Australia Pacific LNG Project

Volume 4: LNG Facility

Chapter 23: Matters of National Environmental Significance

Contents

Figures

Tables

Appendices

23. Matters of national environmental significance

23.1 Introduction

23.1.1 Purpose

The purpose of this chapter is to facilitate the Commonwealth Government's assessment of impacts on matters of national environmental significance (MNES) under Part 8 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the LNG facility.

This chapter is designed to address the requirements of the EPBC Act for assessment of the proposed LNG facility as a standalone report. Volume 2 Chapter 23 and Volume 3 Chapter 23 address the requirements of the EPBC Act for the gas fields and gas transmission pipeline respectively. This aligns with the approach undertaken by Australia Pacific LNG for the referral of actions to the Commonwealth Government as described at Section 23.1.3.

This chapter addresses the requirements of section 8 of the terms of reference (TOR) prepared jointly by the Queensland Coordinator-General and the Commonwealth Government.

While this chapter has been developed as a standalone report, it should be read in conjunction with the other volumes and chapters of the environmental impact statement (EIS) to provide further context to the extent of environmental impact assessment undertaken for the LNG facility, particularly as it pertains to potential impact on the widely held environmental and social values associated with the LNG facility.

23.1.2 Australia Pacific LNG Project

Australia Pacific LNG is seeking to accelerate the development and production of its coal seam gas (CSG) reserves in Queensland through the development of a CSG to liquefied natural gas (LNG) project. The Australia Pacific LNG Project (the Project) will encompass the further development of Australia Pacific LNG's CSG fields, the construction of a gas transmission pipeline, together with the construction of an LNG facility and associated port infrastructure to export LNG to international markets. The overall project concept is presented in Figure 23.1.

The development of the LNG facility is one of three components of the overall Australia Pacific LNG Project which includes:

- CSG fields – the expansion of Australia Pacific LNG's CSG fields in the Surat Basin, to provide gas for the LNG facility.
- Gas transmission pipeline – the construction and operation of a high pressure gas transmission pipeline of approximately 450km to link the Australia Pacific LNG gas fields to the LNG facility
- LNG facility – the construction and operation of the LNG facility including associated onshore and marine facilities. The LNG facility will be developed in stages up to an ultimate production capacity of approximately18 million tonnes per annum (Mtpa), and nominally comprising four LNG trains.

Australia Pacific LNG intends to establish the LNG facility on Curtis Island, Gladstone.

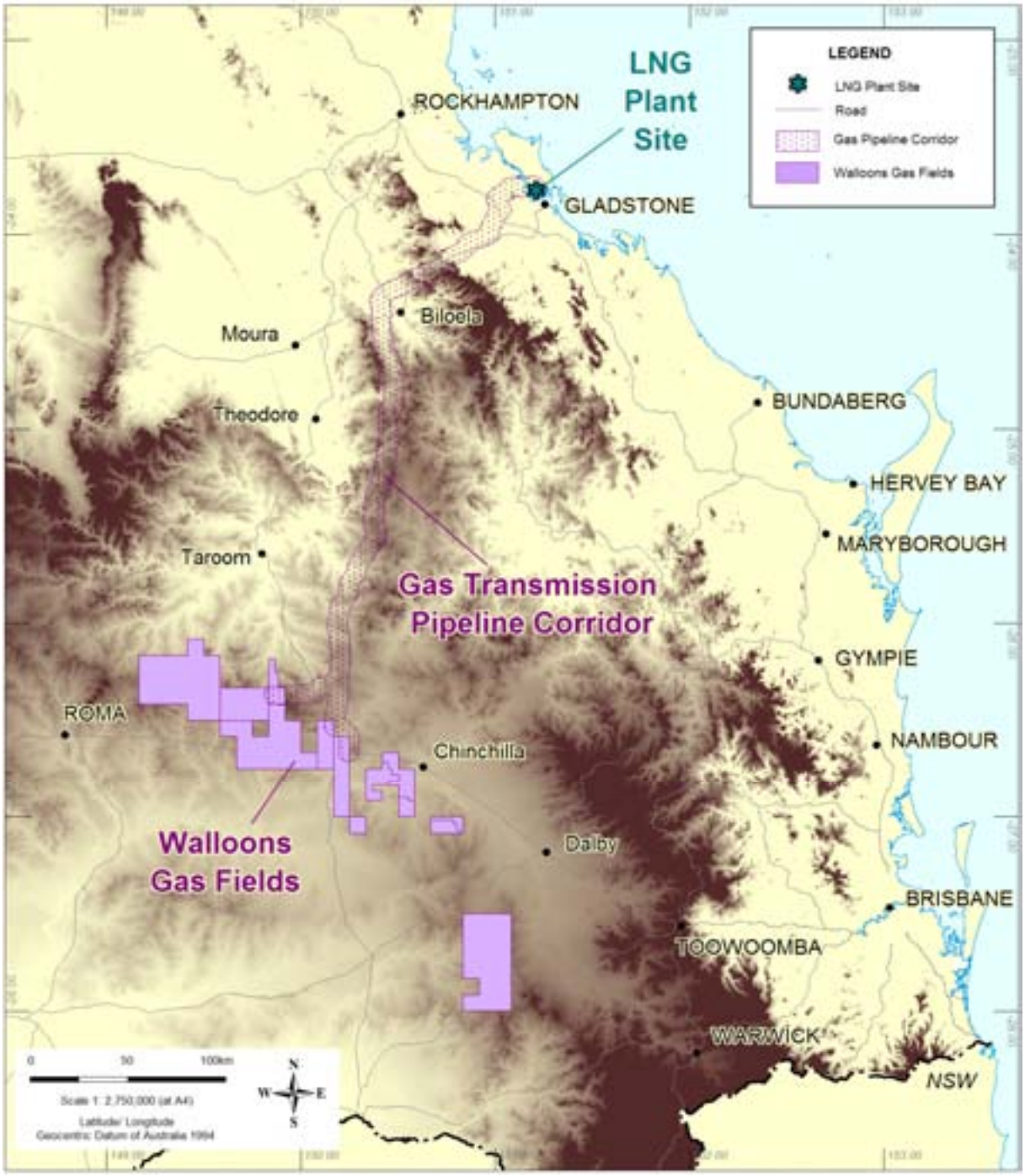

Figure 23.1 Project concept

Resource base and project life

The LNG production trains will have a nominal life of 30 years. It is expected the LNG facility will continue to operate whilst a supply of CSG is available and while an export market for the LNG still exists.

LNG facility development schedule

The LNG facility is to be developed in stages. Construction of Train 1 of the LNG facility is proposed to commence in 2011. Construction of Train 2 would commence approximately nine months after the

commencement of Train 1 to take advantage of the workforce and construction equipment already mobilised on the project. Each train takes about four years to construct hence the first two trains are expected to be operating after approximately four years and nine months.

Construction of additional trains can proceed while completed trains are operating. To avoid safety concerns with site preparation for construction of subsequent trains while the initial LNG trains are operating, the entire development site will be prepared at the commencement of the initial construction period. Areas that are not required until subsequent train construction will be stabilised and landscaped as an interim measure.

The timing of commencement of construction of Trains 3 and 4 will depend on the LNG market and gas development. It is assumed that construction on Train 3 will commence in 2017 and Train 4 would commence approximately nine months after the commencement of Train 3 (as for Trains 1 and 2).

Dredging required for the material offloading facility (MOF) construction would be commenced in 2011 with major capital dredging works closely following. MOF construction would commence soon after completion of the dredging and would be completed in approximately six months. Construction of the ship berths would take approximately 18 months.

23.1.3 Overview of actions relevant to the EPBC Act

On 2 July 2009 Australia Pacific LNG, as the proponent of the Project, submitted three separate referrals for the Project for consideration under the EPBC Act:

- EPBC Act 2009/4974 – Walloons gas fields
- EPBC Act 2009/4976 – gas transmission pipeline
- EPBC Act *1999* 2009/4977 – LNG facility.

The referrals[1] were prepared following discussions with the Director and Assistant Director of the Mining Section of the Environment Assessment Branch of the Department of Environment, Water Heritage and the Arts (DEWHA). It was noted in the referrals that whilst the above project components together form the Project, they are essentially stand-alone elements which will be developed separately (and may be delivered separately in conjunction with other parties).

On 3 August 2009 it was decided by the Minister for the Environment, Water, Heritage and the Arts that each of the actions described above are controlled actions, and as such require assessment and approval by the Minister before they can proceed.

DEWHA indicated the relevant controlling provisions for referral 2009/4974 are:

- Wetlands (Ramsar) (sections 16 and 17B)
- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (sections 20 and 20A).

DEWHA indicated that the relevant controlling provisions under referral 2009/4976 and 2009/4977 (LNG facility) are:

- World Heritage (Sections 12 and 15A)
- National Heritage Places (Sections 15B and 15C)

[1] http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=current_referrals&limit=999999&text_search=australia+pacific+lng

- Listed threatened species and communities (Sections 18 and 18A)
- Listed migratory species (Sections 20 and 20A).

DEWHA further indicated that the Project will need to be assessed under the bilateral agreement with Queensland at the level of an EIS. Therefore the EIS has been prepared in accordance with the requirements of the Queensland Government's *State Development and Public Works Organisation Act* (SDPWO Act), incorporating the requirements of the EPBC Act.

This chapter is designed to address the requirements of the EPBC Act for assessment of the proposed LNG facility as a standalone report. Volume 2 Chapter 23 and Volume 3 Chapter 23 address the requirements of the EPBC Act for the gas fields and gas transmission pipeline respectively.

Whilst this Chapter has been developed as a standalone report, it should be read in conjunction with the other chapters of Volume 4 of the EIS to provide further context to the extent of environmental impact assessment undertaken for the LNG facility, particularly as it pertains to impact on the widely held environmental values associated with the LNG facility area. The information for this chapter is drawn from specialist studies undertaken as part of the EIS for the Project. Table 23.1 provides a guide as to which other chapters of this volume are particularly relevant to the controlling provisions for this controlled action.

Table 23.1 Further EIS relevant reference material for EPBC Act assessment

EPBC referral 2009/4977: LNG facility	
World Heritage (Sections 12 and 15A)	Volume 4 Chapter 3
National Heritage Places (Sections 15B and 15C)	Volume 4 Chapter 5
	Volume 4 Chapter 6
	Volume 4 Chapter 7
	Volume 4 Chapter 8
	Volume 4 Chapter 9
	Volume 4 Chapter 10
	Volume 4 Chapter 11
	Volume 4 Chapter 12
	Volume 4 Chapter 19
	Volume 4 Chapter 24
	Volume 4 Chapter 25
	Technical reports associated with the aforementioned chapters
Listed threatened species and communities (Sections 18 and 18A)	Volume 4 Chapter 3
	Volume 4 Chapter 8
	Volume 4 Chapter 9
	Volume 4 Chapter 10

EPBC referral 2009/4977: LNG facility	
	Volume 4 Chapter 11 Volume 4 Chapter 12 Volume 4 Chapter 15 Volume 4 Chapter 24 Volume 4 Chapter 25 Technical reports associated with the aforementioned chapters
Listed migratory species (Sections 20 and 20A)	Volume 4 Chapter 3 Volume 4 Chapter 8 Volume 4 Chapter 9 Volume 4 Chapter 10 Volume 4 Chapter 11 Volume 4 Chapter 12 Volume 4 Chapter 15 Volume 4 Chapter 24 Volume 4 Chapter 25 Technical reports associated with the aforementioned chapters.

23.1.4 LNG facility

The referral made by Australia Pacific LNG under the EPBC Act indicated it is considered likely the proposed action for the LNG facility would be a controlled action due to potential for impacts on World Heritage, National Heritage places, listed threatened species and communities and listed migratory species.

The referral noted the footprint of the proposed action is within the Great Barrier Reef World Heritage Area (GBRWHA), both on land (at Curtis Island) and in Port Curtis. The GBRWHA is also listed as a National Heritage Place. The referral further noted that database searches undertaken (including utilisation of the EPBC Act protected matter search tool) identified listed threatened species and communities and listed migratory species in the vicinity of the LNG facility study area.

In the response to the referral by Australia Pacific LNG, DEHWA indicated the proposed action for the LNG facility is likely to have a significant impact because there is the potential for significant impacts on critically endangered Littoral Rainforest and Coastal Vine Thickets of the Eastern Australia ecological community through direct removal and introduction of weed species. DEWHA further indicated there is potential for significant impacts on the World and National Heritage values of the Great Barrier Reef including migratory and threatened species.

23.1.5 Methodology

This chapter brings together the assessment on MNES from other chapters within the EIS. It has been produced to provide a standalone assessment of potential impact on MNES in a format suitable for assessment under the EPBC Act. The chapter has been developed considering the format indicated by the TOR for the Project.

Section 23.2 describes and defines the action as it is relevant to the controlling provisions. This summarises the project description provided at Volume 4 Chapter 2, in the context of the controlling provisions. Section 23.3 describes the existing environment and values relevant to the controlling provisions. This enables determination of which areas or matters may be potentially impacted. For those potential direct impacts related to construction or operations this has involved desktop and field investigation to determine the actual presence or likelihood of presence of relevant matters within the clearly identifiable footprint of the LNG facility, or immediately adjacent to that footprint. Section 23.4 provides an assessment of impact on the MNES addressing the EPBC Act Policy Statement 1.1: Significant Impact Guidelines (Department of the Environment and Heritage 2006). This section describes management and mitigation measures for the impacts relevant to MNES. Potential for indirect and cumulative impacts are also identifiable through this process. Section 23.4.6 provides an outline of the environmental management plan (EM Plan) relevant to the LNG facility and Section 23.5 provides an overview of the other approvals relevant to the controlling provisions, and briefly describes the environmental record of Australia Pacific LNG.

The provision of shipping access (through dredging) to the LNG facility site is being provided by GPCand is being assessed through the EIS for the Port of Gladstone Western Basin Dredging and Disposal Project (EPBC Act referral reference number 2009/4904). Impacts associated with this project are summarised in Section 23.4.5.

Cumulative impacts associated with the Project's development in conjunction with the development of other industrial projects in the vicinity of the LNG facility site are addressed in Volume 4 Chapter 25 and those items relevant to MNES are summarised in Section 23.4.6.

Impact assessment is an iterative process whereby an initial assessment of the potential for impact in part determines the level of detail presented on environmental values. Where a potential impact is relevant to more than one protected matter, the impacts on those matters have been assessed together (e.g. impacts on world heritage and national heritage).

23.2 Proposed action – LNG facility

An outline of the proposed action as it pertains to potential impact on MNES is provided in this section e.g. physical location of the LNG facility, potential discharges and other operational and construction activities. A more detailed description of the LNG facility is provided in Volume 4 Chapter 3. A detailed description of the proposed actions for the gas fields and gas transmission pipeline are provided at Volume 2 Chapter 3 and Volume 3 Chapter 3 respectively.

23.2.1 Overview

Australia Pacific LNG's proposed LNG facility is intended to be developed in stages to a nominal capacity of approximately 18 million tonnes per annum (Mtpa) of LNG. The ultimate configuration of the LNG facility is yet to be determined, but is currently expected to comprise four LNG trains, each nominally producing 4.5 Mtpa of LNG. Initially, it is proposed to construct two liquefaction process trains (LNG trains). The timing of construction of subsequent trains will depend on the LNG market and gas field development.

To produce 4.5Mtpa of LNG, each train will require approximately 270 Petajoules (PJ) of CSG per annum which is roughly equivalent to 11 million m^3 of LNG per annum. Recent LNG train design development has enabled the optimum design to be modified to give a production capacity of 4.5Mtpa. The ultimate gas requirements and train configuration will be determined during the front end engineering and design (FEED) phase of the Project.

The LNG facility is planned to operate 24 hours per day, seven days a week.

The LNG facility will utilise ConocoPhillips' Optimized Cascade® process which is a proven and reliable process well suited to a CSG application. The Darwin LNG facility, which was developed by ConocoPhillips and its joint venture partners, utilises this technology and is of similar design to that being planned by Australia Pacific LNG for this development. Each LNG train will utilise six turbines to drive the primary refrigeration compressors.

The establishment of the LNG facility will require the construction of wharf and jetty structures to enable the loading of the LNG vessels. A material offloading facility (MOF) which includes a ferry terminal is also required to enable the transfer of personnel, materials and heavy equipment to the project site for construction and operation.

Capital dredging required for shipping access to the LNG facility will be provided for by Gladstone Ports Corporation (GPC), as part of the Western Basin Dredging and Disposal Project to enable access for multiple port uses, including the LNG facilities and loading facilities. GPC is currently undertaking an EIS process for this project. The scope of the Western Basin Dredging and Disposal Project includes capital and maintenance dredging and dredge material disposal requirements for shipping channels, berth pockets and the approach channel to the MOF.

Minor dredging additional to that described above may be required for construction of marine infrastructure, including the MOF, jetty and wharfs. The disposal of this dredge material will be at location(s) approved under the Western Basin Dredging and Disposal Project.

The LNG facility described in this chapter receives its feedstock or gas from the gas fields via the pipeline described in Volume 3. The interface between the gas pipeline and the LNG facility occurs at a pipeline isolation valve that is installed at the end delivery station of the pipeline, where the gas enters the LNG facility at the site on Curtis Island. Specifically, the point of interface is at the flange on the downstream side of the isolation valve. The isolation valve is actuated and acts as an emergency shutdown valve if required. The construction, operation and decommissioning of the LNG facility from this interface point is relevant to the impact assessment associated with this chapter.

23.2.2 LNG facility location

The proposed LNG facility site is located near Laird Point within the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA) and in the adjacent area of Port Curtis, as shown in Figure 23.2 and Figure 23.3.

The actual extent of land and marine area required for the development were confirmed by pre-FEED studies. The real property description of the terrestrial LNG facility site is Lot 3, SP225924, in the Gladstone Regional Council local authority area. The Department of Infrastructure and Planning (DIP) has freehold tenure over this land.

23.2.3 LNG facility layout

The site for the LNG facility will cover approximately 270ha, which includes a reclamation area of approximately 39ha needed for LNG facility infrastructure as shown in Figure 23.3. The LNG facility

footprint covers approximately 156ha of the Project site on Curtis Island. The proposed Australia Pacific LNG seabed lease area to cover the location of the marine facilities and exclusion zones has an area of approximately 325ha. The LNG facility footprint covers approximately 156ha (58%) of the LNG facility site on Curtis Island as shown at Figure 23.4.

Two options for ship access to the proposed project marine infrastructure (referred to as Option 1b and Option 2a as presented in Figure 23.4) are included in the Western Basin Dredging and Disposal Project EIS. Australia Pacific LNG has a preference for the Option 2a configuration due to ease of manoeuvring, less impact on recreational and commercial vessels and consistency with the near-to-shore marine facilities of the other LNG proponents in the Curtis Island Industry Precinct.

Figure 23.2 LNG facility location

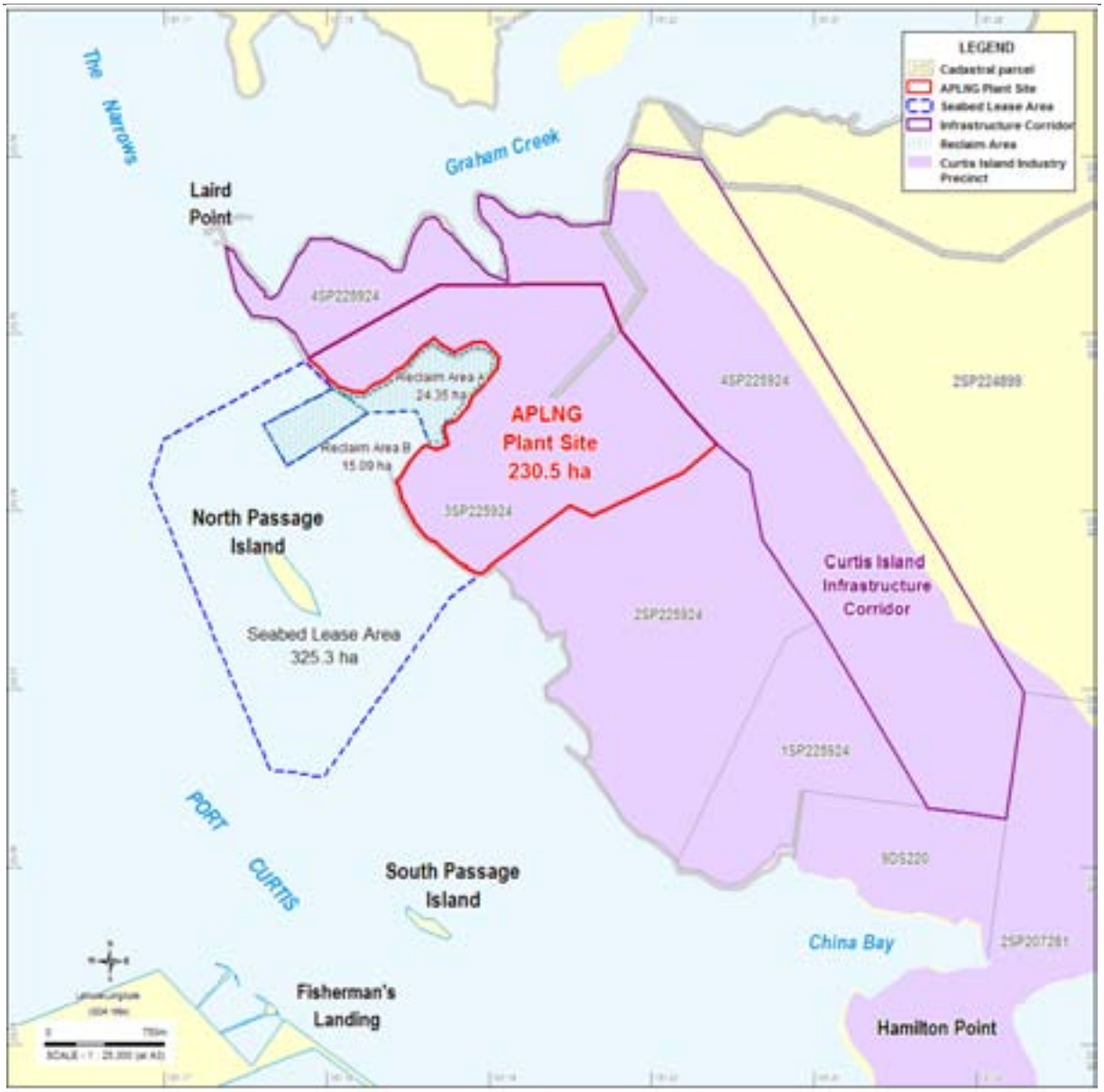

Figure 23.3 Cadastral boundaries and proposed lease areas

Figure 23.4 LNG facility footprint including berthing Options 1b and 2a

23.2.4 LNG facility key components

Australia Pacific LNG will limit clearance of vegetation to areas required for the placement of facility infrastructure. It is expected that approximately 60% of the Project site (refer Figure 23.4) will be cleared with the remainder being retained. Australia Pacific LNG has designed the facility layout to reduce disturbance of the coastal fringing vegetation (particularly mangroves). Vegetated areas that are not cleared during construction will be retained and managed. Cleared areas required around the facility and equipment will be stabilised and maintained. Where practical, areas cleared during construction that are not needed for operation will be landscaped.

It is anticipated that the LNG facility will include the items listed below (For further information regarding the LNG facility components and design parameters refer to Volume 4 Chapter 3):

- Processing facilities (4 x 4.5Mtpa LNG trains for a nominal production of approximately 18 Mtpa LNG):

  - Inlet facility (including pig receiving, inlet separator, and metering)
  - Acid gas removal and solvent regeneration
  - Dehydration and mercury removal
  - Refrigeration and liquefaction (24 refrigeration compressors), with nitrogen rejection
- Marine infrastructure:
  - Loading jetty and wharfs to transfer LNG product to tankers for shipping to market or receipt of shipments of LPG
  - A MOF, which will also serve as a ferry terminal, for the transfer of construction materials and heavy equipment to/from the Project site
  - A temporary “rock dock” to facilitate early transfer of bulk aggregate and waste
- Utilities and support facilities:
  - LNG storage tanks (3)
  - LNG loading and boil off gas compression
  - LPG storage tank (2)
  - LPG spiking system
  - LPG vapour recovery
  - LNG refrigeration
  - Power generation (125MW) and power distribution
  - Vents, e.g. acid gas removal unit (4), nitrogen rejection unit (4)
  - Flares - process gas, wet /dry gas and marine
  - Refrigerant storage
  - Fuel gas system
  - Defrost gas system
  - Effluent treatment
  - Seawater desalination plant
  - Water systems
  - Cooling water (lube oil cooling)
  - Plant and instrument air system
  - Refrigeration gas compressor turbine inlet air chilling system
  - Hot oil system (4 operating heaters)
  - Waste heat recovery system
  - Nitrogen system
  - LNG facility site infrastructure (workshops, offices and warehouses, laboratory, fuel and chemical storage facilities, access roads, laboratory, etc.)

- Communications tower
- Helipad
- Construction workforce office, temporary facilities and accommodation facilities
- Mainland facilities for the transport of materials, equipment and personnel to Curtis Island
- Mainland warehousing/storage facilities
- Tug and non-bulk carrier berths.

LNG and LPG storage tanks

Two LNG storage tanks, each with a capacity of approximately 160,000m^3, a diameter of approximately 80m and a height of approximately 35m, will store the output from Trains 1 and 2. A further tank of similar capacity will be constructed with Trains 3 and 4 to provide additional storage. Each tank will be a full containment type with double-wall construction, with an inner wall being of low temperature steel and the outer wall of reinforced concrete. These LNG storage tanks will be designed to meet requirements of NFPA 59A and relevant Australian Standards as required.

Each LNG storage tank will be equipped with loading pumps, level gauges, level transmitters, relief valves, vents, temperature elements, and other basic instrumentation. Boil-off gas compression will be installed for the recycling and recovery of LNG boil-off gas from the storage of LNG.

In order to meet the heating value requirements of some LNG customers, it may be necessary to increase the energy content of the LNG by adding LPG. The LPG required for this action will be imported by sea, unloaded at the product loading facility and transferred to the LPG storage tank.

One full-containment, refrigerated LPG storage tank with a capacity of 100,000m^3, a diameter of approximately 80m and a height of 30m, will be provided to receive shipments of LPG into the facility. The LPG storage tank will be full containment type with double-wall construction, with an inner wall being of low temperature steel and the outer wall of reinforced concrete. A second full-containment, super-cooled cryogenic LPG storage tank with a capacity of 28,000m^3 will be provided for storage of LPG that will be blended with the LNG during the LNG loading process. This LPG tank will be full containment type with double-wall construction, with an inner wall being of low temperature steel and the outer wall of reinforced concrete. Both LPG storage tanks will be designed to meet requirements established in the relevant Australian and international standards. Each LPG storage tank will be equipped with transfer pumps, level gauges, level transmitters, relief valves, vents, temperature elements, and other basic instrumentation. This unit includes an LPG recovery compressor system. It also includes an LPG cryogenic chilling system which supercools the LPG as it is transferred from the receiving tank into the super-cooled tank.

Utility systems

A closed loop, hot oil system will provide the LNG facility's process heating requirements. Waste heat from the gas turbine exhaust will be recovered to heat the oil. A fixed gas-fired hot oil heater will be provided as a backup to the waste heat unit for each LNG train.

Motor-driven air compressor packages will supply utility air, instrument air, and feed air to the nitrogen generation system. Nitrogen will be used as blanket gas for selected storage tanks and as a purge gas. Nitrogen gas will be supplied to the facility by a membrane type, nitrogen generation units. A liquid nitrogen back-up system will also be provided.

A fuel gas system will provide fuel gas for the liquefaction gas turbine drivers, for the power block gas turbine drivers, and for the gas-fired heaters and flare pilots. The fuel gas system will also supply defrost gas to portions of the refrigeration units and feed gas to defrost the equipment.

Water systems

During construction, water is required for site preparation, including dust control, concrete works and for hydrotesting storage tanks, other equipment and piping. The supply of potable water to service the construction workers onsite and the temporary accommodation facility is required. The operation of the LNG facility also requires water for the process, including demineralised water, potable water and firewater. Desalination of seawater to produce process and potable water will be used to supplement captured stormwater. During construction, a temporary package treatment plant will be used to treat sewage effluent to appropriate standards. A permanent sewage treatment plant will treat sewage effluent during operation of the LNG facility. Treated sewage effluent will be used for on-site irrigation and/or discharged to Port Curtis.

Power generation

The LNG facility will be self-sufficient in power. During construction, power will be supplied by on-site diesel generators. Site power generation during operations will be generated via gas-turbine driven open-cycle generators. The design basis for the EIS is 13 turbines for the four LNG trains. However, Australia Pacific LNG is still optimising the turbine configuration including the potential use of 14 turbines. Back-up diesel generators will also be supplied in the event that power generation is not available from the gas turbines.

Vapour relief (flare) systems

The flare system is a key safety feature of the LNG facility. The vapour relief system will collect and dispose of hydrocarbon containing streams which are typically released during start-up and shutdown, but also during upset and emergency conditions. These streams are disposed of by flaring. The design of the flares has been based on expected “worst-case” upset conditions for each stream. There will be three types of flares consisting of a wet flare, dry flare and marine flare. The wet flare will dispose of warm hydrocarbon streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water. These streams will be mainly generated by relief valve and startup/shutdown control discharges from the process vessels. The dry flare system will handle cryogenic hydrocarbons (both vapour and liquid) from the LNG storage tank and boil-off gas systems. These two flares will be located in ground level flare enclosures. The flare enclosures will be located in a safe area away from the process LNG facilities and LNG storage tanks. The marine flare will handle any flashed LNG vapours generated during loading of LNG product to the ship’s storage tanks and from LNG storage tank and boil-off gas systems.

Berth location alternatives

Alternatives for the general location of the ship berths have been considered by Australia Pacific LNG. Two options have been considered in detail: Option 1b to the south-west of North Passage Island and adjacent to the proposed GPC Fisherman’s Landing Northern Expansion project with shipping access via the Targinie channel, and Option 2a adjacent to the Project site between Curtis Island and North Passage Island with shipping access along Curtis Island past other proposed LNG facilities. For each of these options, Australia Pacific LNG has considered a number of options to optimise wharf and jetty location and design based on dredging requirements, trestle loading and length, access for construction, harbour access for commercial and recreational purposes, shipping manoeuvrability and

shipping safety. Two of the options (Option 1b and Option 2a illustrated on refer Figure 23.5) for the location of the ship berths and associated marine facilities for the LNG plant have been considered in detail. These have been assessed to ensure an optimal solution is implemented through consideration of potential environmental and social impacts, in addition to technical and economic constraints. Included in this assessment are the location of exclusion zones and the cost of infrastructure.

