FINAL REPORT

Desktop Assessment of the Pipeline Northern Alternative Route

Prepared for

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22 March 2009

42626220

URS

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Date: 22 March 2009
Reference: Technical Report Pipeline Northern Alternative

Status: Final

Table of Contents

Table of Contents

Tables, Figures, Drawings, Appendices

Tables

Figures

Tables, Figures, Drawings, Appendices

Introduction Section 1

The following report provides a high level desktop environmental assessment of an alternative gas transmission pipeline corridor (referred to in this report as the northern alternative) linking the Bruce Highway (west of Gladstone) to Curtis Island. This corridor was not initially investigated as part of GLNG EIS baseline studies, however the Queensland Government has recently identified this corridor as a preferred alternative to transport gas from the coal seam gas fields in central west Queensland to the Gladstone State Development Area's LNG Precinct on Curtis Island. The use of this corridor by gas suppliers would negate the need to install additional pipelines in the existing pipeline corridor further to the south, and in particular would provide an alternative route (to the Yarwun Neck) across the coastal range.

During the development of the GLNG EIS several studies (terrestrial, aquatic and marine focussed) have been completed for the gas transmission pipeline corridor (refer to Section 7 of the EIS). These studies have reviewed the potential impacts and mitigation measures associated with the installation of the pipeline and the possible implications on the surrounding area. As such, several EIS studies have partially included this northern alternative study area, albeit at a high level. This report has been developed to compliment those studies in section 7 of the EIS, although it is acknowledged that further assessment work will need to be undertaken when a preferred route option has been selected (refer section 1.3 below).

1.1 Study Area

There are a number of potential pipeline route options within this study area, with no preferred option identified at this stage of the project. Therefore, a broad study area has been assessed, as shown in Figure 1-1. This area lies to the north and north-west of Gladstone. It extends approximately 20 km from the Bruce Highway in a north-east direction to The Narrows. The widest point, in the west of the study area, is approximately 9 km in a north-south alignment.

1.2 Regulatory Framework

The regulatory framework that applies to this northern alternative study area is consistent with that stated in each specific study within section 7 of the EIS (section 8 with respect to marine ecology). Refer to these specific sections for further details. For example:

- Land Use (section 7.11.3);
- Nature Conservation (section 7.4.3);
- Marine Ecology (section 8.7.3);
- Terrain and Soils (section 7.3.1.3);
- Contaminated Land (section 7.3.2.3);
- Surface Water (section 7.5.3); and
- Cultural Heritage (section 7.13.3).

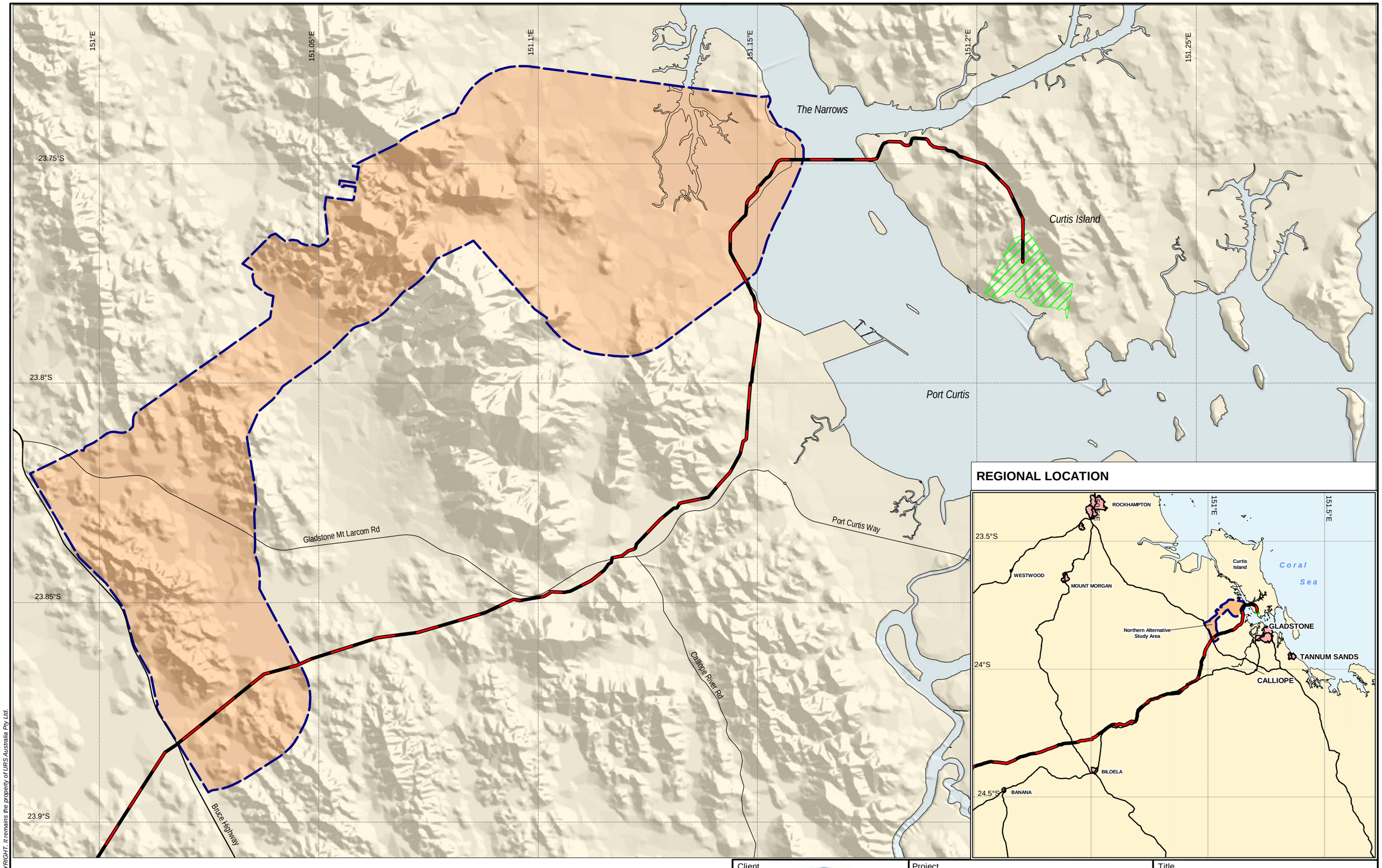
1.3 Phase 2 Protocols

As discussed in Section 7.1 of the EIS, the Phase 2 protocol will be implemented for future investigation works conducted in the northern alternative study area. As such, the implementation of the protocol for the placement of the northern alternative, once its location and construction execution becomes known, will be initiated.

Section 1 Introduction

The purpose of the Phase 2 protocol is to provide a framework for selecting locations of pipeline and associated infrastructure activities in a manner which minimises the environmental impact. The protocol includes:

- identify the elements which have the potential to impact on the environment;
- identify the sensitive features of the existing environment;
- identify site selection criteria for determining the specific locations;
- outline the proposed timing and scope of more detailed field work to enable pipeline activities to be located in accordance with the site selection criteria; and
- Identify mitigation measures which will be employed to minimise impact on the environment.



REGIONAL LOCATION

N W E S

0 1.25 2.5km

Scale 1:80 000 (A3)
Datum: GDA94

Northern Alternative Study Area

LNG Facility Site

Gas Transmission Pipeline

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

URS

Project: GLADSTONE LNG PROJECT
NORTHERN ALTERNATIVE

Title: **NORTHERN ALTERNATIVE STUDY AREA**

Drawn: LL	Approved: JB	Date: 22-03-2009
Job No: **4262 6220**	File No: 42626220-g-264.wor	

Figure: **1-1**

Rev:B

A3

Section 2 Land Use

2.1 Existing Land Use

Based on the Queensland Land Use Mapping Program (QLUMP) the majority of the northern alternative land is used for cattle grazing purposes (refer to Figure 2-1). There are also isolated pockets of production forestry (Targinie State Forest) plantations and fruit tree plantations; however it is understood from previous discussions with GSDA representatives that most of the fruit tree plantations are no longer operational.

It is recommended that the pipeline route avoid or minimise disturbance to these higher value production areas where possible.

151°0'0"E
151°5'0"E
151°10'0"E
23°45'0"S
23°50'0"S
The Narrows
Curtis Island
Port Curtis
Gladstone
Bruce Highway
Gladstone Mt Larcom Rd
Bruce Highway

- Channel/aqueduct
- Cropping
- Grazing natural vegetation
- Intensive animal production
- Intensive horticulture
- Irrigated cropping
- Irrigated perennial horticulture
- Irrigated seasonal horticulture
- Lake
- Managed resource protection
- Manufacturing and industrial
- Marsh/wetland
- Mining
- Nature conservation
- Other minimal use
- Perennial horticulture
- Plantation forestry
- Production forestry
- Reservoir/dam
- Residential
- River
- Services
- Transport and communication
- Utilities
- Waste treatment and disposal

N
W E
S

0 1 2 4
Kilometers

Scale 1:80 000 (A3)
Datum: GDA94

- Gas Transmission Pipeline
- Northern Alternative Study Area
- LNG Facility Site

Client

Project
GLADSTONE LNG PROJECT
LANDUSE ASSESSMENT
NORTHERN ALTERNATIVE

Title
LAND USE WITHIN NORTHERN ALTERNATIVE STUDY AREA

Drawn: MG	Approved: JB	Date: 20-03-2009	Figure: **2-1**
Job No.: **42626220**	File No.: 42626220-g-228.mxd		Rev. B A3

Section 2 Land Use

2.2 Tenure

The majority of land in the study area is freehold tenure (refer to Figure 2-2). Native title will not be applicable across these freehold areas. Small areas of State Land and Reserve are located at the fringe of the northern alternative study area. The study area encompasses a number of GSDA precincts including Yarwun, Aldoga and Targinie Precincts.

The northern alternative study area covers numerous small property lots, the majority being located on GSDA land and owned by the state government.

151°E
151.05°E
151.1°E
151.15°E
151.2°E
151.25°E
23.75°S
23.8°S
23.85°S
23.9°S
The Narrows
Curtis Island
Port Curtis
Bruce Highway
Gladstone Mt Larcom Rd
Port Curtis Way
Callliope River Rd
Bruce Highway
GLADSTONE

N
W E
S

0 1.25 2.5km
Scale 1:80 000 (A3)
Datum : GDA94

Northern Alternative Study Area
LNG Facility Site
Gas Transmission Pipeline

Freehold
Leasehold
Reserve
State Land
National Park
State Forest
Industrial Land

Client

LNG

URS

Project
GLADSTONE LNG PROJECT
LAND USE ASSESSMENT
NORTHERN ALTERNATIVE

Title
LAND TENURE

Drawn: CA	Approved: JB	Date: 22-03-2008
Job No: **4262 6220**	File No: 42626220-g-229b.wor	

Figure: **2-2**

Rev:B
A3

Section 2 Land Use

2.3 Infrastructure

A 250kV power line, the East End Mine Branch and North Coast Railway lines (electrified) are located within the northern alternative study area. Appropriate pipeline protection may need to be installed to avoid electrical interference to the pipeline in the vicinity this infrastructure.

The Bruce Highway and Mount Larcom-Yarwun Road are significant regional roads within the study area (refer to Figure 2-3). Construction techniques will need to avoid or minimise disruption to these high volume traffic routes.

The northern alternative study area is located outside of the 'Material Transportation & Services Corridor', a designated infrastructure corridor within the GSDA. The study area is also not in the vicinity of the proposed Stanwell- Gladstone pipeline corridor.

