing has occurred on most of the lowland landscapes and those formed on shales, however the more rugged topography associated with the sandstone and metamorphic ranges remains relatively undisturbed (Young *et al.*, 1999).

Subregion

The Brigalow Belt bioregion contains 36 sub-regions or provinces that delineate significant differences in geology and geomorphology (Young *et al.*, 1999). The northern CSG fields are situated across nine sub-regions including undulating downs country and ranges, whereas the southern CSG fields are situated across only three sub-regions of undulating downs country. The Roma CSG field also borders onto the Eastern Mulga plains sub-region of New South Wales. The following table (Table 6.4.1) describes the sub-regions associated with the CSG fields and the dominant features of those sub-regions.

Table 6.4.1 Sub-regions of the CSG Fields

Subregion Number	Subregion Name	Features of Subregion [1]	CSG Fields in Subregion
10	Basalt Downs	Formed almost entirely on Tertiary basalts. The more undulating areas carry a bluegrass *Dichanthium sericeum* grassland with *Eucalyptus coolibah* (mountain coolabah) on hillier areas, often with *E. melanophloia* (silver leaved ironbark) and *Corymbia erythrophloia* (red bloodwood).	**North:** Mahalo, Comet Ridge, Denison
11	Isaac-Comet Downs	An extensive but diverse province that is largely undulating and dominated by Tertiary and other Cainozoic deposits. *Acacia harpophylla* (brigalow) and *Eucalyptus cambageana* (Dawson gum) communities on undulating clay or tenure contrast soils and *E. coolibah* on alluvium are the most predominant communities.	**North:** Comet Ridge, Denison

Subregion Number	Subregion Name	Features of Subregion [1]	CSG Fields in Subregion
16	Woorabinda	This subregion is situated on the Expedition and Dawson Ranges and the colluvium and alluvium derived from them. The sandstone ranges carry mixed eucalypt communities dominated by *Eucalyptus crebra* (narrow-leaved ironbark) and *Corymbia* spp.	**North:** Mahalo, Comet Ridge
20	Arcadia	Formed primarily on Triassic sediments of the Bowen Basin with minor areas of Permian sediments in the east. Eastern, southern and western areas are predominantly rugged on coarse sandstones with *Eucalyptus crebra* (narrow-leaved ironbark) and *Corymbia* spp. communities. The central and northern areas are more undulating and largely contained within a broad valley.	**North:** Comet Ridge, Denison, Arcadia, Fairview
21	Dawson River Downs	An undulating province in which outcrops of sediments of the Bowen Basin and Tertiary sediments occur in about equal proportions. The Tertiary soils form undulating to flat plains dominated by *Acacia harpophylla* (brigalow) and softwood communities.	**North:** Comet Ridge
24	Carnarvon Ranges	An extensive belt of predominantly coarse sandstones that form the north-eastern margin of the Great Artesian Basin. The most widespread vegetation type is a mixed eucalypt woodland or forest, usually with a shrubby understorey; dominated by *Eucalyptus crebra* (narrow-leaved ironbark), *Corymbia citriodora*,(spotted gum) and *Corymbia* spp.	**North:** Denison, Arcadia, Fairview
25	Taroom Downs	An undulating province formed on the argillaceous sediments of the Injune Downs Group of the Great Artesian Basin. The vegetation is dominated by *Acacia harpophylla* (brigalow), with areas of vine thicket and bluegrass *Dichanthium sericeum* downs.	**North:** Scotia
26	Southern Downs	Based on Jurassic and Cretaceous sediments, these are predominantly fine grained forming a low hilly landscape including the watershed formed by the Great Dividing Range. The province overlaps with the Mulga Lands bioregion in the far west.	**North:** Denison, Fairview **South:** Roma
27	Barakula	Consists primarily of dissected low Jurassic sandstone and lateritised sandstone hills, plateau remnants and scarps, interspersed with and surrounded by undulating plains.	**North:** Scotia

Subregion Number	Subregion Name	Features of Subregion [1]	CSG Fields in Subregion
28	Dulacca Downs	Undulating to low, hilly country on deeply weathered and dissected fine-grained Cretaceous sediments and associated colluvium and alluvium. Plains and lower slopes are predominantly *Acacia harpophylla* (brigalow), Casuarina cristata (belah) and/or *Eucalyptus populnea* (poplar box).	**South:** Roma
30	Tara Downs	Gently undulating landscape formed by deep weathering, erosion and deposition of the Cretaceous Griman Creek Formation to produce extensive clay plains interspersed with scattered laterised residuals	**South:** Eastern Surat
33	Moonie River- Commoron Creek Floodout	Level to gently undulating country on Quaternary alluvium derived from sandstone to the east, and overlying the Griman Creek Formation. These are also areas of partly consolidated Tertiary alluvial deposits. Major vegetation types include *Acacia harpophylla* (brigalow) and/or *Casuarina cristata* (belah) open forest.	**South:** Eastern Surat

[1] Information derived from Young *et al.* (1999) In Sattler & Williams (1999).

Environmentally Sensitive Areas

Environmentally sensitive areas (ESAs) include National Parks, State Forests, World Heritage Areas, Ramsar wetlands, nationally important wetlands and Essential Habitat. The following section describes environmentally sensitive values in terms of State Forests and National Parks for the CSG fields. World Heritage areas, Ramsar wetlands, Nationally Important wetlands and Essential Habitats are also described for the RFD area (Figures 6.4.7 and 6.4.8).

State Forests and National Parks

Within the northern CSG fields there are a total of 13 State Forests and four National Parks. The southern CSG fields contain nine State Forests. Further details regarding State Forests and National Parks for the CSG fields are located in Appendix N1.

World Heritage Areas

No world heritage areas or national heritage places are listed within the RFD areas (EPA, 2007a).

Ramsar Wetlands of International Significance

The CSG fields are located within the Fitzroy (north) and Condamine-Balonne (south) Catchments. Ramsar wetlands of international significance located within these catchments include Narran Lake Nature Reserve, Shoalwater Bay and Corio Bay. These wetlands are not located in close proximity to the CSG fields (EPA, 2007b).

Nationally Important Wetlands

The Directory of Important Wetlands in Australia (DIWA) lists three nationally important wetlands in the CSG fields study area (EPA, 2007a) (Figure 6.4.7 and Figure 6.4.8). The nationally important wetlands include:

- Palm Tree and Robinson Creeks wetland (Dawson River) is situated 28 km north of Taroom and is approximately 50,223 ha in area. The wetland is situated within the Fitzroy catchment and is characterised by its U-shape, shallow lakes and seasonal streams associated with the junction of Palm Tree and Robinson Creeks (DEWHA, 2008a);
- Boggomoss Springs Wetland (Dawson River) is located 20 km northeast of Taroom and covers approximately 400 ha. Boggomoss Springs is situated within the Fitzroy catchment and is nationally important due to the active artesian springs which is considered a rare wetland habitat type and supports *Arthraxon hispidus,* a rare plant species (DEWHA, 2008b); and
- Lake Nuga Nuga wetland, which is approximately 2,070 ha in area, is located 93 km north-northeast of Injune and extends 8 km in a northwest to southeast direction. The wetland is situated within the Comet River catchment with the following habitats recognised within the Lake Nuga Nuga Wetland: (i) open water supporting extensive aquatic beds (*Nymphaea* spp.); (ii) saline shrubland; and (iii) lake margin (*Acacia harpophylla, Casuarina cunninghamiana*) (DEWHA, 2008c).

Artesian Spring Communities

Artesian spring communities that are dependent on the natural discharge of water from the Great Artesian Basin are listed as threatened ecological communities under the EPBC Act. Artesian spring communities support a number of species that are listed under the EPBC Act, the Queensland *Nature Conservation (Wildlife) Regulation, 2006* (NCWR) and the International *IUCN Red List of Threatened Species* (IUCN, 2008).

In the CSG fields, these communities occur in the Comet, Upper Dawson and Condamine - Upper Balonne catchments.

The condition of artesian springs in the Upper Dawson Catchment varied considerably between the springs surveyed, with the state of each spring largely dependent on: the presence of water, the ability of stock to gain access to the spring, and the presence and abundance of terrestrial weeds. The smaller, shallower springs provided little habitat for aquatic organisms, but usually supported some macrophytes. In contrast, the larger more complex springs often supported relatively abundant instream habitat and macrophytes. Cattle damage and weeds were common and had degraded the condition of many springs. Farm tracks had been constructed across the upper waters of two springs.

Water quality in the springs was characterised by relatively high temperatures, a slight acidity, and low levels of DO and turbidity. This is likely to be reflective of the condition of the underlying groundwater in the GAB, rather than indicative of any external pressures acting on the water quality of the springs.

The springs typically supported many aquatic macrophytes, but little aquatic vertebrate fauna, suggesting that these communities may offer relatively poor habitat and connectivity for vertebrate aquatic organisms. However, the larger more mobile fish and turtles of the Dawson River will be expected to utilise the lower waters of springs, near the confluence with the river. Given the temporal variability in spring flows, it is likely that the springs with smaller flow volumes are less reliable sources of moisture. This may explain why some springs were not intensely vegetated, and why the larger springs typically supported a greater abundance of fauna.

No rare or threatened species were recorded from the artesian springs in the Upper Dawson Catchment, however, the endangered macrophyte salt pipewart has previously been recorded at springs on Hutton Creek in the Upper Dawson Catchment.

Artesian springs elsewhere in the CSG fields may support similar communities to the springs in the Upper Dawson Catchment, where similar geomorphic and hydraulic conditions are present. However, no rare or threatened aquatic floral or fauna have been recorded from artesian springs in the Condamine - Upper

Balonne and Comet Catchments, though this may be because these springs have been poorly surveyed to date.

Essential Habitat

An area of essential habitat is a vegetation community in which a species that is endangered, vulnerable, rare or near threatened, as defined by the NC Act, has been known to occur. A total of 31 essential habitat areas have been identified within the northern CSG fields. Within the Southern CSG fields 24 essential habitat areas have been identified. Further detail regarding essential habitat areas and the corresponding RE data is located in Appendix N1.

6.4.4.2 Terrestrial Flora

This section documents the floristics and vegetation communities of the study area. Community descriptions and quantitative data including floristics and structure for each survey site together with complete flora species lists for all taxa identified are provided in Appendix N1.

Northern CSG Fields

The field survey identified the presence of 156 taxa representing 52 families and 102 genera. There was a relatively moderate diversity of weed species found within the study area with 11 taxa identified representing seven families. A full list of all floral species identified at all quaternary and secondary study sites surveyed in the northern CSG fields is provided in Appendix N1.

Of the 11 exotic weed species described in this study area, three species were identified as being of management concern: *Lantana camara*, Opuntia stricta var. stricta** and *Opuntia tomentosa*.* These species are listed as pest species under the Queensland *Land Protection (Pest and Stock Route Management) Act, 2002.* One of these species, lantana, is also listed as a Weed of National Significance (WONS). Developed by ANZECC, WONS are exotic weed species identified as causing significant environmental damage on a national scale. All exotic weed species identified in this study area are listed within the full flora species list in Appendix N1.

Weed Species

*Lantana camara** (lantana) was identified in only one vegetation community within the Northern CSG fields; however densities appeared to be low. Lantana is a Weed of National Significance and is regarded as one of the worst weeds in Australia. Lantana forms dense, impenetrable thickets that take over native bushland and pastures throughout the east coast of Australia. It competes for resources with, and reduces the productivity of, pastures and forestry plantations. It adds fuel to fires, and is toxic to stock (Weed Management CRC, 2003).