Dredging required for shipping channels, berth pockets and the approach to the MOF for both Option 1b and Option 2a is described in the GPC EIS for the Western Basin Dredging and Disposal Project (GPC 2009). The GPC EIS includes a description of the dredging methodologies. Both options are dependent on dredge material being disposed of in the Western Basin reclamation area, which is a component of the Western Basin Dredging and Disposal Project.

Australia Pacific LNG has a clear preference for the Option 2a configuration due to ease of manoeuvring, less impact on recreational and commercial vessels and consistency with the near-to-shore marine facilities of the other LNG proponents in the Curtis Island Industry Precinct.

Australia Pacific LNG has sought feedback from the community and has determined that Option 2a will be less obtrusive for recreational boaters in the Gladstone Harbour seeking access to Graham Creek. This access is sought not only in severe weather as a safe harbour but also for recreational reasons. The Western Basin can become rough under certain weather conditions and smaller boats seek to travel up north in the Western Basin by skirting the western shore of Curtis Island. A jetty out to and past North Passage Island, in the case of an Option 1b berthing configuration, would be restrictive to small boats and passage would need to be on the western side of North Passage Island. Marine traffic under the jetty would be precluded for safety and security reasons.

Australia Pacific LNG has conducted a navigational simulation study to assess the ease of marine access associated with Option 2a and Option 1b. A key recommendation from the study was to alter the footprint associated with Option 1b, so as to promote easier access for the LNG ships. The recommendation results in an increased dredge footprint. Given that it was concluded that marine access is “easier” for Option 2a than for Option 1b, the overall risk of collision with the facility is lower for Option 2a. As discussed above in the description on MOF configuration alternatives, Option 2a would result in an approach to the MOF that enhances manoeuvrability for barges and ferries, as the approach would be more in line with the currents. This enhances safety for material and personnel movements.

Option 2a would contribute to a lower environmental footprint as a result of lower levels of boil-off gas generated as compared to an Option 1b berthing location. This is because Option 1b requires a longer trestle than Option 2a. With Option 1b, there will be additional environmental impacts associated with the additional piling required and disturbance of mangroves on North Passage Island, versus the preferred Option 2a.

The design of this Option 2a continues to be optimised in consideration of minimising dredge material volume and operability issues. An alternative based on the outcomes of additional manoeuvrability studies has been generated. This includes angling of the MOF in a southerly direction to enhance manoeuvrability and safety for material and personnel movements.

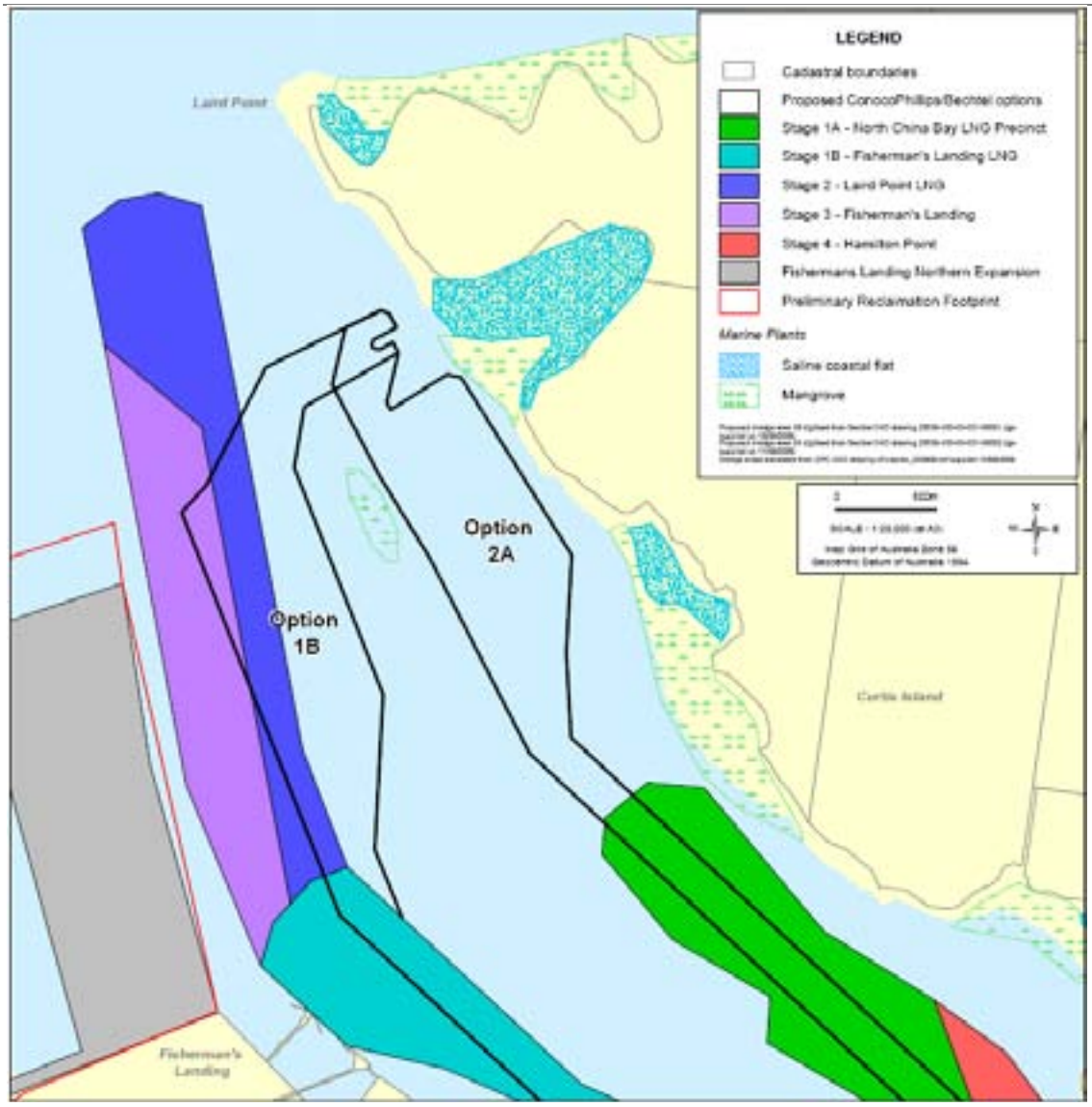

Figure 23.5 Indicative dredge options

Material offloading facility

The MOF will provide for the following functions:

- Offload of modules for LNG trains
- Offload of general construction materials from barges
- Embarkation point for personnel travelling to and from the Project site by ferry.

A temporary “rock dock” will first be constructed at the MOF location to allow offload of equipment and materials for the construction of the main facility. The MOF will be capable of handling approximately 2,500 tonne loads and crane access. Roll-on/roll-off ramps to unload heavy equipment, modules and materials will be provided for construction of all LNG trains.

The design of the MOF continues to be optimised by Australia Pacific LNG. The base case orientation of the MOF, almost orientated perpendicular to the Curtis Island shore, was determined to be the most efficient for access in conjunction with an Option 1b berthing configuration. An alternative orientation to enhance safety and operability has been developed: turning the MOF so that the approach to the

landings is more in line with the direction of the current. This enhances safety and manoeuvrability on modelled approach scenarios. This alternative reduces the required reclamation area for the MOF and results in a smaller footprint for the installation.

Mainland facilities

The facilities on the mainland will be established to provide for barge and ferry transport of materials and personnel as well as mainland material staging and stockpiling, labour sourcing, training and mainland buildings including offices and warehousing. The mainland ferry terminal will accommodate personnel and roll-on/off barges as well as facilities for loading barges with civil materials such as sand, gravel, and rock. Mainland facilities will also afford space for car parking and overnight bus and truck parking. Different facilities may be used initially for construction than what is ultimately used during operations.

Several alternative locations for mainland facilities have been considered by Australia Pacific LNG in consultation with GPC and the Gladstone Regional Council. Outcomes from transport and traffic assessments in particular and other environmental and social assessments for the Project have been considered in the selection process. EIS studies have been based on the following locations:

- Storage and barge loading of gravel, rock, sand and other aggregates from the existing Fisherman's Landing between the existing Rio Tinto Alcan and Cement Australia conveyors
- Transport of construction personnel and other materials from the proposed Fisherman's Landing North Expansion (GPC Fisherman's Landing Northern Expansion Project currently being assessed through an EIS process) to Curtis Island
- Vacant land off Blain Drive in West Gladstone (commonly referred to as 'Ash Pond 7') for car parking facilities during construction, with personnel being bused to the ferry location on Fisherman's Landing northern expansion. Buses and trucks would be staged overnight on the Ash Pond 7 areas
- A permanent operations phase ferry terminal with car parking located on the proposed Fisherman's Landing north expansion.

This arrangement addresses both project and cumulative impacts to onshore traffic issues in the central Gladstone region, ensures adequate space for mainland construction facilities and reduces marine traffic congestion in the Western Basin, particularly through the area near Wiggins Island.

Alternative mainland locations also under consideration include:

- Port Central, adjacent to Auckland Point and Barney Point, for all storage and transport facilities
- A location on the Calliope River adjacent to the RJ Tanna Coal terminal.

Australia Pacific LNG continues to evaluate the alternative locations in consideration of potential environmental and social impacts. Further detail regarding the mainland materials shipping facility is provided at Volume 4 Chapter 3.

23.2.5 Ship access

Dredging will be required to enable vessels to access the Australia Pacific LNG terminal facilities and MOF. This dredging work will be undertaken by GPC as part of the Western Basin Dredging and Disposal Project. This project accommodates the long-term dredging and dredged material disposal required to provide safe and efficient access to the existing and proposed Gladstone Western Basin (Port Curtis, from Auckland Point to The Narrows) development areas.

The Western Basin Dredging and Disposal Project comprises dredging associated with the deepening and widening of existing channels and swing basins and the creation of new channels, swing basins, berth pockets and approaches for MOFs. It is proposed that dredged material be placed into reclamation areas north of Fisherman's Landing to create a land reserve to be used to service new port facilities.

GPC is currently in the process of gaining the necessary environmental approvals to undertake these works (GPC, 2009). The DIP website[2] provides details on the Western Basin Dredging and Disposal Project. The EIS for this dredging and disposal project examines the environmental effects that may arise from the dredging required to service the needs of the Australia Pacific LNG project.

Minor dredging works that may be required for construction of the MOF, jetty and wharfs is included in the scope of the Australia Pacific LNG project. Dredge material will be disposed of in GPC reclamation areas that include the Western Basin Reclamation Area, a component of the Western Basin Dredging and Disposal Project.

Maritime Safety Queensland (MSQ) provides navigational aids, endorses protocols for shipping and provides pilot services for vessels using Port Curtis. Additional navigational aids and pilot services will be required for LNG shipping accessing the project's maritime facilities.

The requirements for pilotage in Port Curtis are defined by MSQ and the GPC. Pilotage will be compulsory for all LNG and LPG vessels using the Port. Australia Pacific LNG, working in conjunction with other LNG industry proponents, MSQ and GPC, has determined that four escort tugs will be used for all LNG transits in and out of Port Curtis. This requirement will provide for an additional element of safety in regard to groundings of LNG vessels, even in the unlikely event of a loss of propulsion or steering. GPC will operate the tugs which will service the LNG industry.

The Pilot and Ship Master will follow the port transiting requirements set out in a Vessel Transit Plan being prepared by MSQ and the GPC in consultation with all LNG proponents in the Port, the Port's pilots, and other relevant stakeholders.

All ships are required to comply with the International Convention of Pollution from Ships (MARPOL) as established by the International Maritime Organisation. This specifically addresses items such as bilge pumping, sewage and waste management.

ConocoPhillips, the Project joint venture partner that will build and operate the LNG facility on behalf of Australia Pacific LNG, has a marine vetting standard that would apply to shipping operations related to the Project. The standard documents safety and environmental requirements to meet the company's marine transportation needs.

23.2.6 LNG facility construction

The construction phase will include onshore and coastal/marine activities.

Coastal/marine construction

Offshore construction will include the construction of the following components:

- Temporary "rock dock"
- MOF construction, including ferry terminal (minor dredging works in preparation for construction)

[2] <http://www.dip.qld.gov.au/projects/transport/harbours-and-ports/port-of-gladstone-western-basin-strategic-dredging-and-disposal-project.html>

- Jetty and trestle construction (including loading platforms, mooring dolphins and catwalks)
- Access channel, swing basin and berth pocket dredging (undertaken by GPC).

As the LNG facility site has no external road access, crews will initially install sea access to site to enable site preparation to commence. A rock dock will first be constructed at the MOF location to allow offload of equipment and materials for the construction of the main facility. One permanent dock capable of approximately 2,500 tonne loads and crane access with roll-on/roll-off ramps to unload heavy equipment, modules and materials will be provided for all LNG trains. The MOF will be designed and constructed with appropriate controls for the Australian Quarantine and Inspection Service (AQIS) and customs. The following outlines a typical construction methodology for the MOF.

The proposed design for the MOF is to use a rock fill causeway approach from the site and then a cellular sheet piled barrier arrangement (for water exclusion) for the wharf structure. The construction of the causeway is anticipated to commence from onshore by "push-out" of suitable materials generated during the site development, to create an initial causeway to the waters edge. As excavation for site commencement progresses, more rock materials will be excavated/ripped from the site. Dump trucks will move this rock material to the causeway and the build out will progress from Curtis Island towards the dredged approaches, primarily by end dumping. Sheet piling will be progressed from a marine barge or using specialty sheet piling equipment which commences from a barge, but is self supporting on the sheet piles as they progress in installation.

The upper surface of the causeway may be finished with concrete stabilised crushed rock, to provide a cambered paving surface for the movement of heavy cargo. Concrete pours will all be made from land approaches as the causeway will be completed prior to the commencement of concrete pours. Temporary concrete batching facilities may be required if the site batching facility is not commissioned and operating during MOF construction. Materials required for the construction of the MOF are as follows:

- Rock fill materials (assuming provided from site excavation)
- Causeway shore protection
- Cement stabilised road base (300mm thick) 15% cement
- Steel sheet piles (barge driven)
- Steel sheet pile whaler beams and tie-backs
- Concrete – for paving, sheet piling capping beam, misc paving
- Bollards
- Bollard foundations – concrete
- Rubber fenders.

The majority of these materials are likely to be sourced from Australia with the potential for steel sheet piles, beams and tie backs to be sourced from overseas.

The construction of the LNG loading jetty and access trestles will initially be staged from the water using floating barges and self-elevating jack-up platforms to install the initial piles for the jetty. The marine contractor personnel will consist of divers, operators, labourers and supervisory personnel. Tugboats will assist in the movement of all barges associated with the construction of the marine loading facilities.

The construction materials will consist of steel sheet piles, steel pipe piles, structural steel, precast concrete members, reinforcing steel and in-situ concrete.

The piles and other prefabricated construction materials will be delivered by barge. Materials may also be stored on barges for short periods as the materials are being installed. It is anticipated several 50m long material barges will be present throughout the construction period.

Once the piling operation is underway, one or two additional items of floating equipment will follow in sequence to lift and set the precast pile caps, beams and deck planks. This equipment will consist of one or two large floating cranes and material barges.

The work will also involve in-situ grouting of the precast members at the pile tops and other connections. In-situ concrete work will be staged in a manner to prevent concrete from entering the water. The roadways and platform deck will be constructed of reinforced in-situ concrete. The work will advance outward from shore, using land-based concrete transit mixers.

Onshore construction

Once suitable access to the LNG site has been established, site preparation will commence. Vegetation will be cleared in the footprint area of the LNG facility, laydown areas and temporary accommodation facility. The temporary accommodation facility, internal access, and materials laydown areas will then be established. This will be followed by the excavation of elevated areas on the site to provide fill for lower elevation areas and so establishing a level site for civil construction. Permanent plant equipment foundations and building slabs will then be installed. Concrete for all foundations and other structures will be supplied from a ready-mix batch plant and transit mixer trucks located on-site.

After the commencement of the concrete foundations, underground piping and electrical work, mechanical erection of the gas turbine, process equipment and ancillary facilities will begin. The facility construction will require the use of cranes, excavators, trucks and other heavy machinery on site. These are likely to be transported to the site by barge or charter ship.

Access around the construction site will utilise typical engineered roads constructed in accordance with standard engineering specifications. Onshore construction will include the following main activities:

- Construction of internal access roads and fences
- Erosion control
- Vegetation clearing
- Earth works and terrain levelling of the construction site
- Foundation excavations for main equipment and buildings
- Construction of the MOF
- Pile driving
- Installation of foundations
- Erection of field erected tanks
- Receipt and installation of process and utility modules
- Erection of field erected or ‘stick-built’ process and utility units

- Interconnection of modules
- Landscaping activities
- Commissioning and start-up activities.

Construction phase transport movements

Utilisation of the MOF and the mainland facilities will enable all construction materials and personnel to be transported to the site by sea.

It is expected that materials will be transported to the Gladstone area by truck and rail from in-country suppliers and subsequently delivered by barge to the project site. It is also expected the facility's construction will involve the fabrication of a proportion of facility process modules overseas or elsewhere in Australia, and their transportation directly to the project site by sea.

A quarantine facility will be provided at the site near the MOF. For modules constructed overseas, inspection by AQIS may initially occur in the module yard before import to Australia. AQIS inspections post shipment can occur on Curtis Island for direct deliveries.

The expected average movement of vessels expected during the construction phase is as follows:

- Large deck barges with coarse aggregate: six per month
- Typical deck barges with sand: two per month
- Bulk cement vessels: two per month
- Roll On/roll off ships: two and half per month
- Jetty tenders: daily round trips from wharf to jetty with piling and beams
- Jetty tenders: daily round trips with armour rock, modules, topsides commodities
- Jetty multicast: pushing tenders and running personnel daily
- Crew boats and food supplies for the temporary accommodation facility: one per two days
- Patrol boats: three daily
- Pilot boats: as required
- Diesel fuel barges: four per month
- Subcontractors deliveries: four per month
- Passenger ferries, two trips in the morning and evening with potential evening trips from Curtis Island for the temporary accommodation camp residents.

Construction phase emissions

Atmospheric emissions

Sources of emissions from construction are likely to consist of engine exhausts from vehicles and diesel generators and from dust generated by earthworks and vehicle movements on sealed and unsealed roads.

Various types of construction equipment will be used from the inception of the site work until start-up and commissioning of the LNG facility. While the majority of this equipment will use diesel fuel, some equipment will use petrol. Table 23.2 provides an estimate of expected emissions generated by the

use of construction equipment over a construction period of four years and nine months, the anticipated time to construct two LNG trains. During this period, it is anticipated that diesel consumption will be in the order of 10ML and petrol consumption in the order of 1.6ML.

Table 23.2 Estimated site air emissions, construction phase

Emission	Total emissions (tonnes) (Trains 1 and 2)	Total emissions (tonnes) (Trains 3 and 4)
NO_X	1,030	720
CO	1,890	1,325
SO_X	80	56
PM_{10}	90	63
CO_2	42,000	29,400
VOCs	150	105

Notes:

Estimate is based on a four year, nine month construction period to construct Trains 1 and 2.

Emissions are site emissions only – no emissions associated with the transport of materials, equipment or personnel to and from the site are included in these estimates.

USEPA emission factors have been used to derive emission levels.

Trains 3 and 4 emissions are lower than Trains 1 and 2 emissions as much of the common infrastructure is installed with Trains 1 and 2.

Wastewater discharges

Wastewater arising from construction phase activities will comprise hydrotest water, flushing water, brine from the desalination system used to supply water to the site, stormwater and sewage treatment plant effluent. However, where appropriate, it is intended hydrotest water, flushing water, and stormwater will be routed to the stormwater detention ponds for reuse on site for dust suppression and irrigation, in accordance with regulatory requirements.

After the hydrotesting of storage and pressure vessels has been completed, the used hydrotest water will be discharged offshore at a location with adequate flushing to enable rapid dispersal. The hydrotest water may contain traces of biocides and oxygen scavengers used to protect the inner surface of the tanks from risks of fouling and corrosion.

It is expected the discharge of brine from the desalination system will be up to 3000m^3/day. Initially, prior to the completion of the jetty, desalination brine will be discharged near to the end of the MOF. It is expected treated sewage effluent from the on-site sewage treatment plant will reach a maximum of 550m^3/day during the construction period.

Wastewater discharges will be reused onsite or discharged into Port Curtis, in accordance with regulatory requirements (refer Volume 4 Chapter 10).

Noise emissions

Noise will be generated from mainland traffic consisting of private vehicles and buses for personnel transport to the embarkation point and trucks for delivery of construction materials and equipment.

Noise emissions generated by construction activities on-site will vary considerably depending on the type of activity being undertaken and the intensity of activity at a specific time. For example, daytime facility construction activities could involve impact hammers, cranes, bulldozers and trucks operating at the same time and jetty construction could involve impact hammers, cranes, trucks and bobcats.

The main noise generating activities are expected to be pile driving for LNG tank foundations and jetty trestles. Marine pile driving generates both underwater and airborne noise.

The key noise emitting equipment and associated sound power levels is outlined in Table 23.3.

Table 23.3 Construction equipment sound power levels

Equipment	Sound power level (dBA 1m from source)
Scraper	117
Impact gun	108
Motor grader	107
Truck (20 tonne)	105
Bobcat	105
Concrete batching plant	105
Pile driver	99
Crane	88
Bulldozer	87
Concrete mixer	75

Further detail regarding noise emissions generated during the construction phase is provided in Volume 4 Chapter 10 and Volume 4 Chapter 15.

23.2.7 LNG facility operations

There will be three main input streams to the LNG facility:

- CSG pre-treated to remove water
- Seawater which is desalinated and treated to provide the quality requirements for domestic use, plant processes and utilities
- Miscellaneous supplies and chemicals required for the general operation and maintenance of the facility.

The LNG production process is shown as a basic flowsheet in Figure 23.6.

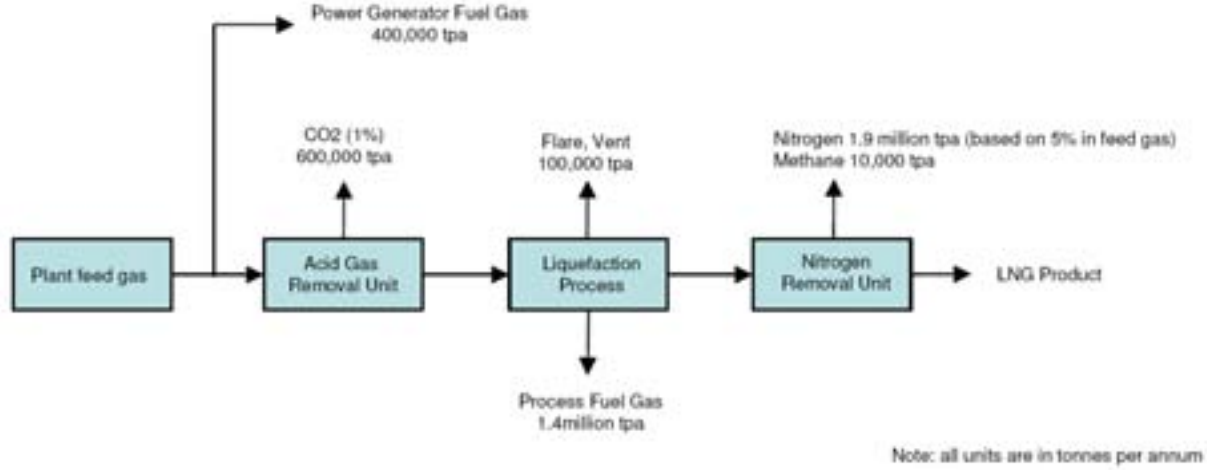

Figure 23.6 LNG production processes

Each liquefaction process train will utilise six turbines arranged with two identical gas turbine driven propane compressor sets in parallel, two identical gas turbine driven ethylene compressor sets in parallel and two identical gas turbine driven methane compressor sets in parallel. The LNG facility will utilise CSG for energy requirements and will be operated 24 hours per day, seven days per week, 365 days per year. During this period, the facility may incur shutdowns on one or more of the production trains but will be continuously manned over the period.

In order to meet the heating value requirements of some LNG customers, it may be necessary to increase the energy content of the LNG by adding LPG. The LPG required for this action will be imported by sea and will be unloaded at the product loading berth. The LPG spiking system is comprised of storage, treatment and chilling of LPG. The imported LPG is stored in an atmospheric pressure tank. LPG from this tank is routed though a treatment system and then to a cryogenic chiller system to the super cooled LPG storage tank. The super cooled LPG is mixed with the LNG product to raise the heating value of the mixed LNG. Vapour from the LPG storage tank will be compressed and re-condensed during normal operation. Only during emergency and upset conditions will these vapours be directed to the marine flare for disposal.

The ship loading facility at the LNG facility will allow for the simultaneous loading of two LNG ships ranging in capacity from 125,000m^3 to 220,000m^3 each. The LNG product will be pumped from the LNG storage tanks to the jetty via a loading line, and transferred to the ship via several loading arms. A vapour return arm will capture gas displaced from the ship's tank, flashed gas including, and vaporised gas from heat gain during ship loading, and return this gas to the LNG tanks via a separate gas line.

The composite gas from the LNG tanks and from the ship loading system will be compressed in boil-off gas compressors as required and returned to the liquefaction section of the facility where it will be re-liquefied. It is expected that during normal operation with all boil-off gas compressors in operation, excess gas that may be produced during ship loading can be returned to the production process, and obviate the need for disposal by flaring. However, depending on thermal condition of the ship upon arrival (after dry dock maintenance or excessively warm) some discharging to the marine flare may be required.

LNG will be transported by specially designed ships. At the LNG facility's nominal capacity of approximately 18 Mtpa, it is expected that a LNG vessel will arrive approximately every one to two days for loading and export. Turnaround time for vessels will be approximately 24 hours, with a product loading duration of approximately 14 hours. The typical LNG tankers will have a minimum

draught of 11.5m and are between 285 and 314 m in length with a carrying capacity of 125,000m^3 to 165,000m^3 of LNG. However, it is possible that LNG tankers with a capacity of up to 220,000m^3 may also be used. These vessels have a draught of up to12m with a length of 315m.

LPG will be imported by ship and unloaded from one of the berths used for LNG ships. The other berth will be used for LNG loading only. The LPG ships are expected to have a capacity of 20,000m^3 to 80,000m^3 of LPG, similar to what is currently experienced in Gladstone Harbour. There is one LPG loading arm. The expected number of LPG ship deliveries per year is about 40 (based on 80,000m^3 ship capacity and four LNG trains operating).

Further detail regarding the Project operations is provided at Volume 4 Chapter 3.

Operational phase transport movements

Transportation of the operational workforce from Gladstone to Curtis Island will be by ferry. It is estimated there will be two ferry trips per day for the hourly operations workforce and two per day for the dayshift staff.

The expected average movement of vessels expected during the operations phase (in addition to shipping movements described previously) is as follows:

- Crew boats and food supplies for operations: one per every two days
- Patrol boats: three daily
- Pilot boats: as required to accommodate LNG movements.
- Diesel fuel barges: one per quarter
- Sub-contractors deliveries: four per month.

During major maintenance shutdowns, additional ferry and barge movements may be required for personnel and equipment.

Operational phase emissions

LNG facilities are typically very low emission facilities compared to other industry located in the Gladstone region. The processing of CSG into the LNG product will generate atmospheric emissions and wastewater discharges (refer to Volume 4 Chapter 16 for a more detailed description of these streams).

Atmospheric emissions

Air emissions are released by the facility during normal operating conditions and as a result of start-up and emergency events.

Normal operations

The production processes operate on a continual basis with static emission rates, and include the following stationary emission sources:

- Gas turbines to drive refrigeration compressors
- Gas turbines for power generation
- Acid gas removal unit
- Hot oil heaters

- Nitrogen rejection unit
- Dry gas flare (pilot light operating)
- Wet gas flare (pilot light operating)
- Marine flare (pilot light operating).

An expected emissions inventory for normal facility operations is given in Table 23.4.

Table 23.4 Point source emissions inventory

LNG production	4.5Mtpa (1 train) (tonnes)[1]	18Mtpa (4 trains) (tonnes)[1]
Emissions (tonnes/per year)		
PM_{10}	56	215
SO_2	1	2
NO_X	860	3,440
CO	780	3090
CO_2	1,337,000	5,112,000
N_2O	30	100
CH_4	3,130[2]	12,540[2]
VOCs	35	180
Greenhouse gas equivalent		
Tonnes CO_2/year	1,412,000	5,408,000

Notes: [1] Emissions from non-routine flaring are included
[2] CH4 emissions do not consider oxidiser on the nitrogen removal unit

The total expected level of fugitive emissions (unintended loss of gas through processing and transmission) has been estimated based on the proponent's experience at the Darwin LNG operation. The estimates for each train are:

- Methane – 180 tonnes/year
- Propane – 190 tonnes/year
- Ethylene – 140 tonnes/year.

Facility start-ups and shutdowns are planned so that emissions are minimised.

Abnormal operating conditions

Abnormal operations are those outside of the general operating parameters for the facility, and which occur intermittently for a short duration. Emissions from these events will be variable and intermittent. These emission sources include:

- Dry gas flare (maintenance or upset conditions)
- Wet gas flare (maintenance or upset conditions)

- Marine flare (maintenance or upset conditions).

Upset conditions could occur in the following situations:

- Operating pressure above normal operating range, which results in relief in a controlled manner to the flare
- Emergency shutdown by LNG facility's safety instrumented system in response to an unplanned event
- Loading of a warm LNG ship, resulting in large rate of boil-off of LNG which is returned to the LNG facility for liquefaction but in excess of capacity.

The regular program of maintenance shutdowns for the LNG facility includes major maintenance campaigns undertaken on each LNG train approximately every three years. These are planned events. Unplanned shutdowns would be extremely rare.

Volume 4 Chapter 13 and Volume 4 Chapter 14 discuss atmospheric emissions in greater detail and examine their potential effects on the local environment.

Wastewater discharges

The LNG facility operations will generate four wastewater disposal streams as follows:

- Stormwater
- Sewage effluent produced by the sewage treatment plant
- Brine from the seawater desalination plant
- Potentially contaminated stormwater from the facility process areas.