Pipelines
Powerlines
Railway
Major Roads
Roads
Airfields

Phillipies Landing Rd
Flinders Rd
Nichols Rd
Targinie Rd
Swan Rd
Targinie Rd
Forest Rd
Goodman Rd
Cullens Rd
The Narrows Rd
Mount Larcom
NORTH COAST LINE RAILWAY
Gladstone Mt Larcom Rd
EAST END MINE BRANCH RAILWAY
Bruce Highway
Millar Rd
Else Rd
NORTH COAST LINE RAILWAY
Gladstone Mt Larcom Rd
Mount Larcom Yarwun Rd
The Narrows
Curtis Island
Fisherman's Landing Wharf
Port Curtis
Gladstone
Beecher

N
W E
S

0 1 2 4
Kilometers
Scale 1:80 000 (A3)
Datum: GDA94

Gas Transmission Pipeline
Northern Alternative Study Area
LNG Facility Site

Client: LNG / URS

Project: GLADSTONE LNG PROJECT
INFRASTRUCTURE ASSESSMENT
NORTHERN ALTERNATIVE

Title: **INFRASTRUCTURE**

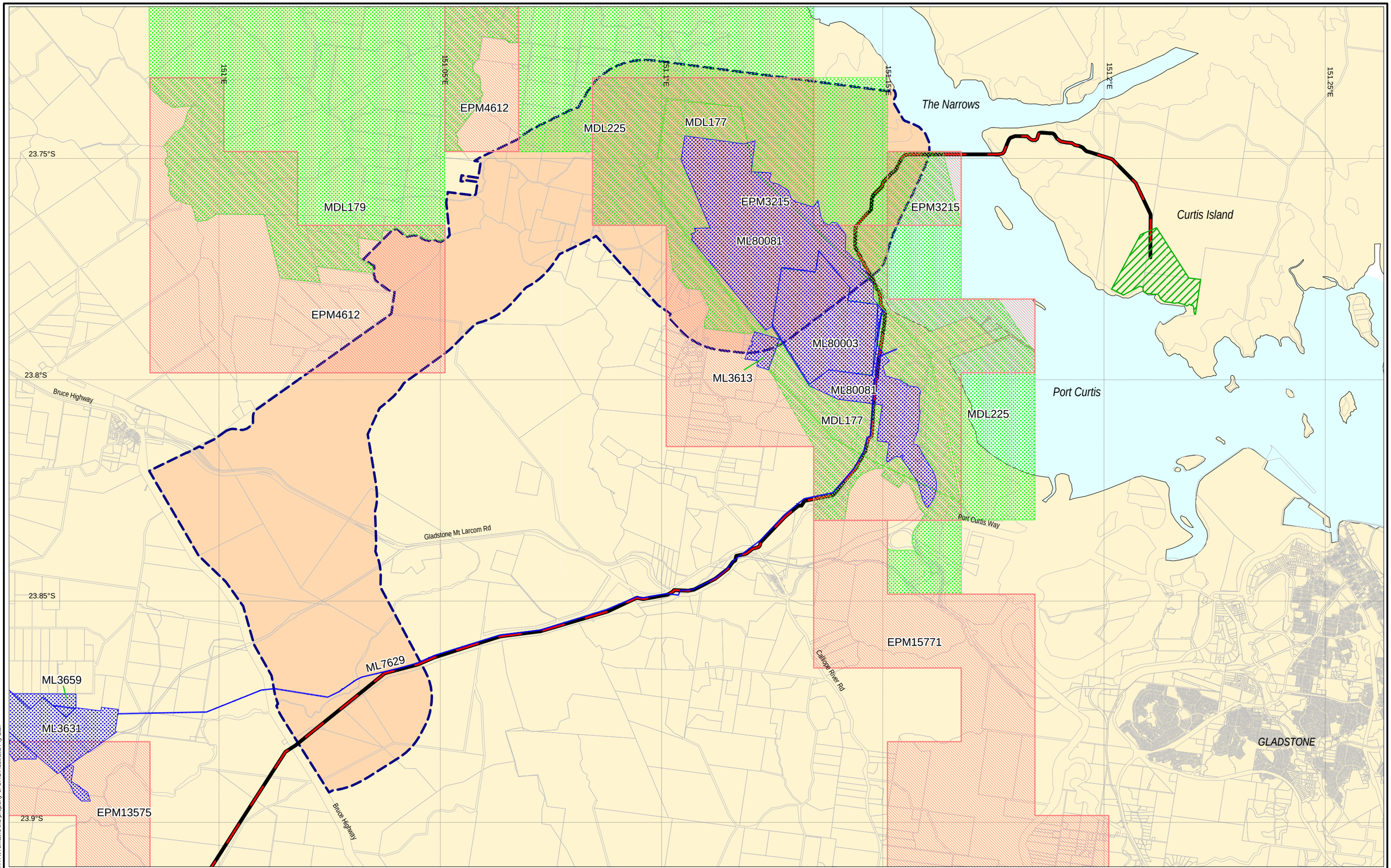
Drawn: MG	Approved: JB	Date: 20-03-2009	Figure: **2-3**	Rev. B
Job No.: **42626220**	File No.: 42626220-g-230.mxd			A3

Section 2 Land Use

2.4 Resource Areas

The eastern section of the northern alternative study area intersects the Stuart Oil Shale Lease (ML 80081 & ML8003). However, the northern alternative study area lies outside of the GSDA precinct which designates protection of the reserve ('Stuart Oil Shale Resource Preservation Area' precinct). A pipeline located at the northern end of the northern alternative study area could avoid these leases.

A number of mineral development licences (MDLs) and exploration permit minerals (EPMs) are located within the northern alternative study area, as shown in Figure 2-4.



N
W E
S

0 1.25 2.5km

Scale 1:80 000 (A3)
Datum: GDA94

- Exploration Permits Coal (EPC) NONE IN AREA
- Mining Lease (ML)
- Mineral Development Lease (MDL)
- Gas Transmission Pipeline
- Petroleum Leases (PL) NONE IN AREA
- Exploration Permits Minerals (EPM)
- Northern Alternative Study Area
- LNG Facility Site

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright. qld dEPARTMENT OF mINES & eNERGY, dATA CORRECT AS AT 08-11-2008.

Client: LNG

URS

Project: GLADSTONE LNG PROJECT
LAND USE ASSESSMENT
NORTHERN ALTERNATIVE

Title: MINERAL DEVELOPMENT LEASES (MDL), EXPLORATION PERMITS MINERALS (EPM), MINING LEASES (ML), PETROLEUM LEASES (PL), AND EXPLORATION PERMITS COAL (EPC)

Drawn: CA	Approved: JB	Date: 12-03-2009	Figure: 2-4	Rev:B
Job No: 4262 6220	File No: 42626220-g-232b.wor			A3

Section 2 Land Use

2.5 Planning Framework

2.5.1 Calliope Shire Planning Scheme

The northern alternative study area is located within the Calliope Shire – part of Gladstone Regional Council. Under the Calliope Shire planning scheme, the area is zoned as 'GSDA area' and 'Rural zone'. Pipeline construction and operation is compatible with these land use zonings.

2.5.2 Gladstone State Development Area

The majority of the northern alternative study area is within the Aldoga and Clinton Precincts (refer to Figure 2-5). Other precincts of note are the 'Restricted Development Precinct' at the far east of the study area. Intended use of these precincts is as follows:

- Aldoga - Industrial development of regional, state and national importance;
- Targinie Precinct – as above; and
- Restricted Development Precinct (title reference 2DT40146) - To provide for the establishment of infrastructure facilities and materials transport infrastructure while ensuring areas of ecological significance are recognised and managed.

151°E
151.1°E
151.2°E
151.3°E
151.4°E
23.7°S
23.8°S
23.9°S
Curtis Island
Coral Sea
Port Curtis
Facing Island
Bruce Hwy
Gladstone Mt Larcom Rd
Port Curtis Wy
Calliope River Rd
Gladstone
Dawson Hwy
Glenlyon Rd
Bruce Hwy

GSDA LEGEND

- Aldoga Precinct
- Clinton Precinct
- Corridor Area Buffer Precinct
- Curtis Island Industry Precinct
- Environmental Management Precinct
- Materials Transportation & Services Corridor
- Restricted Development Precint
- Stuart Oil Shale Reserve Preservation Area
- Targinie Precinct
- Yarwun Precinct

N
W E
S

0 2.5 5km
Scale 1:125 000 (A3)
Datum: GDA94

- Northern Alternative Study Area
- LNG Facility Site
- Gas Transmission Pipeline

Client: LNG / URS

Project: GLADSTONE LNG PROJECT
LAND USE ASSESSMENT
NORTHERN ALTERNATIVE

Title: **GLADSTONE STATE DEVELOPMENT AREA AND PRECINCTS**

Drawn: CA	Approved: JB	Date: 11-03-2009
Job No: **4262 6220**	File No: 42626220-g-232b.wor	

Figure: **2-5**

Rev:B
A3

Section 3 Nature Conservation

An assessment of ecological values was undertaken in order to conduct a constraints analysis over the northern alternative study area. The ecological values were assessed using a desktop approach, which included a review of all available literature and databases.

3.1 Review of Existing Information

Existing data on fauna within the study area was compiled through acquisition and review of the following key references:

- Department of Water, Heritage & the Arts (DEWHA) online Environmental Protection & Biodiversity Conservation (EPBC) Matters of National Environmental Significance (MNES) database;
- Queensland Environmental Protection Agency Wildnet database;
- Queensland Environmental Protection Agency Regional Ecosystem and Essential Habitat mapping v 5.0; and
- Species distribution maps from current field guides.

In order to identify the range of fauna species present within the northern alternative study area and the broader region, reviews of the above data sources were conducted for the area as defined by the coordinates presented in Table 3-1 below.

Table 3-1 Desktop Searches and Search Parameters

Database	Coordinates	Search Buffer
EPBC Protected Matters Report	Longitude 151.08E and Latitude 23.81S	25 kilometres
Wildnet Wildlife Online	Longitude 151.08E and Latitude 23.81S	25 kilometres
Regional Ecosystem mapping	Longitude 151.08E and Latitude 23.81S	10 kilometres
Essential Habitat Mapping	Longitude 151.08E and Latitude 23.81S	10 kilometres
Environmentally Sensitive Areas Mapping	Longitude 151.08E and Latitude 23.81S	10 kilometres

3.2 Regional Context

3.2.1 Bioregions

The northern alternative study area is situated predominantly within the Brigalow Belt bioregion, with a very small section of the study area within the South-East Queensland bioregion.

3.2.2 Sub-regions

The northern alternative study area falls primarily within the Mount Morgan Ranges sub-region of the Brigalow Belt bioregion. That study area within the South-East Queensland bioregion is contained within the Burnett-Curtis Hills and Ranges sub-region.

3.2.3 Site Characteristics

The study area lies to the north and north-west of Gladstone. It extends approximately 20 km from the Bruce Highway in a north-east direction to The Narrows. The widest point, in the west section of the study area, is

approximately 9 km in a north-south alignment. There are no major communities located within the study area; however the townships or localities of Mount Larcom, Butlerville, Targinie and Aldoga are located in close proximity.

The majority of the study area has been cleared of native vegetation for pastoral activities, although some areas of remnant vegetation remain. Topographical features within the study area include the Mt. Larcom Range, positioned within the central portion; a number of smaller ranges and hills, and the coastal plain adjacent to Port Curtis and The Narrows.

A number of creek systems drain the study area, including Larcom Creek, Mosquito Creek, Teningie Creek, and the headwaters of numerous minor waterways. Most waterways within the study area are ephemeral. The eastern portions of Mosquito Creek within the coastal plain are estuarine. Generally, the waterways are fringed by narrow riparian strips of vegetation which are relics of the extensive woodlands that were once present throughout the region.

3.3 Regional Ecosystems

Twenty-two regional ecosystems (REs) are mapped within the study area (Table 3-2). Of these, two are listed under the Vegetation Management Act (VM Act) as 'Of Concern', and three are listed as 'Endangered'. Conservation significant REs comprise approximately 6% of the study area (refer to Figure 3-1). Overall, remnant vegetation comprises approximately 27% of the study area.

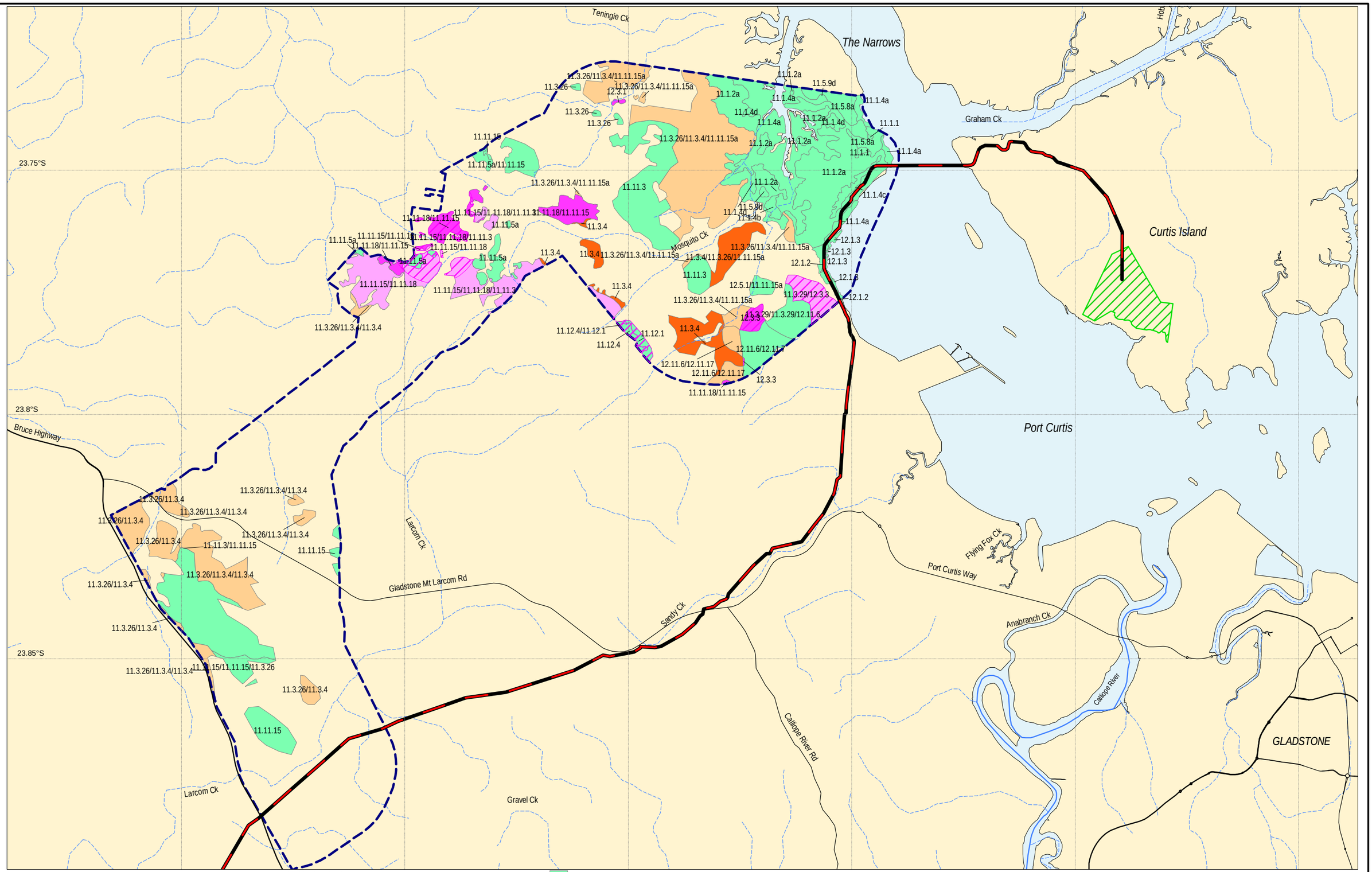
Table 3-2 Regional Ecosystems Mapped Within the Study Area