Opuntia stricta var. *stricta** (prickly pear) and *Opuntia tomentosa** (velvety tree pear) were found in a number of vegetation communities, although densities were consistently low. These species were introduced into pastoral districts in the 1840's and by 1925 the pest had invaded over 24 million hectares. The introduction of the moth, *Cactoblastis cactorum*, in the 1920's controlled the pest, and by the mid-1930's, prickly pear was no longer a major problem (DNRW, 2006).

Regional Connectivity

Regional connectivity of remnant vegetation across the northern CSG fields is reasonably continuous and is dominated by mountain ranges, state forests and national parks. Northwards from Mahalo CSG field, connectivity is retained to the Blackdown Tablelands. From the CSG fields of Mahalo southwards to Arcadia Valley CSG field lies the contiguous remnant vegetation of the Expedition Range which encompasses both Shotover State Forest and Expedition National Park. Fairview CSG field is situated directly south of the range, however vegetation fragmentation is much more evident in this field. Continuity of vegetation in the east-west direction stretches from Lonesome National Park located at the southern end of the Arcadia Valley, and extends across to the Carnarvon Ranges. For further descriptions of corridor linkages and habitat connectivity refer to Appendix N1.

Vegetation of Conservation Significance

Twenty six vegetation communities were identified from desktop analysis as having either 'Of Concern' or 'Endangered' conservation status (as listed under the VM Act); and 33 communities were identified as having 'Of Concern' or 'Endangered' biodiversity status (as determined by the EPA). Four of these vegetation communities were ground-truthed during the survey period. Fourteen vegetation communities were identified as 'Endangered' under the EPBC Act, and of these, two vegetation communities were confirmed through ground truthing. The conservation status of the conservation significant vegetation communities identified, CSG fields location and relevant survey site number is detailed below in Table 6.4.2.

Southern CSG Fields

Targeted flora field studies were undertaken within the Roma CSG field to ground-truth the RE mapping, search for targeted conservation significant flora species and provide a greater understanding of floral diversity and vegetation communities of the area. The survey identified the presence of 92 taxa representing 35 families and 62 genera. There was a relatively low diversity of weed species within the site with five species found. Weed species of concern within the southern CSG fields are discussed further below and in Appendix N1.

A full list of all floral species identified at all quaternary and secondary study sites surveyed in the southern gas field is provided in Appendix N1.

Weed Species

Of the five exotic weed species described in this survey of the southern CSG study area, one species, *Opuntia tomentosa** (velvety tree pear), was identified as being of management concern. This species is listed as a pest species under the Queensland *Land Protection (Pest and Stock Route Management) Act, 2002.* All exotic weed species identified in this study are listed within the full flora species list in Appendix N1.

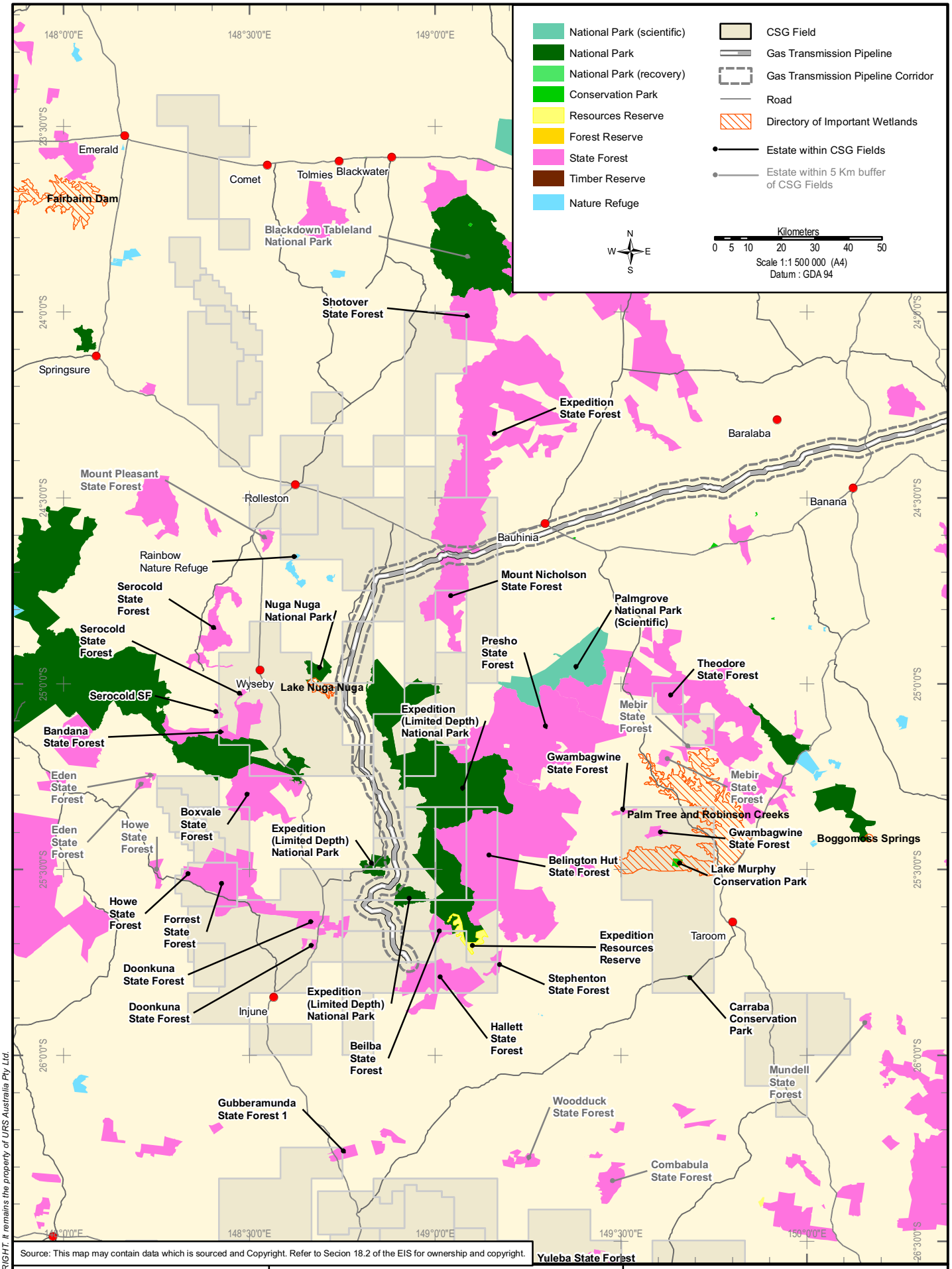
Velvety tree pear *Opuntia tomentosa* was found in a number of vegetation communities within the southern CSG fields, although densities were consistently low. This species was introduced into pastoral districts in the 1840's and by 1925 the pest had invaded over 24 million ha. The introduction of the moth, *Cactoblastis cactorum*, in the 1920's controlled the pest, and by the mid-1930's, prickly pear was no longer a major problem (DNRW, 2006).

Regional Connectivity

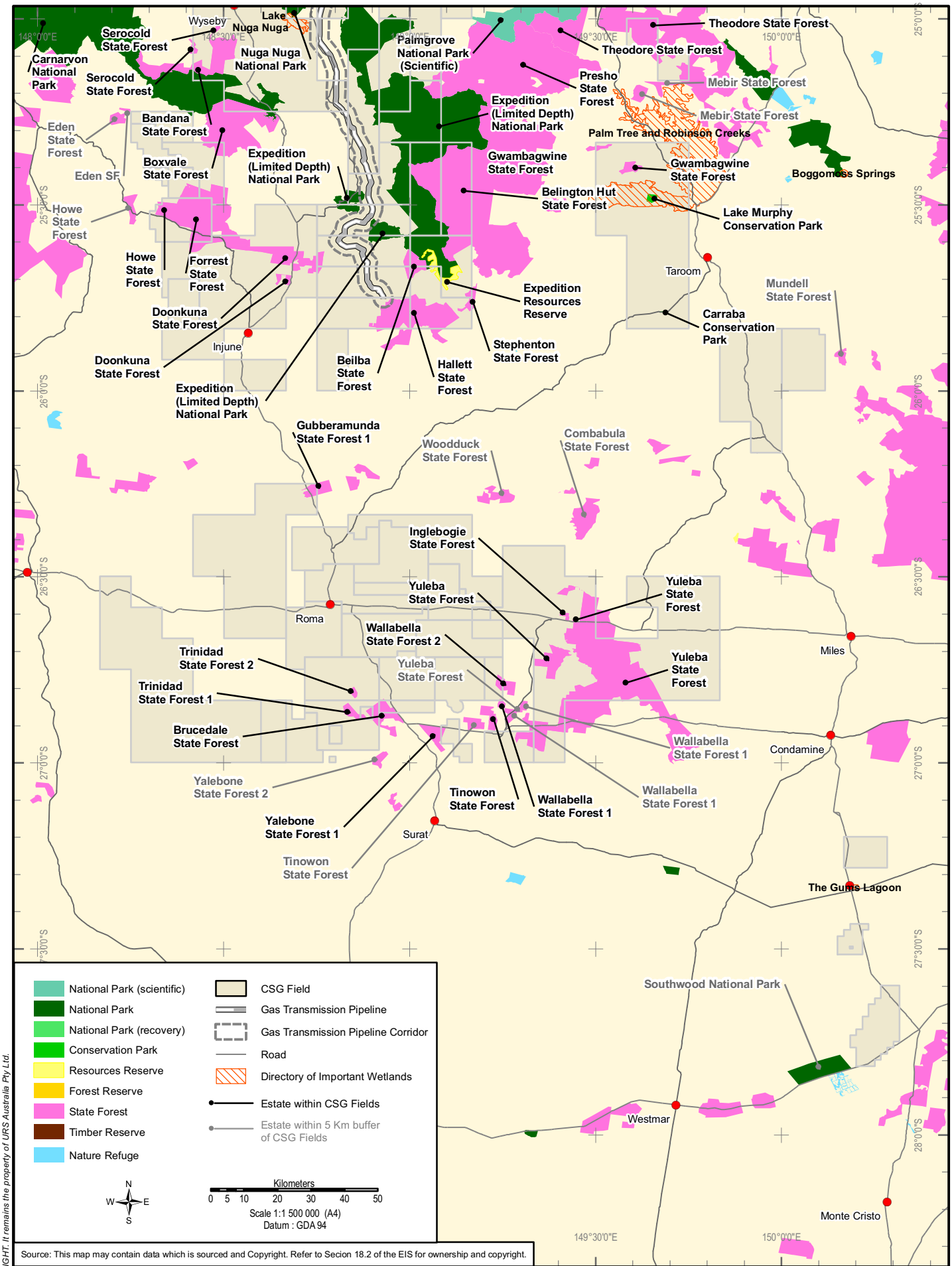
Vegetative connectivity across the landscape of the southern CSG fields is highly fragmented and limited to the remnant vegetation associated with roadside and riparian vegetation, together with several state forests in the south-west of the Roma CSG field. The result is a number of tenuously linked patches of vegetation scattered across a largely cleared and flat landscape, creating very little connectivity on a regional scale. For further details on corridor linkages and habitat connectivity refer to Appendix N1.

Vegetation of Conservation Significance

Desktop analysis of the southern CSG fields identified 21 significant communities as having either 'Of Concern' or 'Endangered' conservation status (as listed under the *Vegetation Management Act, 1999*) and 27 communities as having 'Of Concern' or 'Endangered' biodiversity status (as determined by the EPA). Three of these vegetation communities were confirmed through ground truthing. Six of the vegetation communities listed are regarded as 'Endangered' under the EPBC Act. The conservation status of all conservation significant communities identified, CSG fields location and relevant survey site is detailed in Table 6.4.3.