Sewage treatment plant effluent

The sewage treatment plant will be an extended aeration, biological treatment plant designed to treat the wastewater to applicable standards for use for site irrigation purposes and/or for discharge to Port Curtis. It is anticipated that during steady state LNG production (4 trains), effluent disposal will be at an average rate of 3.5 m^3/hour and up to a maximum rate of 15 m^3/hour. Indicative effluent characteristics from the sewage treatment plant are detailed in Table 23.5. Treated sewage effluent will be stored in a tank for dechlorination purposes prior to being used for irrigation purposes or discharged to Port Curtis. If it is discharged it is likely that treated sewage effluent will be discharged with the desalination plant brine.

Table 23.5 Indicative treated effluent characteristics, sewage treatment plant

Parameter	Concentration
pH	6.5 - 7.5
5 day biochemical oxygen demand (BOD_5)	10 - 20mg/L
Oil	5 - 10mg/L
Total nitrogen	< 4mg/l as N
Total Kjeldahl nitrogen	1 - 4mg/L
Ammonia nitrogen	1 - 4mg/L
Total phosphorus	<1mg/L

Parameter	Concentration
Chlorine	1 - 2mg/L
Total dissolved solids (TDS)	250mg/L

Brine disposal

The brine will be piped and released within the harbour at a location sufficiently far offshore to prevent the formation of stagnant hypersaline areas in harbour waters. The distance between the discharge point and the location of the seawater intake is also an important consideration in the selection of discharge location. For the EIS studies, it has been assumed that the desalination plant brine is discharged from the MOF. Alternative locations under consideration in the FEED phase of the Project include the end of the jetty.

It is anticipated that during steady state LNG production (4 trains), brine disposal will be at an average rate of 96m^3/hour and likely up to 116m^3/hour.

The indicative characteristics of the brine are detailed in Table 23.6.

Table 23.6 Indicative brine characteristics, desalination plant

Parameter	Concentration
pH	6 – 8
TDS	50,000 – 60,000mg/L
Calcium	600 – 750mg/L
Magnesium	2,000 – 2,500mg/L
Potassium	600 – 800mg/L
Sodium	19,000 – 22,000mg/L
Chloride	30,000 – 33,000mg/L
Fluoride	1.5 – 3mg/L
Sulphate	4,000 – 6,000mg/L
Strontium	15 – 25mg/L
Total suspended solids (TSS), average	<15mg/L
TSS, maximum	40mg/L
Chlorine	<1mg/L
Anti-scalant	8mg/L
Flocculent	5mg/L
Polymer	1mg/L
Silica oxide	1 – 2mg/L
BOD_5	5 – 10mg/L

Potentially contaminated wastewater

An integral part of the LNG facility is a dedicated system to collect and treat process and oily wastewater, including oily water from the compressors and various hydrocarbon leaks, and potentially contaminated stormwater prior to reuse or discharge. Such wastewater will be treated by passage through an oil and water separator (corrugated plate interceptor), a dissolved air flotation unit and an effluent filter.

The oily wastewater will be pre-treated in a hydrocarbon sump drum where vapours and condensate will be separated. The condensate will be pumped to the oil and water separator for retrieval of free oil, and the vapours will be sent to the wet gas flare for disposal. The separator produces three waste streams – sludge, treated effluent, and waste oil.

The sludge will be temporarily stored in a sludge holding tank pending periodical transport by a licensed contractor for disposal at a licensed waste management facility. Waste oil will also be stored and transported off-site for recycling.

The treated effluent from the oil and water separator will be sent to the dissolved air flotation unit and effluent filter to remove any remaining oil. It will be stored on-site in a tank with treated sewage effluent and is likely to be discharged into Port Curtis with the desalination plant brine if not used for on-site irrigation purposes.

The indicative characteristics of the treated effluent are detailed in Table 23.7.

Table 23.7 Indicative treated effluent characteristics

Parameter	Concentration
pH	6 - 7
BOD_5	15 - 30mg/L
Oil	5 - 15mg/L
TSS	10 – 30mg/L*
TDS	250 - 350mg/L*

It is anticipated that during steady state LNG production (4 trains), this stream will flow at an average rate of 25m^3/hour and to 100m^3/hour.

Further detail regarding wastewater discharges is provided in Volume 4 Chapter 10.

23.3 Existing environment relevant to the EPBC Act

This section describes the potentially impacted environment and values relevant to the controlling provisions:

- World Heritage (sections 12 and 15A)
- National Heritage Places (sections 15B and 15C)
- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (sections 20 and 20A).

World Heritage and National Heritage places are described jointly, given that the National Heritage listing is due to the World Heritage listing.

Desktop research and field assessment was undertaken to assist determination of the likelihood of impact of the construction and operation of the LNG facility to MNES. The DEHWA EPBC Act protected matters search tool was utilised to assist the assessment. For a selected area the tool generates a list of protected matters that may occur in or near the area. The search tool's database holds mapped locations of World Heritage properties, Ramsar wetlands, threatened, migratory and many marine species, threatened ecological communities and protected areas. It is important to note that information provided through the search tool is indicative only. Local knowledge and information has been sought for the purposes of the LNG facility. A protected matters search was undertaken on 15 October 2009 using the area search type and considering a 'buffer' search area of 10km. This search provided similar results to the search utilised for the EPBC Act referral (2009/4977) made for the Project. A full copy of the protected matters search is provided at Appendix A.

23.3.1 World Heritage and National Heritage Places

The LNG facility is located within the GBRWHA as shown at Figure 23.7. The GBRWHA extends seaward from the low water mark including the waters and the islands within the Port of Gladstone and including Curtis Island. The GBRWHA is both a World Heritage and National Heritage location.

Overview

The Great Barrier Reef is the world's largest World Heritage property extending over 2,000 kilometres and covering approximately 348,000km^2 on the northeast continental shelf of Australia. The Great Barrier Reef contains extensive areas of seagrass, mangrove, sandy and muddy seabed communities, inter-reefal areas, deep oceanic waters and island communities.

The Australian Government agency with the lead role in relation to the protection and management of the GRBWHA is the Great Barrier Reef Marine Park Authority (GBRMPA). The GBRMPA is an Australian Government statutory authority within the Environment, Water, Heritage and the Arts portfolio. The GBRMPA reports directly to the Australian Government Minister for the Environment, Heritage and the Arts.

World Heritage

The Great Barrier Reef was inscribed on the World Heritage List in 1981. The World Heritage criteria against which the Great Barrier Reef was listed remain the formal criteria for this property and are described below. The World Heritage criteria are periodically revised and the criteria against which the property was listed in 1981 are not necessarily identical with the current criteria.

Outstanding example representing a major stage of the earth's evolutionary history

The Great Barrier Reef is by far the largest single collection of coral reefs in the world. The World Heritage values of the property include:

- 2,904 coral reefs covering approximately 20,055km^2
- 300 coral cays and 600 continental islands
- Reef morphologies reflecting historical and on-going geomorphic and oceanographic processes
- Processes of geological evolution linking islands, cays, reefs and changing sea levels, together with sand barriers, deltaic and associated sand dunes

- Record of sea level changes and the complete history of the reef's evolution are recorded in the reef structure
- Record of climate history, environmental conditions and processes extending back over several hundred years within old massive corals
- Formations such as serpentine rocks of South Percy island, intact and active dune systems, undisturbed tidal sediments and "blue holes"
- Record of sea level changes reflected in distribution of continental island flora and fauna.

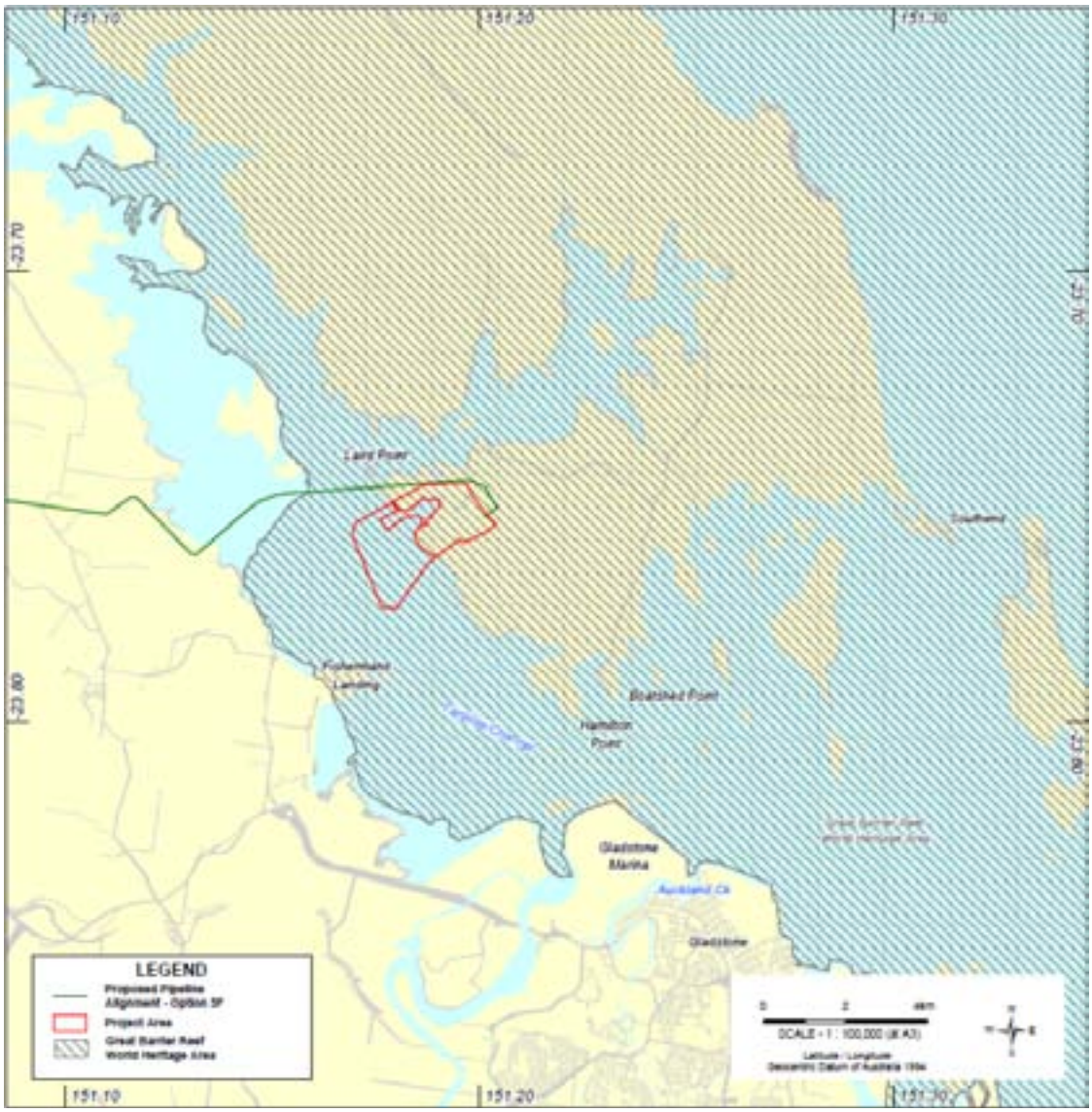

Figure 23.7 LNG facility within the GBRWHA

Outstanding example representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment

Biologically the Great Barrier Reef supports the most diverse ecosystem known to man and its enormous diversity is thought to reflect the maturity of an ecosystem, which has evolved over millions of years on the northeast Continental Shelf of Australia. The World Heritage values include:

- The heterogeneity and interconnectivity of the reef assemblage

- Size and morphological diversity (elevation ranging from the sea bed to 1,142m at Mount Bowen and a large cross-shelf extent encompass the fullest possible representation of marine environmental processes)
- On going processes of accretion and erosion of coral reefs, sand banks and coral cays, erosion and deposition processes along the coastline, river deltas and estuaries and continental islands
- Extensive *Halimeda* beds representing active calcification and sediment accretion for over 10,000 years
- Evidence of the dispersion and evolution of hard corals and associated flora and fauna from the "Indo-West Pacific centre of diversity" along the north to south extent of the reef
- Inter-connections with the wet tropics via the coastal interface and Lord Howe Island via the East Australia current
- Indigenous temperate species derived from tropical species
- Living coral colonies (including some of the world's oldest)
- Inshore coral communities of southern reefs
- Five floristic regions identified for continental islands and two for coral cays
- The diversity of flora and fauna, including:
  - Macroalgae (estimated 400-500 species)
  - Porifera (estimated 1500 species, some endemic, mostly undescribed)
  - Cnidaria: Corals - part of the global centre of coral diversity and including:
    - hexacorals (70 genera and 350 species, including 10 endemic species), and
    - octocorals (80 genera, number of species not yet estimated)
  - Tunicata: Ascidians (at least 330 species)
  - Bryozoa (an estimated 300-500 species, many undescribed)
  - Crustacea (at least 1330 species from 3 subclasses)
  - Worms:
    - Polychaetes (estimated 500 species), and
    - Platyhelminthes: include free-living Tubelleria (number of species not yet estimated), polyclad Tubelleria (up to 300 species) and parasitic helminthes (estimated 1000's of species, most undescribed)
  - Phytoplankton (a diverse group existing in two broad communities)
  - Mollusca (between 5000-8000 species)
  - Echinodermata (estimated 800 extant species, including many rare taxa and type specimens)
  - Fishes (between 1,200 and 2,000 species from 130 families, with high species diversity and heterogeneity; includes the whale shark (Rhynchodon typus)
  - Seabirds (between 1.4 and 1.7 million seabirds breeding on islands)

  - Marine reptiles (including six sea turtle species, 17 sea snake species, and one species of crocodile)
  - Marine mammals (including one species of dugong (Dugong dugon), and 26 species of whales and dolphins)
  - Terrestrial flora: see "Habitats: Islands"
  - Terrestrial fauna, including:
    - Invertebrates (pseudoscorpions, mites, ticks, spiders, centipedes, isopods, phalangids, millipedes, collembolans and 109 families of insects from 20 orders, and large over-wintering aggregations of butterflies), and
    - Vertebrates (including seabirds (see above), reptiles: crocodiles and turtles, nine snakes and 31 lizards, mammals)

- The integrity of the inter-connections between reef and island networks in terms of dispersion, recruitment, and the subsequent gene flow of many taxa
- Processes of dispersal, colonisation and establishment of plant communities within the context of island biogeography (for example,. dispersal of seeds by air, sea and vectors such as birds are examples of dispersion, colonisation and succession)
- The isolation of certain island populations (for example, recent speciation evident in two subspecies of the butterfly *Tirumala hamata* and the evolution of distinct races of the bird *Zosterops* spp.)
- Remnant vegetation types (hoop pines) and relic species (sponges) on islands
- Evidence of morphological and genetic changes in mangrove and seagrass flora across regional scales
- Feeding and/or breeding grounds for international migratory seabirds, cetaceans and sea turtles.

Contain unique, rare and superlative natural phenomena, formations and features and areas of exceptional natural beauty.

The Great Barrier Reef provides some of the most spectacular scenery on earth and is of exceptional natural beauty. The World Heritage values include:

- The vast extent of the reef and island systems which produces an unparalleled aerial vista
- Islands ranging from towering forested continental islands complete with freshwater streams, to small coral cays with rainforest and unvegetated sand cays
- Coastal and adjacent islands with mangrove systems of exceptional beauty
- The rich variety of landscapes and seascapes including rugged mountains with dense and diverse vegetation and adjacent fringing reefs
- The abundance and diversity of shape, size and colour of marine fauna and flora in the coral reefs
- Spectacular breeding colonies of seabirds and great aggregations of over-wintering butterflies

- Migrating whales, dolphins, dugong, whale sharks, sea turtles, seabirds and concentrations of large fish

Provide habitats where populations of rare and endangered species of plants and animals still survive

The Great Barrier Reef contains many outstanding examples of important and significant natural habitats for in situ conservation of species of conservation significance, particularly resulting from the latitudinal and cross-shelf completeness of the region. The World Heritage values include:

- Habitats for species of conservation significance within the 77 broad-scale bioregional associations that have been identified for the property and which include:
  - Over 2,900 coral reefs (covering 20,055km^2) which are structurally and ecologically complex
  - Large numbers of islands, including:
    - 600 continental islands supporting 2,195 plant species in 5 distinct floristic regions
    - 300 coral cays and sand cays
    - Seabird and sea turtle rookeries, including breeding populations of green sea turtles and hawksbill turtles
    - Coral cays with 300-350 plant species in two distinct floristic regions
  - Seagrass beds (over 5,000km^2) comprising 15 species, two endemic
  - Mangroves (over 2,070km^2) including 37 species
  - Halimeda banks in the northern region and the unique deep water bed in the central region
- Large areas of ecologically complex inter-reefal and lagoonal benthos
- Species of plants and animals of conservation significance.

National Heritage

The National Heritage List is a list of places with outstanding natural, Indigenous or historic heritage value to the nation. The Great Barrier Reef is a 'listed place' on the National Heritage List having been entered on that list on 21 May 2007. The Australian Heritage Council assesses if a National Heritage List-nominated place is considered to have heritage value with respect of nine National Heritage List criteria:

a) The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history

b) The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history

c) The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history

d) The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:

   i) A class of Australia's natural or cultural places, or

   ii) A class of Australia's natural or cultural environments

e) The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group

f) The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period

g) The place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons

h) The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history

i) The place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.

The official values of the Great Barrier Reef with respect to the National Heritage List are criteria a, b, c, d and e. Given that the World Heritage Committee determined that the Great Barrier Reef meets the World Heritage criteria described above, it was determined that the property was to be included in the National Heritage List for those World Heritage values[3].

Features of Port Curtis and Curtis Island relevant to World and National Heritage

Biogeographically, Port Curtis falls within the Shoalwater Coast bioregion as defined in the Interim Marine and Coastal Regionalisation for Australia (IMCRA Technical Group 1998), which includes the coastal and island waters from Mackay south to Baffle Creek. This inshore coastal region comprises large bays with very large tidal ranges (up to six metres), large coastal islands, mostly sedimentary substrates, and relatively low rainfall. Port Curtis has areas that are largely not impacted by human activity as well as areas that are highly modified by port developments and various industries.

Port Curtis is a partially enclosed embayment within the GBRWHA and is comprised of a natural deepwater harbour, shallow estuaries, small continental rocky islands, intertidal flats and estuarine islands. Port Curtis estuary is a composite estuarine system that includes the Calliope and Boyne Rivers, The Narrows, Auckland Creek and several smaller creeks and inlets that merge with deeper waters to form a naturally deep harbour, protected by Southern Curtis Island and Facing Island to the east, along with Rodd's peninsula to the southeast. Freshwater input from the Calliope and Boyne Rivers results in elevated natural turbidity levels throughout the area.

Curtis Island forms part of the eastern edge of Port Curtis, and is approximately 40km long and 20km wide (at its widest point). Curtis Island contains a reasonably high diversity of regional coastal vegetation and landscape types including rocky coastlines, parabolic dunes, parallel beach ridges, saltpans, rock platforms, mud flats and marine plains. The topography of Curtis Island is predominantly comprised of undulating terrain and tidal mud flats and salt pans to steeply graded low round hills. The LNG pant site area, located near a small embayment on the south-western portion of Curtis Island known as Laird Point, is surrounded by steeply sloping low round hills to the north, south and east, but is predominantly comprised of gently undulating flats. The western foreshore flats within the LNG facility site area extend approximately 200 to 400m from the shore where several small drainage lines traverse. Curtis Island has historically been subject to rural uses such as cattle grazing. A residential development, South End (of approximately 50 dwellings) lies at the southeast corner of the island.

[3] Commonwealth of Australia Gazette. No. S 99, Monday, 21 May 2007.

Curtis Island and surrounding waters contain several conservation areas which provide for a range of nature-based recreation activities. The Curtis Island National Park is 8,500ha and contains a variety of vegetation types including heath, grassland, low melaleuca woodland, open eucalypt forest and large areas of dry rainforest. Other conservation reserves include the Cape Capricorn Conservation Park, the Garden Island Conservation Park, the Curtis Island Conservation Park, the Curtis Island Nature Refuge, and the Curtis Island State Forest. The Great Barrier Reef Coast Marine Park (Queensland government) exists to the north of the LNG facility site in The Narrows and Graham Creek as a habitat protection area (refer to Queensland Government marine park zoning shown at Figure 23.8). The Cape Capricorn light station and Sea Hill Point lighthouse are known items of heritage significance on Curtis Island. Both lighthouses are distant from Laird Point. Indigenous cultural heritage features are known to exist on Curtis Island. Several sites of Aboriginal significance are located on the western side of Curtis Island, although not near the LNG facility site.

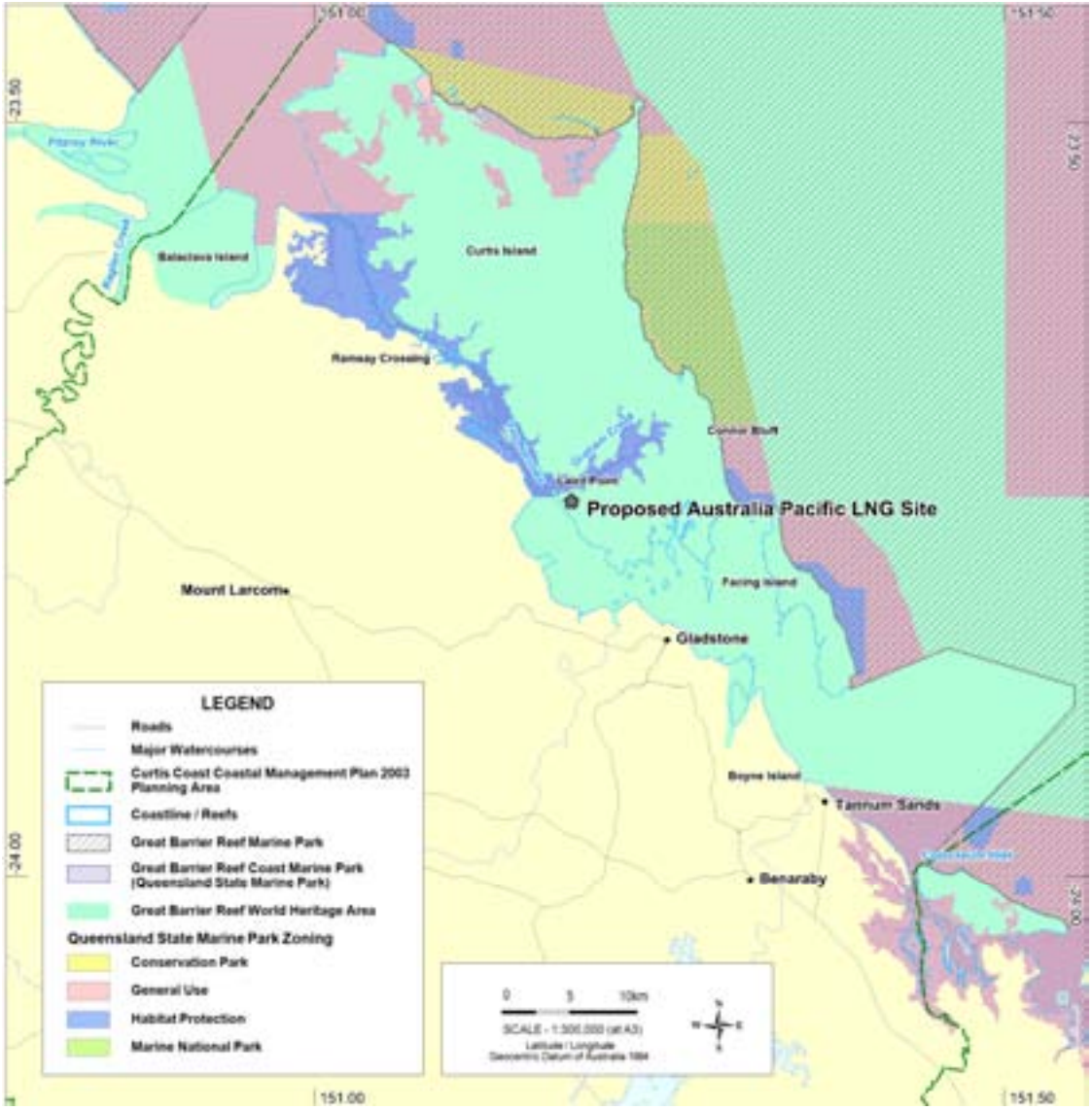

Figure 23.8 Marine park zoning[4]

[4] NB Marine park boundaries are indicative only

The Rodds Bay dugong protection area (DPA) extends into Port Curtis from Rodds Bay in the southeast to the entrance of The Narrows south of Graham Creek (refer to Figure 23.9). This area is classified as a Zone B DPA, which represents habitat that is less significant than a Zone A DPA, however is still considered important.

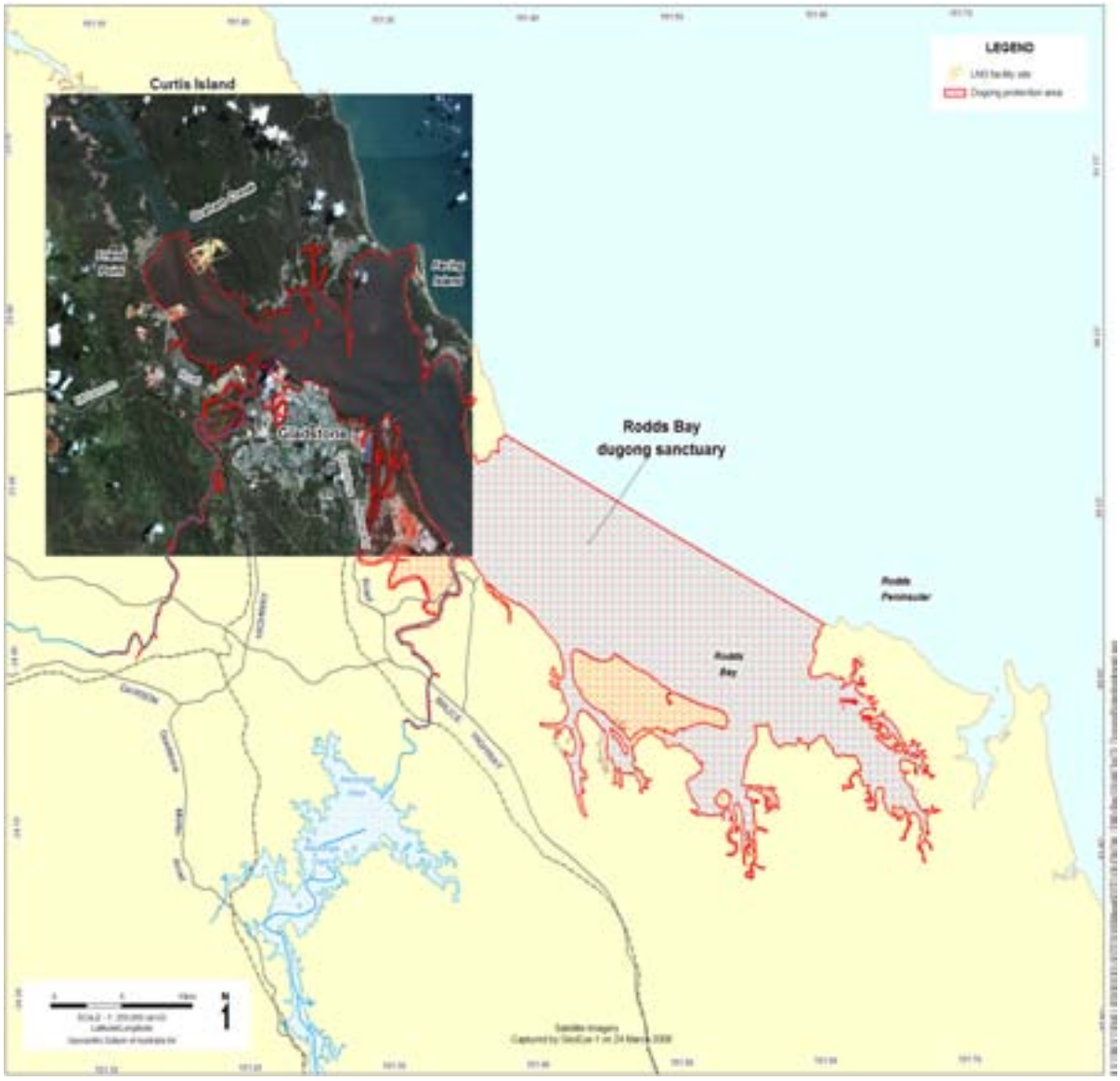

Figure 23.9 Rodds Bay dugong protection area

The great diversity of landscape types across the GBRWHA is part of the recognised value of the area. There are extensive open views from Curtis Island across the water to mountain ranges to the west, and views north and east of a tree covered Curtis Island visually dominate the character of the landscape. Surrounding the LNG facility site, there are enclosed forested hills and valleys and intertidal land systems, such as mangroves, salt marsh and mudflats, contributing to a unique coastal landscape character. These landscape patterns are a major influence on the visual quality of the landscape.

When travelling by boat a sequence of visual experiences is provided, alternating from open long distance views across open expanses of water, to visually enclosed views afforded from within the creek systems.

Key characteristics of the local and regional landscape character are:

- Landscape of contrast and variety
- Large scale water views with extensive vistas to level horizons and huge sky expanses
- Enclosed forested hills and valleys
- Forested mountains
- Mangrove vegetation and associated mudflats.

The Narrows is a 20,903ha passage that separates Curtis Island from the mainland and is one of only five tidal passages (separating large continental islands from the mainland of Australia) within Australia. Habitat types within the wetland include saline coastal flats, mangrove forest, intertidal sand and mud flats, seagrass beds and open marine and estuarine waters. The Directory of Important Wetlands identifies nationally important wetlands at The Narrows (QLD021) and Port Curtis (QLD019).

Balaclava Island and The Narrows was registered on the Register of the National Estate in 1999. The statement of significance for the register of the national estate indicates that The Narrows are (amongst other things) 'an important indicator of past geomorphological processes, as many of Queensland's headlands and coastal ranges have been joined to the mainland by sedimentation processes identical with those operating within The Narrows'. The statement indicates that Hinchinbrook Channel and Howard Passage (Northern Territory) are geologically comparable to The Narrows, however that in contrast to the sub-tropical Narrows, Hinchinbrook Channel and the Howard Passage are wide tropical estuaries at a much earlier stage of development. The statement further indicates that 'the intertidal environments of Balaclava Island and The Narrows are influenced by two different hydrological systems, which interface at a tidal null point at Ramsays Crossing. The origin of the sedimentary environment of The Narrows from these two different hydrological systems has created a complex system of intertidal habitats'. In this zone, there is evident a transition between tropical and temperate littoral communities and a change in the competitive balance between the southern mangrove communities, dominated by the temperate/sub-tropical species *Avicennia marina* and the northern mangrove species dominated by the tropical species of *Rhizophora*.