RE	Description	Area (ha)	VM Status[1]
11.1.1	*Sporobolus virginicus* grassland on marine clay plains	4.96	N
11.1.2	Samphire forbland on marine clay plains	498.26	N
11.1.4	Mangrove forest/woodland on marine clay plains	347.94	N
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	389.45	OC
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains	687.27	N
11.3.29	*Eucalyptus crebra, E. exserta, Melaleuca* spp. woodland on alluvial plains	100.59	N
11.5.8	*Melaleuca* spp., *Eucalyptus crebra, Corymbia intermedia* woodland on Cainozoic sand plains/remnant surfaces	64.98	N
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests	15.26	N
11.11.3	*Corymbia citriodora, Eucalyptus crebra, E. acmenoides* open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	450.78	N

[1] E=Endangered; OC= Of concern; N=Not Of concern

Section 3 Nature Conservation

RE	Description	Area (ha)	VM Status[1]
11.11.5	Microphyll vine forest ± *Araucaria cunninghamii* on old sedimentary rocks with varying degrees of metamorphism and folding	108.14	N
11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains	556.11	N
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	127.08	E
11.12.1	*Eucalyptus crebra* woodland on igneous rocks	15.91	N
11.12.4	Semi-evergreen vine thicket and microphyll vine forest on igneous rocks	9.78	N
12.1.2	Saltpan vegetation including grassland and herbland on marine clay plains	17.86	N
12.1.3	Mangrove shrub land to low closed forest on marine clay plains and estuaries	10.86	N
12.3.1	Gallery rainforest (notophyll vine forest) on alluvial plains	2.65	E
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains	29.14	E
12.5.1	Open forest complex with *Corymbia citriodora* on sub-coastal remnant Tertiary surfaces. Usually deep red soils	17.88	N
12.11.6	*Corymbia citriodora, Eucalyptus crebra* open forest on metamorphics ± interbedded volcanics	130.49	N
12.11.7	*Eucalyptus crebra* woodland on metamorphics ± interbedded volcanics	7.61	N
12.11.17	*Eucalyptus acmenoides* or *E. portuensis* open forest on metamorphics ± interbedded volcanics	4.63	OC
Non-remnant	N/A	5947	N/A
Ocean	N/A	249.3	N/A
Total		9793.93	-



Northern Alternative Study Area
LNG Facility Site
Gas Transmission Pipeline
Major Rivers
Minor Rivers

Not of Concern
Sub-dominant Of Concern
Dominant Of Concern
Sub-dominant Endangered
Dominant Endangered
Essential Habitat

N W E S

0 1.25 2.5km

Scale 1:80 000 (A3)
Datum : GDA94

Client: LNG

URS

Project: GLADSTONE LNG PROJECT
ECOLOGICAL ASSESSMENT
NORTHERN ALTERNATIVE

Title: **REGIONAL ECOSYSTEMS MAPPING**

Drawn: RG	Approved: JB	Date: 22-03-2009	Figure: **3.1**	Rev:B
Job No: **4262 6220**	File No: 42626220-g-226.wor			**A3**

Section 3 Nature Conservation

3.4 Habitat Values

The widespread clearing of native vegetation for the pastoral industry has reduced the quality and quantity of habitat available for native fauna. The proximity of the major urban and industrial centre of Gladstone has further reduced the viability of habitat within the study area. However, habitat for the hardier, generalist fauna species is present in places. Expanses of remnant vegetation are found adjacent to the western boundary, on the Mount Larcom Range in the centre of the study area, on the coastal plains and within intertidal areas. These are largely unconnected as the landscape has been modified.

Regional ecosystems vegetation mapping (EPA, 2005) in terrestrial areas indicates remnant vegetarian as being largely comprised of open forests and woodlands dominated by canopy species such as *Eucalyptus moluccana* (gum-topped box), *Corymbia citriodora* subsp. *citriodora* (lemon-scented gum) and *E. crebra* (narrow-leaved ironbark). Small areas of microphyll vine forest and semi-evergreen vine thicket are also present. These communities may act as habitat for a range of mammals, reptiles, amphibians and birds. However, their relatively small size, degree of disturbance and lack of functional connectivity would tend to limit fauna diversity and capacity to support sensitive species dependent upon high quality core habitat.

The microhabitat features present may also indicate faunal usage. Arboreal hollows, normally found in mature trees, could support possums, gliders, microbats and hollow-nesting birds where retained. In such an altered landscape, the narrow riparian fringe of *E. tereticornis* (forest red gum) along ephemeral waterways is one of the few communities where arboreal hollows would be common. Fire and forestry practices may have reduced arboreal hollow availability in many of the other remnant communities. The presence of stock can also reduce habitat values. Ground microhabitat such as grass tussocks, fallen timber, soil fissures and surface rocks are subject to disturbance by cattle where grazing is occurring. The steeper slopes of the Mt. Larcom Range and other outcrops support rocky habitat suitable for reptiles and ground mammals in particular. The unsuitability of steeper terrain for intensive grazing further increases their value for fauna as secure refugia.

It is likely that macropods are relatively common throughout the study area as their mobility and size provides an advantage over smaller mammals that are subject to predation by feral animals and sensitive to habitat disturbance. The eastern grey kangaroo (*Macropus giganteus*), red-necked wallaby (*M. rufogriseus*) and swamp wallaby (*Wallabia bicolor*) would be widespread in respective habitat types. A number of other macropod species may be present in very restricted habitat.

Birds, being the most mobile of all terrestrial fauna, would be well represented across all feeding groups. As with other fauna, sensitive species or specialists (such as those favouring semi-evergreen vine thickets) may become locally rare as habitat quality and quantity is reduced.

Due to the likely ephemeral nature of most of the streams present within the study area, permanent populations of fish are unlikely to be retained. The occasional flow events may result in commonly found hardy fish such as the spangled perch (*Leiopotherapon unicolor*) and bony bream (*Nematalosa erebi*) repopulating isolated waterholes. The lower brackish or saline reaches of Mosquito Creek would also be likely to support a typical suite of estuarine fish species found in the area.

3.5 Conservation Significant Fauna Records

The 24 species listed in Table 3-3 below, are sourced from the EPA's Wildlife Online database and the Commonwealth Matters of Environmental Significance (MNES) report for the study area.

Table 3-3 Conservation Significant Fauna Species

Species[1,2]	Common Name	Status		Likelihood of Presence
		NC Act[3]	EPBC Act[4]	
Lophoictinia isura[1]	square-tailed kite	R	-	Possible
Erythrotriorchis radiatus[2]	red goshawk	E	V	Unlikely
Accipiter novaehollandiae[1]	grey goshawk	R	-	Possible
Tadorna radjah[1]	radjah shelduck	R	-	Possible
Nettapus coromandelianus[1]	cotton pygmy-goose	R	-	Possible
Aerodramus terraereginae[1]	Australian swiftlet	R	-	Possible
Esacus magnirostris[1]	beach stone-curlew	V	-	Possible in intertidal areas
Calyptorhynchus lathami[1]	glossy black-cockatoo	V	-	Possible
Ephippiorhynchus asiaticus[1]	black-necked stork	R	-	Possible
Geophaps scripta scripta[1,2]	squatter pigeon (southern subspecies)	V	V	Probable
Falco hypoleucos[1]	grey falcon	R	-	Possible
Haematopus fuliginosus[1]	sooty oystercatcher	R	-	Possible in intertidal areas
Melithreptus gularis[1]	black-chinned honeyeater	R		Possible
Epthianura crocea macgregori[1]	yellow chat (Dawson)	E	CE	Unlikely as suitable habitat is probably not present
Lewinia pectoralis[1]	Lewin's rail	R	-	Possible
Numenius madagascariensis[1]	eastern curlew	R	-	Possible in intertidal areas
Ninox strenua[1]	powerful owl	V	-	Possible in the larger extents of remnant vegetation
Turnix melanogaster[1,2]	black-breasted button-quail	V	V	Possible
Pterodroma neglecta neglecta[2]	Kermadec petrel (western)	-	V	Unlikely
Macronectes giganteus[2]	southern giant-petrel	E	E	Unlikely
Rostratula australis[2]	painted snipe	V	V	Possible
Taphozous australis[1]	coastal sheathtail bat	V	-	Possible
Chalinolobus picatus[1]	little pied bat	R	-	Possible

Section 3 Nature Conservation

Species[1,2]	Common Name	Status		Likelihood of Presence
		NC Act[3]	EPBC Act[4]	
Nyctophilus timoriensis[1,2]	eastern long-eared bat	V	V	Possible
Chalinolobus dwyeri[2]	large-eared pied bat	R	V	Possible
Dasyurus hallucatus[2]	northern quoll	-	E	Unlikely
Xeromys myoides[2]	water mouse	V	V	Possible
Furina dunmalli[1,2]	Dunmall's snake	V	V	Possible
Egernia rugosa[1,2]	yakka skink	V	V	Possible
Ophioscincus cooloolensis[1]	Cooloola snake- skink	R	-	Unlikely as preferred habitat type not present
Denisonia maculata[2]	ornamental snake	V	V	Possible
Paradelma orientalis[2]	brigalow scaly-foot	V	V	Possible
Rheodytes leukops[2]	Fitzroy River Turtle	V	V	Possible
Varanus semiremex[1]	Rusty monitor	R	-	Possible

[1] Sourced from the EPA's Wildlife Online database.

[2] Sourced from the Commonwealth's EPBC Matters of Environmental Significance database.

[3] Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Presumed Extinct (PE), Endangered (E), Vulnerable (V), Rare (R), Common (C) or Not Protected ( ).

[4] Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*. The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

3.6 Conservation Significant Flora Records

The 17 flora species listed in Table 3-4 below, are sourced from the EPA's Wildlife Online database and the Commonwealth Matters of Environmental Significance (MNES) report for the study area.

Table 3-4 Conservation Significant Flora Species

Species	Common Name	Status		Likelihood of Presence
		NC Act[1]	EPBC Act[2]	
Cycas megacarpa[1,2]	No common name	E	E	Possible
Asplenium pellucidum[1]	No common name	V	V	Possible
Graptophyllum excelsum[1]	No common name	R	-	Possible
Alyxia magnifolia[1]	No common name	R	-	Possible
Parsonsia larcomensis[1,2]	No common name	V	V	Likely as Essential Habitat exists
Parsonsia lenticellata[1]	narrow-leaved parsonsia	R	-	Possible
Denhamia parvifolia[1]	No common name	V	V	Possible
Dansiea elliptica[1]	No common name	R	-	Possible
Macropteranthes fitzalanii[1]	No common name		-	Possible
Macropteranthes leiocaulis[1]	No common name	R	-	Possible
Acacia storyi[1]	No common name	R	-	Possible
Actephila sessilifolia[1]	No common name	R	-	Possible
Zieria actites[1]	No common name	V	-	Possible
Atalaya rigida[1]	No common name	R		Possible
Cupaniopsis shirleyana[1,2]	wedge-leaf tuckeroo	V	V	Likely as Essential Habitat exists
Atalaya calcicola[1]	No common name	R	-	Possible
Atalaya collina[1,2]	No common name	E	E	Possible
Bosistoa selwynii[2]	heart-leaved bosistoa	-	V	Possible
Bosistoa transversa[2]	three-leaved bosistoa	-	V	Possible
Leucopogon cuspidatus[2]	no common name	-	V	Possible
Quassia bidwillii[2]	quassia	V	V	Possible
Taeniophyllum muelleri[2]	minute orchid	-	V	Possible
Bulbophyllum globuliforme[2]	miniature moss-orchid	R	V	Possible

[1] Sourced from the EPA's Wildlife Online database.

[2] Sourced from the Commonwealth's EPBC Matters of Environmental Significance database.

[3] Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Presumed Extinct (PE), Endangered (E), Vulnerable (V), Rare (R), Common (C) or Not Protected ( ).