Client: LNG / URS	Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	Title: **CONSERVATION AREAS AND FORESTRY AREAS CSG FIELDS (NORTHERN SECTION)**	
	Drawn: MG	Approved: JB	Date: 07-05-2009
	Job No.: **4262 6220**	File No.: 42626220-g-1005.mxd	Figure: **6.4.7**
			Rev. C A4



Client

Project
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title
CONSERVATION AREAS AND FORESTRY AREAS CSG FIELDS (SOUTHERN SECTION)

Drawn: MG	Approved: JB	Date: 07-05-2009	Figure: **6.4.8**	Rev. C
Job No.: **4262 6220**	File No.: 42626220-g-1004.mxd			A4

Table 6.4.2 Conservation Significant REs Identified for the Northern CSG Fields

Regional Ecosystem [1]	Vegetation Community Description	Legislative Conservation Significance [2]			Source [3]	CSG fields
		Qld VM Status	Qld Biodiversity Status	EPBC Status		
11.10.8	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks	OC	OC	Not Listed	Desktop	Comet Ridge, Denison Trough, Arcadia Valley, Fairview
11.11.13	*Acacia harpophylla* or *A. argyrodendron*, *Terminalia oblongata* low open forest on deformed and metamorphosed sediments and interbedded volcanics	OC	OC	Not Listed	Desktop	Denison Trough
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	E	E	E	Desktop	Mahalo, Comet Ridge, Denison Trough
11.3.17	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains	OC	E	Not Listed	Desktop	Denison Trough, Arcadia Valley, Fairview
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	OC	OC	Not Listed	Desktop, Q25	Mahalo, Comet Ridge, Denison Trough, Arcadia Valley, Fairview, Scotia
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils	E	E	Not Listed	Desktop	Denison Trough
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	NC	OC	Not Listed	Desktop, S17, S20, Q18, Q23, Q27	Mahalo, Comet Ridge, Denison Trough, Arcadia Valley, Fairview, Scotia
11.3.27	Freshwater wetlands	NC	OC	Not Listed	Desktop	Comet Ridge, Denison Trough
11.3.27a	Lacustrine wetland	NC	OC	Not Listed	Desktop	Denison Trough
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	OC	OC	Not Listed	Desktop	Denison Trough
11.3.3a	Riverine wetland or fringing riverine wetland.	OC	OC	Not Listed	Desktop	Denison Trough
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	OC	OC	Not Listed	Desktop	Mahalo Comet Ridge, Denison Trough, Scotia

Regional Ecosystem [1]	Vegetation Community Description	Legislative Conservation Significance [2]			Source [3]	CSG fields
		Qld VM Status	Qld Biodiversity Status	EPBC Status		
11.3.6	*Eucalyptus melanophloia* woodland on alluvial plains	NC	OC	Not Listed	Desktop	Denison Trough
11.4.1	Semi-evergreen vine thicket ± *Casuarina cristata* on Cainozoic clay plains	E	E	E	Desktop	Comet Ridge
11.4.2	*Eucalyptus* spp. and/or *Corymbia* spp. grassy or shrubby woodland on Cainozoic clay plains	OC	OC	Not Listed	Desktop	Comet Ridge, Denison Trough
11.4.7	Open forest to woodland of *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* on Cainozoic clay plains	E	E	E	Desktop	Mahalo
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	E	E	E	Desktop	Mahalo, Comet Ridge, Denison Trough
11.4.9	*Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains	E	E	E	Desktop, S15, Q24, Q26	Denison Trough
11.4.9a	*Acacia harpophylla*, *Lysiphyllum carronii* ± *Casuarina cristata* open-forest to woodland	E	E	E	Desktop	Mahalo, Comet Ridge, Denison Trough
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains/remnant surfaces	NC	E	E	Desktop	Denison Trough
11.5.18	*Micromyrtus capricornia* shrubland on Cainozoic sand plains/remnant surfaces	OC	OC	Not Listed	Desktop	Mahalo
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	OC	OC	E	Desktop	Mahalo, Comet Ridge, Denison Trough
11.8.11a	*Melaleuca bracteata* woodland drainage depressions. Occurs in drainage depressions	OC	OC	E	Desktop	Denison Trough
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks. Steep hillsides	NC	OC	E	Desktop	Mahalo, Comet Ridge, Denison Trough
11.9.1	*Acacia harpophylla-Eucalyptus cambageana* open forest to woodland on fine-grained sedimentary rocks	E	E	E	Desktop	Mahalo, Comet Ridge, Denison Trough, Scotia

Regional Ecosystem [1]	Vegetation Community Description	Legislative Conservation Significance [2]			Source [3]	CSG fields
		Qld VM Status	Qld Biodiversity Status	EPBC Status		
11.9.4a	Semi-evergreen vine thicket, generally dominated by a low tree layer (5-10 m high) which is floristically diverse and variable	E	E	E	Desktop, S23, S24	Comet Ridge, Fairview, Denison Trough, Arcadia Valley, Scotia
11.9.4b	Semi-evergreen vine thicket	E	E	E	Desktop	Mahalo, Comet Ridge, Fairview, Denison Trough, Arcadia Valley
11.9.5	Acacia harpophylla and/or Casuarina cristata open forest on fine-grained sedimentary rocks	E	E	E	Desktop	Comet Ridge, Fairview, Denison Trough, Arcadia Valley, Scotia
11.9.6	*Acacia melvillei* ± *A. harpophylla* open forest on fine-grained sedimentary rocks	E	E	Not Listed	Desktop	Scotia
11.9.7	*Eucalyptus populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	OC	OC	Not Listed	Desktop	Comet Ridge, Denison Trough, Fairview, Scotia
11.9.8	*Macropteranthes leichhardtii* thicket on fine grained sedimentary rocks	NC	E	Not Listed	Desktop	Comet Ridge
11.9.10	*Acacia harpophylla, Eucalyptus populnea* open forest on fine-grained sedimentary rocks	OC	E	Not Listed	Desktop	Denison Trough, Fairview, Scotia
11.9.13	*Eucalyptus moluccana* or *E. microcarpa* open forest on fine grained sedimentary rocks	OC	OC	Not Listed	Desktop	Denison Trough

1 An ‘a’ or ‘b’ following the RE number indicates the presence of different vegetation communities within that RE.

2 E: Endangered, OC: Of Concern, NC: No Concern

3 Information gathered from State Government 1: 100,000 Regional Ecosystem Mapping v.5 (DNRM&W, 2005). Study site numbers from both quaternary (Q) and secondary (S) surveys are included to indicate ground-truthing of the community where applicable.

Table 6.4.3 Conservation Significant REs Identified for the Southern CSG Fields

Regional Ecosystem [1]	Vegetation Community Description	Legislative Conservation Significance [2]			Source [3]	CSG fields
		Qld VM status	Qld Biodiversity Status	EPBC Status		
11.3.17	Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains	OC	E	Not Listed	Desktop	Roma, Eastern Surat
11.3.2	Eucalyptus populnea woodland on alluvial plains	OC	OC	Not Listed	Desktop	Roma, Eastern Surat
11.3.21	Dichanthium sericeum and/or Astrebla spp. grassland on alluvial plains. Cracking clay soils	E	E	Not Listed	Desktop	Roma
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	NC	OC	Not Listed	Desktop, S4	Roma, Eastern Surat
11.3.27b	Palustrine wetland	NC	OC	Not Listed	Desktop	Eastern Surat
11.3.28	Casuarina cristata +/- Eucalyptus coolabah open woodland on alluvial plains	OC	OC	Not Listed	Desktop	Roma
11.3.3	Eucalyptus coolabah woodland on alluvial plains	OC	OC	Not Listed	Desktop	Roma, Eastern Surat
11.4.10	Eucalyptus populnea or E. pilligaensis, Acacia harpophylla, Casuarina cristata open forest to woodland on margins of Cainozoic clay plains	E	E	Not Listed	Desktop	Eastern Surat
11.4.12	Eucalyptus populnea woodland on Cainozoic clay plains	E	E	Not Listed	Desktop	Eastern Surat
11.4.3	Acacia harpophylla and/or Casuarina cristata shrubby open forest on Cainozoic clay plains	E	E	E	Desktop	Roma, Eastern Surat
11.4.3a	Palustrine wetland (e.g. vegetated swamp). Melaleuca bracteata woodland associated with Acacia harpophylla communities	E	E	E	Desktop	Eastern Surat
11.4.7	Open forest to woodland of Eucalyptus populnea with Acacia harpophylla and/or Casuarina cristata on Cainozoic clay plains	E	E	E	Desktop	Roma

Regional Ecosystem [1]	Vegetation Community Description	Legislative Conservation Significance [2]			Source [3]	CSG fields
		Qld VM status	Qld Biodiversity Status	EPBC Status		
11.5.13	*Eucalyptus populnea* +/- *Acacia aneura* +/- *E. melanophloia* woodland on Cainozoic sand plains/remnant surfaces	OC	OC	Not Listed	Desktop	Roma
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	OC	OC	E	Desktop	Roma
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks. Steep hillsides	NC	OC	E	Desktop	Roma
11.9.1	*Acacia harpophylla-Eucalyptus cambageana* open forest to woodland on fine-grained sedimentary rocks	E	E	E	Desktop	Roma
11.9.10	*Acacia harpophylla, Eucalyptus populnea* open forest on fine-grained sedimentary rocks	OC	E	Not Listed	Desktop	Roma
11.9.11	*Acacia harpophylla* shrubland on fine-grained sedimentary rocks	OC	OC	Not Listed	Desktop	Roma
11.9.4a	Semi-evergreen vine thicket, generally dominated by a low tree layer (5 – 10 m high) which is floristically diverse and variable	E	E	Not Listed	Desktop	Roma
11.9.4b	Semi-evergreen vine thicket with dense softwood scrub understorey	E	E	Not Listed	Desktop	Roma
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rock	E	E	Not Listed	Desktop	Roma
11.9.7	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	OC	OC	Not Listed	Desktop	Roma
11.9.7a	*Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (10 - 15 m high).	OC	OC	Not Listed	Desktop	Roma
6.4.3	*Eucalyptus populnea, Casuarina cristata* or *Acacia harpophylla* ± *Geijera parviflora* woodland on clay plains	OC	E	Not Listed	Desktop	Roma,

Regional Ecosystem [1]	Vegetation Community Description	Legislative Conservation Significance [2]			Source [3]	CSG fields
		Qld VM status	Qld Biodiversity Status	EPBC Status		
6.5.1	Acacia aneura, Eucalyptus populnea, E. melanophloia open forest on undulating lowlands	NC	OC	Not Listed	Desktop, S8	Roma
6.5.3	Eucalyptus populnea, Acacia aneura ± Eremophila mitchellii woodland within A. aneura communities	NC	OC	Not Listed	Desktop, S9	Roma
6.7.5	Eucalyptus thozetiana or E. cambageana, Acacia harpophylla woodland on scarps	NC	OC	Not Listed	Desktop	Roma

1 An 'a' or 'b' following the RE number indicates the presence of different vegetation communities within that RE.

2 E: Endangered, OC: Of Concern, NC: No Concern

3 Information gathered from State Government 1:100,000 Regional Ecosystem Mapping v.5 (DNRM & W, 2005). Study site numbers from both quaternary (Q) and secondary (S) are included to indicate ground-truthing of the community where applicable.

6.4.4.3 Terrestrial Fauna

The key findings of the nature conservation (fauna) field assessment for the selected CSG fields are described within this section. A full copy of the assessment report outlines the habitat assessments for each of the individual CSG fields in comprehensive detail within Appendix N1 (Section 4.2.6 and 4.2.7).

Northern CSG Fields

The northern CSG fields feature a mix of cleared agricultural and pastoral land with large expanses of remnant vegetation. The more fertile lowland soils, formerly supporting woodlands dominated by brigalow (*Acacia harpophylla*) and poplar box (*Eucalyptus populnea*), have largely been cleared. Remnant vegetation in these areas is generally restricted to isolated patches and narrow strips of riparian woodland along ephemeral streams. Ecological linkages between these patches are usually non-existent. The size and shape of these patches is not conducive to supporting a large variety and abundance of fauna. Functionally they are analogous to 'islands', and are more suitable for the more hardy, mobile and generalist species of macropods and birds. The surrounding land uses and impacts from stock further reduce their value for fauna.