The LNG facility site area lies on the southwestern coast of Curtis Island and south of Graham Creek. It is characterised by undulating hills and slopes and adjacent floodplains dominated eucalypt open forests and woodlands, opening into expansive mudflats of saltpan vegetation and mangrove shrublands along the coastline. A small area of paperbark swamp is also present in the southern portion of the site. Intertidal areas of the LNG facility site form part of the Port Curtis wetland aggregation, considered on importance for its flora and fauna habitat value and diverse range of species. A total of 308.3ha of remnant vegetation is present on site and is generally, in good to average condition with evidence of historical fires, logging, grazing and vehicle tracks present. Some weed infestations are present, mostly associated with drainage lines.

A network of habitats makes up the Great Barrier Reef ecosystem. The interconnectivity of these habitat types is considered vital to the lifecycles of many marine animals and to the healthy functioning of the ecosystem as a whole. The primary environmental features of interest in the vicinity of the proposed development site are the seagrass meadows, mangrove and saltmarsh areas. These vegetated habitats contribute significantly to the high primary productivity of estuarine areas. They also provide structurally complex habitats that maximise food availability and minimise predation for fish, prawns and crabs (Halliday and Young 1996; Thomas and Connolly 2001; Heck et al. 2003). Rocky intertidal and shallow sub-tidal environments also exist in the study area and these are important foraging areas for various fish species. Man-made structures such as jetty and seawalls

also provide additional hard substrata within the Port Curtis region. Extensive unvegetated intertidal banks also occur in the area around Laird Point, and these banks also provide foraging opportunities for fish at high tide and shorebirds at low tide.

The seagrass beds of the Port Curtis region have been extensively investigated and mapped by Rasheed et al. (2003), Taylor et al. (2007) and Chartrand et al. (2009). Approximately 20% of the intertidal (7,246ha) and sub-tidal beds (6,332ha) of Port Curtis are covered by seagrass (refer to Figure 23.10). Generally the area of the seagrass bed and seagrass biomass peaks in later spring and summer and is lowest over winter (McKenzie 1994; Lanyon and Marsh 1995). The principal driver of seagrass change in Port Curtis is local climate conditions. High rainfall events and high inflows of freshwater may result in seagrass declines as a result of inputs from nutrients, sediment, herbicides and reduced salinity. These declines are generally reversed with the associated nutrient inputs enhancing seagrass growth (Waycott et al. 2007). A small seagrass bed consisting of aggregated patches of *Zostera capricorni* occurs in the vicinity of the proposed LNG facility. Aggregated patches of Z. capricorni of light cover with Halophila ovalis occurs in the vicinity of North Passage Island (Rasheed et al. 2003).

Mangroves provide a structurally complex habitat that can provide food and protection directly for juvenile fish and invertebrates and a source of carbon that may be exported by the tide to other areas and contribute to the food web elsewhere in a region (Manson et al. 2005; Meynecke et al. 2008). Extensive mangroves extend along the coastline from the Gladstone city precinct and into The Narrows and these have been surveyed by Danaher et al. (2005). Within the Gladstone region it is estimated that there are 3875 patches of mangroves with an area of 203km^2 and a perimeter of 4,855km (Manson et al. 2005). However, Duke et al. (2003) reported a regional loss of almost 40% of mangrove area in Port Curtis between 1941 and 1999. The mangrove assemblage in Port Curtis while diverse is dominated by red mangrove (*Rhizophora stylosa*) with lesser amounts of yellow mangrove (*Ceriops tagal*) and grey mangrove (*Avicennia marina*) also present. Red mangrove tends to dominate the seaward edge of the assemblage while yellow mangrove and grey mangrove are generally more abundant on the landward edge. The mangrove assemblage is considered to be in a healthy state at the proposed development site and in Port Curtis in general.

Also present in the Curtis Coast region are salt pans, which are largely bare, but contain patches (or isolated plants) of salt marsh species such as *Sueda* spp., *Sarcocornia quinqueflora* and *Sporobolus virginicus*. While saltmarsh habitats receive only intermittent tidal inundation, fish can extend many hundreds of metres into salt marsh habitats on spring tides, and their importance for fisheries production is well documented. Important commercial and recreational fish species such as yellowfin bream (*Acanthopagrus australis*) and various species of mullet are well known to frequently utilise salt marsh habitat in Queensland as juveniles (Morton et al. 1987; Thomas and Connolly 2001; Sheaves et al. 2007).

Figure 23.10 Seagrass distribution in Port Curtis

Intertidal rocky shores occur at a number of locations in the Port Curtis region including in the vicinity of the proposed LNG facility. These rocky shores are best described as a “rubble field” with significant oyster cover, and other macro-invertebrates associated with oyster cover, in particular the oyster borer (*Morula marginalba*). Rasheed et al. (2003) also identified rubble reef areas in the deep channel area from the vicinity of Graham Creek to Fishermen’s Landing which contained medium density cover (>15% of the area surveyed) of bivalves, ascidians, bryozoans and hard corals. Other such areas of reef habitat are located in the vicinity of Hamilton Point.

The proposed development location for the LNG facility located is largely adjacent to and partially over a saltpan which is inundated on spring tides. The development location surrounds a large stand of mangroves that extends between 120m and 200m from Port Curtis. This stand of mangroves contains red mangrove, yellow mangrove, grey mangrove and blind-your-eye (*Excoecaria agallocha*) mangrove. The LNG facility has been designed such that this area of mangrove will be largely retained. While the saltpan is largely unvegetated, isolated plants of various saltmarsh species are present as are a number of small isolated mangrove trees. The landward edge of the saltmarsh

contains small "stunted" mangroves. Isolated patches of mangroves also occur along a number of natural drainage lines within the proposed development site, and small isolated mangrove trees occur in a number of locations. Crab burrows (most probably *Uca* spp.) are associated with the isolated mangrove trees. Saltmarsh species recorded include common samphire (*Sarcocornia quinqueflora*), marine couch (*Sporobolus virginicus*) and spiny sea rush (*Juncus kraussii*). The seaward edge of the proposed development site (Port Curtis) consists of an upper area of sandy beach extending into a predominantly rocky shore which transitions to mud flat in the lower part of the shore. Taylor et al. (2007) identified that a small area of seagrass (principally *Zostera capricorni*) occurs on these mudflats.

The sub-tidal area in the vicinity of the LNG facility is principally bare substrate. A large amount of unconsolidated shell and rubble material is present at many of the sites surveyed. Some macroalgae are present attached to shell and rubble at a number of locations. Evidence of bioturbation is largely absent. No hard coral is present and there is no reef structure that affords any vertical relief, although isolated epifauna individuals (for example, gorgonians) are present.

Further discussion regarding communities and species of conservation significance relevant to the EPBC Act is provided at Sections 23.3.2, 23.3.3and 23.3.4.

Port of Gladstone

There are 10 major trading ports along the Great Barrier Reef coast being Cape Flattery, Cairns, Mourilyan, Lucinda, Townsville, Abbot Point, Mackay, Hay Point, Port Alma and the Port of Gladstone. The Port of Gladstone is Queensland's largest multi-commodity port, housing the world's fourth largest coal export terminal. The waters of the Port of Gladstone (as for most other Queensland trading ports) are within the GBRWHA, however are not within the Great Barrier Reef Marine Park. In the Great Barrier Reef Outlook Report 2009, the GBRMPA recognises that the passage of ships through the Great Barrier Reef is essential to the economic viability of the major industries in the broader region and is important to the Queensland regional economies served by the ports. The shipping industry that transits the waters of the Great Barrier Reef accounts for an estimated $17 billion of Australia's export trade each year.[5]

Within the port and industrial development areas of the Port of Gladstone, the aesthetic values ascribed to the GBRWHA have already been modified significantly. Future expansion of the Port of Gladstone either side of the Targinie Passage has been secured from a state government land use perspective through the designation of the GSDA, in particular the Curtis Island Industrial Industry Precinct, for which uses that are considered highly likely to meet the purpose of the land use designation (per the development scheme for the GSDA) include high impact industry limited to natural gas (liquefaction and storage), infrastructure facility, local infrastructure and materials transport infrastructure.

In 2008/2009 the total port throughput for GPC was 79.1Mt. The Port of Gladstone has six main wharf centres, encompassing 15 wharves. Table 23.8 summarises the ship movements for each of these wharf centres during 2008/2009.

[5] Great Barrier Reef Outlook Report 2009

Table 23.8 Shipping movements for the Port of Gladstone (2008 / 2009)[6]

Wharf centre	Total throughput (2008/2009)	No. of vessels (2008 / 2009)
RG Tanna Coal Terminal (RGTCT) – four wharves	52,396,680	597
South Trees wharves – two wharves	13,977,391	248
Boyne Wharf – one wharf	625,706	61
Fisherman's Landing – three wharves	6,456,814	219
Auckland Point wharves (Gladstone Port Central) – four wharves	1,883,364	204
Barney Point Coal Terminal (BPCT) – one wharf.	3,806,303	68
Total Cargo	79,146,258	1397

23.3.2 Listed threatened species and communities

The EPBC Act provides for the listing of nationally threatened native species and ecological communities. Listed species that may be impacted by the construction and operation of the LNG facility are described below.

Threatened communities

Three threatened ecological communities listed under the EPBC Act were identified by the EPBC protected matters search (described at Section 23.3) including:

- Littoral Rainforests and Coastal Vine Thickets of Eastern Australia (critically endangered)
- Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (endangered)
- Weeping Myall Woodlands (endangered).

The referral made to DEWHA for the LNG facility noted that an ecological community (microphyll/notophyll vine forest on beach ridges) constituting part of the Littoral Rainforests and Coastal Vine Thickets of Eastern Australia is mapped in parts of the LNG facility study area. Subsequent to the submission of this referral the LNG facility site area has been refined to avoid all areas where this community may exist.

Vegetation on and adjacent to the LNG facility site area is not analogous with any threatened ecological community as defined under the EPBC Act. Development of the proposed LNG facility will not impact upon any threatened ecological communities.

Threatened terrestrial species

Threatened flora species

Desktop research undertaken included searches utilising the EPBC protected matters search report, the QLD Herbarium HERBRECS flora collection records and the Department of Environment and

[6] GPCannual report 2008-09

Resource Management's (DERM's) wildlife online database. These searches identified seven threatened flora species from the study area (refer to Section 23.3 for definition of the study area) including one species listed as endangered under the EPBC Act and six species listed as vulnerable. Field surveys were undertaken during four days in April 2009 and three days in October 2009.

Table 23.9 identifies the threatened flora species, their habitat preference and likelihood of occurrence within the LNG facility site area. No threatened flora species listed under the EPBC Act were identified on site during the field survey and there are no historical records of these species occurring on or adjacent to the site. However, based on habitat preference, the LNG facility site area may support suitable habitat for two of these threatened species: large-fruited zamia palm (*Cycas megacarpa*) and quassia (*Quassia bidwillii*).

Threatened fauna species

Desktop research undertaken included utilising the EPBC protected matters search tool and searching the Birds Australia, QLD Museum HERBRECS fauna collection and the DERM's wildlife online databases. Database searches identified three threatened fauna species from the study area including one species listed as critically endangered and two species listed as vulnerable under the EPBC Act. An additional 11 species were identified by the protected matters search tool as possibly being present. Field surveys were undertaken during four days in April 2009 and three days in October 2009.

Table 23.10 outlines the species identified, their habitat preference and likelihood of occurrence within the LNG facility site area. No threatened fauna species listed under the EPBC Act was identified on site during the field survey. Based on habitat preference and known distribution, the LNG facility site area may support suitable habitat for eight of these species; brigalow scaly-foot (*Paradelma orientalis*), yakka skink (*Egernia rugosa*), squatter pigeon (southern subspecies) (*Geophaps scripta scripta*), red goshawk (*Erythrotriorchis radiatus*), northern quoll (*Dasyurus hallucatus*), grey-headed flying-fox (*Pteropus poliocephalus*), large-eared pied bat (*Chalinolobus dwyeri*), and false water-rat (*Xeromys myoides*).

23.3.3 Listed threatened and migratory marine species

Australia is party to international conventions and agreements to protect many migratory species including the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Australia delivers its international obligations to protect migratory species through the EPBC Act.

The EPBC protected matters search identified threatened and migratory marine species along with listed cetacean species potentially occurring within the study area. Desktop research considered various published information relevant to the listed, threatened and migratory marine species.

Given that a large number of the threatened marine species identified are also listed as migratory species, threatened and migratory marine species are described collectively in Table 23.11. Of the 15 species identified by the EPBC protected matters search as potentially occurring in the study area, one species is known to occur in the study area and eight other species may occur in the study area.

Table 23.9 Likelihood of occurrence of threatened flora species in LNG facility site area

Scientific name	Common name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in LNG facility site area**	Source ^
Cycas megacarpa	large-fruited zamia palm	E	Spotted gum – ironbark woodlands and open woodlands on rocky substrates derived from acid volcanics, ironstone and mudstone and at 40 to 680m altitude in the Bouldercombe-Woolooga of southeast and central Queensland (Botanic Gardens Trust 2008)	Possible. Spotted gum – ironbark woodlands on metamorphic hills are present throughout site and may provide some habitat for this species; although species was not recorded on site during survey	1
Bosistoa transversa (syn. *B. selywnii*)	three-leaved bosistoa	V	Lowland subtropical rainforests of subtropical coastal regions to 300 m altitude (DEWHA 2008a)	Unlikely. Rainforest is not present on site	1, 2, 3
Bulbophyllum globuliforme	miniature moss-orchid	V	Epiphyte on the scaly bark of the branches and upper trunk of mature hoop pine (*Araucaria cunninghamii*) trees of subtropical coastal ranges in south east Queensland and northeast New South Wales at 500 to 800m altitude (DNR 1999)	Unlikely. Hoop Pines are not present within the LNG facility site area	1
Cupaniopsis shirleyana	wedge-leaf tuckeroo	V	Rainforests in a variety of soil types on hillsides, mountain tops, lower slopes of valleys, rocky headlands, stream beds and along riverbanks in central east and southeast Queensland (TSSC 2008a)	Unlikely. Rainforest is not present within the LNG facility site area	1, 3
Parsonsia larcomensis	Mt Larcom monkey rope	V	Open heathlands and shrublands at or near the summits of mountain peaks on cliffs or	Unlikely. Suitable habitat is not present on site. Species known to the mainland only	1, 2, 3

Scientific name	Common name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in LNG facility site area**	Source ^
			among outcrops of acid volcanic rocks and serpentinite and in shallow, loamy soils in association with broad-leaved red ironbark (*Eucalyptus fibrosa*) at 350 to 750m altitude (DNR 1999)		
Quassia bidwillii	quassia	V	Lowland rainforests or rainforest margins and occasionally open forests, woodlands and mangroves in lithosols, skeletal soils, loamy sands, sands, silts and sands with clay subsoils at 1 to 617m altitude in coastal regions (DNR 1999)	Possible. Forests and mangrove communities on site may provide suitable habitat for this species; however, no individual was recorded on site during the field survey	1, 3
Taeniophyllum muelleri	minute orchid	V	Epiphyte on branches and branchlets of rainforest trees in coastal regions (DEWHA 2008a)	Unlikely. Whilst a few stunted rainforest derivatives were recorded along the coastline, this species was not identified during the field survey and trees are unlikely to support any significant habitat for this species	1

* EPBC Act Status: E = Endangered, V = Vulnerable. * Likelihood of Occurrence: Known = Species recorded within the LNG facility area; Likely = Species identified by database searches as having geographical range overlapping the wider study area and suitable habitat is mapped within the LNG facility site area; Possible = Species identified by database searches as having geographical range overlapping the wider study area and sub-optimal habitat or preferred habitat features are mapped within the LNG facility site area; Unlikely = Species identified by database searches as having geographical range overlapping the wider study area and suitable habitat is not mapped within the LNG facility site area. ^ Source: 1 = EPBC Act protected matters search report, 2 = QLD Herbarium HERBRECS flora collection records, 3 = DERM's wildlife online database.

Table 23.10 Likelihood of occurrence of threatened terrestrial fauna species identified by database searches

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in LNG LNG facility site area**	Source ^
Brigalow scaly-foot	*Paradelma orientalis*	V	Eucalypt woodland, usually found under logs and debris. Also found climbing in rough Acacia trees. Known from Boyne Island	Possible	1
Yakka skink	*Egernia rugosa*	V	Dry open forests or woodland with dense ground vegetation, rocky areas, fallen timber and other debris	Possible	1
Ornamental snake	*Denisonia maculata*	V	Poorly known. Low-lying areas with cracking clay soils in open forests, woodlands and riparian habitats. Shelters under fallen timber and in soil cracks, and forages for frogs at night	Not expected to occur	1
Squatter pigeon (southern subspecies)	*Geophaps scripta scripta*	V	Widespread but rare. Preference for areas on sandy soil with low gravel ridges and nearby water. Usually in lightly timbered country, especially stony plains and lightly timbered acacia scrublands	Possible	1, 4
Southern Giant-petrel	*Macronectes giganteus*	E	A marine bird that occurs in Antarctic to subtropical waters. It is wide spread throughout the Southern Ocean, most abundant around ice packs where penguins are breeding or over the continental shelf. Nests on off shore islands, often near a steep drop or on slope	Not expected to occur	1
Kermadec petrel (western)	*Pterodroma neglecta neglecta*	V	Oceanic and pelagic, extremely rare visitor to the east coast of Queensland and New South Wales	Not expected to occur	1
Red goshawk	*Erythrotriorchis radiatus*	V	Very rarely seen bird of prey. Found in tropical open woodland, edges of rainforest and dense riparian vegetation. Nests in trees taller than 20m and within 1km of a permanent watercourse or wetland. Foraging usually occurs in open forests and gallery forests. Possibly within foraging range.	Possible	1
Australian painted snipe	*Rostratula australis*	V	Cryptic nomadic bird of shallow wetlands, nests on ground in reeds close to water. Found in areas with shallow muddy freshwater swamps and marshes.	Unlikely	1
Black-breasted	*Turnix melanogaster*	V	Usually low canopy, closed rainforest or monsoon forest, vine	Unlikely	1

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in LNG LNG facility site area**	Source ^
button-quail			thickets and drier shrubby scrubs such as hoop pine, brigalow, belah and bottletree thickets where there is a dense leaf-litter layer. Also occurs in coastal acacia scrubs		
Yellow chat (Dawson subspecies)	*Epthianura crocea macgregori*	CE	This subspecies is known only from Curtis Island, the Torilla Plain and Fitzroy River delta in Central Queensland, but it is seasonally mobile and possibly also occurs in other localities. It inhabits wetlands and associated grasslands on seasonally inundated marine plains (Houston and Melzer 2008)	Unlikely	2
Northern quoll	*Dasyurus hallucatus*	E	Generally occurs in densely vegetated areas ranging from rainforest through woodland to coastal heathlands. Utilises logs, rocks and hollows for shelter	Possible	1
Large-eared pied bat	*Chalinolobus dwyeri*	V	Dry forests and woodlands, moist eucalypt forests. Roosts in caves and mines, particularly in sandstone areas. Possibly within foraging range	Possible	1
Grey-headed flying-fox	*Pteropus poliocephalus*	V	Feeds on blossoms, fruits and leaves of many plants. Commonly roosts by day in 'camps' in dense riparian vegetation. It is highly mobile between camps and foraging areas	Likely	1, 4
False water-rat	*Xeromys myoides*	V	Distribution along coastal areas of the Queensland. Found in coastal wetlands such as lagoons, mangroves, swamps and sedged lakes close to fore dunes	Possible	1

^Source: 1 = EPBC Act protected matters search tool, 2 = Birds Australia (includes studies undertaken on all of Curtis Island), 3 = QLD Museum Fauna Collection Records, 4 = DERM's wildlife online database *Status: EPBC: CE = Critically endangered, E = Endangered, V = Vulnerable.

**Likelihood of occurrence: Known: species has been previously recorded within LNG facility site area; Likely: species is known from the wider study area and preferred habitat is present on site; Possible: species is known from the wider study area and suboptimal habitat is present on site; Unlikely: species is known from the wider study area however, suitable habitat is not present on site; Not expected to occur: due to a lack of habitat and/or a lack of relevant records the species is not expected to occur.

Table 23.11 Likelihood of occurrence of threatened and migratory marine fauna species identified by database searches

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility study area**	Source^
saltwater crocodile	*Crocodylus porosus*	Mi	Tropical coasts and coastal rivers and swamps south to about Gladstone, extending well inland via major rivers and billabongs	Possible	1
flatback turtle	*Natator depressus*	V, Mi	South End on Curtis Island is a medium density nesting beach for flatback turtles. Foraging habitats for the species are shallow coastal environments including rocky reef and sedimentary habitats	Likely	1, 2, 3
green turtle	*Chelonia mydas*	V, Mi	Occasional nesting on Curtis and Facing Islands. Forage in shallow coastal areas, in particular seagrass beds	Likely	3, 4
loggerhead turtle	*Caretta caretta*	E, Mi	Occasional nesting on Curtis and Facing Islands, but the principal nesting area on the east coast is the Bundaberg region. Foraging occurs over a wide range of intertidal and sub-tidal habitats including coral and rocky reefs, seagrass meadows, and unvegetated sand or mud areas	Likely	5
leatherback turtle	*Dermochelys coriacea*	E, Mi	Oceanic environments from the sea surface to the seabed. Nests on beaches but major nesting areas are overseas. No recorded nesting of the species in Queensland since 1996	Unlikely	6
olive ridley turtle	*Lepidochelys olivacea*	E, Mi	Nests on beaches, but no concentrated nesting occurs in Australia and none recorded in recent times from the east coast. Principally forages in shallow unvegetated coastal environments	Possible	7
hawksbill turtle	*Eretmochelys imbricata*	V, Mi	Principally forages in rocky reef and coral reef habitats. Nesting in Queensland occurs on beaches on Cape York and the Torres Strait	Possible	8
humpback whale	*Megaptera novaeangliae*	V, Mi, Ce	Principally occurs in oceanic waters. Port Curtis is not a	Unlikely	9

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility study area**	Source^
			known feeding, resting or calving area for the species		
Bryde's whale	*Balaenoptera edeni*	Mi, Ce	Occurs in oceanic waters and do not generally frequent estuarine areas	Unlikely	9
killer whale	*Orcinus orca*	Mi, Ce	Occurs in oceanic waters and do not generally frequent estuarine areas	Unlikely	9
green sawfish	*Pristis zijsron*	V	Occur in shallow coastal and estuarine environments. Detailed records of the occurrence of the species from 1912 to 2004 identify that no individuals of the species have been recorded in the Port Curtis region during that period	Unlikely	10
whale shark	*Rhincodon typus*	V	Occurs in oceanic waters and do not generally frequent estuarine areas	Unlikely	11
dugong	*Dugong dugon*	Mi, Ce	Occurs in coastal tropical and subtropical waters in association with seagrass beds. Known to occur in Port Curtis	Known	12
Indo-Pacific humpback dolphin	*Sousa chinensis*	Mi, Ce	Occurs in coastal and estuarine waters. Known to occur in Port Curtis	Likely	13
Australian snubfin dolphin*	*Orcaella heinsohni*	Mi, Ce	Occurs in coastal and estuarine waters. Known to occur in Port Curtis although more common on the east coast of Australia north of Townsville	Likely	14

*Status: EPBC: CE = Critically endangered, E = Endangered, V = Vulnerable, Mi = Migratory, Ce = Cetacean.

[1] Limpus et al. (2006); [2] Hodge et al. (2006); 3 Limpus et al. (2002); 4 Brand-Gardner et al. (1999); 5 Limpus (2008a); 6 Limpus (2009b); 7 Limpus (2008b); 8 Limpus (2009b); 9 Bannister et al. (1996); 10 Stevens et al. (2005); 11 Meekan et al. (2008); [12] Lawler and Marsh (2001); [13] Corkeron et al. (1997); [14] Parra (2006); [15] Read et al. (2004)

NB the Australian snubfin dolphin (Orcaella heinsohni) was previously identified as the widely distributed Irrawaddy dolphin (Orcaella brevirostris). It is now known that the Irrawaddy dolphin does not occur in Australia.

**Likelihood of occurrence: Known: species has been previously recorded within LNG facility site area; Likely: species is known from the wider study area and preferred habitat is present on site; Possible: species is known from the wider study area and suboptimal habitat is present on site; Unlikely: species is known from the wider study area however, suitable habitat is not present on site; Not expected to occur: due to a lack of habitat and/or a lack of relevant records the species is not expected to occur.

23.3.4 Listed migratory species

Australia is party to international conventions and agreements to protect many migratory species including: Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea - Australia Migratory Bird Agreement (ROKAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Australia delivers its international obligations to protect migratory species through the EPBC Act.

Migratory bird species

Desktop research was undertaken including utilising the EPBC protected matters search tool and searching the Birds Australia, QLD Museum HERBRECS fauna collection records and the DERM's wildlife online databases. This research also considered the other relevant studies undertaken on Curtis Island and in Port Curtis recently.

Database searches and a review of recent surveys undertaken within the study area identified 56 migratory listed bird species. Table 23.12 outlines these species, their habitat preference and likelihood of occurrence within the LNG facility site area. Seven migratory species listed under the EPBC Act were identified during the field survey of the study area; eastern reef egret (*Egretta sacra),* white-bellied sea-eagle (*Haliaeetus leucogaster),* rainbow bee-eater (*Merops ornatus),* whimbrel (*Numenius phaeopus),* Pacific golden plover (*Pluvialis fulva),* Caspian tern (*Sterna caspia)* and eastern curlew (*Numenius madagascariensis).*

Based on habitat preference, the LNG facility site area may support suitable habitat for a further 34 species which may be expected to occur, at least occasionally.

23.4 Assessment of potential impact on MNES

23.4.1 Assessment methodology

The current EPBC Act Policy Statement 1.1, 'Significant Impact Guidelines: Matters of National Environmental Significance' (the significant impact guidelines) provide guidance for the assessment of potential impact on MNES through provision of a definition of 'significant impact' and of when a significant impact is 'likely':

> "A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance.
>
> To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment".