[4] Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*. The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Section 3 Nature Conservation

3.7 Environmentally Sensitive Areas

A number of environmentally sensitive areas (ESAs) are located in or around the study area including (refer to Figure 3-2):

- The Great Barrier Reef World Heritage Area (GBRWHA), which extends along The Narrows south to Graham Creek;
- The Great Barrier Reef Marine Park, the area of which is nearly identical to that of the GBRWHA, with the exclusion of state owned islands and internal waters;
- The Great Barrier Reef Coastal Marine Park, which includes all tidal waters and tidal land between the tip of Cape York to Baffle Creek (north of Bundaberg) and extends approximately three nautical miles seaward from Highest Astronomical Tide (HAT);
- There are no terrestrial national parks within the study area;
- Targinie State Forest (in two parcels) is the only managed terrestrial estate present within the study area;
- The Directory of Important Wetlands in Australia (DIWA) lists the following nationally important wetlands in the area (EPA, 2003):
  - Great Barrier Reef Marine Park;
  - Northeast Curtis Island;
  - Port Curtis; and
  - The Narrows.
- There are no referable wetlands under the Integrated Planning Regulation 1998 at or near the project site; and
- Essential Habitat for the conservation significant flora species *Cupaniopsis shirleyana* (wedge-leaf tuckeroo), *Parsonsia larcomensis* and *Quassia bidwillii* is mapped within the study area.

3.8 Corridor Linkages

Ecological corridor linkages are typically poor within the study area due to historical clearing practices. Remnant vegetation on the Mt Larcom Range, on the coastal plain and riparian communities along watercourses offer some habitat connectivity and functional opportunity for fauna movement in the area, however these linkages are relatively poor in the context of the overall landscape.

National Estate

- National Park (scientific)
- National Park
- National Park (recovery)
- Conservation Park
- Resources Reserve
- Forest Reserve
- State Forest
- Timber Reserve
- Land
- Coastline
- Road
- Towns

State Marine Park Zone

- General Use
- Habitat Protection
- Conservation Park
- Estuarine Conservation
- Buffer
- Marine National Park
- Preservation
- Scientific Research
- Directory of Important Wetlands
- Great Barrier Reef World Heritage Area

151°5'0"E
151°10'0"E
151°15'0"E
23°45'0"S
23°50'0"S
SCRUBBY MOUNTAIN STATE FOREST
MOUNT LARCOM STATE FOREST
TARGINIE STATE FOREST
The Narrows Wetland Aggregation
The Narrows Habitat Protection Zone
Curtis Island
Butlerville
Fisherman's Landing Wharf
Targinie
Port Curtis
GARDEN ISLAND CONSERVATION PARK
Port Curtis Wetland Aggregation
Bruce Highway
Mount Larcom
Gladstone Mt Larcom Rd
Aldoga
Yarwun
Port Curtis Way
Callemondah
West Gladstone
Gladstone
Byellee
Clinton
New Auckland
Kin Kora
MOUNT STOWE STATE FOREST
CALLIOPE CONSERVATION PARK

N
W E
S

0 1 2 4
Kilometers

Scale 1:80 000 (A3)
Datum: GDA94

- Gas Transmission Pipeline
- Northern Alternative Study Area
- LNG Facility Site

Client: LNG / URS

Project: GLADSTONE LNG PROJECT
ECOLOGICAL ASSESSMENT
NORTHERN ALTERNATIVE

Title: **ENVIRONMENTALLY SENSITIVE AREAS**

Drawn: MG	Approved: JB	Date: 20-03-2009	Figure: **3-2**	Rev. B
Job No.: **42626220**	File No.: 42626220-g-231.mxd			A3

Section 4 Marine Ecology

The marine and coastal areas potentially affected by the pipeline northern alternative comprise a range of habitats, including:

- Seagrass meadows;
- Mangroves;
- Intertidal areas; and
- Estuaries.

4.1 Description of Environment

The intertidal strip from Friend Point south along the coast to Fisherman's Landing was investigated by URS in June 2008. Investigations were conducted as part of the EIS process; however the project brief at that time excluded investigations further to the west and north-west. Therefore a desktop assessment of the study area has been completed for this section.

Aerial seagrass observations of exposed intertidal banks were undertaken in May 2008, revealing patchy *Zostera capricornii* adjoining the east coast of Kangaroo Island (and as shown in Figure 4-1). Subtidal investigations were conducted for the area between Friend and Laird Points. The results from these surveys are presented in Appendix R1 of the EIS.

The marine and coastal habitats to the west of Kangaroo Island and Friend Point are expected to be similar to those described in Section 8-7 of the EIS.

The majority of mangroves in the area are likely to be composed of closed *Rhizophora* forests, with open *Avicennia/Ceriops* forests at higher elevations, and smaller patches of closed, mixed systems. The regional ecosystem analysis described in Section 3 of this report contains a description of the vegetation communities present in the area.

As there is little direct information on the estuarine and coastal habitats in this area, it would be recommended that if this option were to proceed then field surveys should be carried out to gain a better understanding of these habitats.

N
W E
S

0 0.5 1.0 1.5 2.0Km

APPROXIMATE SCALE

Northern Alternative Study Area

REDCLIFFE ISLAND
DUFFY CREEK
WOPPINGTON ISLAND
void
Mackay/Capricorn
DEEP CREEK
SCRUBBY CREEK
TENINGIE CREEK
BLOWER SPIT
TARGINIE
KANGAROO ISLAND
GRAHAM CREEK
LAIRD POINT
FRIEND POINT
HUMPY CREEK
TARGINIE CREEK
0 1.9km

Legend

Seagrass Meadows - Gladstone
- Isolated patches
- Aggregated patches
- Continuous cover

Place Names Gazetteer

Directory of Important Wetlands

Foreshore

Seagrass Meadows - Qld 1984-88

Coastal Management Plan Regions
- Cape York Peninsula Coast
- Capricorn Coast
- Cardwell-Hinchinbrook Coast
- Curtis Coast
- Dry Tropical Coast
- Gulf of Carpentaria Coast
- South-east Queensland Coast
- Torres Strait Coast
- Wet Tropic Coast
- Whitsunday Coast
- Wide Bay Coast

Marine Parks
(more)

- Buffer
- Conservation
- Conservation/Mineral Resource
- Conservation Park
- Estuarine Conservation
- General Use
- General Use A
- General Use B
- Habitat
- Habitat Protection
- Marine National Park A
- Marine National Park B
- National Park
- Preservation
- Protection
- Scientific Research

Coastal Wetlands - Central
- Closed Aegiceras
- Closed Avicennia
- Closed Avicennia/Ceriops
- Closed Ceriops
- Closed Mixed

(more)

- Closed Rhizophora
- Closed Rhizophora/Aegiceras
- Closed Rhizophora/Avicennia
- Closed Rhizophora/Ceriops
- Dense Seagrass
- Exposed Banks
- Medium Seagrass
- Open Avicennia
- Open Avicennia/Ceriops
- Open Ceriops
- Saline Grassland
- Saltpan
- Sparse Seagrass
- Water and Terrestrial

Dugong Protection Areas
- A
- B

Coastline

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 / URS	Project: GLADSTONE LNG PROJECT MARINE ECOLOGY ASSESSMENT NORTHERN ALTERNATIVE		Title: **COASTAL HABITAT RESOURCES AND ZONING**
	Drawn: CA	Approved: JB	Date: 22-03-2009
	Job No.: **4262 6220**	File No. 42626220-g-262b.cdr	Figure: **4-1** Rev. B A3

Section 4 Marine Ecology

4.2 Potential Impacts

The potential impacts of locating a pipeline through the estuarine system to the west of Kangaroo Island could include, but are not limited to:

- Loss/modification of habitat associated with clearing of mangroves, trenching activities;
- Loss/modification of intertidal areas;
- Possible disturbance of acid sulfate soils;
- Changes to flows/hydrodynamics in the estuarine systems;
- Creation of turbid plumes;
- Possibility of spills of oils, fuels or chemicals;
- Introduction of pest species; and
- Direct impacts on fauna.

4.3 Potential Mitigation Measures

Detailed mitigation measures have been described in section 8.4 of the GLNG EIS. These measures will be incorporated into the Gas Transmission Pipeline EMP, including any site specific measures identified as part of Phase 2 protocol assessment work.

The study area includes a land area of approximately 9,800 ha, which deviates from the proposed gas transmission pipeline corridor in the vicinity of Kp 400 km and extends in a northerly direction, encompassing a 2-3 km wide buffer through undulating and low hilly to hilly lands to the west of the Mount Larcom Range. The route traverses the northern sector of the Mount Larcom range then heads in an easterly direction towards Curtis Island.

5.1 Method of Assessment

The terrain has been assessed in terms of geological regimes, landform types and associated soils. The mapping has been carried out with reference to existing geological, topographic, soils and land resources information as the basis for identifying terrain units that occur within the area using the procedures detailed in Appendix L2 of the EIS.

As mapped, a terrain unit comprises a single or recurring area of land that is considered to have a predictable combination of physical attributes in terms of bedrock, surface slope and form, and soil/substrate conditions. Accordingly, engineering and environmental characteristics determined for a particular terrain unit may be extrapolated to other mapped occurrences of the same terrain unit.

5.1.1 Desktop Assessment

The terrain analysis undertaken for the study area has essentially involved an desktop assessment of terrain conditions along the route as a means of identifying areas of potential high engineering/geological constraints for pipeline construction, as well as areas of potentially high environmental impact that may result from construction of the pipeline in particular locations. To date, limited field investigation work has been undertaken within the study area. This was carried out as part of an acid sulfate soils investigation on the coastal flats in the vicinity of Friend Point for the initially proposed gas transmission pipeline corridor. More detailed field investigations including soil drilling or test pitting, soil sampling and testing will be undertaken if the northern deviation pipeline option proceeds.

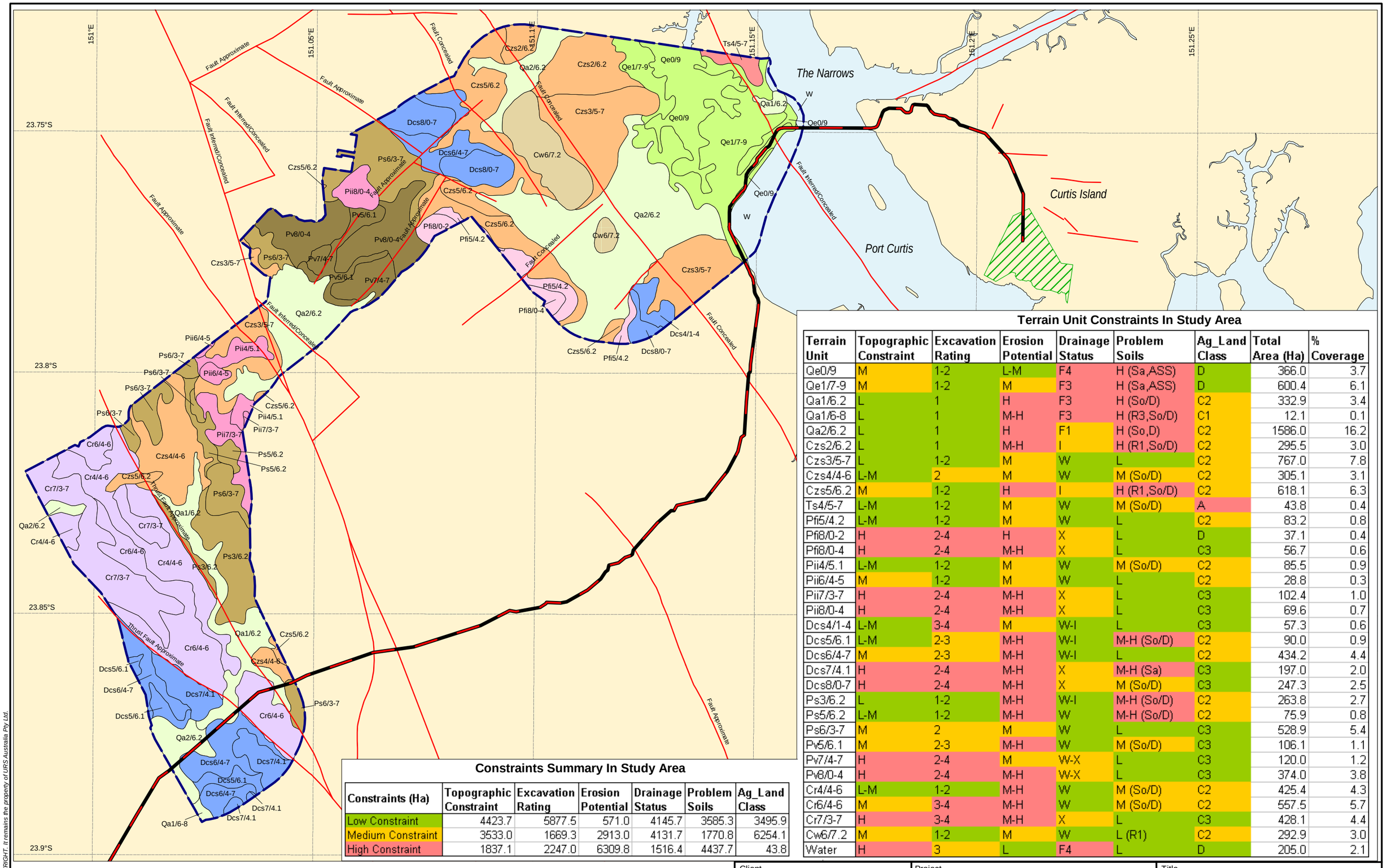
5.2 Terrain Units and Soils

The terrain units located within the study area are shown in Figure 5-1 in which they are coloured on the basis of the geological regime in which they occur. A key to the identification of terrain units (including a general description of a range of soils types likely to occur in the area) is provided in Appendix L2 of the EIS. Detailed descriptions of the terrain units and associated soil types, together with an assessment of engineering/environmental attributes and constraints for construction and on-going operations are also included in Appendix L2. A summary of the terrain units identified within the study area together with the engineering/environmental constraints and potential impacts assessed are included in Table 5-1. The basis for the assessment of construction constraints and associated environmental impacts on a terrain unit basis is addressed in detail in Appendix L2.