Conversely, the forested woodlands of the Shotover, Expedition and Carnarvon Ranges act as significant refuge and habitat for a large suite of native species. A large proportion of the Ranges are held in managed or protected estate. A number of state forests and national parks are found within or adjacent to the CSG fields. These act as secure sources of fauna dispersing along the ranges. The Scotia CSG field, which lies to the south-east of the Fairview CSG field, is largely devoid of large remnant patches and does not feature the sandstone ranges of the other northern CSG fields.

Survey Results

Field surveys and habitat assessments were conducted within the Fairview and Arcadia Valley CSG fields. Fifty-two species of birds, reptiles, amphibians and mammals were incidentally recorded during flora assessments in these areas. The only significant species observed was the squatter pigeon (southern) (*Geophaps scripta scripta*).

A detailed description of habitat values for the individual northern CSG fields is presented in Appendix N1 (Section 4.2.6).

Southern CSG Fields

The southern CSG fields of Roma and Eastern Surat Basin do not feature the rugged sandstone ranges found in the northern CSG fields. This has contributed to more intensive agricultural and pastoral activity in these regions. The Roma field is mostly cleared with the larger remnants, the majority of which are in forestry reserves, restricted to the south-eastern portions. Consequently, opportunities for fauna within this field are limited. The Eastern Surat Basin field possesses few larges areas of remnant vegetation. Patches are restricted to isolated stands of disturbed woodland and riparian corridors.

Survey Results

Fieldwork was only undertaken within the Roma field. Seventy-four species of birds, reptiles, amphibians and mammals were incidentally recorded during flora assessments in this area. No significant species were observed.

A detailed description of habitat values for the individual southern CSG fields is presented in Section 4.2.7 of Appendix N1.

Significant Fauna Species

Significant fauna species include those recognised under various categories of the NC Act or EPBC Act[3]. The potential presence of significant species in a designated area is determined through a search of available databases such as Queensland Museum records, Wildlife Online and the EPBC protected matters report. Whilst all of these databases were accessed, only the Queensland Museum data includes spatial references. Therefore searches for significant fauna at specific sites (i.e. within the CSG fields boundaries) could only be undertaken using this database. Records are based primarily on the submission of results from various independent studies or individuals and therefore they are not necessarily complete for an area and are only useful as a guide to the diversity of fauna. Conversely, absence from such a list does not necessarily mean a certain species is not present within the study area. Records of significant species for the CSG fields, and their status, are shown in Table 6.4.4. Queensland Museum fauna records (Qld Museum, 2008) for the CSG fields noted 14 significant species.

Table 6.4.4 Conservation significant fauna species known for the CSG fields study area

Scientific Name	Common Name	Conservation Significance	
		NC Act[1]	EPBC Act[2]
Falco hypoleucos	Grey falcon	R	Not Listed
Geophaps scripta	Squatter pigeon	V	V
Nyctophilus timoriensis	Long-eared bat	V	V
Onychogalea fraenata	Bridled nailtail wallaby	E	E
Chalinolobus dwyeri	Large-eared pied bat	R	V
Chalinolobus picatus	Little pied bat	R	Not Listed
Cyclorana verrucosa	Warty waterholding frog	R	Not Listed
Adelotus brevis	Tusked frog	V	Not Listed
Acanthophis antarcticus	Common death adder	R	Not Listed
Anomalopus brevicollis	Burrowing skink	R	Not Listed
Delma torquata	Collared delma	V	V
Denisonia maculata	Ornamental snake	V	V
Egernia rugosa	Yakka skink	V	V
Furina dunmalli	Dunmall's snake	V	V

[1] The NC Act uses the following categories for significant fauna species: **E: Endangered, V: Vulnerable, NT: Near Threatened and R: Rare**.

[2]The EPBC Act uses the following categories for significant fauna species: **CE: Critically Endangered, E: Endangered, V: Vulnerable and CD: Conservation Dependent**

6.4.4.4 Aquatic Ecology

This section documents the water quality, aquatic flora and fauna species present and artesian spring communities of the targeted sections of the CSG fields. Community descriptions and quantitative data for each survey site together with complete flora and fauna species lists for all taxa identified are provided in Appendix N4.

Water Quality

Dissolved oxygen (DO) concentrations were outside the guideline ranges at all sites. All sites except Carnarvon Creek (Site 24) had low DO levels, whereas Carnarvon Creek was high. Low DO concentrations were probably related to the high turbidity experienced at most sites, a high biological oxygen demand and the low mixing of the waters. The high DO concentrations at Carnarvon are likely to reflect the abundance of filamentous algae in senescing pools at this location.

Turbidity was high throughout the study area and was probably related to sediment-laden runoff associated with clearing of riparian vegetation and erosion of steep banks. High turbidity is characteristic of all three catchments, and of the greater central Queensland region. Due to surrounding land uses, waterways within the region are impacted by relatively high inputs of nutrients, pesticides and other contaminants. By their nature, ephemeral streams such as those in the study area are commonly subject to a range of severe (natural) stresses, and as such the water quality of the creeks within the study area may be characterised by elevated turbidity, salinity and nutrient enrichment (Chessman, B. [Centre for Natural Resources NSW] pers. comm. 2003, 21 October).

Aquatic Flora

The diversity of aquatic macrophytes in the CSG fields is relatively low. The composition and cover of these communities varies across the study area. The limited cover of macrophytes, and in particular the lack of submerged species, is likely to be related to the largely ephemeral nature and turbid conditions of many of the waterways in the study area. Larger waterways, such as the Dawson and Comet Rivers and Lake Nuga Nuga, support more permanent water and provide a more stable habitat for aquatic macrophytes, and are therefore likely to support more abundant and diverse communities.

No rare or threatened species of aquatic flora have been recorded from the waterways of the study area. Exotic macrophytes were recorded at sites in the Upper Dawson and Comet Catchments.

Aquatic Macroinvertebrate Communities

Aquatic macroinvertebrate communities within the study area were generally indicative of poor to moderate habitat and/or water quality, reflecting the results of water quality and aquatic habitat assessments at the sites (see Appendix N4).

The larger waterways in the study area support more permanent water, and therefore offer more stable habitat for macroinvertebrates. As a result, these waterways will be expected to support a more abundant and diverse community of macroinvertebrates, and contain more taxa that are sensitive to pollution and disturbance. However, this was not consistently the case, with many of the smaller ephemeral creeks supporting macroinvertebrate communities that were comparable with the larger waterways. The specific differences in macroinvertebrate communities between sites appeared to be related to site-specific differences in the availability and diversity of habitat.

Fish Communities

Most of the fish species that were captured from the study area can tolerate a large range of water quality conditions. Spangled perch, glassfish, carp gudgeons, eastern rainbowfish and eel-tailed catfish are tolerant species that can live in water characterised by low DO levels, high conductivity and relatively high turbidity. Although exact water quality tolerances could not be sourced for the exotic carp, goldfish and mosquitofish, these species are also reported to have wide environmental tolerances. Golden perch, bony bream, fly-speckled hardyheads, purple-spotted gudgeons and Pacific blue-eye have narrower water quality tolerances than the other species collected.

The relative composition and abundance of fish communities within the study area is largely controlled by the life history requirements of the species involved. Many of the fish in the study area undertake freshwater migrations for reproduction, dispersal or foraging. This movement typically occurs in spring and summer, and is triggered by large flow events. Therefore, the specific composition of fish

communities at any given site is likely to vary between seasons, with a greater abundance and diversity of fish likely to be present at many locations during periods of flow.

Turtle Communities

Krefft's river turtles are likely to be relatively common in the larger permanent waterways of both the Upper Dawson and Comet catchments. White-throated snapping turtles are also likely to be present in flowing water habitats across both the Upper Dawson and Comet Catchments. Saw shelled turtles may be present in the faster flowing waterways in the Upper Dawson and Comet Catchments, such as the upper Dawson River. Fitzroy River turtles may also be present in the flowing waters of the Dawson and Comet Rivers. Eastern snake-necked turtles may be present in the ephemeral creeks of the Upper Dawson and Condamine – Upper Balonne Catchments, though there absence during our surveys suggests they are not likely to be common. The Macquarie River turtle may occur in the deeper pools of the larger (more well connected waterways) in the Condamine – Upper Balonne Catchment, such as Tchanning, Bungil and Wallumbilla Creeks. However, their absence from the surveys indicates that they are not likely to be abundant, a likely reflection of the highly ephemeral nature of these waterways and the lack of in-stream habitat.

It is unlikely that the relative composition of turtle communities within the study area will vary significantly between seasons, with distribution and abundance largely being controlled by the presence of water and the level of connectivity at each watercourse. The abundance and distribution of individual animals may be expected to vary during the breeding season, with an increase in the abundance of female turtles adjacent to suitable nesting sites, followed by an increase in the abundance of juveniles post hatching.

Other Aquatic Vertebrates

The presence of semi-aquatic vertebrates encountered during the surveys was recorded. Further details are located in Appendix N4.

6.4.5 Potential Impacts and Mitigation Measures

The development stages of each CSG fields include exploration, construction, operation, and rehabilitation and decommissioning activities. Through the different stages of the CSG field activities the disturbances created vary. A comprehensive description and assessment of potential impacts for each of the different development stages is detailed in Section 5.2 of Appendix N1 and summarised into general impacts and mitigation in the following sections and below in Table 6.4.6 (terrestrial) and Table 6.4.7 (aquatic).

As previously discussed in Section 3.6, the local disturbance area generated for each well site is progressively reduced and rehabilitated throughout the stages of CSG fields development. For example, the area required for a drilling lease is approximately 1 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 total land surface area potentially impacted within the RFD equates to approximately 37 % of the RFD area. However 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.

Many of the existing environments in which the RFD areas are located have been heavily modified due to broad scale vegetation clearing, and as such the conservation significant (endangered and of-concern) REs that remains in the RFD area is approximately 4 % of the total surface area of the RFD area (the

Arcadia, Fairview and Roma CSG fields). These REs are predominately located within riparian, steeply sloped, fenceline and roadway areas. Given that CSG field activities have flexibility as to where they can be installed/undertaken, these areas can, in most circumstances be avoided.

The flora and fauna habitat values of each of the nine individual CSG fields have been discussed in detail in Sections 4.2.2 to 4.2.7 of Appendix N1 and describe the following for each field:

- Overall description and location;
- Species diversity;
- Habitat diversity;
- Habitat values;
- Corridor linkages;
- Known fauna records;
- Conservation significant species;
- Conservation significant vegetation; and
- Feral & pest species.

6.4.5.1 Summary table of ecologically significant values for each field

An outcome of this habitat assessment was the appreciation of the similarities and disparities between the CSG fields. The Mahalo, Comet Ridge, Denison Trough, Arcadia Valley and Fairview CSG fields share similarities in that all possess significant areas of cleared land and remnant vegetation, as well as a variety of landforms. The Roma, Scotia and Eastern Surat Basin CSG fields on the other hand, are dominated by intensive agricultural and pastoral land use with remnant vegetation in the minority. Development within the latter fields will potentially incur fewer ecological impacts due to the prevalence of cleared land and historical disturbance to woodlands. The former CSG fields comprise a greater proportion of remnant vegetation and therefore there is a greater risk of incurring ecological impacts. However, pre-development identification of natural values and the preferred placement of infrastructure within cleared areas will tend to mitigate these impacts.