Table 23.12 Likelihood of occurrence of migratory bird species in LNG facility site area

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
White-throated needletail	*Hirundapus caudacutus*	Mi	Variety of habitats, including over infrastructure. Aerial forager	Likely	1, 2, 6
Fork-tailed swift	*Apus pacificus*	Mi	Varied; airspace over habitat ranging from rainforest to semi-desert	Likely	1
Southern giant-petrel	*Macronectes giganteus*	Mi	A marine bird that occurs in Antarctic to subtropical waters. It is wide spread throughout the Southern Ocean, most abundant around ice packs where penguins are breeding or over the continental shelf. Nests on offshore islands	Not expected to occur	1
Brown booby	*Sula leucogaster*	Mi	Mainly tropical marine habitats including deep waters and inshore shallows	Possible	4
(Eastern) great egret	*Ardea alba* (*modesta*)	Mi	Floodwater, rivers, shallows of wetlands, intertidal mudflats	Likely	1, 6
Cattle egret	*Ardea ibis*	Mi	Found in pasture and the shallows of freshwater wetlands	Possible	1, 2
Eastern reef egret	*Egretta sacra*	Mi	Found on beaches, rocky shores, tidal rivers and inlets, mangroves, and exposed coral reefs	Known	2, 4, 5, 6
Eastern osprey	*Pandion cristatus*	Mi	Found around coastal waters, beaches, reefs and estuaries	Likely	2, 4, 6
White-bellied sea-eagle	*Haliaeetus leucogaster*	Mi	Coastal seas, islands, estuaries and inlets. Follows major rivers and wetlands far inland. Huge nests of sticks, usually in tall trees	Known	1, 2, 4, 5, 6
Pacific golden plover	*Pluvialis fulva*	Mi	Widespread along the coastline. Found on muddy, rocky and sandy wetlands, shores, paddocks, salt marsh, estuaries and lagoons	Known	1, 2, 4, 5

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
Grey plover	*Pluvialis squatarola*	Mi	Generally found on intertidal flats, particularly in estuaries and bays. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 4
Little ringed plover	*Charadrius dubius*	Mi	Very small number of individuals regularly visit Australia, mostly Northern Territory and far north Queensland. Found on the muddy edges of freshwater wetlands (R1).	Not expected to occur	1
Double-banded plover	*Charadrius bicinctus*	Mi	Distributed around the southern and east coast of Australia on tidal flats and coastal beaches. Occasionally freshwater wetlands and inland salt lakes. EPBC report indicates roosting known to occur in the wider study area	Likely	1
Lesser sand plover	*Charadrius mongolus*	Mi	Found in sheltered bays, harbours and estuaries with large intertidal sand flats or mudflats. EPBC report indicates roosting known to occur in the wider study area	Likely	1
Greater sand plover	*Charadrius leschenaultii*	Mi	Occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. EPBC report indicates roosting known to occur in the wider study area	Likely	1
Painted snipe***	*Rostratula benghalensis s. lat*	Mi	Cryptic nomadic bird of shallow wetlands, nests on ground in reeds close to water. Found in areas with shallow muddy freshwater swamps and marshes	Unlikely	1
Latham's snipe	*Gallinago hardwickii*	Mi	Low rank vegetation around shallows of wetlands, reeds, sedges, salt marsh	Possible	1, 2
Swinhoe's snipe	*Gallinago megala*	Mi	Distribution along coastal northern Australia, particularly the	Not expected to	1

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
			Northern Territory and the Kimberley and occasionally far north Queensland . Found on a variety of freshwater wetlands such as billabongs, swamps, flooded grasslands and claypans	occur	
Pin-tailed snipe	*Gallinago stenura*	Mi	Little known in Australia with most recorded sightings in the north west. Possibly absent from Queensland. Sightings have been in coastal freshwater wetlands (R1)	Not expected to occur	1
Black-tailed godwit	*Limosa limosa*	Mi	Found in fresh and brackish waters and intertidal mudflats. EPBC report indicates roosting known to occur in the wider study area	Likely	1
Bar-tailed godwit	*Limosa lapponica*	Mi	Coastal tidal mudflats and sandbars of estuaries and lagoons.	Likely	2, 4, 6
Little curlew	*Numenius minutus*	Mi	Widespread in the north of Australia and scattered elsewhere. Found on coastal and inland grasslands, often artificially grassed areas or on the grassed edges of freshwater wetlands (R1)	Unlikely	1
Whimbrel	*Numenius phaeopus*	Mi	Common across northern Australia and uncommon to rare further south. Found mainly on the coast, on tidal and estuarine mudflats and lagoons, especially near mangroves	Known	1, 2, 4, 5, 6
Eastern curlew	*Numenius madagascariensis*	Mi	Associated with sheltered coast, bays and estuaries. Moving between the low and high tide marks	Known	1, 2, 4, 5, 6
Terek sandpiper	*Xenus cinereus*	Mi	Found in coastal bays and estuaries on tidal mudflats fringed by mangroves and on exposed sea-grass beds. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 4
Common sandpiper	*Actitis hypoleucos*	Mi	Distribution around Australia however it is more common in northern Australia. Prefers rocky creeks and mangrove-lined inlets,	Possible	1, 4

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
			rarely seen in intertidal mudflats (R1). EPBC report indicates roosting known to occur in the wider study area		
Grey-tailed tattler	*Heteroscelus brevipes*	Mi	Found in coastal habitats foraging in intertidal pools, mudflats, sand beaches, rock ledges and reefs. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 2, 4, 6
Wandering tattler	*Heteroscelus incana*	Mi	Distribution along the east coast of Australia. Generally found on rocky coasts and off shore islands, this species tends to avoid mud flats (R1)	Unlikely	1
Common greenshank	*Tringa nebularia*	Mi	Distribution around Australia occurring on intertidal mudflats and a variety of coastal and inland wetlands. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 2, 4, 6
Marsh sandpiper	*Tringa stagnatilis*	Mi	Wide spread distribution across Australia on a variety of fresh and salt water wetland, preferring freshwater water bodies. Generally avoids intertidal mudflats unless well sheltered (R1). EPBC report indicates roosting known to occur in the wider study area	Possible	1, 2, 4
Common redshank	*Tringa totanus*	Mi	Considered an uncommon but regular migrant to the coastlines in the north of Australia and a rare vagrant elsewhere (R1). Found in sheltered coastal habitats	Not expected to occur	1
Wood sandpiper	*Tringa glareola*	Mi	More common in the northern half of Australia. Preference for shallow freshwater wetlands and pools with emergent reeds and grass (R1)	Unlikely	1
Ruddy turnstone	*Arenaria interpres*	Mi	Found around the coastline on beaches, coasts with exposed rock, stony or shell beaches, mudflats or reefs. EPBC report indicates	Likely	1

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
			roosting known to occur in the wider study area		
Asian dowitcher	*Limnodromus semipalmatus*	Mi	Found along on coastal beaches, mudflats and salt fields. Considered to be rare or vagrant to the east coast (R1)	Possible	1
Great knot	*Calidris tenuirostris*	Mi	Found in sheltered areas such as mudflats of estuaries, inlets, harbours, lagoons and mangrove swamps. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 2
Red knot	*Calidris canutus*	Mi	Distributed around the coastline on sheltered areas such as mud flats, sandbars in estuaries and lagoons. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 4
Sanderling	*Calidris alba*	Mi	Found around the coastline on open sandy beaches	Unlikely	1, 4
Red-necked stint	*Calidris ruficollis*	Mi	Wide distribution, in sheltered inlets, bays, lagoons, estuaries, intertidal and inland mudflats and protected sandy or coralline shores. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 4, 6
Long-toed stint	*Calidris subminuta*	Mi	Preference for shallow freshwater swamps and brackish swamps rather than open mudflats (R2). Very rare vagrant to Queensland. Feeds in shallow water with low vegetation which provides cover while feeding (R1)	Not expected to occur	1
Pectoral sandpiper	*Calidris melanotos*	Mi	Relatively low numbers of individuals regularly migrate to Australia. Usually solitary and found on freshwater wetlands (R1)	Not expected to occur	1
Sharp-tailed sandpiper	*Calidris acuminata*	Mi	Widespread distribution, found in flooded fields, mudflats, mangroves, rocky shores and beaches. Occurs on both coastal	Likely	1, 2, 4

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
			and inland wetlands but prefers non-tidal fresh or brackish wetlands (R1). EPBC report indicates roosting known to occur in the wider study area		
Curlew sandpiper	*Calidris ferruginea*	Mi	Found on intertidal mudflats of estuaries, lagoons, mangroves, as well as beaches, rocky shores, floodwaters and flooded saltbush surrounds of inland lakes. EPBC report indicates roosting known to occur in the wider study area	Likely	1, 2, 4
Broad-billed sandpiper	*Limicola falcinellus*	Mi	Generally uncommon, found in sheltered coastal estuaries and lagoons with intertidal mudflats, and on muddy coastal creeks and swamps. EPBC report indicates roosting known to occur within the wider study area	Possible	1
Ruff	*Philomachus pugnax*	Mi	Considered a rare but recurrent visitor to the coastlines of Australia, more common in south and northwest. Prefers muddy substrate around fresh and brackish wetlands (R1)	Not expected to occur	1
Red-necked phalarope	*Phalaropus lobatus*	Mi	Considered a rare but regular migrant to the NW of Australia and irregular in the remainder of Australia. Very rare in Queensland. Mostly pelagic during the non breeding period (R1)	Not expected to occur	1
Oriental pratincole	*Glareola maldivarum*	Mi	Generally in northern Australia but occasional individuals can be seen in southern Australia. No known records for the study area. Typical areas include wetlands, tidal flats, open areas or beaches	Not expected to occur	1
Little tern	*Sterna* (*Sternula*) *albifrons*	Mi	Almost exclusively coastal, nesting on sandy beaches or shingle pits	Likely	1, 4
Caspian tern	*Sterna* (*Hydroprogne*)	Mi	Distributed around the Australian coastline, prefers shelters	Known	2, 4, 5, 6

Common name	Scientific name	EPBC Act status*	Preferred habitat	Likelihood of occurrence in the LNG facility site area**	Source^
	caspia		estuaries, inlets and bays. Distribution extends inland to fresh and saline wetlands and floodwaters.		
Common tern	*Sterna hirundo*	Mi	Found around the Australia coastline and in offshore waters. Typically well offshore but also seen along ocean beaches, estuaries and large lakes	Likely	8
Oriental cuckoo	*Cuculus saturatus*	Mi	Typically found in dense vegetation with a closed canopy such as, rainforest margins, monsoon forest, vine thicket, dense eucalypt forest, paperbark swamp and mangroves	Possible	4
Rainbow bee-eater	*Merops ornatus*	Mi	Open country, most vegetation types, sand dunes, banks	Known	1, 2, 4, 5, 6
Rufous fantail	*Rhipidura rufifrons*	Mi	Rainforest, dense wet eucalypt forest, paperbark and mangrove swamps, riparian vegetation	Likely	1, 4, 6
Satin flycatcher	*Myiagra cyanoleuca*	Mi	Distributed along the east coast of Australia from far northern Queensland to Tasmania. Found in forests, woodlands, mangroves and coastal heath but avoids rainforest	Likely	1, 4, 6
Black-faced monarch	*Monarcha melanopsis*	Mi	Distributed along the east coast, found in rainforests, mangroves, eucalypt woodlands, coastal scrub and damp gullies	Likely	1, 2, 4, 6
Spectacled monarch	*Monarcha* (*Symposiarchus*) *trivirgatus*	Mi	Mainly found in coastal rainforest but also found in mangroves and gullies of dense wet eucalypt forest	Likely	1, 2, 4, 6
Barn swallow	*Hirundo rustica*	Mi	Found in a wide variety of habitats with the exception of the more heavily forested regions and drier inland areas. Often near water	Possible	1

^Source: 1 = EPBC protected matters search tool, 2 = Birds Australia, 3 = QLD Museum fauna collection records, 4 = DERM's wildlife online database, 5 = WorleyParsons this study, 6 = Other studies within the wider study area.

*Status: EPBC: Mi = migratory

**Likelihood of occurrence: Known: species has been previously recorded within LNG facility site area; Likely: species is known from the wider study area and preferred habitat is present on site; Possible: species is known from the wider study area and suboptimal habitat is present on site; Unlikely: species is known from the wider study area however, suitable habitat is not present on site; Not expected to occur: due to a lack of habitat and/or a lack of relevant records the species is not expected to occur.

*** Although Australian birds are now considered to be an endemic species Rostratula australis the species is listed as migratory under the EPBC Act as Painted Snipe R. benghalensis s. lat.

(R1) = (Geering, Agnew & Harding 2007), (R2) = (Morcombe 2003)

The policy statement provides further guidance indicating that a proponent should consider:

- Whether there are any MNES in the vicinity of the proposed actions (refer to Section 23.3)
- Whether at the broadest scope of the construction and operation of the LNG facility (refer to Section 23.2) there is potential for impacts on MNES
- Whether there are any proposed measures to avoid or reduce impact on MNES (refer to this section and Section 23.4.6)
- Whether any impacts of the proposed action on matters of MNES are likely to be significant impacts (this section).

Sections 23.4.2, 23.4.3, and 23.4.4 discuss potential impact on MNES for the controlling provisions of World Heritage and National Heritage Places, listed threatened species and communities and listed migratory species respectively, with reference to the significant impact guidelines.

With reference to the second dot point above, consideration of indirect and offsite impacts (such as upstream, downstream and facilitated impacts), has been made to the extent that the impacts could reasonably be predicted to follow from the construction and operation of the Project, and are sufficiently close to the LNG facility site area to be said to be a consequence of the Project or attributed to be within the contemplation of Australia Pacific LNG as proponent for the development of the Project. Given that GPC is currently undertaking an EIS for the Port of Gladstone Western Basin Dredging and Disposal Project (Referral EPBC 2009/4904 - to which Australia Pacific LNG has contributed information for dredging requirements) and that the GPC project will conceptually provide shipping access to a number of potential port customers, impact assessment for the GPC project is being undertaken through the EIS for that project. A summary of relevant impacts from that EIS is provided at Section 23.4.5.

For the purposes of the assessment it has been considered that land-based decommissioning activities will have similar impacts to construction activities.

23.4.2 World Heritage and National Heritage Places

The significant impact guidelines (policy statement 1.1) indicate an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property or on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- One or more of the World Heritage or National Heritage values (respectively) to be lost
- One or more of the World Heritage values or National Heritage values (respectively) to be degraded or damaged
- One or more of the World Heritage values or National Heritage values (respectively) to be notably altered, modified, obscured or diminished.

The significant impact guidelines provide further guidance through examples of actions likely to have a significant impact on natural heritage values. These examples are virtually identical for world and national heritage values and places. Those examples relevant to the ascribed values of the Great Barrier Reef are briefly described in Table 23.13.

Table 23.13 Examples of significant impact on World Heritage or National Heritage Places

Values associated with geology or landscapes
• Damage, modify, alter or obscure important geological formations in a World Heritage property or National Heritage place • Damage, modify, alter or obscure landforms or landscape features, for example, by excavation or infilling of the land surface in a World Heritage property or National Heritage place • Modify, alter or inhibit landscape processes, for example, by accelerating or increasing susceptibility to erosion, or stabilising mobile landforms, such as sand dunes, in a World Heritage property or National Heritage place • Divert, impound or channelise a river, wetland or other water body in a World Heritage property or National Heritage place • Substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants or substances in a river, wetland or water body in a World Heritage property or National Heritage place.
Biological and ecological values
• Modify or inhibit ecological processes in a World Heritage property or National Heritage place • Reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property or National Heritage place • Fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property or National Heritage place • Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property or National Heritage place • Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property or National Heritage place.
Wilderness, natural beauty or rare or unique environment values
• Involve construction of buildings, roads, or other structures, vegetation clearance, or other actions with substantial, long-term or permanent impacts on relevant values • Introduce noise, odours, pollutants or other intrusive elements with substantial, long-term or permanent impacts on relevant values.

Given the Great Barrier Reef was placed on the National Heritage List due to its World Heritage listing and associated values, it is considered relevant to assess the potential for impact on world heritage and national heritage values together.

For each of the world heritage values Table 23.14 indicates the aspects of the construction and operation of the LNG facility that have potential to particularly impact that value. Section 23.4.2 deals specifically with potential impacts of the LNG facility relevant to the world heritage values described at Section 23.3.1. Further detailed assessment for each of those impacts is provided in the chapters and technical reports described in Table 23.1. The EIS in its entirety provides further context to the potential impact of the LNG facility.

Table 23.14 Potential sources of impact to World Heritage value

World Heritage value	Potential source of impact
Outstanding example representing a major stage of the earth's evolutionary history	Construction of the LNG facility by Australia Pacific LNG Construction and operation of shipping access by GPC
Outstanding example representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment	Construction and operation of the LNG facility by Australia Pacific LNG Construction and operation of shipping access by GPC
Contain unique, rare and superlative natural phenomena, formations and features and areas of exceptional natural beauty	Construction and operation of the LNG facility by Australia Pacific LNG Construction and operation of shipping access by GPC
Provide habitats where populations of rare and endangered species of plants and animals still survive	Construction and operation of the LNG facility by Australia Pacific LNG Construction and operation of shipping access by GPC

Site selection

Given that the GBRWHA exists on the seaward side of low water mark for the majority of the Queensland coast (from the tip of Cape York Peninsula to between Bundaberg and Gladstone) it is highly likely that projects undertaken in central and northern Queensland that require port access will have some interaction with the GBRWHA. Therefore in the discussion of avoidance, minimisation or mitigation of impact on the world heritage values of the GBRWHA it is considered relevant to discuss the consideration of site selection relevant to those values for the LNG facility.

Australia Pacific LNG undertook an LNG facility siting study to identify potential site options for the LNG facility. This study was reliant on input from several sources including the Connell Wagner study completed for the DIP. The study initially examined potential port sites located on the east Australian coast between Townsville and Brisbane (refer to Figure 23.11). Early investigations also included sites in New South Wales.

Figure 23.11 LNG facility locations considered

The Australia Pacific LNG study of potential port sites commenced in 2008, and initially reviewed the following locations:

- Multi cargo facility, Port of Abbot Point
- Port of Mackay

- Dudgeon Point adjacent, Port of Hay Point
- Stanage Point, Shoalwater Bay locality
- Collins Island, Shoalwater Bay locality
- Port Clinton, Shoalwater Bay locality
- Cape Manifold, Shoalwater Bay locality
- Stockyard Point, Shoalwater Bay locality
- Torilla Peninsula, Shoalhaven Bay
- Broad Sound
- Cattle Point, Port Alma
- Sea Hill Point, Curtis Island
- Hamilton Point, Curtis Island
- North China Bay, Curtis Island
- Boatshed Point, Curtis Island
- Laird Point, Curtis Island
- Hummock Hill Island, Gladstone
- Port of Bundaberg
- Bulwer Island, Brisbane.

The initial review undertaken examined a variety of key issues as follows:

- Maritime
  - Under keel clearance (available depth adjacent to port area)
  - Metocean conditions
  - Navigability
  - Capital and maintenance dredging requirements and dredged material disposal options
  - Port capacity (where applicable)
- Land access
  - Land availability
  - Native title impacts
- Environment
  - Marine ecological values
  - Terrestrial ecological values
  - Air quality protection
  - Noise amenity protection
- Land use planning

  - Land use compatibility and buffer land availability
  - Great Barrier Reef Marine Park zoning / issues
  - Community support
- Site suitability
  - Proximity to wharf
  - Geotechnical conditions
  - Civil and structural engineering issues.

As a result of the initial review of the potential site locations, the following locations were selected for further investigation:

- Port of Abbot Point
- Cattle Point, Port Alma
- Hamilton Point, Curtis Island
- Hummock Hill Island, Port of Gladstone
- Boatshed Point, Curtis Island
- Laird Point, Curtis Island.

A site selection screening study was performed on each of the sites to assess the location suitability for an LNG facility and the associated constructability. Prior consultant reports were initially reviewed to identify potential site selection criteria. Site specific conceptual layouts were developed to establish site cost criteria to be used in a comparison ranking matrix of the key cost drivers together with site related subjective advantages and disadvantages for an LNG facility. This ranking comparison identified the following as the key cost driver criteria for comparing the potential site locations:

- Proximity to the feed gas supply (pipeline length)
- Onshore and offshore jetty/trestle length
- Dredging requirements
- Site civil cut and fill requirements
- Site access
- Construction viability.

Based on screening level evaluations of these and other criteria, two locations on Curtis Island were selected for a more rigorous detailed site development selection: Hamilton Point and Laird Point (two berth options). The sites were selected because of the following factors:

- Relative proximity to the Australia Pacific LNG's CSG fields
- An existing natural deep water harbour
- Proximity to the existing heavy industrial base in Gladstone
- The perceived availability of suitable land in the GSDA
- DIP support for LNG development on Curtis Island.

Both sites are located within the Curtis Island Industry Precinct of the GSDA. The Curtis Island Industry Precinct designates the land in the precinct for the development and operation of LNG facilities (including liquefaction and storage) for export. The Curtis Island Industry Precinct also designates land for the establishment of infrastructure associated with the LNG facilities including transport linkages to wharf facilities. The two sites investigated further are both consistent with this development intent.

The site ranking evaluated seven key site parameters including subcategory factors in comparing the two locations:

- Key cost drivers – including onshore and offshore LNG loading jetty length, dredging to accommodate the ships, civil site development cut and fill quantities, sufficient land area for the facility and temporary accommodation facility and laydown
- Other site parameters – including presence of acid sulfate soils, land ownership availability, proximity to future airport exclusions zones, site contour and natural limitations
- Marine facilities – including adequate manoeuvring, capital costs, channel maintenance, ferry safety and MOF service functioning
- Shipping – Navaids and sea access route
- Community – proximity to local population and site location in relation to current airport
- Infrastructure – proximity to available transportation and wharf facilities
- Health safety and environment – environmental and cultural heritage issues
- Industrial planning and development attitude – available planning support.

In all, 62 factors were considered in the site comparison. These factors were weighted in importance and assigned a criteria weight. From the analysis, the Laird Point site was selected as the preferred option. The Laird Point site has the following attributes:

- Available land within a state development area assigned for LNG facility development
- Navigable access given extension of dredged shipping channels
- Ability to design marine facilities with short trestle length
- Soils and geology suitable for LNG facility development
- Adequate land for viable LNG facility layout for full development and safety risk considerations
- Located in an industrial precinct with opportunities for industrial synergies to minimise overall industry potential environmental impacts
- Proximity to the feed gas supply.

Soils, topography, geomorphology and geology

The LNG facility is to be constructed in stages. It will extend over an area of approximately 156ha and oriented to minimise earthworks. However, this will still result in significant landform modification through stormwater diversion, vegetation clearing and earthworks, such as the filling the intertidal and supratidal flats to RL 6m Australian height datum (AHD).

The LNG facility construction will bring about a number of changes in local drainage flow, including stormwater diversion. Any unlined or unvegetated channels would have the potential for erosion.

During operation, stormwater will be diverted along the northern and southern boundaries of the study area. Onsite stormwater will be directed to sediment basins for reuse or, when overflow occurs, discharged into Port Curtis.

Development of the LNG facility will dictate some alteration to the existing landform would occur, however the extent of the impact would be mitigated through implementation of suitable engineering controls (including conservative batter slopes and strategic placement of other stabilisation works).

The dominant feature of Curtis Island (as viewed from the mainland) is a ridgeline running in a northwesterly to southeasterly direction, located to the northeast of the LNG facility site area. This landform will not be impacted by development of the LNG facility.

The potential consequential impacts of the alteration to landform, such as impacts on stormwater quantity and quality, are able to be mitigated through measures described for water resources. Further detail regarding potential impact to topography, geology and soils is provided at Volume 4 Chapter 5.

Landscape character and visual amenity

One of the criteria of the listing of the GBRWHA on the World Heritage list is the exceptional natural beauty of the Great Barrier Reef. However it is recognised that Gladstone Harbour's industrial influenced landscape has a lower sensitivity than untouched areas of the world heritage area.

Key characteristics of the local and regional landscape character surrounding the LNG facility site are:

- Landscape of contrast and variety- which includes heavy industry and port related activities
- Large scale water views with extensive vistas to level horizons and huge sky expanses
- Enclosed forested hills and valleys
- Forested mountains
- Mangrove vegetation and associated mudflats.

The visual impacts of the proposed LNG facility would be highest immediately to the west of the site at Laird Point. In this harbour area, a high visual effect is experienced by high sensitivity recreational boaters, especially by boats within 3km of the site, navigating The Narrows.

The impacts on the sensitive residential and recreational areas in the vicinity of Gladstone are significantly reduced by the distances between the LNG facility and Gladstone, generally over 10km away. This in turn creates a low impact.

Due to the topography of Curtis Island, the LNG facility is screened from most eastern view locations, eliminating impact. The minor exception to this is night lighting that will create a night glow but not have direct light effects. Lighting design for the LNG facility will meet compliance with health and safety requirements, however where possible, detailed lighting design will consider methods to minimise light spill and reduce light glow.

Overall, there will be a visual impact by virtue of the character and scale of the development. However, the site allows for high levels of visual screening and integration to be achieved through management of vegetation areas both on and off the development sites.

The implementation of the following visual mitigation strategies will reduce visual effects consistent with the scale of the development. Further, they will achieve a visual integration of the LNG facility into the forested hillsides of the Laird Point location. Light pollution associated with flaring has the largest

potential impact on visual amenity. To reduce the visual impact, Australia Pacific LNG have adopted a ground flare into the main dry/wet vapour relief (flare) systems, compared to a more conventional stack flare. The use of the ground flare for these systems is the single largest mitigation measure to reduce visual impact, as flaring will be lower to the ground and shielded by the ground flare enclosures. A vertical stack marine flare has been proposed within the design however, the option of including the marine flare within the ground flare is being investigated.

Additional mitigation measures which will be adopted are as follows:

- Reduce as far as practical the cleared areas needed to support the construction and operation of the LNG facility
- Reduce the penetration of the mangrove fringe at the MOF to the essential width to accommodate the water interface facility
- Where practicable, retain mangroves and develop the wider storage areas behind the mangrove fringe
- Landscape cut and fill batters to reduce colour contrast with adjoining vegetation
- Any building that is not compromised with regard to heat absorption will be painted to lessen the contrast between these elements and the adjoining bushland
- Ensure that site lighting is either directional or shielded and that the elevation of poles is kept to a minimum consistent with site coverage requirements
- Evaluate the outcomes of more lights that have a lower elevation to achieve the required light levels to assist in lowering the height of light towers

It is considered that development of the LNG facility is consistent with local (GPC land use plan) and state (GSDA development scheme) planning regimes for the location and henceforth the level of visual impact is considered to be acceptable in the context of these planning regimes. Preliminary project planning considered the development of the LNG facility at various locations within the GBRWHA. Given the existing level of industrial development within the Port of Gladstone, development of the LNG facility at this location is considered to be a minimal impact outcome relative to development at other locations from the perspective of visual amenity.

Terrestrial ecology

A total of 308.3ha of remnant vegetation is present on site and is generally in good to average condition with evidence of historical fires, logging, grazing and vehicle tracks present. Some weed infestations are present and mostly associated with drainage lines. Potential impacts associated with the Project are related to vegetation clearing necessary for facility development and subsequent impacts such as the introduction and / or spread of weeds and pests, potential lighting impacts and impacts to habitat.

The proposed Project would require the clearing of remnant vegetation on site however this does not include any threatened ecological community listed under the EPBC Act, endangered regional ecosystem (RE) under the *Vegetation Management Act 1999* (VMA) or vegetation with high biodiversity values under the biodiversity planning assessment. No high value regrowth vegetation as defined under the VMA is present on site or would be impacted upon by the proposed Project. Dredge option 2a would require the clearing of 155.9ha of remnant vegetation including 50.4ha of concern RE and 105.5ha least concern RE and representing 50.6% of the total extent of remnant vegetation on site. An additional 0.7ha of mangrove shrublands on North Passage Island would be removed as part

of Option 1b, increasing the total extent of remnant vegetation to be removed on site to 50.8%. Vegetation proposed to be cleared is not recognised as having high biodiversity values and the proposed clearing would not result in any regional ecosystems present on site falling into a higher conservation status.

Field surveys of the LNG facility site area identified 121 species of flora across 51 families and 100 genera recorded including 25 non-native species (refer to Volume 4 Chapter 8 for a list of species identified). Three significant weed species were identified on site being the common prickly pear (*Opuntia stricta*) and rubber vine (*Cryptostegia grandiflora*) and lantana (*Lantana camara*). Rubber vine and common lantana are also listed as weeds of national significance under the Australian Weeds Strategy (NRMMC 2006) and all were recorded on site in small, isolated infestations.

Thirteen endangered, vulnerable or rare (EVR) bird species, four EVR reptile species and eight EVR mammal species were identified as potentially occurring within the Project area (refer to Volume 4 Chapter 8 for a list of species identified) along with 39 migratory bird species that may utilise habitat within the Project area from time to time.

The construction and operation of the LNG facility has the potential to impact upon terrestrial flora and fauna values on site through direct loss or harm to individual species, populations and vegetation communities and degradation/modification of habitat areas. However, with the implementation of mitigation measures recommended in this assessment, these impacts can be managed to reduce their severity and longevity, thereby minimising the overall impact of the LNG facility on these values. Vegetation clearing will be limited as far as practicable and existing tracks and cleared areas will be utilised where possible to minimise the total extent of remnant vegetation to be cleared as part of the Project. Specific measures to reduce impacts during clearing activities will be undertaken such as:

- Where practicable, construction infrastructure such as site offices will be located and construction machinery will be stored in proposed cleared areas or existing tracks and open areas with little understorey and not in retained vegetated areas
- Trees will be felled into construction areas or in natural slots between stands of trees to minimise damage to other trees during clearing activities and machinery contact with standing trees on vegetated margins and in retained vegetation areas will be avoided where practicable
- Vegetation clearing and construction activities will be restricted to dry weather conditions where practicable to reduce the potential for erosion and sediment runoff/loss of topsoil
- Erosion control measures will be implemented to reduce sediment/top soil loss through run-off. Topsoil will be retained where practicable and along with mulch and discarded vegetation debris, be spread in retained vegetated areas to ensure there is no net loss of soil quality and habitat value on site.
- Cleared construction areas and vehicle tracks will be watered regularly to reduce dust emissions
- Hazardous substances and materials including fuels, oils and chemicals will be stored, handled and disposed of in accordance with standard procedures to minimise potential leakage to adjacent vegetated areas. Spill prevention and response procedures will be implemented for construction and operation. Emergency spill response teams will be trained in clean-up and reporting of spills
- Vehicles will be equipped with spark arresters (on diesel engines) and fire extinguishers and personnel will be trained in basic fire fighting. Fire breaks will be created and maintained around infrastructure and selected personnel will be trained in fire-fighting

- Designated retained vegetated areas will be actively managed throughout the Project's life to promote the native biodiversity and recruitment, encourage fauna use and reduce weed invasion
- Disturbed vegetated areas that are no longer utilised post-construction will be stabilised and landscaped as appropriate to the location and adjacent site activities
- Pre-clearing surveys will be undertaken prior to all clearing activities within remnant vegetation on site to identify the presence of EVR and other significant flora species (none previously identified). Pre-clearing inspections to be conducted by a qualified fauna spotter to identify potential nesting, roosting or refuge sites. If significant nesting sites are located, clearing operation will where practicable be timed to avoid the breeding season of the identified species. A suitably trained fauna spotter/catcher to be present during clearing operations to provide direction on the clearing procedures, to capture and relocate fauna and to treat injured fauna found during the clearing program
- Clearing procedures will be developed which allow more mobile fauna to move away from the construction area. Where practical, clearing will be undertaken in a mosaic pattern with habitat trees felled last
- The clearing of hollow bearing trees will be minimised where practical. The clearing plan will allow time for mobile species potentially utilising these hollows to move away from the clearing operation. Inspections of all hollows will be undertaken prior to removal of the tree. Tree sections containing hollows will be retained and placed in the designated retained vegetation for utilisation by ground dwelling fauna
- A biosecurity management plan will be developed for the management of weed and pest species
- Consideration will be given to minimising the potential impacts of night lighting through the use of current technology and lighting techniques (such as, light placement, light shields, the utilisation of yellow insect lights and motion detection lighting where practical).

With the implementation of mitigation measures as described, the potential impacts associated with the LNG facility can be managed to reduce their severity and longevity, thereby minimising the overall impact on these values. Further detail regarding potential impacts of the LNG facility to terrestrial ecology and proposed mitigation measures is provided at Volume 4 Chapter 8.

Marine ecology

From a marine ecology perspective the primary environmental features of interest in the vicinity of the proposed development site are the seagrass meadows, mangrove and saltmarsh areas. Port Curtis provides habitat for marine species of conservation significance including dugong, inshore dolphins and marine turtles.

A number of potential impacts from the construction and operation of the proposed LNG facility and associated infrastructure have been identified. These potential impacts and associated management and mitigation measures are described below:

- Construction of the LNG Facility will require the reclamation of approximately 2.4ha of mangroves and 24ha of saltpan/saltmarsh. The area of mangroves represents 0.03% of the estimated mangrove cover (6,736ha), and 0.5% of the saltpan/saltmarsh habitat (4,573ha) in the Port Curtis region. The plant footprint site boundaries for the LNG facility have been chosen to minimise the removal of mangrove habitat in particular. A large stand of mangroves and a

small mangrove-lined creek in the centre of the proposed project is proposed to be left undisturbed. The Australia Pacific LNG approach to compensatory measures for the loss of habitat is discussed in Section 23.4.8

- When vessel based activities overlap with habitats utilised by dugong and marine turtles they are at particular risk from boat strike which can cause significant injury or mortality. Marine turtles and dugong are vulnerable to boat strike when they are at the surface breathing and resting between dives. Vessel speed and water depth are the main factors affecting the risk of boat strikes with faster vessels in shallower water posing a greater risk. For the Project, slow moving vessels such as tugs, barges, and LNG ships are considered to pose an inherently low risk of boat strike to dugong and marine turtles in Port Curtis. Australia Pacific LNG will continue to work with relevant government agencies and other industries that are, or proposing to operate fast transport activities to develop practical “whole of basin” approaches to mitigation. .Australia Pacific LNG will establish a process for visual observations and recording of dugongs and cetaceans at and adjacent to the study area

- Activities associated with construction in the marine environment and operations, in particular vessel movements, have the potential to displace dugong and cetaceans from critical habitat and interrupt critical behaviours through the creation of underwater noise. There are a number of underwater noise sources that may impact on cetaceans and dugong. These include pile driving and vessel traffic. Percussive piling for the construction of the MOF jetty is most likely to be of a frequency and volume that will cause disturbance to dolphins. It is considered that disturbance to dolphins will occur during the construction phase as a result of pile driving, however, dolphins will again utilise the area once construction activities cease. The overlap of dolphin populations with areas of high vessel activity suggests at least, in part, they habituate to boating activities. Noise generated by vessel activity can also change the behaviour of dugong and result in alienation from important habitat. In the case of Port Curtis, existing high value dugong (seagrass) habitat occurs in areas unaffected by the current development. The use of mitigating strategies including the option of use of bubble curtains (forcing air from compressors into an enclosure around the noise source), pile cap cushions and applying “soft starts” to pile driving will be implemented. Soft starts refer to the increasing of pile energy gradually over a period of time. Monitoring of the usage of the area adjacent to the LNG facility by dolphins and dugong will be undertaken prior, during and after construction. The principal aim of this monitoring is to determine if animals are displaced from habitat and whether this impact persists through time.