Section 5 Terrain Soils and Land Capability

Table 5-1 Terrain Unit Assessment of Engineering/Environmental Constraints and Impacts

Terrain Unit	Area (ha)	%	Topographic Constraints	Excavation Rating	Erosion Potential	Drainage Status	Problem Soils	Ag. Land Class
Qe0/9	366.0	3.7	M	1-2	L-M	F4	H(Sa/ASS)	D
Qe1/7-9	600.4	6.1	M	1-2	M	F3	H(Sa/ASS)	D
Qa1/6.2	332.9	3.4	L	1	H	F3	H(So/D)	C2
Qa1/6-8	12.1	0.1	L	1	M	F3	H(R1,So/D)	C1
Qa2/6.2	1586	16.2	L	1	M-H	F1	H(So/D)	C2
Czs2/6.2	295.5	3.0	L	1	M-H	I	H(R1,So/D)	C2
Czs3/5-7	767.0	7.8	L	1-2	M	W	M(So/D)	C2
Czs4/4-6	305.1	3.1	L-M	2	M	W	M(So/D)	C2
Czs5/6.2	618.2	6.3	L-M	1-2	H	I	H(R1,So/D)	C2
Ts4/5-7	43.8	0.4	L-M	1-2	M-H	W	M(So/D)	C1
Pfi5/4.2	83.2	0.8	L-M	1-2	M	W	L	C2
Pfi8/0-2	37.1	0.4	H	2-4	H	X	L	D
Pfi8/0-4	56.7	0.6	H	2-4	M-H	X	L	C2
Pii4/5.1	85.5	0.9	L-M	1-2	M	W	M(So/D)	C2
Pii6/4-5	28.8	0.3	M	1-2	M	W	L	C2
Pii7/3-7	102.4	1.0	H	2-4	M-H	X	L	C3
Pii8/0-4	69.6	0.7	H	2-4	M-H	X	L	C3
Dcs4/1-4	57.4	0.6	L-M	3-4	M	W-I	L	C3
Dcs5/6.1	90.0	0.9	L-M	2-3	M-H	W-I	M-H(So/D)	C2
Dcs6/4-7	434.2	4.4	M	2-3	M-H	W-I	L	C2
Dcs7/4.1	197.0	2.0	H	2-4	M-H	X	M-H(Sa)	C3
Dcs8/0-7	247.4	2.5	H	2-4	M-H	X	M(So/D)	C3
Ps3/6.2	263.8	2.7	L	1-2	M-H	W-I	M-H(So/D)	C2
Ps5/6.2	75.9	0.8	L-M	1-2	M-H	W	M-H(So/D)	C2
Ps6/3-7	528.9	5.4	M	2	M	W	L	C3
Pv5/6.1	106.1	1.1	L-M	2-3	M-H	W	M(So/D)	C3
Pv7/4-7	120.0	1.2	H	2-4	M	X	L	C3
Pv8/0-4	374.0	3.8	H	2-4	M-H	X	L	C3
Cr4/4-6	425.4	4.3	L-M	1-2	M-H	W	M(So/D)	C2
Cr6/4-6	557.5	5.7	M	3-4	M-H	W	M(So/D)	C2
Cr7/3-7	428.1	4.4	H	3-4	M-H	X	L	C3
Cw6/7.2	292.9	3.0	M	1-2	M	W	L(R1)	C2
Water	205.0	2.1	H	3	L	F4	L	D
Total	**9793.9**	**100**	-	-	-	-	-	-



Terrain Unit Constraints In Study Area

Terrain Unit	Topographic Constraint	Excavation Rating	Erosion Potential	Drainage Status	Problem Soils	Ag_Land Class	Total Area (Ha)	% Coverage
Qe0/9	M	1-2	L-M	F4	H (Sa,ASS)	D	366.0	3.7
Qe1/7-9	M	1-2	M	F3	H (Sa,ASS)	D	600.4	6.1
Qa1/6.2	L	1	H	F3	H (So/D)	C2	332.9	3.4
Qa1/6-8	L	1	M-H	F3	H (R3,So/D)	C1	12.1	0.1
Qa2/6.2	L	1	H	F1	H (So,D)	C2	1586.0	16.2
Czs2/6.2	L	1	M-H	I	H (R1,So/D)	C2	295.5	3.0
Czs3/5-7	L	1-2	M	W	L	C2	767.0	7.8
Czs4/4-6	L-M	2	M	W	M (So/D)	C2	305.1	3.1
Czs5/6.2	M	1-2	H	I	H (R1,So/D)	C2	618.1	6.3
Ts4/5-7	L-M	1-2	M	W	M (So/D)	A	43.8	0.4
Pfi5/4.2	L-M	1-2	M	W	L	C2	83.2	0.8
Pfi8/0-2	H	2-4	H	X	L	D	37.1	0.4
Pfi8/0-4	H	2-4	M-H	X	L	C3	56.7	0.6
Pii4/5.1	L-M	1-2	M	W	M (So/D)	C2	85.5	0.9
Pii6/4-5	M	1-2	M	W	L	C2	28.8	0.3
Pii7/3-7	H	2-4	M-H	X	L	C3	102.4	1.0
Pii8/0-4	H	2-4	M-H	X	L	C3	69.6	0.7
Dcs4/1-4	L-M	3-4	M	W-I	L	C3	57.3	0.6
Dcs5/6.1	L-M	2-3	M-H	W-I	M-H (So/D)	C2	90.0	0.9
Dcs6/4-7	M	2-3	M-H	W-I	L	C2	434.2	4.4
Dcs7/4.1	H	2-4	M-H	X	M-H (Sa)	C3	197.0	2.0
Dcs8/0-7	H	2-4	M-H	X	M (So/D)	C3	247.3	2.5
Ps3/6.2	L	1-2	M-H	W-I	M-H (So/D)	C2	263.8	2.7
Ps5/6.2	L-M	1-2	M-H	W	M-H (So/D)	C2	75.9	0.8
Ps6/3-7	M	2	M	W	L	C3	528.9	5.4
Pv5/6.1	M	2-3	M-H	W	M (So/D)	C3	106.1	1.1
Pv7/4-7	H	2-4	M	W-X	L	C3	120.0	1.2
Pv8/0-4	H	2-4	M-H	W-X	L	C3	374.0	3.8
Cr4/4-6	L-M	1-2	M-H	W	M (So/D)	C2	425.4	4.3
Cr6/4-6	M	3-4	M-H	W	M (So/D)	C2	557.5	5.7
Cr7/3-7	H	3-4	M-H	X	L	C3	428.1	4.4
Cw6/7.2	M	1-2	M	W	L (R1)	C2	292.9	3.0
Water	H	3	L	F4	L	D	205.0	2.1

Constraints Summary In Study Area

Constraints (Ha)	Topographic Constraint	Excavation Rating	Erosion Potential	Drainage Status	Problem Soils	Ag_Land Class
Low Constraint	4423.7	5877.5	571.0	4145.7	3585.3	3495.9
Medium Constraint	3533.0	1669.3	2913.0	4131.7	1770.8	6254.1
High Constraint	1837.1	2247.0	6309.8	1516.4	4437.7	43.8

N W E S

0 1.25 2.5km

Scale 1:80 000 (A3)
Datum: GDA94

Northern Alternative Study Area

LNG Facility Site

Gas Transmission Pipeline

Client: LNG / URS

Project: GLADSTONE LNG PROJECT
TERRAIN SOILS AND
LAND CAPABILITY ASSESSMENT
NORTHERN ALTERNATIVE

Title: **GEOLOGY AND TERRAIN UNITS**

Drawn: CA | Approved: JB | Date: 22-03-2009

Job No: **4262 6220** | File No: 42626220-g-225b.wor

Figure: **5-1** | Rev:B | A3

Section 5 Terrain Soils and Land Capability

5.3 Pipeline Construction – Potential Constraints and Impacts

The engineering constraints and associated potential environmental impacts that will influence the planning and selection of the preferred location of the alternative pipeline alignments within the study area include, but are not limited to, the following:

- Topographic constraints;
- Excavation rating – which relates to the ease or difficulty of excavation within the typical pipeline trench depth;
- Erosion potential - if the land is subject to clearing or disturbance associated with pipeline construction;
- Drainage status - assessment of area drainage conditions and susceptibility to flooding/tidal inundation;
- Problem soils - the occurrence of reactive soils, sodic, dispersive and/or saline soils including acid sulfate soils (ASS);
- Agricultural land classes – potential changes to agricultural land capability; and
- Seismicity and ground stability.

5.4 Summary of Findings

The study area encompasses a total land area of 9,794 ha, which together with the occurrence and distribution of terrain units within the area are as shown in Figure 5-1. On a terrain unit basis, an assessment of potential pipeline location and construction constraints and associated environmental impacts is shown in Table 5-1. A summary of findings is as follows:

***Topographic Constraints**:* - Approximately 1,837 ha (18.8%) of the study area has been assessed as having high (H) or moderate to high (M-H) levels of topographic constraint and by association a potentially high level of environmental impact. A further 3,533 ha (36%) of the study area has been assessed as having a moderate (M) level of topographic constraint and by association a potential moderate level of environmental impact. The remaining 4,424 ha (45.2%) of the study area has been assessed as having low (L) or low to moderate (L-M) levels of topographic constraint and by association a low level of environmental impact..

Excavation Conditions- The likelihood of encountering difficult excavation conditions (in particular strong rock) within pipeline trench depth (2.0-2.5 m) has been assessed. The assessment is broadly based on the increasing levels of engineering effort and/or specialist excavation techniques and equipment required to complete the trench excavation. The rating classes used range from Rating 1 (readily excavated using a conventional buck-wheel excavator), Rating 2 (tracked excavator with low strength rock ripping capability), Rating 3 (typically requiring the use of a heavy-duty continuous chain-digger), and Rating 4 (requiring heavy rock-breaking equipment or drill and blast techniques).

Approximately 2,247 ha (23%) of the study area has been assessed as having Class 2-4 or Class 3-4 substrate conditions, thereby presenting a potentially high level of environmental impact. A further 1,669 ha (17%) of the study area has been assessed as having Class 2, Class 2-3 or Class 3 substrate conditions, thereby presenting a potential moderate level of environmental impact. The remaining 5,878 ha (60%) of the study area has been assessed as having Class 1 or Class 1-2 substrate conditions, thereby presenting a low level of environmental impact.

***Erosion Potential**:* - Approximately 6,310 ha (64%) of the study area has been assessed as having moderate to high (M-H) or high (H) erosion potential, thereby presenting a potentially high level of environmental impact. A further 2,913 ha (30%) of the study area has been assessed as having a moderate (M) level of erosion potential and by association a moderate level of environmental impact . The remaining 571ha (6%) of the study area has been assessed as having low (L) or low to moderate (L-M) levels of erosion potential, thereby presenting a low level of environmental impact.

Drainage Status:- A total of 1,516 ha (15.5%) of the study area has been assessed as being subject to periodic or regular (frequent) stream flooding or tidal inundation (F3 or F4) thereby presenting a potential high level of constraint and environmental impact. A further 4,132 ha (42%) of the study area has been assessed as being subject to infrequent flooding (F1), including poorly drained areas (I) or excessively well-drained (W-X or X) steeply sloping lands, assessed to represent a moderate level of engineering constraint and associated environmental impact. The remaining 4,146 ha (42.5%) of the study area comprises essentially well-drained (W or W-I) lands, thereby presenting a low level of environmental constraint and associated impact.

Problem Soils:- Approximately 4,438 ha (45%) of the study area has been assessed as having high (H) or moderate to high (M-H) levels of reactive, sodic and/or potentially dispersive, saline and ASS soil layers (mainly in the subsoil horizons), thereby representing a potentially high level of environmental impact if exposed and unprotected. A further 1,771 ha (18%) of the study area have been assessed as having moderate (M) levels of sodic and/or potentially dispersive soil layers (mainly in the subsoil horizons), thereby representing a moderate level of environmental impact if exposed and unprotected. The remaining 3,585 ha (37%) of the study area do not contain problem soil occurrences, thereby representing a low level of potential environmental impact.