While the heavily disturbed landscape allows for the easy placement of infrastructure, remnant stands of vegetation do act as corridors for the movement of flora and fauna species. Consequently, the traversing of these areas for CSG activities may reduce the integrity of the vegetation community and its use as a corridor if not appropriately managed.

Substantial amelioration of potential impacts can also be undertaken through the identification and rehabilitation of corridor linkages within the CSG fields. Fauna movement will be greatly enhanced by improvement to habitat within areas such as the Lonesome Holdings and Fairview leases, and along waterways in general throughout the CSG fields.

As a result of these conditions, the scale of the potential impact and the associated mitigation measure will vary depending on the CSG activity and the location within the RFD area. The potential impacts and mitigation measures are discussed below and further detailed within Tables 6.4.6 and 6.4.7, where specific potentials impacts are described for each of the anticipated activities for the individual exploration, construction, operation and decommissioning phases of the project.

6.4.5.2 Terrestrial Flora

Vegetation Clearing

Localised Potential Impact

The installation of both temporary and permanent CSG infrastructure may result in the need to clear vegetation from specific areas associated with development of the CSG field. For well leases this may

involve the potential clearing of up to 1 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 infrastructure within previously cleared areas in accordance with the mitigation strategy (outlined below).

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 FRD and future development area FDA 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 Sections 6.4.4.3 and Appendix N1 (Section 4.2.2 and 4.2.6). The northern RFD 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 %) (Figure 6.4.7) 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, as outlined below, 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 Sections 6.4.4.3 and Section 4.2.3 and 4.2.7 of Appendix N1. Strategies outlined below will mitigate potential impacts to the remaining isolated pockets of habitat and riparian corridors with biodiversity value in the southern CSG fields.

Mitigation Measures

- Phase 2 Infrastructure scouting and location protocols to identify constraints and environmental receptors (Section 6.4.5.6 and Appendix N1);
- Where practicable, the placement of infrastructure in areas that have been previously disturbed;
- Where practicable, the avoidance of remnant vegetation and isolated stands of timber;
- Where practicable, the lopping of branches rather than the removal of vegetation;
- Retention of habitat trees;
- Progressive rehabilitation and revegetation of disturbed areas;
- Return cleared timber to seismic line areas following surveys to discourage third party access and to recreate habitat for small mammals, frogs and reptile species; and
- Biodiversity offsets for disturbance to conservation significant communities (Section 6.4.5.4).

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

Mitigation Measures

Refer to mitigation measures for vegetation clearing.

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. The potential effects of dust deposition on vegetation are determined by a number of factors including:

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

The dominant woodland species of the vegetation communities within the CSG fields typically exhibit physiological qualities that are not sensitive to dust deposition. The sclerophyllous foliage of *Eucalyptus* and *Corymbia* woodland species is generally pendulous (i.e. points down), with a thick smooth cuticle that does not encourage particulate matter to remain on the surface. The dominant woodland species are also generally hardy and well adapted to adverse conditions (e.g. extended dry conditions and low nutrient soils).

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 Section 5.2 to 5.4 of 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 Table 6.4.6.

Mitigation Measures

- Use of dust suppression around sensitive receptors (e.g. houses/sensitive flora communities);
- Enforce practical speed limits when driving on unsealed roads in areas of sensitive receptors;
- Consideration of sealing roads around sensitive receptors where practical; and
- Driver education.

Weeds

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

The implementation of weed control protocols as per Santos EHS09 Weed and Pest Animal Control includes a number of mitigation strategies including vehicle wash down procedures and weed control awareness programs.

Loss of Topsoil

Localised Potential Impact

Improper storage of topsoil during CSG field activities may result in the reduction or loss of the native seed bank and topsoil viability for rehabilitation.

Regional Impact

The nature of topsoil impacts are primarily at a localised scale and potential impacts from topsoil management in the regional context are not expected to be significant. Potential impacts will mitigated with a number of strategies including those outlined below and in Table 6.4.6.

Mitigation Measures

- Topsoil is to be stored for later use in rehabilitation. Topsoil stockpiles are not to exceed 2 m in height;
- Topsoil that is to be stored for over six months is to be kept free of declared weeds, covered with a suitable grass species and watered to ensure biological integrity of the material is maintained. Appropriate erosion controls devices are to be installed where required, to ensure topsoil does not wash away; and
- Topsoil that is to be stored for over six months is to be stored, where practicable, to ensure that no vehicles or other equipment drive over it.

6.4.5.3 Terrestrial Fauna

Loss of 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 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 braches 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 scouting protocols 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 (Section 6.4.5.5). Other mitigation for habitat loss is outlined below and in Table 6.4.6.

Mitigation Measures

- Phase 2 scouting and location protocols to identify constraints and environmental receptors (Section 6.4.5.5);
- Phase 2 specialist field investigations where required to ensure no disturbance to conservation significant species (Section 6.4.5.5);
- Where practicable, the placement of infrastructure in areas that have been previously disturbed;
- Where practicable, the lopping of branches rather than the removal of vegetation;
- Retention of habitat trees;
- Progressive rehabilitation and revegetation of disturbed areas; and
- Return cleared timber to seismic line areas following surveys to discourage third party access and to recreate habitat for small mammals, frogs and reptile species.

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.

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.

Mitigation Measures

- Pipeline trenches are to be fenced to exclude stock and wildlife during construction works;
- Inspection of open excavations and trenches at the start of works are to be conducted by a qualified personnel for the removal of any entrapped species;
- Where practicable, trenches are to be backfilled overnight with minimum trench area left open;
- Open trenches are to have materials installed to provide refuge for species or allow fauna to escape e.g. ramping of the trench;
- Implementation of vehicle speed limits and signage where appropriate;
- Driver education for fauna awareness; and
- Liaison with wildlife rescue organisations and/or individuals.

Noise & Vibration

Fauna may be affected in the short-term by noise & 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.

Mitigation Measures

- Maintenance of mufflers and other noise suppression devices; and
- Drilling, construction and excavation activities are short term and exposure to noise generated would not be sufficient to cause long term impacts.

6.4.5.4 Aquatic Ecology

An overview of impacts and mitigation measures for the aquatic ecological values of the CSG field is provided below and detailed further within Appendix N4.

Artesian Springs

Localised Potential Impacts

- Degradation of threatened ecological communities (artesian springs) caused by CSG construction and operational activities;
- Water table drawdown effects on artesian springs from CSG water extraction; and
- Accidental spillage of fuel and oil from construction equipment.

Regional Impact

The above listed impacts have the potential for impact at localised areas of well field infrastructure development in the vicinity of artesian spring sites. Significant impacts on artesian springs across the CSG fields are not considered likely to be significant in the regional context, given that their locations should be avoided in most instances, and the following mitigation measures are followed where appropriate.

Mitigation Measures

- Phase 2 scouting and location protocols to identify constraints and sensitive environmental receptors (Section 6.4.5.5);
- Phase 2 specialist field investigations where required, to ensure avoidance of disturbance to artesian spring communities (Section 6.4.5.5);
- Monitoring program where appropriate, for depth of aquifers and the rate of spring discharge over the period of water extraction to enable early detection of drawdown impacts on artesian springs;
- The placement of infrastructure in areas that have been previously been disturbed; and
- A minimum ecological buffer of 100 m or greater around artesian spring sites; and fuel storage and handling activities conducted in accordance with AS1940 (Storage and Handling of Flammable and Combustible Liquids – encompassing spill containment and response protocols). Report any spilt contaminants immediately and contain before they disperse into springs.

Instream Habitat Disturbance

Localised Potential Impact

Removal of riparian vegetation and / or instream habitat resulting in increased turbidity and sedimentation with the construction of road or pipeline crossings.

Regional Impact

The above listed impacts have the potential for impact at localised areas of well field infrastructure development in the vicinity of artesian spring sites. Significant impacts on artesian springs across the CSG fields are not considered likely to be significant in the regional context, given that their locations should be avoided in most instances, and the following mitigation measures are followed where appropriate.

Mitigation Measures

- Where practicable, locate roads to minimise disturbance to riparian vegetation. Implement silt curtains and erosion control matting below works in riparian zones to prevent runoff from entering watercourses. Monitor turbidity below containment measures. Rehabilitate riparian vegetation after clearing (to ensure bank stability; and
- Select construction methods that where practical minimise the disturbance to aquatic habitats, such as: trenchless excavation (using a horizontal directional drill); isolation and open cut excavation. Where crossings traverse flowing wet watercourses, construct containment dams to isolate work areas. Monitor water quality upstream and downstream of containment dams daily during construction to detect changes to: turbidity, dissolved oxygen, pH and conductivity. Where a reduction in downstream water quality is detected, stop or scale back construction and review and revise erosion and sediment control measures, as necessary. Rehabilitate instream habitat and bed and banks following the completion of works.

Obstruction of Fish Passage

Localised Potential Impact

Temporary damming of watercourses for the construction of road or pipeline crossings is likely to lead to the obstruction of fish passages.

Regional Impact

Potential regional impacts from obstruction of fish passages are not considered to be significant to the regional fish assemblage or population of any conservation significant species. The potentially impacted

waterways are ephemeral and populated by generalist species adapted to survival in dry periods and natural obstruction of passage.

Mitigation Measures

Appropriate controls to mitigate impacts from watercourse diversion include:

- Construct dams of material appropriate to each watercourse (e.g. steel plates, flumes, sand bags or aquadams), make dams impermeable with polyethylene liner and sand bags;
- If flowing water is present, maintain flow with pumps that have a capacity that exceeds expected flows. Have backup pumps and generators on site to ensure that flow is continuous;
- Screen pump intakes (with mesh openings no larger than 2.54 mm) to ensure that no fish are entrapped;
- Salvage fish from isolated workspaces and translocate to flowing waters using current best practice;
- When construction is complete, remove the upstream dam slowly, to allow water to flush the sediment from the workspace area. Pump the sediment-laden water out of the flooded work area into sumps or onto vegetation;
- Operate a clean-water pump to sustain partial flow in the watercourse below the downstream dam until it is removed; and
- Design crossings to provide for fish passage. Where practicable, design bridge crossings to be single span (to minimise instream disturbance), and level crossings to incorporate culverts. To facilitate fish passage, design culverts so that they are:
  - As short and wide as possible, and allow the passage of anticipated flood volumes and debris;
  - Deep enough to allow fish movement (a minimum depth of 0.5 m for the fish species present); and
  - Installed without a 'drop off' at the culvert outlet or inlet (these impede fish migration).

6.4.5.5 Biodiversity Offsetting

A program to implement offsetting of cleared vegetation communities will be carried out in accordance with current policies for the offsetting of significant vegetation communities. A biodiversity offset strategy and management plan will be developed. The plan will include consideration of the following:

- Compliance with the requirements of the Policy for Vegetation Management Offsets (DNRW, 2007) and the regional vegetation management codes both for the coastal bioregions and Brigalow Belt Bioregions, under the provisions of the Queensland VM Act (DNRW, 2006a and DNRW, 2006b);
- Consideration of existing Santos biodiversity offsets including the EMP for Fairview project area offset strategy (Santos, 2008);
- Acquisition of a remnant/regrowth community that is greater in area than that which will be impacted by the project;
- Support of the same suite of plant species contained in RE types being offset;
- Maximising biodiversity gains through site selection;
- Where practicable, by ensuring offset locations close to communities impacted by the project;
- Where practicable, ensuring offset sites be larger contiguous stands of vegetation with connectivity to other habitat types to increase the viability of ecological processes;
- Placing potential offset(s) parcels under a secure protection such as a conservation covenant to ensure that protection runs with title;
- Inclusion of management measures to ensure offset areas remain viable in perpetuity. Such measures may include the management of supplementary planting, weed, fire, feral animal, livestock management and restriction on access; and

- Monitoring and maintenance activities to measure success and viability of the offset.