- Lighting from the operational LNG facility may impact sea finding behaviour of hatchlings and the selection of nesting areas by adult flatback turtles (although the light regime is already highly modified in the Gladstone area and will be further modified by future developments). A combination of solutions may be used to mitigate light impacts on marine turtle nesting while allowing for safe and efficient construction and operation of coastal infrastructure. Solutions may include physically shielding the lights and directing the lights onto work areas, lowering the height of lights, reducing the amount of reflective surfaces through the use of matt paints on surfaces where practical and the use of motion detecting sensors and light timers. Australia Pacific LNG will use a sensitive lighting approach to reduce light spill impact on marine fauna.

- Construction of the MOF will involve the reclamation of intertidal and sub-tidal areas and the dredging of an approach channel. The area to be reclaimed is approximately 8.3 hectares. Dredging a -5 m lowest astronomical tide approach channel to the Australia Pacific LNG MOF requires the removal of approximately 108,000m^3 of sediment. All dredging is anticipated to be conducted by GPC. Dredging results in the removal of the animals contained in the sediment

within the dredged area, a turbidity plume that is transported outside the dredge area, and the possible mobilisation and transportation of nutrients and contaminants. A turbidity plume can decrease the ambient light levels extending through seabed which can affect photosynthesis through the water column and impact vegetated habitats on the seabed such as seagrass and algae. The intensity and duration of the decreased light intensity affect the likelihood and magnitude of impacts. When suspended sediments in a turbidity plume settle out, they can also potentially smother benthic assemblages. While increases in turbidity are a natural event, the duration of elevated turbidity plumes from the proposed dredging program are much longer than those that occur naturally. To minimise impacts during dredging and material placement, the following measures will be considered:

  - Development of a dredge management plan consistent with the plan for the Western Basin Dredging and Disposal Project and including:
    - Dredging operation within safe weather conditions (as defined by the Harbour Master) to prevent spills
    - Management of tailwater decant to maintain water quality within background levels
  - Placement of geo-textile fabric on the inner face before commencement of infilling to minimise the transport of fine sediments from within the MOF
  - Where practical, deployment of silt curtains to prevent migration of turbidity plumes

- Intake of saltwater for the desalination plant may result in the entrainment and mortality of plankton including fish and crustacean larvae of species of commercial and recreational significance. It is not currently possible to predict the quantities of plankton entrained or the impact of the entrainment on the structure of assemblages in Port Curtis. However, the volume of water entrained relative to the volume of Port Curtis is very low (include maximum volume of water) and there is a high level of natural mortality among planktonic organisms. Overall strategies to reduce water demand and collect and use stormwater will reduce (but not remove) the overall need for desalinated water, and hence will reduce the volume of plankton that will be entrained. The intake will be appropriately screened to prevent the intake of larger animals and the intake rate will be as low as practical by using an appropriate intake design. It is not possible however to prevent the intake of all plankton. The intake of plankton will be considered when designing the position of the seawater intake within the water column and the velocity of the intake water

- Operation of the desalination plant will produce a brine waste stream to be discharged into Port Curtis. It is expected the discharge of brine from the desalination system during construction will be up to 3,000m^3/day. It is anticipated that during operations (steady state LNG production for operations (4 trains)), brine disposal will be at an average rate of 96m^3/hour and likely up to 116m^3/hour. As a consequence of the increased salinity, the brine discharge tends to be negatively buoyant and will tend to sink to the seabed under calm conditions. The brine impact assessment has identified the toxicological risks posed by known compounds in the desalination effluent from the desalination plant that could be considered as contaminants to the receiving marine environment in the vicinity of the discharge location. The spatial scale of elevated salinity of the magnitude that could result in any ecologically meaningful impact is in the order of tens of metres from the discharge location. The major issue of potential concern is residual oxidant concentrations (chlorine and disinfection by-products).Chlorine in discharge can potentially impact marine organisms. Residual chlorine in the brine will be treated through a dechlorination process prior to discharge to reduce chlorine concentration. This process of

dechlorination will also reduce the likelihood that chlorination by-products are formed. As a result, there are unlikely to be any significant impacts on the receiving environment from discharge of residual oxidants or any other residual contaminants present in the brine waste stream. An environmental monitoring program will be developed for the LNG facility and this may include monitoring of suspended solids from liquid discharges to reduce potential impacts from smothering and the affects of increased light attenuation in the water column on sensitive marine receptors such as seagrass. To mitigate impacts from high suspended solids loads on the marine environment, waste materials collected off screens and filters will likely be transferred to land fill, rather than into the brine stream discharged into the marine environment. This will be further investigated during detailed design. The predicted salinity levels and the other constituents in the discharge are not predicted to have significant impacts

- Treated sewage will be stored in a tank for dechlorination purposes prior to being used for irrigation purposes or discharged to Port Curtis. If discharged to Port Curtis, it is likely that treated sewage effluent will be discharged with the desalination plant brine. The risk to the marine environment from discharge of treated sewage wastewater is primarily from residual oil, chlorine, nutrient loads and ammonia-N. The risks associated with residual oil are the same as previously mentioned above. The residual chlorine concentrations of 1–2 mg/L predicted in the sewage wastewater are up to two orders of magnitude higher than the lowest reported no observed effect concentration data. Total nitrogen and phosphorus concentrations of 4mg/L and 1mg/L respectively are anticipated within the treated sewage. In combination, there is the potential for increased aquatic algae or phytoplankton growth within areas affected by a concentrated discharge plume. Wherever possible, water reuse on site is the principal approach to reducing impacts through reducing the need to discharge into the marine waters of Port Curtis. To mitigate impacts from residual chlorine when discharge into the marine environment does occur, dechlorination of sewage wastewater prior to discharge will be undertaken.

There is the potential for hydrocarbon or chemical spills to occur during construction of operation phases of the LNG facility. During the construction phase, there is a risk of small spills occurring as a result of the increased number of vessels and activities operating in the vicinity of the LNG facility site area. Vessels and onshore construction activities will have emergency response procedures (refer to Volume 4 Chapter 24) in place in the event of an incident.

During operation of the LNG facility there is the potential for large spills to occur. However, all vessel movements will be under the jurisdiction and control of GPC and MSQ. At a national level, the Australian Maritime Safety Authority manages the National Plan to Combat the Pollution of the Sea by Oil and Other Noxious and Hazardous Substances (the National Plan) that provides an organisational framework for ship-sourced oil and chemical spill response throughout Australia. The National Plan is implemented through various national and state level contingency plans, including the Queensland Coastal Contingency Action Plan. In the unlikely event of a spill occurring, the response plans of GPC (as subsets of the Queensland and National plan) would be implemented.

Further detail regarding marine ecology impact assessment and management measures is provided at Volume 4 Chapter 10.

Water resources

Development of the LNG facility development will include bulk earthworks that will impact on surface water drainage on the site and adjoining land:

- Filling of the tidal flats and fringing areas to RL 6.0m AHD

- Extensive cut and fill earthworks to create building platforms
- Diversion of main drainage lines to convey runoff from uphill areas around the site.

In addition to the changed drainage lines and outlet locations, the construction of the LNG facility will create significant impervious areas due to buildings, roadways and storage tanks. Thus, the proposed development has the potential to impact on the quantity, quality and distribution of runoff discharged from the site.

It is not proposed to utilise the groundwater as a source of supply for the LNG facility during construction or operational phases. Therefore, the LNG facility is not expected to have an impact on groundwater quality or quantity under normal operating circumstances.

Construction

There will be high erosion potential during the construction period during rain events due to the removal of vegetation and associated earthworks. There is also the potential release of contaminants that may be attached to the soils that enter drainage lines and subsequently flow into Port Curtis.

All runoff from the construction works area will be directed to the sediment ponds for treatment prior to discharge to Port Curtis. The sediment ponds will capture the first 25mm of runoff. Riprap aprons will be constructed at all discharge outlets to prevent scour and erosion.

Operations

All runoff from the LNG facility will be collected and conveyed in shallow swale drains to sediment basins and discharged from the site if not re-used. Runoff from the LNG train and storage tank areas and from the southern sector of the plant is to be directed to the hydrotest pond prior to discharge to Port Curtis at the entrance to the existing drainage line. Runoff from the administration and maintenance facilities area and the temporary accommodation facility area at the eastern end of the site is to be directed to a smaller sediment basin prior to discharge to the bypass channel. The sediment basins will provide minor reductions in peak flows discharged from the LNG facility.

The primary pollutants of concern in runoff discharged from the LNG facility are suspended solids and fuels/chemicals that may be used at the LNG facility. Stormwater that may be contaminated by process chemicals or other materials from process areas will be collected in a separate drainage system and directed to a dedicated treatment facility.

Stormwater runoff from plant process areas will be routed to a treatment process comprising a corrugated plate interceptor separator followed by dissolved air flotation and tertiary filtration prior to disposal by irrigation with the sewage effluent irrigation. This strategy will prevent fuels and chemicals being discharged to Port Curtis in stormwater runoff. Excess treated stormwater and treated sewage wastewater will be discharged to Port Curtis.

Stormwater runoff quality modelling predicts that the proposed stormwater quality management strategy will provide comparable reductions in suspended solids and total phosphorus pollutant loads against the Healthy Waterways, 2006 load reduction targets recommended for southeast Queensland.

Stormwater management plan

The key objectives for stormwater quality management are:

- To minimise the wastes or other contaminants exported from the site in stormwater runoff
- To manage stormwater impacts on the aesthetic or environmental values of receiving waters

- To limit soil erosion and mobilisation of sediments and contaminants downstream of the site.

To document mitigation and management measures to meet these objectives, a stormwater management plan (Volume 5 Attachment 26) has been prepared for the construction and operation phases of the LNG facility. The plan includes:

- Water quality objectives for releases from the LNG facility
- Potential key pollutant risks
- Management actions to minimise the risks
- Monitoring requirements for early detection of contamination.

The plan requires appropriate erosion and sediment control works to be provided and specifies measures to be implemented during the construction period to minimise the export of sediment and other pollutants in runoff discharged from the site.

The plan includes a maintenance schedule for the stormwater management structures to ensure that water quality and quantity leaving the site does not become impacted or uncontrolled.

Further detail regarding impact assessment and mitigation measures is provided in Volume 4 Chapter 11.

Coastal environment

Components of the LNG facility associated with potential impacts to the coastal environment are as follows:

- Jetty and product loading facilities
- MOF (dredging of the approach to MOF assessed by Western Basin Dredging and Disposal Project EIS)
- Swing basin and approaches (dredging assessed by Western Basin Dredging and Disposal Project)
- Reclamation and revetments
- Discharges from the LNG facility including seawater desalination plant brine, treated sewage wastewater and treated stormwater (described previously).

Assessment of the coastal environment considered the potential impacts to coastal processes resulting from the Project development on Curtis Island. The impact assessment associated with the development of the channels and swing basins required to meet the needs of other proposed development in Port Curtis is described in the Western Basin Dredging and Disposal Project EIS (GPC, 2009).

Conclusions from the GPC Western Basin Dredging and Disposal Project EIS numerical modelling results indicated that dredging and reclamation works for the Project will have negligible impact (1cm or less) on the high tide levels throughout the area. Current velocity in the MOF approach channel generally decreases but localised increases in velocity (0.35m/s flood tide and 0.7m/s ebb tide) occur on the shoals upstream of North Passage Island as a result of increased flows there.

The potential impact to the rate of natural flushing of the estuary is important to the assessment of turbid plumes and waste stream discharges. Dredging works associated with the development of the LNG facility are predicted to marginally increase local flushing times (approximately five days within

the swing basin). Local flushing times in Graham Creek and The Narrows are naturally poor and are not significantly affected by dredging works in the Western Basin, including those for the Project options.

The proposed GPC shipping channels and the berth/turning circle areas (from the Western Basin Dredging and Disposal Project) align with the south easterly winds, providing deeper water for waves to propagate. The local wave climate predictions in the GPC EIS indicate that the majority of waves reaching the undeveloped Western Basin (base case) are from the south-south easterly direction. Dredging would have negligible impact on wave directions, but would allow more wave energy from the south-southeast to penetrate into this area due to increased depth. This potentially has an impact on shorelines around the proposed swing basin. After dredging works at the LNG facility site there is a potential for larger waves to propagate into the swing basin during tropical cyclone wind events from the southeast sector.

The finished reclaim land level includes an allowance for sea level rise adjustment based upon model projections (based on the CSIRO mid-level sea level rise projection of 0.47m by 2070).

Potential impacts associated with the MOF and the loading berths include some removal of mangroves and minor turbid plumes from revetment construction. Silt barriers or similar may be used during construction. Dry working conditions are likely to be encountered in the inter-tidal area for a large percentage of the time, which will assist to minimise turbid plume generation. It is considered that turbid plume impacts would be naturally mitigated to a large extent by the intertidal nature of the site. Furthermore, the mangrove fringe adjacent to the MOF would act to trap fine sediments and provide a natural silt barrier for low turbidity concentrations associated with the construction process.

The marine structures are expected to have a low potential for impact to coastal processes as sand transport activity is very low. As the loading berth jetty is proposed to be piled currents and waves will be able to pass through underneath these structures and therefore they are expected to have a minimal impact. Where required, decommissioning of facilities at the end of their operational life would require dismantling and removal of assets above deck level to leave the structure essentially in skeleton form and to remain as marine habitat. Berths and approaches could be allowed to naturally in-fill over time.

There is potential for finer sediments to be deposited at the MOF site as it is proposed as a solid structure which would create quiescent zones where material may accumulate. This sediment accumulation would not need to be dredged unless it becomes an obstacle to operations.

Dredge plumes associated with dredging and reclamation works in the Western Basin are considered as part of the GPC Western Basin Dredging and Disposal Project EIS. Australia Pacific LNG's Option 2a dredging will not result in potential impacts from plumes of a magnitude greater than those occurring for the Western Basin Dredging and Disposal Project. Dredged material for MOF construction would likely be removed using a backhoe dredge to provide a construction base for the MOF and dredge plumes may be mitigated through bunds or silt curtains. Dredged material from the MOF construction would be transported to a GPC approved disposal site as per the Western Basin Dredging and Disposal Project EIS.

Potential erosion of shorelines from vessel wave wash and natural wave action in the swing basin will be identified and managed through monitoring. This monitoring would trigger mitigation measures if deemed necessary. Sand shoals upstream and downstream of North Passage Island may also be monitored by hydrographic survey (as one option) on an annual basis to determine if changes to the shoals are occurring and to implement a management plan if necessary.

b)

Further detail regarding impact assessment and associated management measures relevant to coastal environment is provided at Volume 4 Chapter 12.

Shipping

Major shipping routes within the GBRWHA can be divided into an inner and outer route, with a number of additional channels connecting the routes.

Following consultation with MSQ, it is anticipated that LNG shipping associated with the Project will use the outer route only for westbound cargoes and ships returning from Western Ports. Shipping destined for northern Asia ports will avoid the Torres Strait, transiting the Coral Sea and Western Pacific. Some ships may cross the Pacific Ocean bound for the Americas. It is also recognised that Project ships may use shipping channels which are beyond the eastern boundary of the Marine Park, therefore avoiding potential impacts on the Marine Park.

LNG will be exported by specially-designed ships from the LNG facility on Curtis Island and exit through the GBRMP. LNG ships will represent an approximate increase of three percent in current shipping movements through the GBRMP for the first LNG train. This may increase to 13 percent once the four LNG trains are operational.

All ship movement through the GBRMWHA will be in accordance with all international and national shipping regulations, namely:

- All vessels employed in marine activity, whether contracted or sub-contracted, will be inspected according to the International Marine Contractors Association (IMCA) ”Common Marine Inspection Document”.
- All vessels and port facilities will comply with the provisions of the International Ship and Port Facility Security Code (ISPS Code) Parts A and B.
- Any vessel contracted by, or on behalf of, the Australia Pacific LNG Project will have a structured and documented safety management system (SMS). All systems shall demonstrate that quality management and quality system elements meet the requirements of the International Maritime Organization (IMO)26 regulations on the International Safety Management Code for the Safe Operation of Ships (ISM Code) and for Pollution Prevention (MARPOL). The ISM Code has been added to Chapter IX of the International Convention for the Safety of Life at Sea (SOLAS) and is now mandatory.

Appropriate precautions will be undertaken (in consultation with State and Commonwealth regulators (particularly AQIS and Bio-security Qld) and the GPC against translocating potential pest species.

Ballast water operations will be undertaken in accordance with approved Australian Government arrangements for the management of ballast water.

Given the existing shipping movements in Port Curtis (refer to Table 23.8) and the standard management practices described above, consequential impacts from shipping associated with the LNG facility are not expected to have a significant impact on the GBRWHA.

Summary of potential impact

It is considered the development of the LNG facility will not damage, modify, alter or obscure important geological formations in a World Heritage property or National Heritage place. The development of the LNG facility will impact on and alter the landforms and landscape features near Laird Point on Curtis Island through excavation and infilling. However the extent of this impact is considered to be localised and consistent with local and state planning regimes for the expansion of the Port of Gladstone in Port

Curtis. The area is part of the Port of Gladstone, designated for future development in the GPC Land Use Plan. The area to be developed is designated as an industrial precinct, particularly for the development of the Queensland LNG Industry.

It is considered that the development of the LNG facility will have a minor impact on landscape processes in the coastal environment, through the dredging and reclamation works associated with this and other Projects. This impact is largely associated with the works to be undertaken by GPC and assessed through the Western Basin Dredging and Disposal Project EIS. A summary of impacts of this Project is provided at Section 23.4.5. The development of the LNG facility will divert two to three drainage lines on Curtis Island, and reclaim an area of tidal wetland. In the context of the GBRWHA this impact is considered to be minor and will be mitigated through actions described previously.

The operation and construction of the LNG facility will not substantially increase concentrations of pollutants in stormwater runoff or other discharges. Results of the modelling of discharges from the LNG facility's desalinisation plant indicate that salinity impact will be within the natural ambient salinity variations and are not likely to be detrimental to the marine environment. The cumulative impact of dredging associated with the Western Basin Dredging and Disposal Project and the relatively minor local dredging for the LNG facility is predicted to have a temporary and localised impact on the concentrations of suspended sediments in areas adjacent to the dredging activities.

Development of the LNG facility will remove vegetation and associated habitat. However, this impact is likely to be minor in the context of total extent of these habitats in the region and is localised. Ecological processes associated with Port Curtis may be impacted by the Project in the short term, during dredging and reclamation works, however these works are not expected to have a long term impact. Project operations pose some risk of impact to marine species through boat strike, lighting and underwater noise impacts. Proposed management measures are considered to provide sufficient mitigation to this risk.

Construction of the LNG facility will remove vegetation and habitat from part of the GBRWHA. However it is not considered that this will reduce the diversity or significantly modify the composition of plant and animal species in the world heritage area. It is not considered the construction and operation of the LNG facility will fragment, isolate or substantially damage habitat important for the conservation of biological diversity in the GBRWHA. It is considered that the construction and operation of the LNG facility will not cause a long term reduction in rare, endemic or unique plant or animal populations or species in the GBRWHA. Australia Pacific LNG is actively supporting the management of environmental values of the adjacent environmental management precinct of Curtis Island, managed by the DIP. This will further mitigate potential impacts of fragmentation.

The LNG facility will have an impact on the visual amenity of Curtis Island, as considered from certain view-sheds. This impact has been mitigated to some extent through plant design and use of natural landscape features. Whilst an impact on visual amenity will be made by the structures of the LNG facility, it is considered the development of Curtis Island in this fashion is consistent with local and state planning regimes for the expansion of the Port of Gladstone in Port Curtis.

The operations of the LNG facility will produce noise and air emissions however it is not considered these will have a significant impact on the values of the GBRWHA.

It is considered that construction and operations of the LNG facility will not cause any values of the GBRWHA to be lost, degraded or damaged. The construction and operations of the LNG facility is likely to cause minor modification to some of the attributes of the GBRWHA within the Port Curtis area, which assists to make up the values of the GBRWHA. The area to be developed is excluded from the Great Barrier Reef Marine Park. The development is consistent with state and local planning regimes.

Avoidance of potential impacts on the GBRWHA has been considered when developing proposed mitigation measures.

23.4.3 Listed threatened species and communities

Threatened ecological communities

As described at section 23.3.2 vegetation on and adjacent to the LNG facility site area is not analogous with any threatened ecological community as defined under the EPBC Act. As such, it is considered that the development of the LNG facility will not impact upon threatened ecological communities as defined under the EPBC Act.

Threatened species - terrestrial flora

As described at Section 23.3.2, whilst no threatened species (terrestrial flora) have been identified through field survey on the LNG facility site, it is considered that based on habitat preference, the LNG facility site may support suitable habitat for two threatened species namely the large-fruited zamia palm and quassia. These two species are described further in the context of the significant impact guidelines.

Potential impacts of the development of the LNG facility on terrestrial flora are likely to be primarily associated with the physical clearing of vegetation for infrastructure development. Other potential impacts are:

- Introduction and / or spread of invasive weeds or pests
- Leaching of pollutants or release of sediment into retained areas of vegetation
- Air emission impacts on adjoining areas.

If unmanaged, edge-effects and fragmentation have the potential to increase the prevalence of weed species in the vegetation adjacent to the LNG facility site due to canopy clearance, altered run-off patterns and increased exposure to foreign material carried to the study area on machinery and equipment.

Large-fruited zamia palm

The large-fruited zamia palm is listed at endangered under the EPBC Act and is endemic to southeast Queensland. It is found from Woolooga in the south to Bouldercombe in the north. Spotted gum – ironbark woodlands on metamorphic hills are present throughout site and may provide some habitat for this species, although the species was not recorded on site during the field survey effort.

Large, healthy populations are considered important to the long-term viability of this species and are generally characterised by a broad range of life stages from large mature trees from five to eight metres tall through to seedlings. The national multi-species recovery plan for cycads Queensland Herbarium. (2007) has identified seven important populations including three in state forests at Biloela, Kroombit and Wonbah. These populations are large with a natural deposition of size classes and as such are considered particularly significant to the long-term conservation of this species. Other important populations occur in a recreational reserve at Bouldercombe and in not of concern remnant vegetation (as defined under the Queensland *Vegetation Management Act 1999*) on freehold land at Biloela, Mount Morgan and on the Dee Range.

The national recovery plan has identified threats to this species including:

- Destruction of habitat and individuals due to land clearing

- Legal harvesting and commercial salvage
- Illegal destruction and harvesting
- Loss of genetic variation and insect pollinators
- Land management practices.

The section below discusses each of the significant impact criteria relevant to the potential impact of the development of the LNG facility on the large-fruited zamia palm.

Significant impact criteria: large-fruited zamia palm

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

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

   This species was not recorded on site during survey efforts and there are no historical records of this species occurring on or directly adjacent to the LNG facility site area. The site does however contain suitable habitat for this species and it is possible, although highly unlikely, that a small population or individual trees are present on site. Given the absence of known large populations on the surrounding land and that all recognised important populations occur on mainland Australia, it is considered highly unlikely that any population occurs on site. Furthermore as a result of this, it is highly unlikely that any population present on site would be viable in the long-term or significantly contribute to the overall total population of this species. As such, the LNG facility has the potential to result in a decrease in population size in the short-term (if the species does exist on site) however this is not considered to lead to a long-term decrease in the overall population of this species.

2. Reduce the area of occupancy of the species.

   Whilst the geographical distribution range of the large-fruited zamia palm overlaps the LNG facility site, it is unlikely to significantly contribute to the area of occupancy of this species, due to its isolation (if present) from known large populations and the poor dispersal mechanisms of this species. Distribution is limited by dispersal as seeds are highly toxic to animals, limiting the potential for this species to naturally extend a significant distance beyond known population areas. Consequently the LNG facility is unlikely to contribute to a reduction of the overall area of occupancy for this species.

3. Fragment an existing population into two or more populations

   The absence of historical and current records of this species occurring within or adjacent to the LNG facility site area suggests that any populations that may occur on site will already be small and isolated. The LNG facility does have the potential to fragment existing populations on site, if they occur, however, these populations are already considered not viable in the long-term and do not significantly contribute to the overall viability of the species.

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

   The recovery plan has identified critical habitat areas for this species, all of which occur on mainland Australia, and the site is not listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act. As such, the LNG facility is not considered to adversely affect habitat critical to the survival of this species.

5. Disrupt the breeding cycle of an important population.

Little is known about the pollination ecology of the large-fruited zamia palm, although beetles from the genera Hapalips and Ulomoides have been recorded from the male cones of the species. Seed is produced from autumn but like all cycads remain dormant for at least nine months before germination. Given the isolated of the LNG facility site and absence of this species during survey efforts, it is likely any populations that do occur on site would be already be affected by inbreeding and poor pollination rates and have a low seed bank. As such, the LNG facility, whilst potentially resulting in the disruption of the seed bank and loss of individuals, if they occur on site, would not significantly contribute to the disruption of the breeding cycle of this species.

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

   The LNG facility site area may provide suitable habitat for this species however, this species has a dispersal-limited distribution. Given no other populations have been identified on Curtis Island, it is highly unlikely this species would recruit to the LNG facility site. As such, it is considered unlikely that the LNG facility will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

   The LNG facility has the potential to introduce and spread invasive weed species on site however, given its isolation from known populations on mainland Australia and the poor dispersal mechanisms of this species, it is unlikely any degradation of potential habitat for this species will detrimentally impact upon this species' ability to recruit into the LNG facility site area. This, combined with the implementation of management measures, suggests it is highly unlikely that the LNG facility would significantly contribute the overall degradation of habitat areas for this species.

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

   The LNG facility has the potential to introduce and spread plant diseases which may detrimentally impact upon this species however within the implementation of management measures this potential impact would be minimised.

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

9. Interfere with the recovery of the species.

   The LNG facility site area does not form any critical habitat area for this species nor were any important populations identified on or adjacent to the site. As such, the LNG facility is not considered to interfere with the recovery of this species.

Quassia

The quassia is endemic to Queensland and is listed as vulnerable under the EPBC Act. It is known to occur in several localities from Mackay south to Goomboorian, north of Gympie, and has a geographical distribution range that overlaps the LNG facility site. Forest and mangrove communities on site may provide some habitat value to this species however, no individuals were recorded within the LNG facility site area during the field survey and there are no historical records of this species occurring within or adjacent to the site.

There is no recovery plan established under the EPBC Act for the management of quassia however main threatening processes have been identified and include soil erosion and habitat clearing as a result of agriculture, forestry, urban development and recreational activities. Inappropriate fire regimes are also considered a major threat although the response of this species to fire is relatively unknown. Rather, it is the establishment and spread of weed species through fires, especially common lantana (Lantana camara) and exotic grasses, which poses the most risk to the viability of this species.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the quassia.

Significant impact criteria: quassia

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

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

   Searches for this species have failed to confirm its presence within the study area. Site specific searches will be conducted for this species in suitable habitat proposed to be disturbed. If found to occur an application to DEWHA for disturbance is recommended. Design and implement a translocation plan according to Australian Network for Plant Conservation (Vallee et al. 2004). If offsets are necessary they will be made according to DEWR (2007).

   As the species has not been located and is only predicted to occur within the study area, with the implementation of the proposed mitigation and offset measures if individuals are located, a long-term decrease in the size of an important population is not considered likely as a result of the LNG facility.

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

   As the species has not been located and is only predicted to occur within the study area, with the implementation of the proposed mitigation and offset measures if individuals are located, reduction in the area of occupancy of an important population is not considered likely as a result of the LNG facility.

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

   As the species has not been located and is only predicted to occur within the study area, with the implementation of the proposed mitigation and offset measures if individuals are located, fragmentation of an important population is not considered likely as a result of the LNG facility.

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

   Habitat for quassia is not listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act. Whilst habitat on site may be suitable for the species it is not considered to be habitat critical to the survival of the species that is, it is not considered that the area is critical habitat for activities such as breeding or dispersal, for the long-term maintenance of the species, to maintain genetic diversity and long term evolutionary development, or for the reintroduction of populations or recovery of the species.

5. Disrupt the breeding cycle of an important population.

   Given that 0.1% of the potential habitat of the species in the bioregion falls within the study area and as the species has not been located and is only predicted to occur within the study area, with the implementation of the proposed mitigation and offset measures if individuals are

located, disruption of the breeding cycle of an important population is not considered likely as a result of the LNG facility.

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

   The LNG facility may result in the clearing and disturbance of potential habitat for the quassia, however, no populations are known to the site or surrounding area suggesting that potential habitat on site does not form any significant habitat area for this species. Given that 0.1% of the potential habitat of the species in the bioregion falls within the study area, with the implementation of the proposed mitigation and offset measures if individuals are located, modification, destruction, removal, isolation or a decrease in the availability or quality of habitat to the extent that the species is likely to decline is not considered likely as a result of the LNG facility.

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

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   This species is not known to be susceptible to any specific diseases and disease is not listed as a threatening process for the species. Weed hygiene practices implemented under a weed management plan, such as wash-down facilities for vehicles entering the area and controls on the source and quality of any required fill or landscaping material will also act to control potential disease introduction and/or spread.

9. Interfere substantially with the recovery of the species.

   Given that 0.1% of the potential habitat of the species in the bioregion falls within the study area, no habitat critical to the survival of this species will be disturbed. As the species is considered unlikely to be present, and with the implementation of proposed mitigation and offset measures if any individuals are found, it is unlikely that the LNG facility will interfere with the recovery of the species.

Threatened species – terrestrial fauna

As described at section 23.3.2, whilst no terrestrial fauna species listed as critically endangered, endangered or vulnerable under the EPBC Act have been identified through field survey on the LNG facility site, it is considered, based on habitat preference, the site may support suitable habitat for eight threatened species: brigalow scaly-foot, yakka skink, squatter pigeon (southern subspecies), red goshawk, northern quoll, grey-headed flying-fox, large-eared pied bat and false water-rat.