***Agricultural Land Classes**;* - As mapped, only a very small area of 44 ha (0.4%) within the study area has been rated as Land Class A. A further 12 ha (0.1%) has been rated as Land Class C1. Collectively, these areas represent the only land considered to be suited to regular or limited cultivation for cropping purposes. Approximately 6,242 ha (64%) of the study area has been assessed as Land Class C2 (grazing on good quality native pastures). A further 2,287 ha (23.5%) of the area has been assessed as Land Class C3 (limited grazing lands). The remaining 1,209 ha (12.5%) of the land in the study area has been rated as Land Class D (non-agricultural lands). In terms of potential environmental impact, pipeline construction in Class A lands represents a potential high level of impact. Pipeline construction in Class C1 or Class C2 lands represents a moderate level of potential environmental impact. Pipeline construction in Class C3 and Class D lands, represents a low level of environmental impact with respect to the alienation of good quality agricultural lands.

Seismicity and Ground Stability:- A preliminary review of regional seismicity events and consideration of the location of potential geological hazards (primarily major geological structural features and faults) and the likelihood of damage to the gas pipeline and associated facilities due to potential ground instability, has been undertaken, with findings provided in Appendix L2. The approximate locations of known and inferred geological fault lines are shown in Figure 5-1. These features represent potential zones of instability with respect to pipeline location and construction.

The potential severity of the seismic faults and ground instability has not been accurately determined, and the effects on the pipeline are as yet unknown. A detailed investigation will be undertaken during FEED to identify and quantify any such problems. The results of this investigation will allow appropriate mitigation measures to be determined to ensure pipeline integrity during the full design life of the project.

Section 6 Contaminated Land

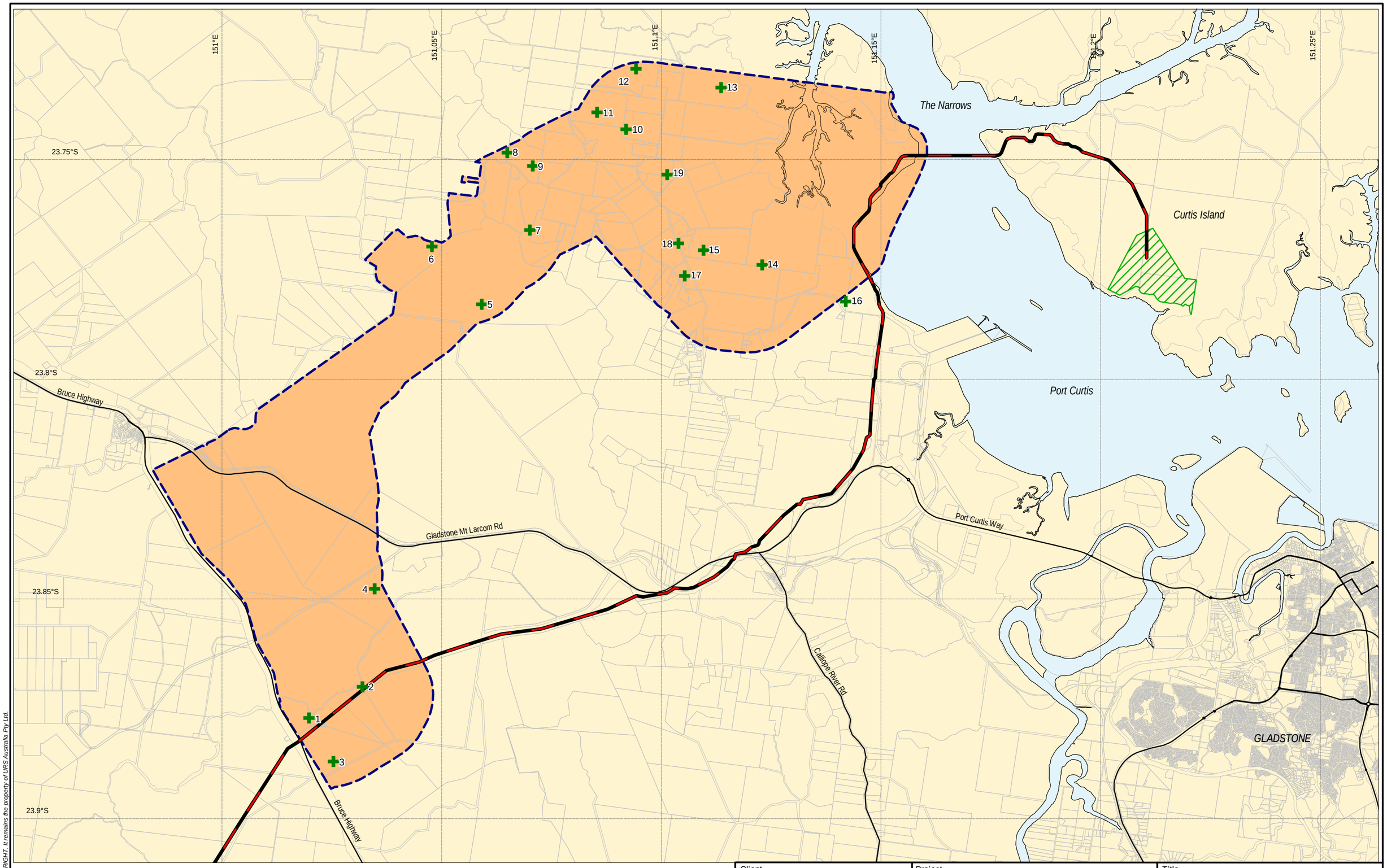
6.1 Contaminated Land Assessment

The review of the study area included an appraisal of aerial photography. Nineteen Areas of Potential Concern (AOPC) were identified within the study area with the potential to be contaminated on the basis of existing infrastructure (e.g. chemical storage tanks, cattle dip sites, industrial facilities and unknown ground disturbance) and potentially contaminating activities that may have occurred there, as shown in Figure 6-1.

The following list highlights the AOPCs identified during this review. The location numbers relate to the locations identified in Figure 6-1

1. Discolouration – soil disturbance (unknown reason);
2. Cattle Dip – identified through typical paddock configuration and structures located adjacent to creek;
3. Soil disturbance – possibly a dried out dam;
4. Soil disturbance – possible dam;
5. Unknown Aboveground Storage Tank;
6. Unknown Aboveground Storage Tank;
7. Unknown Aboveground Storage Tank;
8. Discolouration – soil disturbance (unknown reason);
9. Discolouration – soil disturbance (unknown reason);
10. Unknown Aboveground Storage Tank;
11. Unknown Aboveground Storage Tank;
12. Discolouration – soil disturbance (unknown reason);
13. Quarry/Mine;
14. Soil disturbance - discolouration – possible old dam;
15. Unknown Aboveground Storage Tank;
16. Mine;
17. Discolouration – soil disturbance (unknown reason);
18. Unknown Aboveground Storage Tank & possible drums/rubbish; and
19. Discolouration – soil disturbance (unknown reason).

The above AOPCs have been selected from visual assessment of aerial photography. Prior to the selection of the final pipeline route, each AOPC will be field assessed in greater detail to ascertain the potential for current or historical soil and/or groundwater contamination. Site specific management measures will then need to be developed (such measures will be included in the final pipeline EMP). These measures will include a range of strategies dependent on site status, including site avoidance, site remediation and site management.



Client

URS

Project

GLADSTONE LNG PROJECT
CONTAMINATED LAND ASSESSMENT
NORTHERN ALTERNATIVE

Drawn: CA | Approved: JB | Date: 12-03-2009

Job No: **4262 6220** | File No: 42626220-g-224b.wor

Title

IDENTIFIED AREAS OF POTENTIAL CONCERN

Figure: **6-1**

Rev:B

A3

Section 7 Surface Water

7.1 Hydrological Overview

The study area is located within the Calliope River Basin. The major watercourses within the study area include Deep, Targinie, Mosquito, Humpy, Scrubby, Larcom and Police Creeks and Sneaker Gully (refer Figure 7-1). All of these watercourses are ephemeral. Periods of flow are generally short and limited to periods during and immediately after rainfall. The downstream receiving water is the Great Barrier Reef, an Environmental Protection Agency (EPA) designated wetland and a World Heritage Area.

7.2 Environmental Values

Specific environmental values for the watercourses within the study area are not defined within the Environmental Protection Policy (Water) and there are no detailed local plans relating to environmental values for the catchments. Using data gathered from a site visit (which was undertaken in close proximity to study area and within the same basin) and desktop studies, environmental values have been identified for the watercourses within the Calliope Basin, as detailed below.

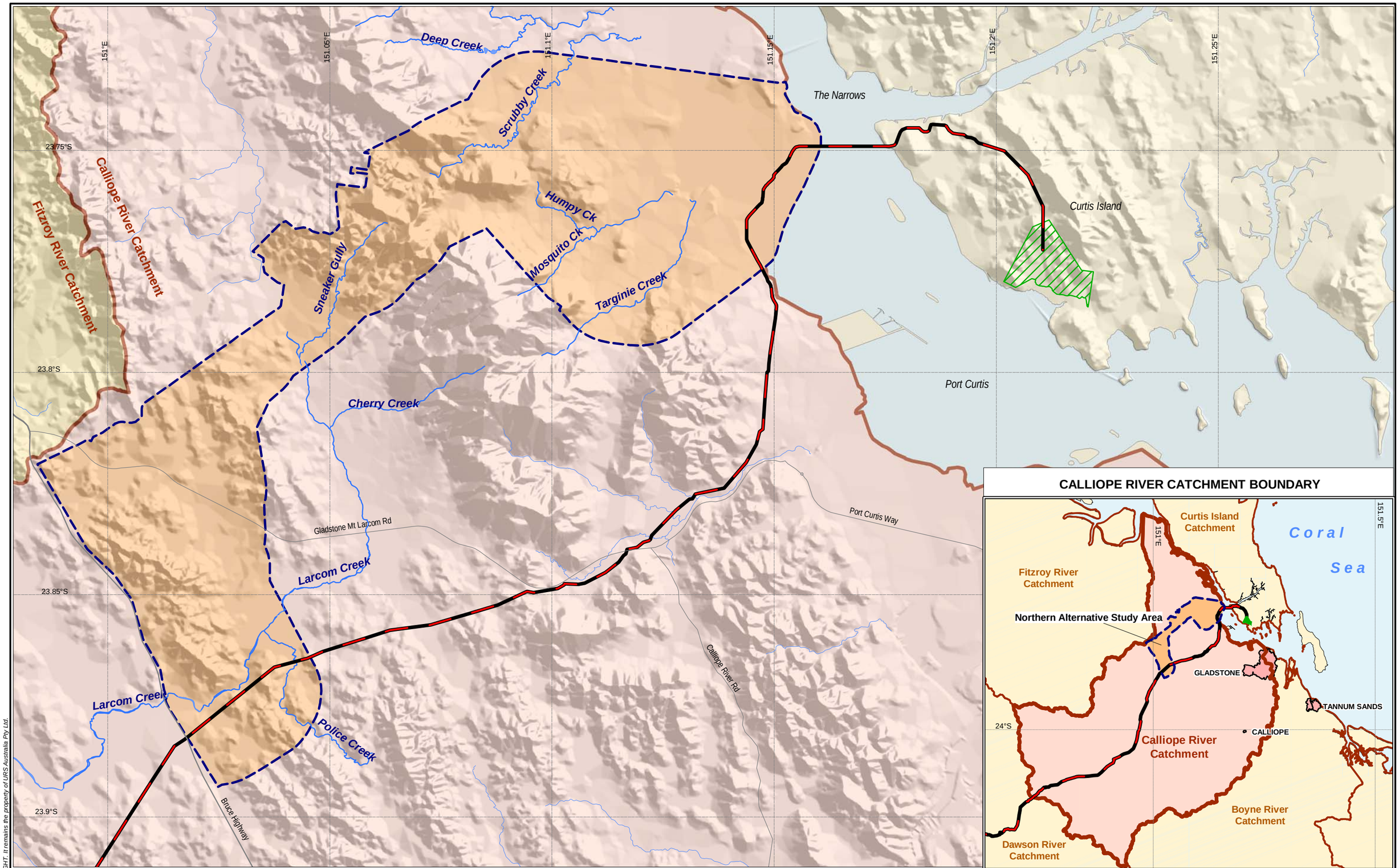
Table 7-1 Environmental Values for the Watercourses and Receiving Environment of the Northern Alternative

Environmental Values	Calliope Basin
Protection of high ecological value aquatic habitat	X
Protection of slightly to moderately disturbed aquatic habitat	✓
Protection of highly disturbed aquatic habitat	X
Suitability for human consumers of aquatic food	✓
Suitability for primary contact recreation (e.g. swimming)	✓
Suitability for secondary recreation (e.g. boating)	✓
Suitability for visual (no contact) recreation	✓
Protection of cultural and spiritual values	✓
Suitability for industrial use (including manufacturing plants, power generation)	✓
Suitability for aquaculture (e.g. red claw, barramundi)	X
Suitability for drinking water supplies	X
Suitability for crop irrigation	✓
Suitability for stock watering	✓
Suitability for farm use	✓

Table Notes:

✓: River basin is suitable for the environmental value.

X: River basin is not suitable for the environmental value.