6.4.5.6 Phase 2 Protocols

Given that targeted ecological field surveys were not a practical method of biodiversity assessment for all of the specific locations of project components, the mechanism to implement targeted field assessment of biodiversity values and assess potential impacts for the specific locations of project components will be triggered by the current Santos' environmental management practices at the development and scoping stage for specific exploration fields. This process is outlined in further detail in Section 5.5 of Appendix N1.

The Santos environmental management practice for CSG fields development activities was implemented for all CSG fields activities commencing from 2009 (Work instruction for Planning and Obtaining Approval for CSG activities, Santos 2008). The generation of this work instruction was to formalise the Phase 2 protocol developed and incorporate it into existing Santos management processes.

This work instruction outlines a process to optimise field planning and ensure sustainable environmental practices. The work instruction outlines responsibilities and details a staged process for the implementation of measures to ensure correct field assessments are undertaken to an appropriate level, and potential impacts are correctly assessed and minimised before selecting specific sites for the CSG fields development and impacts arising from implementation. The elements of the process relevant to the assessment of biodiversity and potential impacts are outlined below in Table 6.4.5.

Table 6.4.5 Process for further Biodiversity Assessment at specific well field operations

Scouting protocol	Trigger	Responsibility	Actions	Outcome
Desktop Review	Proposed ground disturbance	Santos Activity Manager	Constraints mapping, assessment of ATP / PL number against environmental values summary	Identification of desktop environmental values and any potential conservation values requiring field confirmation
Site Field Scouting	Identification of potential desktop conservation values	Santos Environmental Group	Site investigation of potential significant conservation values	Identification of any ecological values requiring further characterisation and assessment of conservation value. Outline of regulatory approval process to be undertaken
Specialist Investigation	Confirmation of potential conservation values requiring specialist investigation	Qualified Ecology Team	Assessment of baseline environmental values potential ecological impacts	Ecological report detailing impact assessment and mitigation measures for regulatory approval

The information obtained from the desktop review, site field scouting and specialist investigations will then be used by Santos to select the specific sites for the CSG fields development elements and to implement the necessary works. The following documents are the guidelines to be used to mitigate potential impacts:

- Santos EHS01 Land Disturbance;
- Santos EHSMS09.5 Environmental Impact Assessment and Approvals;
- Santos EHSMS11-11 Decommissioning and Abandonment;

- Santos EHSMS14 Monitoring, Management & Reporting;
- Santos EHS09 Weed and Pest Animal Control; and
- EMPs for relevant CSG fields.

6.4.5.7 Cumulative Impacts

Section 1 identifies other CSG development projects planned for the surrounding region. Some of these projects are up to 100 km from the GLNG Project CSG fields areas and some may be within the GLNG Project future development area (FD area). There is limited information available as to the planned development of those projects or the quantity and timing of the development of the wells or associated infrastructure; however, a qualitative assessment can be made of the possible cumulative impacts.

Santos will develop the RFD areas in accordance with the EIS. There will be no other development by other petroleum producers in the tenements described in the RFD area. Infrastructure impacts will not exceed those stated in the project description.

It is however, possible that other companies may develop CSG facilities within the FD area as part of the planned CSG development projects in addition to the existing CSG domestic supply facilities. This will mean that there will be more CSG development in the FD area than the Santos project. As an area is developed, the number of wells will increase. The spacing of wells will not intensify with field development.

The total land surface area directly impacted by the Santos activities in the RFD Area is estimated at 2,500 ha. This constitutes 0.37 % of the RFD area of 6,800 km^2. The impacted surface area is associated with a network of trunk roads and access roads that connect the CSG wells. Accordingly the impacts described in this section affect a relatively small area of land and the impact on such areas will be reduced by the application of the mitigation methods described in this section.

Much of the FD area is cleared agricultural land and as such FD area development activities are unlikely to reduce nature conservation values significantly. The ongoing operation of the developed fields is unlikely to have any significant cumulative effects upon nature conservation values. Nevertheless, the greatest cumulative impacts from the development of the CSG fields will be the fragmentation of habitat and disturbance to microhabitat such as hollow-bearing trees, fallen timber and thickets of vegetation. Progressive rehabilitation, appropriate field planning and pre-development scouting will assist in the mitigation of these cumulative impacts.

Cumulative impacts may occur if additional fields in the FD area are developed whilst existing fields in the RFD area continue to produce. Clearing will be widely dispersed over the area, and will occur gradually over a 25+ year timeframe. Rehabilitation of disturbed areas such as seismic lines and well lease pads will also occur progressively over the life of the projects. The conversion of appraisal wells to operating wells in particular will result in a significant reduction in the cleared area with rehabilitation of the impacted area to a standard consistent with the existing land use and vegetation type.

The cumulative impact will carry a relatively small footprint over the large regional area of the FD area. Impacts are expected to be greater at creek crossings, riparian areas and aquatic ecosystems.

It is expected that the other CSG fields development projects will include some or all of the proposed mitigation measures in relation to flora and fauna impacts described in this section. By utilising these mitigation measures, it is anticipated that there will be a minimal cumulative impact on the surrounding environment.

Tables 6.4.6 and 6.4.7 provides a summary of potential terrestrial ecology and aquatic ecology impacts and mitigation measures for the each of activities anticipated for the exploration, construction, operation and decommissioning phases of the project.

Table 6.4.6 Potential Terrestrial Ecology Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction (including exploration)			
Seismic Surveys.	Removal of selected trees and the lopping of tree branches to allow vehicle and equipment access may threaten flora, fauna and vegetation communities.	• Avoid remnant vegetation and isolated stands of timber where practicable. • Minimise the width of the seismic line. • Retain habitat trees. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise impact on flora, fauna and vegetation communities.
	Removal of fallen timber on the seismic line to allow vehicle and equipment access.	• Return cleared timber to the seismic line following the survey to discourage third party access and to recreate habitat for small mammals, frogs and reptile species.	Minimise impact on fauna communities.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Detour tracks required due to rough terrain (i.e. erosion zones, watercourses) causing disturbance to habitat.	• Avoid traversing remnant vegetation and isolated stands of timber where practicable. • Use natural breaks or existing crossings along watercourses for locating new access tracks. • Minimise the width of the seismic line. • Retain habitat trees. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.
	Fauna mortality or injury from vehicle strikes.	• Vehicle speed limits. • Driver education. • Liaison with wildlife rescue organisations or individuals.	Minimise fauna mortality and injury.
	Potential harm to stock, wildlife and humans from shotholes left open.	• Plug all shotholes. • Field inspection of seismic line to report on condition of works and any outstanding remedial works required.	Minimise human, stock and fauna injury or mortality.
	Potential for erosion on seismic lines or associated access tracks.	• Install appropriate erosion control measures as required. • Field inspection of seismic line to report on condition of	Minimise erosion.

Aspect	Potential Impact	Mitigation Measures	Objective
		works and any outstanding remedial works required. • Progressive rehabilitation and revegetation of disturbed areas.	
	Potential for marker pegs left on site after the completion of the seismic program to cause harm to stock and wildlife.	• Field inspection of seismic line to report on condition of works and any outstanding remedial works required.	Minimise fauna mortality and injury.
Establishment of Coreholes.	Fauna mortality/ injury.	• Retain habitat trees. • Avoid clearing remnant vegetation and isolated stands of timber where practicable. • Field scouting of proposed corehole site by competent person. • Liaise with wildlife rescue organisations or individuals.	Minimise fauna mortality and injury.
	Loss of habitat.	• Retain habitat trees. • Avoid clearing remnant vegetation and isolated stands of timber, where practicable. • Minimise lease pad clearing area. • Rehabilitate unsuccessful core holes as soon as reasonably practicable.	Minimise disturbance to habitat.
	Potential for erosion due to corehole development.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Noise impacts to fauna.	• Drilling activities are short term and the exposure to noise generated would not be sufficient to cause long term impacts. • Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
Establishment of access tracks.	Fauna mortality/ injury.	• Avoid clearing remnant vegetation and isolated stands of timber, where practicable. • Field scouting of proposed corehole site by competent person. • Liaison with wildlife rescue organisations or individuals. • Retain habitat trees.	Minimise fauna mortality and injury.

Aspect	Potential Impact	Mitigation Measures	Objective
	Loss of habitat.	• Avoid clearing remnant vegetation and isolated stands of timber, where practicable. • Where practicable, minimise clearing by reducing road width. • Minimise impact to surrounds by constructing roads that are two-tyre tracks only where standards allow. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.
	Potential for erosion on seismic lines or associated access tracks.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	The potential for weed seed and pest animal spread.	• Implement weed and pest animal control protocols as per Santos EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
Use of access tracks.	Fauna mortality or injury from vehicle strikes.	• Enforce speed limits when driving in areas of high vegetation cover to reduce likelihood of hitting wildlife and during times of high wildlife activity i.e. dawn and dusk. • Driver education. • Liaison with wildlife rescue organisations or individuals.	Minimise fauna mortality and injury.
Dust.	Dust associated with vehicles.	• Use dust suppression around sensitive receptors (e.g. houses/ sensitive flora communities). • Progressive rehabilitation and revegetation of disturbed areas.	Minimise project noise and dust creation.
Construction of pilot and appraisal wells.	Fauna mortality/ injury.	• Avoid clearing remnant vegetation and isolated stands of timber, where practicable. • Liaison with wildlife rescue organisations or individuals. • Enforce speed limits when driving in areas of high vegetation cover to reduce likelihood of hitting wildlife and during times of high wildlife activity i.e. dawn and dusk. • Retain habitat trees. • Infield infrastructure should be fenced for security reasons as well as for the exclusion of livestock and native animals.	Minimise fauna mortality and injury.

Aspect	Potential Impact	Mitigation Measures	Objective
	Loss and fragmentation of habitat.	• Avoid clearing remnant vegetation and isolated stands of timber where practicable. • Minimise lease pad clearing area, where practicable. • Where practicable, position wells and access roads to reduce the potential for "vegetation islands". • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.
	Potential for erosion on well leases.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Dust impacts to fauna and vegetation communities.	• Implement dust suppression programs when necessary.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Drilling activities are short term and the exposure to the noise generated would not be sufficient to cause long term impacts to wildlife. • Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
Upgrade to production wells (Reduction in lease pad size as part of the partial rehabilitation process).	Potential erosion during earthworks at the site.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	Potential contamination caused by spillage of drilling fluids or other chemicals and regulated wastes.	• Field inspection of lease pad to report on condition of works and any outstanding remedial works required. • All potential contaminants are to be bunded according to AS.1940 and the Santos EHSMS.	No contamination of habitat.
	Improper storage of topsoil.	• Topsoil is to be stored for later use in rehabilitation. • Topsoil stockpiles are not to exceed 1.5 m in height and are to be marked "Not for General Use - For Rehabilitation Only" or similar. • Topsoil that is to be stored for over six months is to be kept free of declared weeds, covered with a suitable grass species and water to minimise erosion and ensure biological integrity of the material is maintained. • Appropriate erosion controls devices are to be installed	Minimise topsoil loss.

Aspect	Potential Impact	Mitigation Measures	Objective
		where required, to ensure topsoil does not wash away. • Topsoil that is to be stored for over 6 months is to be fenced or signed where practicable to ensure that no vehicles or other equipment drive over it. • Stockpiling should be undertaken as per best practice guidelines.	
	The potential for weed seed spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
Gas and water pipeline gathering systems.	Fauna mortality/ injury.	• Avoid traversing remnant vegetation and isolated stands of timber, where practicable. • Liaison with wildlife rescue organisations or individuals. • Enforce speed limits when driving in areas of high vegetation cover to reduce likelihood of hitting wildlife and during times of high wildlife activity i.e. dawn and dusk. • Infield infrastructure should be fenced for security reasons as well as for the exclusion of livestock and native animals. • Temporary fencing should be installed around open trenches to prevent harm to stock and native fauna.	Minimise fauna mortality and injury. Minimise erosion. Minimise project noise and dust creation.
	Fragmentation of habitat.	• Vegetation removed from the pipeline easement is to be stockpiled for use during rehabilitation. • Cleared timber is to be placed over the pipeline during rehabilitation to provide habitat to small mammals and reptiles. • Timber will be placed in a manner that still allows pipeline surveillance activities to occur. • Where practicable, the clearing required for pipeline installation for in-field gathering lines is to be kept to a minimum to allow fauna movement. • Where practicable, pipelines will be located adjacent to existing infrastructure e.g. fence lines or access tracks. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.