Potential impacts of the LNG facility on terrestrial fauna are likely to be primarily associated with habitat loss, degradation, fragmentation and loss of connectivity due the physical clearing of vegetation for infrastructure development. The introduction and/or spread of invasive weeds or pests may also impact on fauna species.

Northern quoll

The northern quoll is distributed from southern Queensland across the north of Australia to Broome in Western Australia. They are usually solitary, occupying large home ranges of over 100ha for males and approximately 35ha for females (Woinarski et al. 2008). They utilise a variety of dens including

rock crevices, tree hollows, logs, termite mounds, and monitor burrows. The most significant threatening process for this species is the introduction of cane toads (*Rhinella marina*) into areas which the northern quoll utilises. Data suggests local populations of northern quoll in the Northern Territory are usually extinct within a year of the arrival of cane toads. Field surveys confirmed the presents of cane toads within the LNG facility site area. However, there are populations of northern quolls persisting in Queensland in areas where cane toads are present. As such, it is assumed a population of northern quolls may persist on Curtis Island.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the northern quoll.

Significant impact criteria: northern quoll

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

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

   It is understood the most significant threatening process that may lead to potential long term decline in any possible northern quoll population is the presence and expansion in range of the cane toad (Woinarski et al. 2008). Cane toads were observed on site during the field assessment. However all observed toads were dead, possibly due to the lack of available water at the time. The current extent to which cane toads may inhabit other areas of Curtis Island was not determined during this study. If a northern quoll population persists on the Island the facilitation of the establishment of cane toads on site (for example, through the introduction of additional water bodies for breeding) may be considered a potential threat to this population. However, given cane toads are already established within the Curtis Island Industry Precinct and water storage areas also already exist on Curtis Island, it is considered unlikely development of the LNG facility would have a significant impact on the northern quoll.

   It is expected that any possible decrease in any possible local population would be minor.

2. Reduce the area of occupancy of the species.

   The proposed development will result in the removal of habitat suitable for this species and there is potential for a reduction in the area of occupancy for this species should a population be present.

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

   The proposed LNG facility is located on the south eastern end of Curtis Island. Considering the proposed footprint of the LNG facility and the home range of this species; it is considered unlikely the development of this plant would result in fragmentation of a potential population of northern quolls on Curtis Island.

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

   There is currently no recovery plan that outlines critical habitat for the northern quoll. Persisting populations of northern quolls are more likely to be found at rocky sites, particularly with large boulders, on steeper slopes and shallow soils and with low disturbance by fire (Woinarski et al. 2008). The eucalypt woodland habitat within the LNG facility site area it is not consistent with this habitat description. The lack of historical records also indicates there is no habitat present that is critical to the survival of the species.

5. Disrupt the breeding cycle of an important population.

A lack of records indicates there is no habitat present that is critical to the breeding cycle of a population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

7. Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat.

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

9. Interfere with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Brigalow scaly-foot

The brigalow scaly-foot is distributed throughout the Brigalow Belt. The species was once thought to be confined to remnant brigalow (*Acacia harpophylla*) or sparse tussock grass vegetation on grey cracking soils (Shea 1987). Recent records, however, have found the species in additional habitats including *Acacia falciformis* woodland, gidgee (*A. cambagei*) woodland, poplar box (*Eucalyptus populnea*) open woodland, sandstone rises in dry sclerophyll forests, lemon-scented/spotted gum (*Corymbia citriodora*) and narrow-leaved red ironbark (*E. crebra*) dominated forest and mixed open woodland with spinifex (*Triodia mitchelli*) (Schulz and Eyre 1997; Kutt et al. 2003). Most records are from relatively undisturbed habitats but the species does also occur in young regrowth (two-three years old), heavily grazed areas (Kutt et al. 2003) and cultivated areas, indicating resilience to disturbance (DEWHA 2009d). Fragments of invertebrates such as spiders and crickets have been recorded from scats. However sap, particularly from *Acacia* species, constitutes a significant proportion of this species diet (Tremul 2000).

There is a known population at Lilly Hills on Boyne Island, 15km south of Gladstone (Tremul 2000). Given the proximity of the Lilly Hills population and the apparent suitability of the habitat within the LNG facility site area it is considered the species may occur on Curtis Island.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the Brigalow scaly-foot.

Significant impact criteria: Brigalow scaly-foot

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

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

The eucalypt woodland within the LNG facility site area is considered suitable habitat for a population of brigalow scaly-foot. Considering the extent of similar suitable habitat within the wider area and provided effective pre-clearing surveys are conducted by a suitably qualified fauna spotter/catcher it is considered unlikely the LNG facility will lead to a long term decrease in the size of an important population.

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

   If a population is present on Curtis Island then development of the LNG facility may impact the extent of suitable habitat available for that population. A lack of records indicates that any possible population would not be considered an important population.

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

   There is little information regarding the home range requirements or movement patterns of the brigalow scaly-foot.

   Considering the location of the LNG facility and the extent of suitable habitat outside of the development footprint, it is unlikely that the LNG facility will result in the fragmentation of an existing population, whether or not such a population would be considered an important population.

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

   There is no identified critical habitat for the brigalow scaly-foot. Habitat features identified as being utilised by this species include low lying shrubs and tussocks, rock outcrops and ground cover such as leaf litter, rocks, fallen timber and fallen bark (Richardson 2006).

   Considering the extent of similar suitable habitat within the wider area, the habitat within the LNG facility site area is not considered critical to the survival of this species. The lack of historical records also indicates tthere is no habitat present that is critical to the survival of the species.

5. Disrupt the breeding cycle of an important population.

   There is little understanding of the breeding cycle of this species. Considering the extent of suitable habitat within the wider area, if a population was present on Curtis Island it is considered unlikely the breeding cycle of this population would be disrupted by the proposed development. The lack of historical records indicates that there is no habitat present that is critical to the breeding cycle of an important population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such tits modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

Disease has not been identified as a threatening process for this species. A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Yakka skink

The yakka skink is distributed throughout the Brigalow Belt and north to Cape York. It is usually found in open dry sclerophyll forest or woodland and lives in colonies, occupying communal burrows, often under dead timber or in deep rock crevices. They are usually found in areas of coarse gritty soils that are well drained (Ehmann 1992; Cogger 2000; Drury 2001; Wilson 2005). Colonies have been observed among piles of logs or rocks that have been left remaining in cleared paddocks, demonstrating resilience to disturbance (DEWHA 2009b). The species is threatened by loss of habitat, loss of shelter sites through agricultural practices, too-frequent fire, trampling of burrows by livestock and predation by foxes and cats (Drury 2001).

The Brigalow Belt Reptile Recovery Plan (Richardson 2006) indicates there have been no sightings of yakka skink within the Calliope Shire. However these results may be due to a lack of general survey effort within the region and the difficulty of observing this species in the field. Database searches did not reveal any field results within the wider area. The habitat within the LNG facility site area is apparently suitable for this species and the site is within the potential range of this species. A population may exist on Curtis Island.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the yakka skink.

Significant impact criteria: yakka skink

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

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

   The Queensland Brigalow Belt Reptile Recovery Plan (Richardson 2006) does not identify any population considered an important population of this species.

   Given the proposed development footprint and the extent of similar habitat within the wider area and provided that pre-clearing surveys by qualified fauna personnel are conducted, it is considered unlikely that LNG facility activities would lead to the decline of a potential local population, whether or not such a population would be considered an important population.

2. Reduce the area of occupancy of a population.

   If a population is present on Curtis Island then development of the LNG facility may impact the extent of suitable habitat available for that population. A lack of records indicates that any possible population would not be considered an important population.

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

Providing pre-clearing surveys for colonies are conducted it is considered unlikely the proposed development would result in the fragmentation of a local population, whether or not such a population would be considered an important population.

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

   There is no specific habitat identified as critical habitat for yakka skink. Micro habitat features utilised include rock outcrops and ground cover such as leaf litter, fallen timber and fallen bark (Richardson 2006).

   Considering the extent of similar suitable habitat within the wider area, the habitat within the LNG facility site area is not considered critical to the survival of this species. The lack of historical records also indicates there is no habitat present that is critical to the survival of the species.

5. Disrupt the breeding cycle of an important population.

   Provided effective pre-clearing surveys are undertaken, it is considered unlikely that the LNG facility will disrupt the breeding cycle of this species should a population be present. The lack of historical records indicates that there is no habitat present that is critical to the breeding cycle of an important population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   Disease has not been identified as a threatening process for this species. A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Squatter pigeon (southern subspecies)

Squatter pigeons are terrestrial, foraging and breed on the ground and the southern subspecies occurs mainly in dry grassy eucalypt woodlands and open forests (Frith 1982; Crome and Shields 1992). It also inhabits *Callitris* and acacia woodlands and was reported from open plains in its historical southern range (Frith 1982). Most birds live in sandy sites near permanent water (Blakers et al. 1984). Squatter pigeons dust-bathe and are often encountered on dirt tracks and in areas of bare soil denuded of ground cover by livestock (Frith 1982, Higgins and Davies 1996). Although they remain common in heavily grazed country in tropical Queensland (DEWHA 2009c) they are typically

more common in un-grazed land compared to grazed land (Woinarski and Ash 2002). Birds may occasionally feed in sown grasslands and pastures. Squatter Pigeons eat mainly seeds, including those of exotic pasture plants, and some insects (Crome and Shields 1992, Higgins and Davies 1996).

There is no known population on Curtis Island but eucalypt woodland within the LNG facility site area is potentially suitable habitat for the species. The lack of permanent freshwater does limit its suitability.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the squatter pigeon.

Significant impact criteria: squatter pigeon

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

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

   There is currently no specific recovery plan for this species. No specific population has been identified as important to the long term survival of the species (DEWHA 2009c).

   The LNG facility site area contains open eucalypt woodland habitat, which is potentially suitable habitat for this species. Within the Curtis Island and Gladstone area there is a large extent of similar habitat available. Squatter pigeon is considered locally nomadic and is classified as a high mobility taxon (EPA 2006). The lack of permanent freshwater means the study area is unlikely to support an important population. Considering the habitat within the LNG facility site area and the extent of similar habitat in the wider area it is considered unlikely the proposed development would lead to the decline of any possible local population, whether or not such a population would be considered an important population.

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

   If a population is present on Curtis Island then development of the LNG facility may impact the extent of suitable habitat available for that population. A lack of records indicates any possible population would not be considered an important population.

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

   The squatter pigeon is a high mobility taxon (EPA 2006). The LNG facility is located on the south eastern end of Curtis Island. Given the proposed footprint of the plant and the mobility of the species it is considered unlikely that the development would result in fragmentation of a potential population. A lack of records indicates any possible population would not be considered an important population.

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

   Given the extent of similar suitable habitat within the wider area the habitat within the LNG facility site area is not considered critical to the survival of this species. The lack of historical records also indicates there is no habitat present that is critical to the survival of the species.

5. Disrupt the breeding cycle of an important population.

   The lack of historical records indicates there is no habitat present that is critical to the breeding cycle of an important population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   Disease may be a threatening process. A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

   Provided quarantine rules and regulations are adhered to, it is considered unlikely a disease will be introduced as a result of the LNG facility.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Red goshawk

The red goshawk occurs in woodlands and forests, ideally with a mosaic of vegetation types and permanent water, particularly riverine forests. The species avoids both very dense and very open habitats. The species is sparsely distributed, with home ranges of 120km^2 and 200km^2 for females and males, respectively (Marchant and Higgins 1993). The species occurs in areas of high biodiversity, typically with large bird populations.

There is no database record for the LNG facility site area but it lies within the foraging range of one or more red goshawks and the eucalypt woodland is suitable as foraging habitat. The LNG facility site area does not contain a permanent watercourse or wetland and is unlikely to be utilised as breeding habitat.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the red goshawk.

Significant impact criteria: red goshawk

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

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

   The lack of historical records and the absence of a suitable freshwater waterbody indicate the LNG facility site area does not support an important population.

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

Development of the LNG facility would reduce the extent of suitable foraging habitat available for any individuals in the area. A lack of records indicates that any possible population would not be considered an important population.

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

   The species is considered a high mobility taxon (EPA 2006) occupies large home ranges. The proposed LNG facility is located on the south eastern end of Curtis Island. Given the proposed footprint of the plant and the mobility of the species it is considered unlikely the development would result in fragmentation of a potential population. A lack of records indicates any possible population would not be considered an important population.

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

   Given the extent of similar suitable habitat within the wider area the habitat within the LNG facility site is not considered critical to the survival of this species. The LNG facility site area has not been identified as a potential nesting location. The lack of historical records also indicates there is no habitat present that is critical to the survival of the species.

5. Disrupt the breeding cycle of an important population.

   The LNG facility site area has not been identified as a potential nesting location. The lack of historical records indicates there is no habitat present that is critical to the breeding cycle of an important population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   Disease may be a threatening process. A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

   Provided quarantine rules and regulations are adhered to, it is considered unlikely a disease will be introduced as a result of the LNG facility.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Grey-headed flying-fox

The grey-headed flying-fox is distributed along the coastal lowlands of south eastern Australia from Gladstone to Geelong (DECCW NSW 2009). The species is highly mobile, moving up and down the

coast in search of flowering trees (primarily eucalypts) for nectar and various fruit on which it feeds. It occurs in rainforest, open and closed forest communities, open woodland and urban areas. Communal roost sites (camps) are usually in riparian communities. There are no identified roosting sites within the LNG facility site area. It is considered unlikely the proposed development in this area will affect any known roosting sites.

Night foraging is usually conducted within 15km of a daytime roost and can extend up to 50km. As such, the LNG facility site area potentially falls into the foraging range of this species. Nectar and pollen from flowering eucalypts, melaleucas and banksias are the primary diet of this species (DEWHA 2009e).

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the grey-headed flying-fox.

Significant impact criteria: grey-headed flying-fox

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

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

   The grey-headed flying-fox is highly mobile, moving up and down the east coast of Australia in response to the availability of food. This mobility indicates this is a single interbreeding population (DEWHA 2009e). There is no identified important population of this species. In considering the potential impacts on local populations a camp has been identified south of Gladstone, however this camp is located greater than 15km distance from the LNG facility site area. This camp is at the northern extent of the species' range (DECC NSW 2009).

   The eucalypt woodland and melaleuca wetland within the LNG facility site area are suitable for foraging. Considering the proximity of the nearest known camp, the size of the area impacted and the extent of similar habitat within the wider area it is considered unlikely development of the LNG facility at this location will lead to the long term decrease of a grey-headed flying fox population in this area, whether or not the population would be considered an important population.

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

   Habitat within the LNG facility site area may lie within the foraging range of the grey-headed flying fox. As such, the LNG facility may result in reduced habitat within the foraging range of this species. Any reduction in the area of occupancy of the local population would be minor, whether or not the population would be considered an important population.

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

   Gladstone is considered the northern extent of the grey-headed flying-fox distribution. It is considered unlikely the LNG facility will result in fragmentation of a grey-headed flying-fox population, whether or not the population would be considered an important population.

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

   There is no camp in or near the LNG facility site. Given the extent of similar foraging habitat within the wider area the LNG facility site is not considered critical to the survival of this species.

5. Disrupt the breeding cycle of an important population.

There is no camp in or near the LNG facility site. Given the extent of similar foraging habitat within the wider area the LNG facility site is not considered critical to the breeding cycle of the local population, whether or not the population would be considered an important population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

   Grey-headed Flying-foxes are not considered susceptible to any established exotic species. A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   Disease is identified as a low priority threat for the grey-headed flying-fox. There are three viruses that are known to be carried: Australian bat lyssavirus, hendra virus and menangle virus. The impact of lyssavirus is not thought be significant unless the population is under stress, during which the impact increases. The impact of the hendra and menangle viruses is unknown (DECC NSW 2009).

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species. Provided that quarantine rules and regulations are adhered to, it is considered unlikely a disease will be introduced as a result of the LNG facility.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Large-eared pied bat

The large-eared pied bat has been recorded roosting in disused mine tunnels, rock overhangs, caves and fairy martin (*Petrochelidon ariel*) nests (Dwyer 1966, Eyre et al. 1997, Schulz 1998; Thomson 2002). It is possible the species roosts in the hollows of trees (DEWHA 2009a). In south eastern Queensland, the species seems to be more associated with higher altitude moist forests and adjacent rainforest (Eyre et al. 1997), while most records from New South Wales are from dry and wet sclerophyll forest including *Callitris* forests, tall open eucalypt forests with a dry understorey, sub-alpine woodland, and sandstone outcrop country (Duncan et al. 1999).

There are no areas of extensive cliffs or caves within the LNG facility site area. No major roosting site has been identified in the wider area. However it is possible that woodland within this LNG facility site area is utilised within the foraging range of a roost community within the Curtis Island/Gladstone area. If tree hollows are utilised as roosts then the LNG facility site area potentially provides roosting sites for a population. If this species is present within the wider area it may be impacted by loss of habitat within its foraging range.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the large-eared pied bat.

Significant impact criteria: large-eared pied bat

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

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

   There is no important population of large-eared pied bat identified for this area and no database record. The closest identified important population is at Shoalwater Bay (DEWHA 2009a). The distribution and ecology of this species is not well understood. The Shoalwater Bay area is currently accepted as being the northern range of this species. Large-eared pied bats appear to exist in small populations throughout the range with the larger maternity colonies consisting of up to 50 individuals (DEWHA 2009a).

   The development is very unlikely to disturb a major roost site for this species, as there are no caves or cliffs present on site. The loss of tree hollows and of potential foraging habitat is not considered likely to lead to a decrease in the size of an important population.

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

   If there is a local population within the Gladstone region there is potential for foraging habitat to be lost due to the development of the LNG facility. It is considered unlikely the development will reduce the area of occupancy of an important population.

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

   Given the current understanding of this species, the potential for fragmentation of a population is likely to be through the disturbance of maternity sites. The LNG facility site area does not contain any mines or caves, the known maternity site types. As such, it is unlikely that the proposed development will fragment an existing population.

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

   The LNG facility site area does not contain any mines or caves, the known maternity site types. As such, it is unlikely that the proposed development will affect any habitat considered critical to the survival of the species.

5. Disrupt the breeding cycle of an important population.

   The LNG facility site area does not contain any mines or caves, the known maternity site types. As such, it is unlikely that the proposed development will disrupt the breeding cycle of a population, whether or not it would be considered an important population.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

Invasive species have not been identified as a threatening process for the large-eared pied bat (DEWHA 2009a). A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

   Given the current lack of knowledge regarding the ecology of this species the impacts of disease on the large-eared pied bat is unknown. The potential effects of Australian bat lyssavirus on this species are unknown (ARMCANZ 1999).

   A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species. Provided quarantine rules and regulations are adhered to, it is considered unlikely that a disease will be introduced as a result of the LNG facility.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

False water-rat

The false water-rat is found in disjunct populations along the Northern Territory and Queensland coasts. This specialised rodent inhabits intertidal wetlands and adjacent habitats. It is an active predator of invertebrates, particularly grapsid crabs (Ball 2004). There is no identified population near the LNG facility site, with the closest known population located approximately 45km south of Gladstone (DERM 2009). However standard survey techniques do not generally record this species. The false water-rat constructs nesting mounds in which it shelters during the day and in between tidal cycles. Little is currently known about the reproductive biology of the false water-rat. One study has observed that up to eight animals may share a mound. The study observed that the species were of mixed age however, there was only one sexually active male in each mound. Studies indicate that the false water-rat requires a large area in which to forage.

The habitat of the LNG facility site and areas adjacent (mangroves with associated mudflats, sand bar and grassland) provide potential habitat for the species. Although the proposed development layout leaves a large part of this potential habitat area undeveloped the construction of the wharves will directly impact this habitat.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the false water-rat.

Significant impact criteria: false water-rat

Significant impact criteria (vulnerable species):

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

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

   A number of important populations of false water-rat have been identified in protected areas along the central and south eastern Queensland coast.

   The mangrove habitat, marine couch plain and associated sandbar across the front of the saltpan provides potential habitat at the LNG facility site area. This area is directly impacted

through the construction of the wharf facilities and may be impacted through edge effects from the remainder of the LNG facility. Edge effects relevant for this species include an altered hydrological regime and the potential increase of feral species such as cat and rodents. If a population of false water-rats occurred at this location it is likely to be impacted by the proposed development.

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

   If a local population of false water-rat occurs within the LNG facility site area, the LNG facility is likely to reduce the area of occupancy for this population, whether or not any such population would be considered an important population.

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

   The proposed development footprint involves the construction of a wharf facility and the reclamation of an area of the tidal mudflat. The construction of the wharf facilities fragments the existing mangrove habitat. If a population of false water-rat is present within the LNG facility site area there is potential for the LNG facility to cause fragmentation of suitable habitat.

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

   Ecological information and expert knowledge was used to demarcate 'essential habitat' for the species as part of the Queensland DERM biodiversity planning assessments, DERM (2009). A review of the biodiversity planning assessment indicated that no essential habitat for this species has been identified in the LNG facility site area or wider area. Given the extent of similar suitable habitat within the wider area the habitat within the LNG facility site is not considered critical to the survival of this species.

5. Disrupt the breeding cycle of an important population.

   The LNG facility will not impact on any known populations of false water-rat. However if a local population of false water-rat exists within the LNG facility site area, there is potential for this development to impact on the breeding of this population either directly of through edge effects associated with the development.

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

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would result in overall species decline.

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

   Identified threats to false water-rat populations include direct predation from feral predators such as dogs, cats and foxes, competition for resources from native and introduced fauna and habitat destruction or degradation by hard hoofed feral animals such as pigs and cattle (DERM 2009).

   A biosecurity management plan as described in Volume 4, Chapter 8 will be developed to control and prevent the establishment of invasive species.

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

A biosecurity management plan as described in Volume 4, Chapter 8 will be developed to control and prevent the establishment of invasive species.

9. Interfere substantially with the recovery of the species.

   The LNG facility site area is not considered to contain habitat important enough for the species such that its modification, destruction, removal or isolation, or a decrease in its availability or quality would interfere with the recovery of the species.

Threatened species – marine fauna

It is considered likely that five threatened marine species may utilise the offshore area of the LNG facility site, or areas immediately adjacent to the offshore area, namely the marine turtles (loggerhead turtle, green turtle, hawksbill turtle, olive ridley turtle and flatback turtle).

Potential impacts of the LNG facility on marine fauna are described in Section 23.4.2 (further detail in Volume 4 Chapter 10) and include habitat reclamation, boat strike, noise and light emissions, dredging related impacts and wastewater discharge. The potential impact of the LNG facility on each of the threatened marine fauna species is described in the following sections with reference to the significant impact guidelines.

Marine turtles – green turtle

Green Turtles are found in tropical and subtropical waters throughout the world. They usually remain within the 20°C isotherms, although individuals may also stray into temperate waters. Green Turtles nest, forage and migrate across tropical northern Australia. Green Turtles lay their eggs on sand beaches. The east coast population of green turtles is split into a southern and a northern stock, with key breeding sites being Heron Island and Raine Island respectively. Green Turtles forage in shallow coastal areas, in particular seagrass beds. Foraging grounds and juvenile habitat for Green Turtles in Queensland include the Capricorn region of the Great Barrier Reef.

Occasional nesting of green turtles has been recorded from Facing and Curtis Islands (eastern side of the Island). As described at Table 23.11 it is considered likely that this species could occur in the LNG facility study area (marine areas) potentially moving through the area for foraging purposes.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the green turtle.

Significant impact criteria: green turtle

Significant impact criteria (vulnerable species):

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

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

   The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population.

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

   The green turtle is widely distributed throughout tropical and sub-tropical waters. The LNG facility will not reduce the area of occupancy in any ecologically meaningful way.

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

The LNG facility will not create any barriers to movement for green turtles.

Adversely affect habitat critical to the survival of a species.

Nesting beach habitat will not be physically impacted by the LNG facility. Seagrass beds are the critical foraging habitat for the species. However the area impacted by the development does not contain significant seagrass cover. The major seagrass beds in Port Curtis occur elsewhere.

4. Disrupt the breeding cycle of an important population.

   Lighting near turtle rookeries has the potential to disrupt the nesting of adult turtles and the survival of hatchlings. The light regime in the Port Curtis region is already heavily modified by existing industrial and residential development. While occasional nesting of green turtles is recorded from Facing and Curtis Islands, the east coast population of green turtles is split into a southern and a northern stock, with key breeding sites being Heron Island and Raine Island respectively. Nonetheless, landscape topography in concert with a range of measures designed to reduce the light spill from the LNG facility will result in no disruption to the breeding cycle of the small number of green turtles that may nest on Curtis Island.

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

   While habitat will be lost as a result of constructing the MOF, and further habitat disturbed as a result of dredging of the approach channel, it is not of a sufficient scale to affect the survival of any marine turtle species. Further, the area to be reclaimed and disturbed does not constitute high value green turtle habitat.

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

   It is not likely that an invasive species that is harmful to green turtles will be introduced.

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

   It is not likely that a green turtle disease will be introduced.

8. Interfere substantially with the recovery of the species.

   There is a recovery plan in place for all marine turtle species found in Australia. The LNG facility activities will not interfere with the recovery of marine turtle species.

Marine turtles – olive ridley turtle

The olive ridley turtle nests throughout tropic waters and migrates through tropical and sub-tropical areas of the world. Low density nesting has been recorded in north-western Cape York Peninsula, Queensland, between Weipa and Bamaga. No records of nesting have been collected for the eastern Australian coast.

This species principally forages in shallow unvegetated coastal environments, although it is considered that it does not commonly feed in the central Queensland area. As per Table 23.11 it is thought possible that this species could occur in the LNG facility study area (marine areas), moving through the area for foraging purposes.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the olive ridley turtle.

Significant impact criteria: olive ridley turtle

Significant impact criteria (endangered species):

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

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

   The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population.

2. Reduce the area of occupancy of an important population

   The olive Ridley turtle is widely distributed throughout tropical and sub-tropical waters. The LNG facility will not reduce the area of occupancy in any ecologically meaningful way.

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

   The LNG facility will not create any barriers to movement for olive Ridley turtles.

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

   The olive Ridley turtle does not commonly feed in central Queensland. While some feeding habitat will be lost due to construction of the MOF and further habitat disturbed as a result of dredging of the approach channel, suitable feeding habitats are found throughout Port Curtis and elsewhere in the central Queensland region.

5. Disrupt the breeding cycle of an important population.

   No concentrated nesting of olive Ridley turtles occurs in Australia and none have been recorded in recent times from the east coast.

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

   While habitat will be lost as a result of constructing the MOF, and further habitat disturbed as a result of dredging of the approach channel, the impact is not of a sufficient scale to affect the survival of any marine turtle species.

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

   It is considered unlikely an invasive species that is harmful to olive Ridley turtles will be introduced due to the LNG facility.

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

   It is considered unlikely a disease harmful to the olive Ridley turtle disease will be introduced due to the LNG facility.

9. Interfere substantially with the recovery of the species.

   There is a recovery plan in place for all marine turtle species found in Australia. The LNG facility activities will not interfere with the recovery of marine turtle species.

Marine turtles – flatback turtle

The flatback turtle does not have a global distribution. It is found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya. It is considered that nesting is confined to Australia. In Queensland, nesting occurs from Bundaberg to the Torres Strait and in the Gulf of Carpentaria. A medium density flatback turtle rookery occurs at South End on Curtis Island and nesting also occurs on Facing Island. Foraging habitats for the species are shallow coastal environments including rocky reef and sedimentary habitats.

As described in Table 23.11 it is considered likely that this species could occur in the LNG facility study area (marine areas), moving through the area for foraging purposes. The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the flatback turtle.

Significant impact criteria: flatback turtle

Significant impact criteria (vulnerable species):

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

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

   The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population.

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

   The flatback turtle is widely distributed throughout tropical Australia and also occurs in Papua New Guinea. The LNG facility will not reduce the area of occupancy of the flatback turtle in any ecologically meaningful way.

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

   The LNG facility will not create any barriers to movement for flatback turtles.

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

   Nesting beach habitat will not be physically impacted by the LNG facility. While some feeding habitat will be lost due to construction of the MOF and further habitat disturbed as a result of dredging of the approach channel, suitable feeding habitats are found throughout Port Curtis and elsewhere in the central Queensland region.

5. Disrupt the breeding cycle of an important population.

   Lighting near turtle rookeries has the potential to disrupt the nesting of adult turtles and the survival of hatchlings. The light regime in the Port Curtis region is already heavily modified by existing industrial and residential development. A medium density flatback turtle rookery occurs at South End on Curtis Island and nesting also occurs on Facing Island. The turtle rookery on Curtis Island is separated from the proposed LNG facility by an undulating and vegetated landscape. The landscape topography in concert with a range of measures designed to reduce the light spill from the LNG facility will result in no disruption to the breeding cycle of flatback turtles.

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

While habitat is being lost as a result of the construction of the MOF, and further habitat disturbed as a result of dredging of the approach channel, the impact is not of a sufficient scale to affect the survival of any marine turtle species.

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

   It is considered unlikely that an invasive species that is harmful to flatback turtles will be introduced due to the LNG facility.

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

   It is considered unlikely that a disease harmful to flatback turtle will be introduced by the LNG facility.

9. Interfere substantially with the recovery of the species.

   There is a recovery plan in place for all marine turtle species found in Australia. The LNG facility activities will not interfere with the recovery of marine turtle species.

Marine turtles – loggerhead turtle

The loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters with nesting mainly concentrated on sub-tropical beaches. In Queensland nesting is concentrated in the south-east particularly along the Bundaberg coast. Occasional nesting is recorded from Facing and Curtis Islands. Foraging areas are widely distributed.

As described in Table 23.11 it is considered likely that this species could occur in the LNG facility study area (marine areas), moving through the area for foraging purposes.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the Loggerhead turtle.

Significant impact criteria: Loggerhead turtle

Significant impact criteria (endangered species):

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

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

   The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population.

2. Reduce the area of occupancy of the species.

   Globally, the loggerhead turtle is a circum-tropical species. The LNG facility will not reduce the area of occupancy of the loggerhead turtle in any ecologically meaningful way.

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

   The LNG facility will not create any barriers to movement for loggerhead turtles.

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

   While some feeding habitat will be lost due to construction of the MOF and further habitat will be disturbed as a result of proposed dredging of the approach channel, suitable feeding habitats are found throughout Port Curtis and elsewhere in the central Queensland region.