CALLIOPE RIVER CATCHMENT BOUNDARY

N W E S

0 1.25 2.5km

Scale 1:80 000 (A3)
Datum: GDA94

Gas Transmission Pipeline

Northern Alternative Study Area

LNG Facility Site

Client: LNG / URS

Project: GLADSTONE LNG PROJECT
SURFACE WATER ASSESSMENT
NORTHERN ALTERNATIVE

Title: **WATERCOURSES AND CATCHMENTS**

Drawn: CA	Approved: GR	Date: 22-03-2009
Job No: **4262 6220**	File No: 42626220-g-223b.wor	

Figure: **7-1**

Rev:B

A3

Section 7 Surface Water

7.3 Climatic Data

The Calliope Basin is subject to a range of climatic regimes. The region is described as subtropical to semi-arid, with a summer-dominated but variable rainfall pattern.

Rainfall and pan evaporation data was obtained from the Bureau of Meteorology (BoM) and is presented and discussed in Appendix O2 (Section 4.1.1 and 4.1.2) of the EIS. The meteorological stations in close proximity to the study area include Gladstone Airport (Station Number 039326), Gladstone Radar (Station Number 039123) and Gladstone Post Office (Station Number 039041).

7.4 Stream Flows

The Department of Natural Resources and Water (NRW) records stream flow at a number of locations within the Calliope River Catchment. Of significance to the study area is Calliope River (at Castlehope, Station No 132001A). Mean Monthly flow data is presented and discussed in Appendix O2 (Section 4.2) of the EIS.

7.5 Existing Flood Characteristics

The assessment of existing flood characteristics was limited to major watercourses where significant environmental risk could occur from inappropriate design, or construction of the pipeline.

7.5.1 Flood Hydrology

Hydrological estimates were undertaken for Targinie, Mosquito, Scrubby and Larcom Creeks. Flood estimations were determined using two methods: Flood Frequency and Rational Method. A flood frequency analysis was undertaken for Larcom Creek. For catchments under 50km^2 (including Targinie Creek (48km^2), Mosquito Creek (20km^2) and Scrubby Creek (14km^2)) the Rational Method was used. A flood frequency analysis was considered to provide poor representation of these small catchments. Design peak flows were then derived for a range of probabilities average recurrence intervals (ARI) using the appropriate method (Table 7-2). Refer to Appendix O2 of the EIS for a detailed description of the methods used.

Table 7-2 Predicted peak flows at key watercourse crossing locations

No	Watercourse	Catchment Area (km^2)	2yr ARI Peak Flow (m^3/s)	10yr ARI Peak Flow (m^3/s)	100yr ARI Peak Flow (m^3/s)
1	Targinie Creek	48.36	49	115	274
2	Mosquito Creek	19.71	27	62	147
3	Scrubby Creek	13.67	20	47	111
4	Larcom Creek	90.49	31	361	1,602

7.5.2 Flood Assessment

To approximate the flood depths at each watercourse crossing, a basic hydraulic assessment of the 4 key watercourse crossing locations has been undertaken using industry accepted software (HEC-RAS v3). Flood extents have not been added due to the water level remaining within the channel for 2yr ARI to 100yr ARI. The water level results are summarized below in Table 7-3 and cross sections provided in Figures 7-2 to 7.5. Refer to Appendix O2 of the EIS for details on approximating flood depths.

Table 7-3 Predicted flood depths at key watercourse crossing locations

No	Watercourse	2yr ARI Depth (m)	10yr ARI Depth (m)	100yr ARI Depth (m)
1	Targinie Creek	1.6	2.3	3.5
2	Mosquito Creek	1.2	1.7	2.5
3	Scrubby Creek	1.1	1.5	2.2
4	Larcom Creek	1.3	4.0	6.6

7.6 Existing Water Quality

A baseline water quality assessment was undertaken (refer Section 5 in Appendix O2 of the EIS). Within the study area limited data is available. The gauging station in close proximity to the study area with available water quality data is Calliope River (Station No 132001A). This data is analysed and discussed and compared against the EPAs Queensland Water Quality Guidelines 2006 (QWQG) in Section 5 of Appendix O2 of the EIS. As such, no further analysis is presented here.

7.7 Potential Impacts and Mitigation Measures

The potential impacts and mitigation measures as summarised for the gas transmission pipeline in Section 7-5 (and further detailed in Appendix O2 of the EIS) remain the same for the study area.

A qualitative risk assessment approach was used to determine the potential impacts and mitigation measures through the different stages of construction, operation and decommissioning (refer to Section 7.5 of EIS). Potential impacts from the pipeline are expected to be of higher risk during the construction phase. These include earthmoving activities, works adjacent to/within drainage lines, contaminant mobilisation, pollution and flooding risks. These impacts are to be minimised using erosion and sediment control techniques such as contour drains that will be included in an Environmental Management Plan which will be developed and implemented). During the operational phase of the project a routine operation and maintenance program will be implemented, including aerial and/or ground inspections.

With the implementation of the proposed management and mitigation measures in this report it is expected that the levels of risk will be reduced, resulting in minimal impact on the environmental values of the surface water environment in the study area.