Aspect	Potential Impact	Mitigation Measures	Objective
	Potential erosion during earthworks at the site.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Dust impacts to fauna and vegetation communities.	• As pipeline activities will be localised for a short duration, the potential impacts to flora and fauna can be managed as required. • Dust suppression mechanisms will be implemented when needed.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Pipeline activities will be localised and for a short duration therefore impacts to fauna form noise would be minimal. • Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
	Fauna trapped in trench leading to mortality or injury.	• Avoid traversing remnant vegetation and isolated stands of timber, where practicable. • Liaison with wildlife rescue organisations or individuals. • Trench is to be backfilled overnight with minimum trench area left open. The open trench is to have materials installed to allow fauna to escape e.g. ramping of the trench. • Inspection of trenches at the start of work is to be conducted by a component person for the removal of species caught in the trench.	Minimise fauna mortality and injury.
Gas processing facilities (250 m x 200 m compound area).	Fauna mortality/ injury.	• Where practicable, locate compressor stations in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Compressor stations and other infield infrastructure should be fenced for security reasons as well as for the exclusion of livestock and native animals.	Minimise fauna mortality and injury.
	Loss and fragmentation of habitat.	• Where practicable, site compressor stations in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands	Minimise disturbance to habitat.

Aspect	Potential Impact	Mitigation Measures	Objective
		of timber. • Where practicable, minimise the area of the compound facility. • Design and location of compound areas should be reviewed against the relevant constraints map for correct placement of the facility in the landscape. • Progressive rehabilitation and revegetation of disturbed areas.	
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Potential for erosion during earthworks at the site.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	Dust impacts to fauna and vegetation. Communities.	• Implement dust suppression program.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
Associated water infrastructure- storage ponds and water treatment facilities.	Fauna mortality/ injury.	• Where practicable, site storage ponds and water treatment facilities in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Fence storage ponds to prevent ingress by stock and wildlife.	Minimise fauna mortality and injury.
	Loss and fragmentation of habitat.	• Where practicable, site storage ponds and water treatment facilities in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Where practicable, minimise the area of the storage ponds and water treatment facilities. • Design and location of storage ponds and water treatment facilities will be reviewed against the relevant constraints map for correct placement of the facility in	Minimise disturbance to habitat.

Aspect	Potential Impact	Mitigation Measures	Objective
		the landscape. • Progressive rehabilitation and revegetation of disturbed areas.	
	Potential for erosion during earthworks at the site.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Dust impacts to fauna and vegetation communities.	• Implement dust suppression programs.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
Accommodation facilities and associated infrastructure.	Fauna mortality/ injury.	• Where practicable, site infrastructure in locations that have been previously cleared. • Avoid clearing remnant vegetation, isolated stands of timber. • Infrastructure should be fenced for security reasons as well as for the exclusion of livestock and native animals.	Minimise fauna mortality and injury.
	Loss and fragmentation of habitat.	• Where practicable, site infrastructure in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Where practicable, minimise the area of disturbance for construction of infrastructure. • Design and location of infrastructure should be reviewed against the relevant constraints map for correct placement of the facility in the landscape. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.
	Potential for erosion during earthworks at the site.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	The potential for weed seed and pest animal	• Implement management program EHS09 Weeds and	Limit spread of weeds

Aspect	Potential Impact	Mitigation Measures	Objective
	spread.	Pest Animal Control.	and pest animals.
	Dust impacts to fauna and vegetation communities.	• Implement dust suppression programs.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
Road construction.	Fauna mortality/ injury.	• Utilise existing road and track network where practicable. • Where practicable, place roads in locations that have been previously cleared. • Avoid clearing remanent vegetation, isolated stands of timber. • Construct road at a minimum width for intended traffic	Minimise fauna mortality and injury.
	Loss and fragmentation of habitat.	• Utilise existing road and track network where practicable. • Where practicable, place roads in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Where practicable, minimise the area of the compound facility. • Design and location of compound areas should be reviewed against the relevant constraints map for correct placement of the facility in the landscape. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Potential for erosion during road construction.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	Dust impacts to fauna and vegetation communities.	• Implement dust suppression programs.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Maintain mufflers and other noise suppression devices.	Minimise project noise

Aspect	Potential Impact	Mitigation Measures	Objective
			and dust creation.
Borrow pits and laydown and storage areas.	Fauna mortality/ injury.	• Where practicable, place borrow pits and storage areas in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Borrow pits should be fenced to exclude livestock and native fauna.	Minimise fauna mortality and injury.
	Loss and fragmentation of habitat.	• Where practicable, place borrow pits and storage areas in locations that have been previously cleared. • Avoid clearing remnant vegetation and isolated stands of timber. • Where practicable, minimise the area of the borrow pits and storage areas. • Design and location of borrow pits and storage areas will be reviewed against the relevant constraints map for correct placement of the facility in the landscape. • Progressive rehabilitation and revegetation of disturbed areas.	Minimise disturbance to habitat.
	The potential for weed seed and pest animal spread.	• Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
	Potential for erosion during earthworks at the site.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	Dust impacts to fauna and vegetation communities.	• Implement dust suppression programs.	Minimise project noise and dust creation.
	Noise impacts to fauna.	• Maintain mufflers and other noise suppression devices.	Minimise project noise and dust creation.
Operation			
Operation of production wells.	No impacts to flora, fauna and vegetation communities.	• Production wells are greatly reduced in size and surrounds are rehabilitated.	Minimise project noise and dust creation.
	Fauna mortality or injury from vehicle strikes	• Enforce speed limits when driving in areas of high vegetation cover to reduce likelihood of hitting wildlife and during times of high wildlife activity i.e. dawn and	Minimise fauna mortality and injury.

Aspect	Potential Impact	Mitigation Measures	Objective
		dusk.	
Operation of Compressor Stations.	Noise.	• Minimise noise output where practicable.	Minimise project noise and dust creation.
Road Use.	Fauna mortality or injury from vehicle strikes.	• Enforce speed limits when driving in areas of high vegetation cover to reduce likelihood of hitting wildlife and during times of high wildlife activity i.e. dawn and dusk.	Minimise fauna mortality and injury.
	Dust.	• Implement dust suppression programs where necessary.	Minimise project noise and dust creation.
Borrow pits.	Weed infestations.	• Monitor disturbed areas for declared and environmental weeds. • Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
Laydown and storage areas.	Dust.	• Implement dust suppression programs where necessary.	Minimise project noise and dust creation.
	Erosion.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	Weed infestations.	• Monitor disturbed areas for declared and environmental weeds. • Implement management program EHS09 Weeds and Pest Animal Control.	Limit spread of weeds and pest animals.
Decommissioning			
Production Wells. Pipelines. Processing and Associated Facilities. Infrastructure. Treatment plants, pipes, tanks water ponds. Roads and Access Tracks. Borrow pits and Storage.	Dust.	• Implement dust suppression programs.	Minimise project noise and dust creation.
	Potential for erosion during decommissioning activities.	• Refer to mitigation measures for erosion on seismic lines due to seismic surveys above.	Minimise erosion.
	Fauna mortality or injury from vehicle strikes.	• Enforce speed limits when driving in areas of high vegetation cover to reduce likelihood of hitting wildlife and during times of high wildlife activity i.e. dawn and dusk.	Minimise fauna mortality and injury.

Table 6.4.7 Potential Aquatic Ecology Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction			
Roads.	Disturbance of threatened ecological communities near artesian springs.	• Plan roads to avoid artesian springs. • Where possible, a minimum ecological buffer of 100 m should be retained. • Where road construction is required in areas of the CSG Fields that contain artesian springs, further detailed assessments of the potential for impact may be required. • Conduct fuel storage and handling activities in accordance with AS1940.	Minimise impact of project on artesian springs.
	Accidental spillage of fuel and oil from construction equipment.	• Report any spilt contaminants immediately and contain before they disperse into springs.	
Watercourses.	Removal of riparian vegetation and disturbance of riparian soils resulting in increased erosion, turbidity and sedimentation.	• Where possible, locate roads to minimise disturbance to riparian vegetation. • Implement silt curtains and erosion control matting below works in riparian zones to prevent runoff from entering watercourses. • Monitor turbidity below containment measures. • Rehabilitate riparian vegetation after clearing (to ensure bank stability).	Minimise project impact on watercourses and riparian regions.
	Removal of instream habitat and increased turbidity and sedimentation with the construction of road crossings.	• Select construction methods that where practical minimise the disturbance to aquatic habitats, such as: trenchless excavation (using a horizontal directional drill); isolation and open cut excavation.	
	Temporary damming of watercourses for the construction of road crossing.	• Where crossings traverse flowing wet watercourses, construct containment dams to isolate work areas.	
	Obstruction of fish passage with the construction of road crossings.	• Monitor water quality upstream and downstream of containment dams daily during construction to detect changes to: turbidity, DO, pH and conductivity. • Design crossings to provide for fish passage. Where possible, design bridge crossings to be single span (to	

Aspect	Potential Impact	Mitigation Measures	Objective
		minimise instream disturbance), and level crossings to incorporate culverts. To facilitate fish passage, design culverts so that they are: – As short and wide as possible, and allow the passage of anticipated flood volumes and debris; – Deep enough to allow fish movement (a minimum depth of 0.5 m for the fish species present); and – Installed without a 'drop off' at the culvert outlet or inlet (these impede fish migration).	
	Accidental spillage of fuel and oil from construction equipment.	• Conduct fuel storage and handling activities in accordance with AS1940. • Report any spilt contaminants immediately and contain before they disperse into springs. • Where a reduction in downstream water quality is detected, stop or scale back construction and review and revise erosion and sediment control measures, as necessary. • Rehabilitate instream habitat and bed and banks following the completion of works.	
	Disturbance of threatened ecological species.	• Appropriate controls for the diversion of watercourses include: – Construct dams of material appropriate to each watercourse (e.g. steel plates, flumes, sand bags or aquadams), make dams impermeable with polyethylene liner and sand bags; – If flowing water is present, maintain flow with pumps that have a capacity that exceeds expected flows. Have backup pumps and generators on site to ensure that flow is continuous; – Screen pump intakes (with mesh openings no larger than 2.54 mm) to ensure that no fish are entrapped; – Salvage fish from isolated workspaces and translocate to flowing waters using current best practice;	

Aspect	Potential Impact	Mitigation Measures	Objective
		– When construction is complete, remove the upstream dam slowly, to allow water to flush the sediment from the workspace area. Pump the sediment-laden water out of the flooded work area into sumps or onto vegetation; – Operate a clean-water pump to sustain partial flow in the watercourse below the downstream dam until it is removed; and – Where possible, plan roads to avoid disturbance to habitats on major waterways that may support threatened species (as listed under the EPBC Act).	
Pipelines near Artesian springs.	Disturbance of threatened ecological communities.	• Plan pipeline routes to avoid artesian springs. • These communities are listed as threatened ecological communities under the EPBC Act. • Where possible, a minimum ecological buffer of 100 m should be retained. • Where construction is required in areas of the CSG Field that contain artesian springs, further detailed assessments of the potential for impact may be required.	Minimise impact of project on artesian springs.
	Accidental spillage of fuel and oil from construction equipment into artesian springs.	• Conduct fuel storage and handling activities in accordance with AS1940. • Report any spilt contaminants immediately and contain before they disperse into springs.	
Watercourses.	Removal of riparian vegetation and in-stream habitat, and increased turbidity and sedimentation with the construction of crossings.	• Where practical, locate pipeline crossings to minimize disturbance to riparian vegetation. • Implement silt curtains and erosion control matting below works in riparian zones. • Select construction methods to minimise the disturbance to aquatic habitats, such as: trenchless excavation (using HDD); isolation and open cut excavation. • Where crossings traverse flowing wet watercourses, construct containment dams to isolate work areas.	Minimise project impact on watercourses and riparian environment.