Section 7 Surface Water

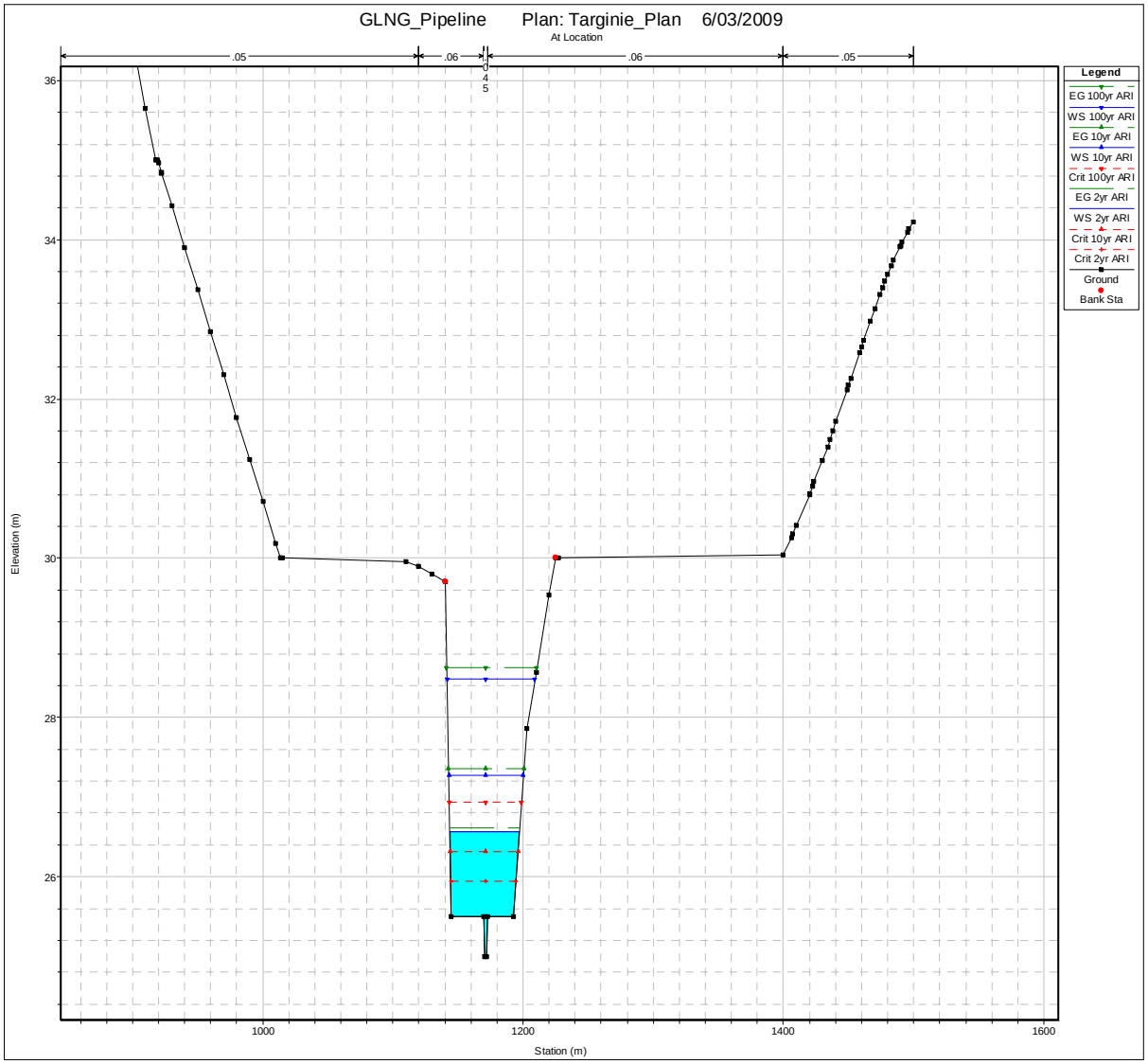


Figure 7-2 Targinie Creek Cross Section

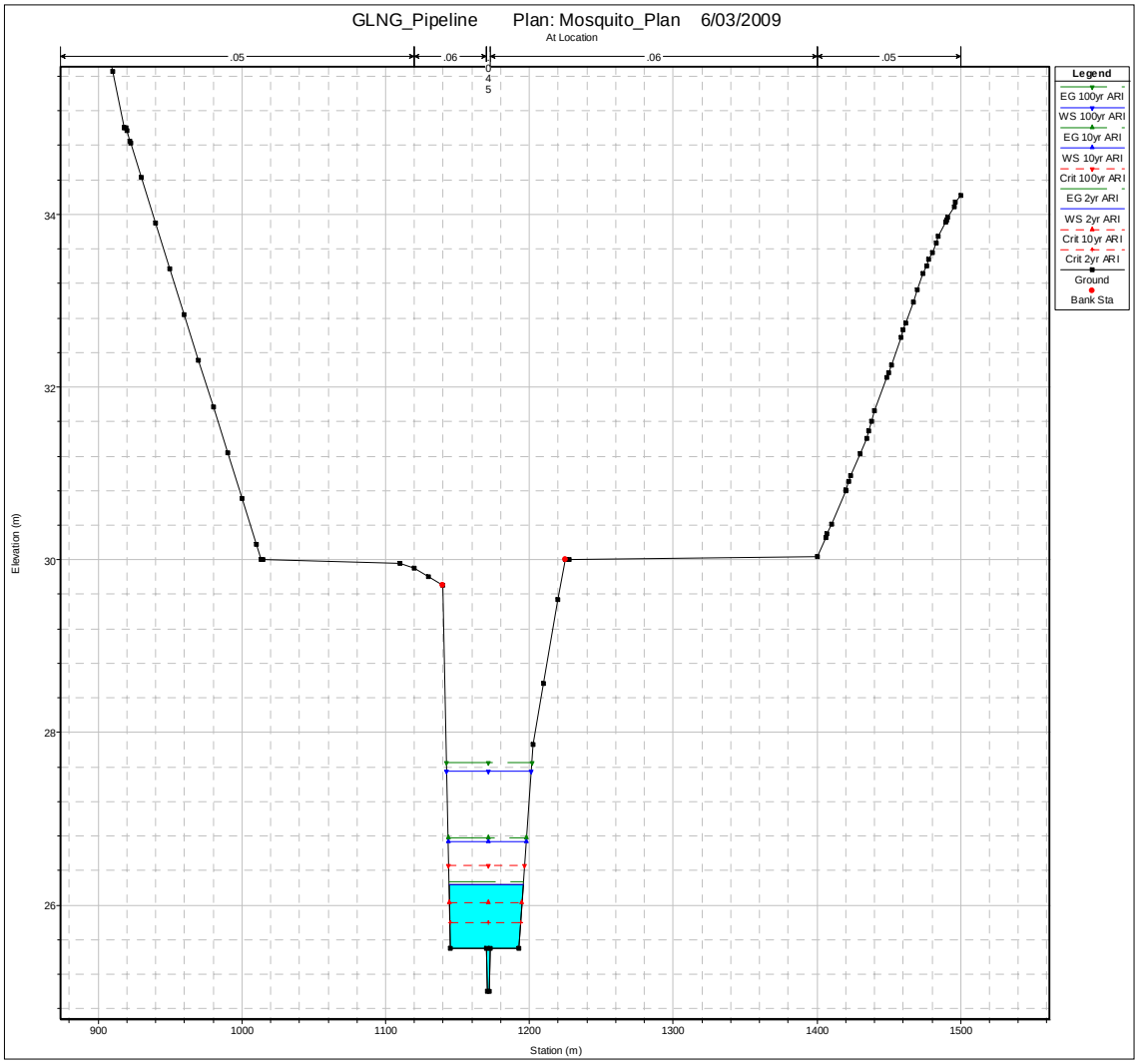


Figure 7-3 Mosquito Creek Cross Section

Section 7 Surface Water

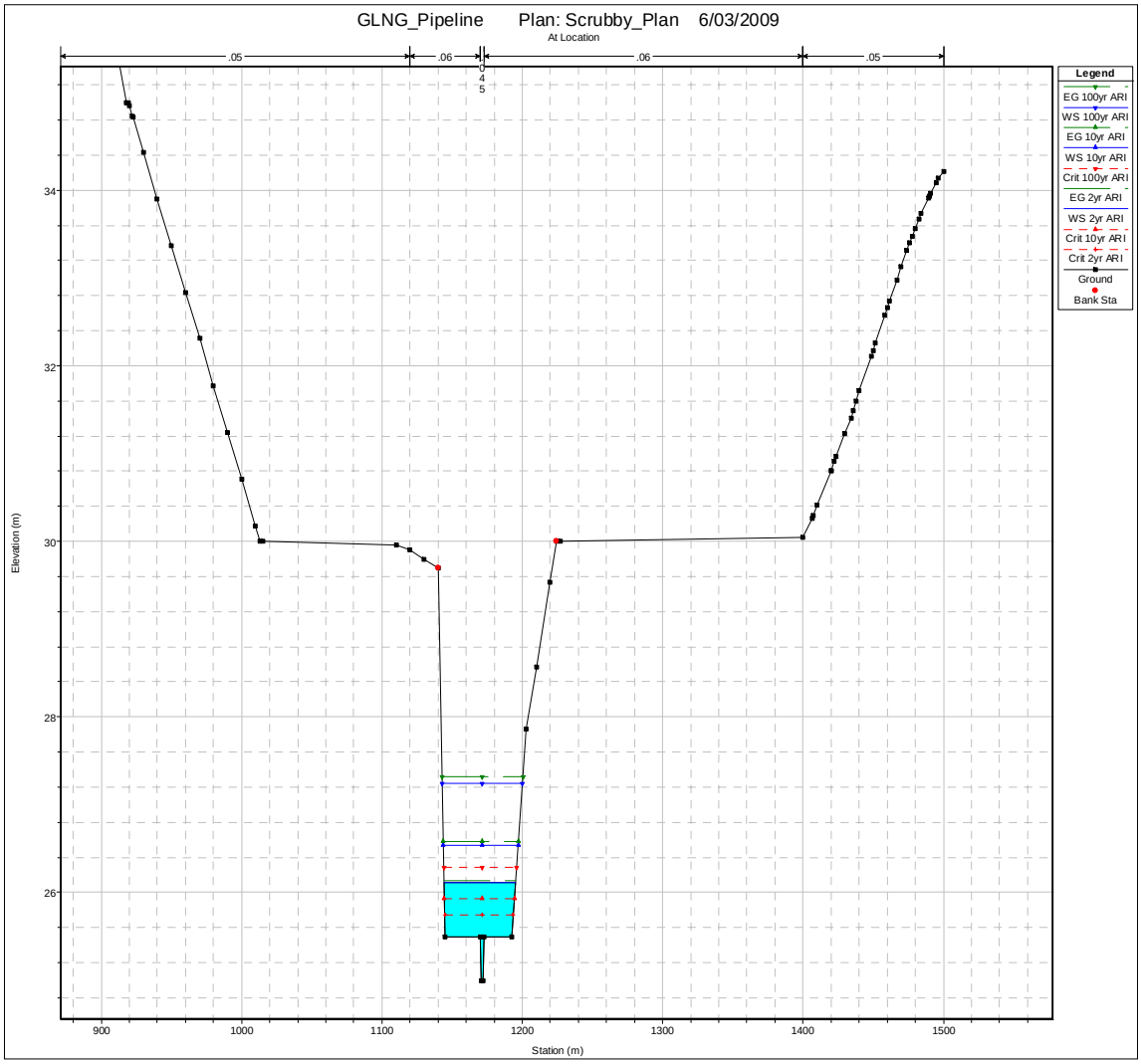


Figure 7-4 Scrubby Creek Cross Section

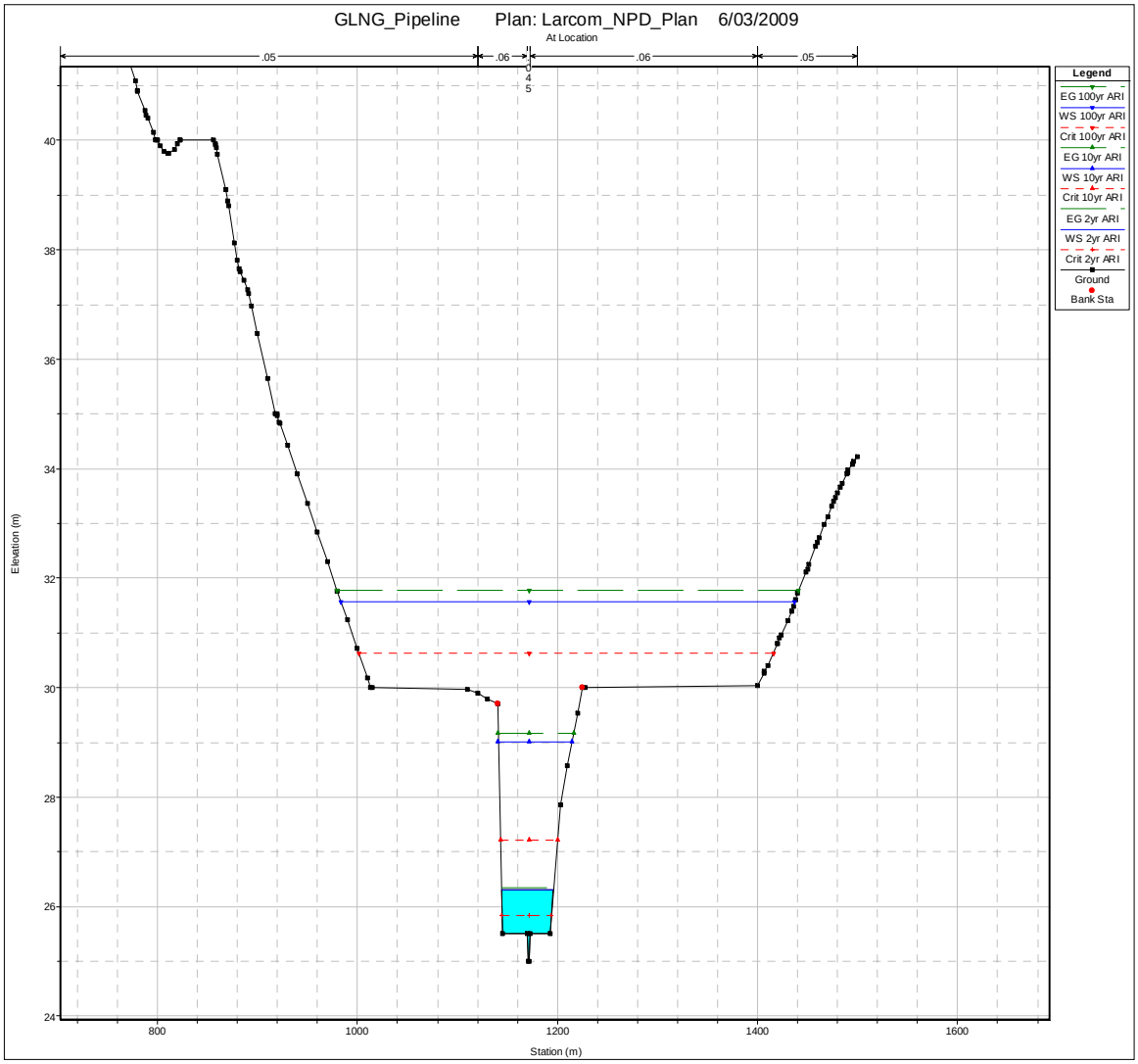


Figure 7-5 Larcom Creek Cross Section

Section 8 Cultural Heritage- Non-Indigenous

8.1 Non- Indigenous Cultural Heritage

A desktop assessment of the study area was conducted using mapping layers and by reviewing existing data of known and potential non-Indigenous cultural heritage sites in the vicinity. Results of the assessment are detailed below.

8.1.1 Known non-Indigenous Cultural Heritage Sites

There are no registered sites (on a cultural heritage register or database) recorded within the study area.

One site that was surveyed and assessed as part of the GLNG Project and was classified as a Heritage/Archaeological Site (HAS) (see Table 8-1) is included in the study area.

Table 8-1 Site description of HAS-23 Survey Tree

SITE NAME	HAS-23 Survey Tree
Location	The Narrows, north east of Mount Larcom GPS Coordinates: Lat: -23.81146476 Long: 151.0012635
Environmental Context	Only a few mature trees remain along the road corridor and in neighbouring properties, although the corridor contains regrowth of native species such as eucalypts.
Site Description	A large mature ironbark exhibiting a distinct broad arrow survey mark on a weathered scar surface. A later re-use of the survey mark is shown by a brass plaque inscribed with 'BJV 534'. The bark that was sheared from the cut still litters the foot of the tree.
Previous Impacts	The survey tree shows several periods of use and abandonment and fire damage.
Ground Surface Visibility	25%
Additional Comments	The survey tree is located approximately 100m north of the pipeline corridor. The mark is in good condition. The tree is still living.

8.1.2 Potential Non-Indigenous Cultural Heritage Sites

There are two sites identified in previous reports located within or in the immediate vicinity of the study area (refer to Figure 8-1). For the purpose of this assessment, and in line with terminology used in the non-Indigenous cultural heritage report for the EIS, these sites have been classified as potential sites.

Table 8-2 provides a basic description and location details for potential non-Indigenous sites located within or in the immediate vicinity of the NDP study area.

Table 8-2 Known and potential sites located within or in the immediate vicinity of the Northern Alternative.

Site Name	Location / GPS Coordinates[2]	Reference	Comments
Former Mt. Larcom Station Homestead and Massacre Site	Lot 2 SP147877 Lat: -23.878904 Long: 151.021392	Connell Hatch 2008 McDonald 2001	This site is reportedly identifiable from the Bruce Highway by a sizeable flowering bougainvillea, broken hand-made bricks and iron scraps. The site is also associated with an attack on the station in 1855 where five people were killed. The graves of those killed are reportedly located a short distance from the homestead and are marked by the remains of a fence. This site has potential state significance as an archaeological place and would require specific investigation and management.
Euroa Homestead	Lot 200 SP116496 Lat: -23.840390 Long: 151.040701	Connell Hatch 2008 Gladstone Regional Council 2008	There is little information recorded about this site. However, it is reportedly vacant and being maintained by an on site manager. The minutes of the Gladstone Regional Council General Meeting (12/08/08) detail a suggestion made by a member of the gallery. It was suggested that Council may wish to consider restoring the Euroa homestead as part of a Q150 project.

[2] GPS coordinates are based on descriptive information provided in external reports and are therefore approximate only.

151°E
151.05°E
151.1°E
151.15°E
151.2°E
151.25°E
23.75°S
23.8°S
23.85°S
23.9°S
The Narrows
Curtis Island
Port Curtis
Bruce Highway
HAS-23
Gladstone Mt Larcom Rd
Euroa Homestead
Port Curtis Way
Former Mt. Larcom Station Homestead and Massacre Site
Callemondah River Rd
Bruce Highway
GLADSTONE

N
W E
S

0 1.25 2.5km
Scale 1:80 000 (A3)
Datum: GDA94

Non-Indigenous Cultural Heritage Site
Gas Transmission Pipeline
Northern Aletrnative Study Area
LNG Facility Site

Client
LNG
URS

Project
GLADSTONE LNG PROJECT
CULTURAL HERITAGE ASSESSMENT
NORTHERN ALTERNATIVE

Title
NON-INDIGENOUS CULTURAL HERITAGE SITES

Drawn: LL	Approved: JB	Date: 22-03-2009	Figure: **8-1**
Job No: **4262 6220**	File No: 42626220-g-263.wor		Rev:A **A3**

8.1.3 Potential for Unknown Cultural Heritage Sites

The historical background assessment undertaken for the study area indicates a rich history associated with this area. The area was opened up for settlement in the late 1880s, with Mount Larcom Homestead being the major pastoral lease in the area. The introduction of rail to the area in the late 1800s and early 1900s encouraged further settlement and pastoral activity. In the early 1900s, gold mining played a prominent role in the area and the proposed deviation is sited within the southern end of the Langmorn Goldfields with several important gold leases occurring within the vicinity of the pipeline. As such, there is a high likelihood that non-indigenous cultural heritage sites could occur within the study area, associated with previous pastoral, gold mining and transportation activities.

8.1.4 Potential Impacts and Mitigation Measures

1. HAS-23 Survey Tree

HAS-23 is classified as a locally significant site for which a specific recommendation has been provided in Section 7-13 of the EIS.

2. The Former Mount Larcom Station Homestead/ Massacre Site and Euroa Homestead

This desktop assessment has identified one potential site within the northern realignment area and one potential site just outside the realignment area within close proximity to the south-eastern boundary. The sites should be managed as if they have the potential to be of State significance until further assessment (including field surveying) is completed. In particular, the former Mount Larcom Station Homestead and Massacre Site are most likely to be of State significance as an archaeological place and would require further assessment and management if works are planned within this area. In the interim, avoiding disturbance to these sites should be practised and all staff made aware of their location.

3. Potential non-Indigenous Cultural Heritage Sites

This assessment did not include field surveys or consultation, and as such the northern realignment area has the potential to contain non-Indigenous cultural heritage material. Accordingly, further assessment including a cultural heritage survey of the study area would be required.