Aspect	Potential Impact	Mitigation Measures	Objective
		• Monitor water quality upstream and downstream of containment dams daily during construction. • Where a reduction in downstream water quality is detected, stop construction and review and revise erosion and sediment control measures, as necessary. • Rehabilitate riparian vegetation and in-stream habitat following the completion of works.	
	Temporary damming of watercourses for the construction of crossings.	• Appropriate controls for the diversion of watercourses include: – Construct dams of material appropriate to each watercourse (e.g. steel plates, flumes, sand bags or aquadams), make dams impermeable with polyethylene liner and sand bags. – If flowing water is present, maintain flow with pumps that have a capacity that exceeds expected flows. Have backup pumps and generators on site to ensure that flow is continuous. – Screen pump intakes (with mesh openings no larger than 2.54 mm) to ensure that no fish are entrapped. – Salvage fish from isolated workspaces and translocate to flowing waters. – When construction is complete, remove the upstream dam slowly, to allow water to flush the sediment from the workspace area. Pump the sediment-laden water out of the flooded work area into sumps or onto vegetation. – Operate a clean-water pump to sustain partial flow in the watercourse below the downstream dam until it is removed.	
	Accidental spillage of fuel and oil from construction equipment into watercourses.	• Conduct fuel storage and handling activities in accordance with AS1940. • Report any spilt contaminants immediately and contain before they disperse into springs.	

Aspect	Potential Impact	Mitigation Measures	Objective
	Disturbance of threatened ecological species.	• Where possible, plan pipeline routes to avoid disturbance to habitats on major waterways that may support threatened species (as listed under the EPBC Act). This includes: sand banks and riffle – pool sequences on the Dawson and Connors Rivers, which may support Fitzroy River Turtles; and deep, well connected pools in Tchanning, Bungil and Wallumbilla creeks, which may support Murray cod.	
Wells (Drilling).	Leases located near artesian springs.	• Plan drilling leases to avoid artesian springs. These communities are listed as threatened ecological communities under the EPBC Act.	Minimise project impact on artesian springs.
	Drawdown effects on aquifers.	• Conduct a groundwater impact study to assess the potential impacts of drawdown on artesian springs. • Monitor the depth of aquifers and the rate of spring discharge over the period of water extraction to enable early detection of drawdown. The specific design of the monitoring program to be dictated by the findings of the groundwater impact study.	
Watercourses.	Removal of riparian vegetation for drilling operations.	• Where possible, locate drilling operations to minimize disturbance to riparian vegetation. Rehabilitate any disturbed riparian vegetation following the completion of works.	Minimise project impact on watercourses and riparian environment.
	Increased turbidity, nutrients and sedimentation with runoff from drilling operations.	• Implement silt curtains and erosion control matting below drilling works to prevent runoff from entering watercourses.	
	Accidental spillage of fuel and oil from construction equipment into watercourses.	• Conduct fuel storage and handling activities in accordance with AS1940 (Storage and Handling of Flammable and Combustible Liquids – encompassing spill containment and response protocols). • Report any spilt contaminants immediately and contain before they disperse into watercourses.	
	Disturbance of threatened ecological species.	• Where possible, locate drilling operations to avoid disturbance to habitats on major waterways that may support threatened species (as listed under the EPBC	

Aspect	Potential Impact	Mitigation Measures	Objective
		Act). This includes: sand banks and riffle – pool sequences on the Dawson and Connors Rivers, which may support Fitzroy River Turtles; and deep, well connected pools in Tchanning, Bungil and Wallumbilla creeks, which may support Murray cod.	
Above ground infrastructure.	Construction in riparian zones. Transport of sediments, nutrients and contaminants to springs and watercourses.	• Design construction plans so that compressor stations etc are not constructed in the riparian habitat of artesian springs and watercourses.	Minimise project impact on artesian springs, watercourses and riparian environment.
Operation			
Roads (Operation of Vehicles and Equipment) Artesian springs and watercourses.	Accidental spillage of fuel and oil into waterways.	• Conduct fuel storage and handling activities in accordance with AS1940 (Storage and Handling of Flammable and Combustible Liquids – encompassing spill containment and response protocols). • Report any spilt contaminants immediately and contain before they disperse into watercourses.	Minimise project impact on watercourses and riparian environment.
Pipelines Artesian springs and watercourses.	Leakage of water or gas into waterways, which may alter water quality and enhance erosion.	• Early detection and reparation of leaks. • Assess magnitude of any impact. • Rehabilitate any disturbed riparian vegetation or in-stream habitat, as necessary. • Ongoing monitoring of water quality, as required.	Minimise project impact on watercourses and riparian environment.
Wells (Production).	Transport of sediments, nutrients and contaminants to springs and watercourses in runoff from well sites.	• Stormwater management facilities will be implemented (in line with the project EMP) to prevent runoff from entering watercourses.	Minimise project impact on watercourses and riparian environment.
Above ground infrastructure including water management facilities.	Transport of sediments, nutrients and contaminants to springs and watercourses in runoff from compressor stations.	• Stormwater management facilities will be implemented (in line with the project EMP) to prevent runoff from entering watercourses.	Minimise project impact on watercourses and riparian environment.
Decommissioning			
Decommissioning of	Any decommissioning works conducted	• Where decommissioning activities are constructed	Restore area as nearly

Aspect	Potential Impact	Mitigation Measures	Objective
Infrastructure and Equipment. Artesian springs and watercourses.	adjacent to artesian springs and watercourses have the potential to transport sediments, nutrients and contaminants to these areas.	adjacent to wet springs and watercourses, implement silt curtains and erosion control matting to prevent runoff from entering watercourses. • Monitor turbidity below containment measures. • Rehabilitate riparian vegetation following the completion of works.	as possible to pre-project condition.
Remediation of Contaminated Areas. Artesian springs and watercourses.	Transport of contaminated waters and sediments to springs and watercourses in runoff from contaminated areas.	• Undertake a risk assessment of site contamination (in accordance with applicable Queensland regulatory requirements and National environmental protection measures at the time of closure) to determine the requirements for remediation.	Restore area as nearly as possible to pre-project condition.

6.4.6 Summary of Findings

6.4.6.1 Terrestrial Ecology

The desktop and field studies conducted for the CSG fields ecological assessment have determined that each field possesses a range of ecological values. The northern CSG fields of Mahalo, Comet Ridge, Denison Trough, Arcadia Valley and Fairview each include elements of the forested Expedition and Carnarvon Ranges as well as cleared pastoral areas. The forested ranges, by way of their rugged topography, large areas of bushland and interconnectedness, typically possess greater potential for supporting significant fauna, flora and vegetation communities than other portions of the CSG fields.

The northern CSG fields of Scotia and the southern CSG fields of Roma and Eastern Surat Basin hold relatively lesser values due to the extensive clearing that has previously occurred within these areas. Despite this there is the potential for significant fauna, flora and vegetation communities to be present.

Fieldwork has verified the ecological values of the RFD areas. Future development of these CSG fields will be managed to minimise impact on the natural values. A considered approach to development involving the implementation of mitigation measures, as outlined in Table 6.4.6, will ensure that impacts to fauna and flora are minimised and the CSG fields will continue to support a range of significant species and vegetation communities. The following mitigation measures are proposed:

- Avoidance of works within protected areas or in sensitive regional eco systems.
- **Weed Infestation:** Implement weed control protocols as per Santos EHS09 Weeds and Pest Animal.
- **Vegetation Clearing:** Control and avoid clearing remnant vegetation and isolated stands of timber where practicable. Minimise the width of the seismic line and retain habitat trees. Ensure progressive rehabilitation and revegetation of disturbed areas.
- **Erosion:** Install appropriate erosion controls e.g. contour banks to manage water movement. Field inspection of well leases to report on condition of works and any outstanding remedial works proposed.
- **Habitat Fragmentation:** Avoid traversing and clearing remnant vegetation and isolated stands of timber where practicable. Use natural breaks or existing crossings along watercourses for locating new access tracks and minimise these impacts further by constructing roads that are two-tyre tracks only. Rehabilitate unsuccessful coreholes and other disturbed areas as soon as reasonably practicable.
- **Fauna Mortality / Injury:** Avoid clearing remnant vegetation and isolated stands of timber, where practicable.
- **Dust Impacts:** Use dust suppression around sensitive receptors (e.g. houses/ sensitive flora communities).

A program to implement offsetting of cleared vegetation communities will be carried out in accordance with current commonwealth and state legislative criteria for the offsetting of significant vegetation communities.

6.4.6.2 Aquatic Ecology

The environmental values of watercourses within the study area are relatively low and consistent with those of the wider catchments. Environmental values are dictated primarily by the ephemeral nature of many of the region's waterways, although agricultural development (particularly grazing) within the region has significantly influenced water quality and the physical characteristics of aquatic habitat. Degraded creeks in the catchment are characterised by riparian vegetation loss, erosion, low habitat diversity, invasion of weed species, poor water quality and sedimentation. Several road crossings of creeks in the study area are likely to cause alterations of flow and restrict aquatic fauna passage under particular flow regimes.

Section 6 Coal Seam Gas Fields Environmental Values and Management of Impacts

Water quality is generally poor and is characterised by high turbidity and low or variable DO levels. Watercourses within the region are impacted by relatively high inputs of nutrients, pesticides and other contaminants from surrounding land uses, and are subject to a range of severe natural stresses. As such, the water quality of the creeks within the CSG fields is currently characterised by elevated turbidity, salinity, and likely nutrient enrichment.

Biodiversity is relatively low, with only fish and macroinvertebrate species that are tolerant of varying and often harsh conditions inhabiting the study area. Introduced species, including the declared noxious mosquitofish and carp, and the introduced goldfish were found in the waterways of the CSG fields. Nevertheless, these creeks do offer some habitat to the native fish species that were recorded in the study area, and may provide habitat for breeding and dispersal during periods of high flow. The larger waterways in the study area, such as the Dawson and Comet Rivers and Lake Nuga Nuga support more permanent water, and therefore offer more stable habitat for aquatic organisms. As a result, these waterways will be expected to support more abundant and diverse communities, and contain more taxa that are sensitive to pollution and disturbance. However, this was not consistently the case, with many of the smaller ephemeral creeks supporting communities that were comparable with the larger waterways. The specific differences in communities between sites appeared to be related to site-specific differences in the availability and diversity of habitat. Nonetheless the presence of permanent water and the level of connectivity in each watercourse was clearly an important factor in structuring the communities of larger aquatic vertebrates, such as fish and turtles.

No rare or threatened species of aquatic fauna have been recorded from the watercourses of the study area however there is potential for listed species to be present. This will be further investigated during Santos scouting investigations.

The development and operation of the CSG fields may potentially impact the aquatic ecology of the area. Mitigation measures developed to avoid and / or reduce the associated impacts include appropriate water extraction and discharge methods, managed operation of vehicles and proper equipment handling, vegetation clearing and erosion control measures, crossing construction design, maintenance of fish passage, rehabilitation strategies for temporary water crossings and minimisation of mosquito breeding habitat.