5. Disrupt the breeding cycle of a population.

   Lighting near turtle rookeries has the potential to disrupt the nesting of adult turtles and the survival of hatchlings. The light regime in the Port Curtis region is already heavily modified by existing industrial and residential development. While occasional nesting of loggerhead turtles is recorded from Facing and Curtis Islands, the major breeding location for the east coast population of loggerhead turtles is along the Bundaberg coast. Nonetheless, landscape topography in concert with a range of measures designed to reduce the light spill from the LNG facility will result in no disruption to the breeding cycle of the small number of loggerhead turtles that may nest on Curtis Island.

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

   While habitat will be lost as a result of constructing the MOF, and further habitat disturbed as a result of dredging of the approach channel, the impact is not of a sufficient scale to affect the survival of any marine turtle species.

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

   It is considered unlikely that an invasive species that is harmful to loggerhead turtles will be introduced due to the LNG facility.

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

   It is considered unlikely that a disease harmful to the loggerhead turtle disease will be introduced due to the LNG facility.

9. Interfere with the recovery of the species.

   There is a recovery plan in place for all marine turtle species found in Australia. The LNG facility activities will not interfere with the recovery of marine turtle species.

Marine turtles – hawksbill turtle

Hawksbill turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. Nesting is mainly confined to tropical beaches. In Queensland the major nesting of Hawksbill Turtles occurs in the northern Great Barrier Reef and Torres Strait.

The northern Great Barriers Reef and particularly Milman Island and the inner Great Barrier Reef Cays north from Cape Grenville are considered to be important foraging grounds and juvenile habitat for Hawksbill Turtles. The preferred foraging habitat of the hawksbill turtle is rocky and coral reefs. As per Table 23.11 it is thought possible that this species could occur in the LNG facility study area (marine areas), moving through the area for foraging purposes.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the hawksbill turtle.

Significant impact criteria: hawksbill turtle

Significant impact criteria (vulnerable species):

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

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

The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in the size of a population.

2. Reduce the area of occupancy of the species.

   Globally, the hawksbill turtle is a widely distributed species. The LNG facility will not reduce the area of occupancy of the hawksbill turtle in any ecologically meaningful way.

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

   The LNG facility will not create any barriers to movement for hawksbill turtles.

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

   The preferred foraging habitat of the hawksbill turtle is rocky and coral reefs. The LNG facility will not adversely impact any such foraging habitat for the species.

5. Disrupt the breeding cycle of a population.

   Hawksbill turtle nesting on the east coast occurs on eastern Cape York beaches and some islands offshore of the eastern Cape. No nesting occurs in central Queensland. Therefore the breeding cycle of the hawksbill turtle will not be impacted by the LNG facility.

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

   The LNG facility will not adversely impact the availability or quality of habitat for the species, (that is, rocky and coral reefs).

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

   It is considered unlikely that an invasive species harmful to hawksbill turtles will be introduced due to the LNG facility.

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

   It is considered unlikely that a disease harmful to hawksbill turtle disease will be introduced by the LNG facility.

9. Interfere with the recovery of the species.

   There is a recovery plan in place for all marine turtle species found in Australia. The LNG facility activities will not interfere with the recovery of marine turtle species.

23.4.4 Listed migratory species

Migratory species – birds

A draft significant impact guidelines policy was introduced for a group of 36 migratory bird species in 2009. This policy is utilised for the impact assessment for those birds covered by the draft policy that have been identified as potentially occurring at the site.

Impact assessment for the other listed migratory birds that were identified as potentially occurring on or adjacent to the LNG facility site has been undertaken considering the overarching DEWHA Significant Impact Guidelines 1.1.

Draft policy: 36 migratory shorebird species

Draft EPBC Act policy statement 3.21 Significant impact guidelines for 36 migratory shorebird species: Migratory species (DEWHA 2009f) is used for this assessment. Using these guidelines a site is considered to provide important habitat for migratory shorebirds (excluding Latham's snipe) if;

- The site is identified as internationally important
- The site supports at least 0.1 per cent of the flyway population of a single species
- The site supports at least 2000 migratory shorebirds
- The site supports at least 15 shorebird species.

Latham's snipe is included as one of the 36 migratory shorebird species covered by the draft policy. However as Latham's snipe does not commonly aggregate in large flocks or use similar habitat to many of the other coastal species, habitat important to Latham's snipe is not likely to be regularly identified using the aforementioned process. Consequently the draft policy provides separately for the identification of important habitat for Latham's snipe. Important wetlands for the Latham's snipe are identified in the draft policy as sites that:

- Have previously been identified as internationally important for the species, or sites that
- Support at least 18 individuals of the species and
- Are naturally occurring open freshwater wetlands with vegetation cover nearby (for example, tussock grasslands, sedges, lignum or reeds within 100 m of the wetland).

Site is defined for migratory shore birds as: 'the entire (discrete) area of contiguous habitat used by the group of migratory shorebirds, which may include multiple roosts and feeding areas.'

For permanent wetlands, suppor' is defined as; 'migratory shorebirds are recorded during surveys and/or are known to have occurred at the site within the previous five years' DEWHA (2009).

Considering the data reviewed and these draft guidelines, there is potential for the wetlands within the study area to be classified as important habitat for migratory shorebirds. Seven of the species listed for consideration under policy statement 3.21, have been recorded within the study area during field surveys or during recent surveys of the Curtis Island Industry Precinct. A further nine species have been identified as being known to roost in the area through the EPBC Act protected matters search report (considering a 10km radius of the LNG facility site). Further shorebird field survey work will be conducted from November 2009 to March 2010.

Migratory plovers (Charadriidae) and sandpipers (Scolopacidae) listed in the draft EPBC Act policy statement 3.21 that are known to occur in the study area include; Pacific golden plover (*Pluvialis fulva*), bar-tailed godwit, whimbrel, eastern curlew, grey-tailed tattler, common greenshank and red-necked stint. A further 16 species are considered to potentially occur within the study area based on their distribution and preferred habitat: grey plover, double-banded plover, lesser sand plover, greater sand plover, Latham's snipe, black-tailed godwit, terek sandpiper, common sandpiper, marsh sandpiper, ruddy turnstone, Asian dowitcher, great knot, red knot, sharp-tailed sandpiper, curlew sandpiper and broad-billed sandpiper.

Double-banded plover breeds in New Zealand. All other species listed above breed in the northern hemisphere. Other than Latham's snipe all of these species forage in the intertidal zone, though some species will also use freshwater habitats. Tidal mudflats, saltmarsh and mangroves are important habitats for these species. Latham's snipe is essentially restricted to freshwater habitats and is assessed separately.

Table 23.15 discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on migratory shorebirds.

Table 23.15 Significant impact criteria: migratory shorebirds (36 migratory shorebird species)

Ecological element affected
Loss of important habitat There will be a loss of approximately 24 ha of salt pan and saltmarsh and 2.4ha of mangroves. Recent field surveys have shown that these areas are utilised as foraging habitat by some shorebird species. The area directly affected has not been identified as a significant feeding area or roosting site (EPA 1999). It is considered that this loss of foraging habitat would not significantly decrease the foraging habitat available for shorebirds within the wider Port Curtis area. Indirectly, disturbance from the construction and operation of this LNG facility (and related activities such as dredging for access) may reduce the usability of the adjacent undisturbed habitat. This is discussed below.
Degradation of important habitat leading to a substantial reduction in migratory shorebirds using the site Activities resulting in the potential degradation of habitat utilised by shorebirds in the study area are the construction of the LNG facility including the wharf and impacts associated with the LNG facility, such as the dredging to enable shipping access to the wharf. The construction of the LNG facility will impact on habitat utilised by some shorebirds in this area. The proposed footprint covers the majority of the existing saltpan on site. This saltpan is utilised by some migratory shorebirds. The construction of the wharf facilities will impact on the mudflats where these facilities are constructed. There is potential for some shorebird species to continue to forage in areas adjacent to the LNG facility area (outside of the development footprint). The dredging and reclamation works associated with the Western Basin Dredging and Disposal Project has the potential to impact habitat for migratory shorebirds within the Port Curtis area. The impact of these works is being assessed through the EIS being undertaken by GPC for the Western Basin Dredging and Disposal Project and is summarised in Section 23.4.5.
Increased disturbance leading to a substantial reduction in migratory shorebirds using the site Disturbance may result in a reduction of available foraging time and may cause shorebirds to expend energy which is required for migration. The habitat areas of most importance when considering potential disturbance levels are roosting sites and feeding grounds. Disturbance of roosting sites may result in unnecessary expenditure of energy to relocate to a safer location. Shorebirds have a limited opportunity to forage during the low tide times. Disturbance can prevent birds from foraging effectively (Bamford et al. 2008). Of the various forms, small aircraft and helicopter disturbance is seen as the most severe and long lasting. Close approaches from the water generally disturb more birds than approaches from the land. This is due to the majority of the shore birds being close to the water's edge when foraging or roosting. Disturbance from the land is generally a result of movement along the tidal flat which includes people and animals, particularly dogs (Davidson and Rothwell 1993). Studies undertaken on shorebirds in the Dutch Wadden Sea suggest that shorebirds are impacted by high sound levels with the threshold for noise impact considered to be 120 dB(A). Birds impacted by noise move away from the area (Smit and Visser 1993). For the LNG facility site disturbance may occur during construction and / or operation. The primary mode of access to the proposed facility will be via a boat. Although a helipad will be constructed on site, there will be minimal use of helicopters.

The construction period potentially involves a high level of disturbance with increased activity on land, water and potentially in the air (albeit that there will be limited helicopter access to the island). It is assumed that increased activity and potentially loud intermittent noise during construction may result in a significant level of disturbance. Although there are shorebirds present year round, including some first year birds, for the migratory birds the area would be most significantly utilised from November through to March each year.

Once operational, LNG facility activities may cause disturbance in the wider Port Curtis area as a result of increased shipping activity, smaller boats undertaking ferry roles and generally increased activity around the LNG facility. High levels of operational activity around the immediate facility will potentially disturb shorebird foraging activity on this area of the mudflat. Only limited helicopter access is expected during operation. Shorebirds have differing levels of tolerance to disturbance, with species such as eastern curlew and bar-tailed godwit having particularly low tolerance levels (Davidson and Rothwell 1993). Buffer zones of 150 – 200m around identified important habitat have been determined as necessary for minimisation of disturbance of those less disturbance-tolerant shorebird species (Paton et al. 2000). A reduction in the use of the mudflat immediately adjacent to the wharf facility is likely for those less disturbance tolerant species of shorebirds. However there is a suitable distance between the LNG facility and the identified major feeding and roosting locations within the wider Port Curtis area for the activity of the wharf not to disturb these areas. Providing a buffer to boating activity around the identified important feeding and roosting sites is maintained, it is likely there will be minimal disturbance to these areas as a result of the operational activity of this plant.

Direct mortality of birds leading to a substantial reduction in migratory shorebirds using important habitat

Given the mobility of shorebirds, it is considered unlikely that the construction and operation of this LNG facility will result in direct mortality of shorebirds in the study area. Shorebirds are likely to move away from disturbance during the construction period.

A potential indirect impact is the increased access to the area by feral predators. Feral dogs, cats and foxes have previously been recorded on Curtis Island.

A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

Latham's snipe

Important wetlands for the Latham's snipe are considered using different criteria (under the policy statement 3.21 Significant impact guidelines for 36 migratory shorebird species: Migratory species *(2009)*) and are identified as sites that:

- Have previously been identified as internationally important for the species, or sites that
- Support at least 18 individuals of the species and
- Are naturally occurring open freshwater wetlands with vegetation cover nearby (for example, tussock grasslands, sedges, lignum or reeds within 100 m of the wetland).

Table 23.16 discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on Latham's snipe.

Table 23.16 Significant impact criteria: Latham's snipe

Ecological element affected
Loss of important habitat

There is no important habitat for Latham's snipe in the LNG facility site i.e. there are no naturally occurring open freshwater wetlands in the LNG facility site. Some habitat may be created in drainage lines due to heavy rain events but would be highly ephemeral. Foraging opportunities for the species would be very sporadic.

Degradation of important habitat leading to a substantial reduction in migratory shorebirds using the site

There is no important habitat for Latham's snipe in the LNG facility site.

Increased disturbance leading to a substantial reduction in migratory shorebirds using the site

Use of the LNG facility site by Latham's snipe is unlikely to be reduced by the LNG facility associated disturbance.

Direct mortality of birds leading to a substantial reduction in migratory shorebirds using important habitat

Given the mobility of the species, it is considered unlikely that the construction and operation of this LNG facility will result in direct mortality of Latham's snipe in the study area. If present, the species is likely to move away from disturbance during the construction period.

A potential indirect impact is the increased access to the area by feral predators. Feral dogs, cats and foxes have previously been recorded on Curtis Island.

A biosecurity management plan as described in Volume 4 Chapter 8 will be developed to control and prevent the establishment of invasive species.

Other listed migratory wetland and marine birds

In addition to the plovers and sandpipers discussed above database searches and field surveys identified nine species of birds listed as migratory under the EPBC Act that are strongly associated with wetlands and marine habitats as occurring, or having the potential to occur, in the study area. Of these, five species have been identified during field surveys or during recent surveys of the Curtis Island industrial precinct (Table 23.17).

Table 23.17 Other listed migratory wetland and marine birds

Common name	Scientific name	Likelihood of occurrence in the study area^
Brown booby	*Sula leucogaster*	Possible
(Eastern) great egret	*Ardea alba* (*modesta*)	Known
Cattle egret	*Ardea ibis*	Possible
Eastern reef egret	*Egretta sacra*	Known
Eastern osprey	*Pandion cristatus*	Known
White-bellied sea-eagle	*Haliaeetus leucogaster*	Known
Little tern	*Sterna* (*Sternula*) *albifrons*	Likely
Caspian tern	*Sterna* (*Hydroprogne*) *caspia*	Known
Common tern	*Sterna hirundo*	Likely

^Likelihood of Occurrence: Known: species has been recently recorded within the Curtis Island industrial precinct study area; Likely: species is known from the wider study area and preferred habitat is present on site; Possible: species is known from the wider study area and suboptimal habitat is present on site.

Apart from the little tern, the migratory species identified in Table 23.17 are considered to have stable populations in the region. There are no areas of critical habitat or threatening processes identified for these individual species.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on migratory wetland and marine birds

Significant impact criteria: migratory wetland and marine birds

Significant impact criteria (migratory species):

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

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Brown booby

   This marine species is likely at the LNG facility site only as an occasional visitor. No important habitat for the species will be modified, destroyed or isolated by the LNG facility.

   Great egret, cattle egret and eastern reef egret

   Great egret is common and widespread in a variety of habitats. Cattle egret is associated with paddocks and livestock, but requires wetlands for breeding. Eastern reef egret prefers rocky shores and reefs but also uses mudflats. No important habitat for these species will be modified, destroyed or isolated by the LNG facility.

   Eastern osprey and white-bellied sea-eagle

   These large raptors occur on coastal and inland water bodies. Disturbance associated with the LNG facility may reduce foraging activity in and around the LNG facility site. An eastern osprey nest has been identified on North Passage Island and as such Option 1b potentially impacts this nesting site.

   Little tern, Caspian tern and common tern

   Caspian tern occurs in maritime areas and on larger inland water bodies. Common tern is marine and coastal. Little tern occurs in sheltered coastal areas and on ocean beaches.

   The study area contains suitable foraging and roosting habitat for the three species. A sand bar provides possible breeding habitat for little tern but this will not be directly affected by the LNG facility. Considering the suitable habitat potentially impacted by this development and the extent of similar suitable habitat within the wider Port Curtis area, it is unlikely that the area potentially impacted by the LNG facility would be considered important habitat for these species.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for a migratory species.

   A biosecurity management plan as described in Volume 4, Chapter 8 will be developed to control and prevent the establishment of invasive species.

Of these species only little tern is likely to be significantly affected by invasive species, should breeding occur on site. Little tern is subject to predation and trampling of nests by livestock. Feral predators and horses and cattle are already established in the study area. The control of foxes, cats and dogs has been identified as a management objective.

Management of feral species should ensure that there is no increase in feral species activity in the LNG facility site.

3. Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

The LNG facility site is not considered important habitat for these species. The LNG facility is not expected to disrupt the lifecycle of any ecologically significant proportion of any population of these species.

Field surveys have identified a pair of eastern osprey nesting on North Passage Island. As such, Option 1b for the development of marine facilities for the LNG facility (which extends to North Passage Island) has the potential to impact this nesting pair. However the pair is not considered to represent an ecologically significant proportion of the population. The eastern osprey regularly nests on infrastructure.

No little tern nesting sites have been identified within the study area but the sand bank at the front of the site and the sandy beach at Laird Point are potentially suitable nesting sites for the species. They are however, unlikely to be utilised currently due to the amount of activity of cattle and horses in this area. A biosecurity management plan as described in Volume 4, Chapter 8 will be developed to control and prevent the establishment of invasive species. Active management of feral species around the site may increase the suitability of the area for breeding for the little tern, given the removal of the current disturbance by cattle and horses.

Terrestrial migratory species

In addition to the shorebirds and waterbirds discussed above database searches and field surveys identified nine species of terrestrial birds listed as migratory under the EPBC Act as occurring, or having the potential to occur, in the study area. Of these, five species have been identified during field surveys or during recent surveys of the Curtis Island industrial precinct.

Six species potentially utilise the eucalypt woodland, melaleuca woodland and/or the mangroves within the study area: oriental cuckoo, rainbow bee-eater, black-faced monarch, spectacled monarch, satin flycatcher and rufous fantail. The LNG facility will result in the loss and fragmentation of habitat potentially utilised by these species. Fragmentation of the habitat may favour species such as the noisy miner (*Manorina melanocephala*), which aggressively competes with other birds for territory and resources. As such, the potential loss of suitable habitat for these species is likely to be greater than simply the habitat lost within the development footprint. However, given the extent of similar habitat available within the wider Port Curtis area, it is considered unlikely that the LNG facility will impact significantly on these species.

The other three species, barn swallow, fork-tailed swift and white-throated Needletail, are aerial foragers. These species may potentially forage in air space over the study area. It is considered unlikely these species will be impacted by the proposed development. Table 23.18 lists the terrestrial migratory species potentially impacted upon by the project and discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on these species.

Table 23.18 Terrestrial migratory species

Common name	Scientific name	Likelihood of occurrence in the study area^
White-throated needletail	*Hirundapus caudacutus*	Likely
Fork-tailed swift	*Apus pacificus*	Likely
Oriental cuckoo	*Cuculus saturatus*	Possible
Rainbow bee-eater	*Merops ornatus*	Known
Rufous fantail	*Rhipidura rufifrons*	Known
Satin flycatcher	*Myiagra cyanoleuca*	Known
Black-faced monarch	*Monarcha melanopsis*	Known
Spectacled monarch	(*Monarcha*) *Symposiarchus trivirgatus*	Known
Barn swallow	*Hirundo rustica*	Possible

Significant impact criteria: migratory terrestrial species

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

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   No important habitat for these species will be modified, destroyed or isolated by the LNG facility.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for a migratory species.

   A biosecurity management plan as described in Volume 4, Chapter 8 will be developed to control and prevent the establishment of invasive species.

   Of these species only rainbow bee-eater is likely to be significantly affected by invasive species, should breeding occur on site. Rainbow bee-eaters nest in burrows in soil and sand banks. Feral predators and cane toads, which are known to prey on eggs and nestlings (Boland 2004b), are already established in the study area. The control of foxes, cats and dogs has been identified as a management objective.

   Management of feral species should ensure that there is no increase in feral species activity in the LNG facility site.

3. Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

   There is no evidence to suggest that the study area supports an 'ecologically significant proportion of a population' of any of the migratory birds known or considered likely to occur.

Migratory species – marine fauna

As described in section 23.3.3, it is known or considered possible that migratory marine species may utilise the offshore area of the LNG facility site, or areas immediately adjacent to the offshore area. In addition to those migratory species identified as threatened species at Section 23.4.3, saltwater

crocodile, the dugong, and two dolphins, Australian snubfin dolphin and Indo-Pacific humpback dolphin may utilise habitat within or adjacent to the LNG facility site area.

Potential impacts of the LNG facility on marine fauna are described in Section 23.4.2 (further detail in Volume 4 Chapter 10) and include habitat reclamation, boat strike, noise and light emissions, dredging related impacts and wastewater discharge. The potential impact of the LNG facility on each of the threatened marine fauna species (excluding those threatened marine species for which potential impact was described previously) is described in the following sections with reference to the significant impact guidelines. Given the similar usage patterns and potential for impact, the dolphins are grouped together in one assessment table.

Saltwater crocodile

The southern most range of the estuarine crocodile is generally recognised as the Fitzroy River although individuals straggle as far south as Colosseum Inlet and Seven Mile Creek systems. While it is plausible estuarine crocodile may be sited near the proposed LNG Facility, the area does not represent key habitat for the species. The key areas for estuarine crocodile populations in Queensland is the north western Cape York Peninsula, particularly parts of the Wenlock River and the Lakefield National Park (Read et al. 2004).

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the saltwater crocodile.

Significant impact criteria: saltwater crocodile

Significant impact criteria (migratory species)

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

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   No important saltwater crocodile habitat will be destroyed or isolated as a result of the proposed development.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   It is considered unlikely that an invasive species that is harmful to saltwater crocodile will be introduced due to the LNG facility.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   There is the potential for alienation of saltwater crocodile from habitats due to ferry operations and construction activities in general. Impacts from the brine discharge from the desalination facility are not considered to be of a sufficient magnitude above background values to result in any measurable impacts to saltwater crocodile.

Dugong

The dugong has a large range across tropical and subtropical coastal and island waters from east Africa to Vanuatu. It is considered that the extent of occurrence of dugong includes the entire

Queensland coast. The most important areas for dugong are around Hinchinbrook Island, Cleveland Bay and Shoalwater Bay in the Great Barrier Reef, and Hervey Bay and Moreton Bay further south.

Dugong almost solely consume seagrass and are associated with seagrass beds in the Port Curtis region, but the region is not identified as supporting large populations of these animals. The nearest large populations of dugong occur in Shoalwater Bay to the north and Hervey Bay to the south. The dugong that do occur in the Port Curtis region are centred around the Rodds Bay area (Lawler and Marsh 2001), but they are recorded using seagrass beds in the northern part of Port Curtis such as those near Wiggins Island (Taylor et al. 2007; Chartrand et al. 2009).

Dugongs prefer seagrasses that are early or 'pioneer' species, particularly species of the genera *Halophila* and *Halodule*. The description of seagrass beds in Port Curtis by Rasheed et al. (2003) indicates that the relatively small seagrass beds directly adjacent to the Project site near Laird Point (refer to Figure 23.10) consists of aggregated and isolated patches of the *Zostera capricorni* species of seagrass. Seagrass beds adjacent to North Passage Island consist of aggregated patches of *Z. capricorni* of light cover with *Halophila ovalis.* Conversely, large seagrass beds in other areas of Port Curtis such as the Western Basin and south of Fishermen's Landing are dominated by species of the genera *Halophila* and include species of the genera *Halodule.* Therefore it is considered likely that dugong using northern Port Curtis would prefer feeding in these areas of Port Curtis.

The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on the dugong.

Significant impact criteria: dugong

Significant impact criteria (migratory species)

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

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   It is considered that no important dugong habitat will be destroyed or isolated as a result of the proposed development. Areas of seagrass that may be impacted by the development of the LNG facility are not considered to be areas of important habitat.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   It is considered unlikely that an invasive species that is harmful to dugong will be introduced due to the LNG facility.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   There is the potential for alienation of dugong from habitats due to ferry operations and construction activities in general. Mitigation measures are proposed to limit the scale of any disturbance from construction activities (refer to Volume 4 Chapter 10). It is considered unlikely that the Project would seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species. The predicted mean and maximum increases in salinity due to the cumulative discharges (for this and other proposed projects on Curtis Island) of desalination

brine are well within the natural ambient salinity variations and would not be detrimental to the marine environment and therefore would not result in any measurable impact to dugong.

Dolphins

It was identified that two species of dolphins (Indo-Pacific humpback dolphin and the Australian snubfin dolphin that are listed as migratory under the EPBC Act are known to occur or are likely to occur in the LNG facility site area.

Both the Australian snubfin dolphin and the Indo-Pacific humpback dolphins usually inhabit shallow coastal waters of less than 20m depth and are often associated with rivers and estuarine systems, enclosed bays and coastal lagoons (Corkeron et al. 1997; Hale et al. 1998; Parra 2006). There are no estimates of dolphin abundance in Port Curtis.

Parra (2006) examined habitat use of both Australian snubfin dolphins and Indo-Pacific humpback dolphins in Cleveland Bay (Townsville). While there was significant overlap in habitat use by the two species, differences were also found. Australian snubfin dolphins preferred slightly shallower (1–2 m) waters than Indo-Pacific humpback dolphins (2–5 m). Shallow areas with seagrass ranked high in the habitat preferences of Australian snubfin dolphins, whereas Indo-Pacific humpback dolphins favoured dredged channels.

The following assessment considers the two species together, as the impacting processes are the same and the likely responses are similar. The section below discusses each of the significant impact criteria relevant to the potential impact of the LNG facility on dolphins.

Significant impact criteria: dolphins

Significant impact criteria (migratory species)

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

1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   No important dolphin habitat is being destroyed or isolated as a result of the proposed development.

2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   It is considered unlikely that an invasive species that is harmful to dolphins will be introduced due to the LNG facility.

3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   There is the potential for alienation of dolphins from habitat during construction activities. Mitigation measures are proposed to limit the scale of any disturbance from construction activities (refer to Volume 4, Chapter 10). Suitable habitats that dolphins can utilise within Port Curtis are outside the area likely to be impacted by the LNG facility. The predicted mean and maximum increases in salinity due to the cumulative discharges (for this and other proposed Projects on Curtis Island) of desalination brine are well within the natural ambient salinity

variations and would not be detrimental to the marine environment and therefore would not result in any measurable impact to dolphins.

23.4.5 Consequential impacts relating to shipping access development

As an indirect impact of the undertaking of this and other Projects proposed to be developed in Port Curtis, GPC proposes to undertake the Western Basin Dredging and Disposal Project. This Project is a controlled action for which GPC is the proponent and it is being assessed through a separate EIS. Impacts associated with the Western Basin Dredging and Disposal Project relevant to a consideration of consequential impacts for the Australia Pacific LNG Project (LNG facility) are summarised below and detailed in the EIS for the Western Basin Dredging and Disposal Project.

- Impacts to marine water quality due to the dredging operations and decant discharge from the reclamation area. Regions of persistent elevated turbidity are predicted as a consequence of overflow dredging and the emptying of the hopper adjacent to the eastern bund wall, with subsequent rehandling. Decant discharge is predicted to generate elevated turbidity in the region of the outfall and along the northern bund wall of the reclamation area. It is noted that these potential impacts to water quality area temporary. Mitigation measures detailed include development and implementation of a reactive dredge management plan, and appropriate design of the reclamation facility. Impacts noted as not being able to be mitigated include those to hydrodynamics and flushing efficiency.
- Impacts to coastal processes include changes in flow and water level condition adjacent to the reclamation area to the north and west, potentially changing the rate at which the ebb tide drops and reducing the time that the tidal flats are dry during the lower parts of the cycle, initial scour of fine silts from the north-eastern corner of the reclamation area, increase in maintenance dredging requirements. The report noted that it is not necessary to mitigate the changes to tidal flows and water levels as they are within the normal bounds of the processes that occur in the natural system.
- The primary direct impact to marine ecology will involve the removal of the seabed environment under the direct footprint of the reclamation area and channel dredging areas (approximately 902 ha). The major indirect impact relates to the degradation of water quality during dredging and disposal activities. Other impacts identified include potential impacts to fauna due to vessel operations and noise, ongoing disturbance to benthic systems or mobile species transit routes from an altered hydrodynamic regime, ongoing impacts to water quality from reclamation decant and increased potential for pollution due to land use change. Mitigation measures identified include; development of a reactive dredge management plan (which considers sensitive habitat monitoring to inform dredge management) to mitigate against impacts on water quality, dredge management strategies (e.g. use of fauna spotter and turtle excluders) to avoid impacts on marine fauna, use of soft starts during pile driving activities and appropriate design of the reclamation facility. Offsets are proposed to be implemented for habitat losses that are unable to be avoided.
- Impact to terrestrial ecology is linked to the loss and potential degradation of marine plant communities and intertidal habitats. The change in coastal processes as a result of reclamation is likely to reduce the extent and suitability of habitat for shorebirds in the area. Mitigation measures proposed include minimising construction during critical migratory periods (where possible) and establishing construction management procedures. Offsets are proposed to be implemented for habitat losses that are unable to be avoided.

- The placement of dredged material in the proposed reclamation area will have a permanent effect on the visual landscape and amenity of the area, particularly when viewed from the water in the vicinity of the reclamation area. Mitigation measures include the avoidance of loss or damage to landscape features (including minimising vegetation removal), stabilisation of reclaimed area and management of construction activities.

23.4.6 Cumulative impacts

Cumulative impact assessment has been undertaken to take into account not only the potential impacts of the LNG facility element of the Project, but its effects in combination with the impacts of other proposed projects that may have a significant impact on the environment associated with the Project. Cumulative impact assessment has been undertaken for each aspect of the Project utilising a methodology (and considering certain projects) described at Volume 1 Chapter 5. Further detail on the assessment is provided at Volume 4 Chapter 25. A summary of the cumulative impact assessment relevant to MNES is provided below.

Soils, topography, geomorphology and geology

Potential cumulative impacts resulting from land disturbance on Curtis Island mostly occur during the construction phase. These impacts may include:

- Landform modification (stormwater diversion, vegetation clearing and earthworks) resulting from construction and operation of the LNG facility
- Destabilisation of soils (erosion) and sedimentation of Port Curtis during construction.

The majority of the identified impacts would occur if appropriate mitigation measures and approved environmental management plans (EM Plans) are not implemented by projects on Curtis Island. It is expected that the residual risk of cumulative impacts would be low if all projects follow regulatory requirements and implement management measures.

Landscape character and visual amenity

The cumulative effect of the Australia Pacific LNG Project, QCLNG and GLNG projects on Curtis Island is considered low, predominantly due to the distance from sensitive receptors.

The establishment of industrial development in the Curtis Island Industry Precinct will replace the existing natural landscape defining the western banks of the Gladstone Harbour, with industrial elements reflecting the eastern banks. The views from vistas around Gladstone, such as Auckland Point, Round Hill and Mount Larcom, will be slightly affected by the introduction of industrial development to Curtis Island. However, it is important to note that the industrialisation of the landscape is consistent with the zoning amendments made to the Gladstone State Development Area with the designation of the Curtis Island Industry Precinct.

One of the most significant visual effects relating to the cumulative consideration of the facilities is the effect of night lighting. Other projects propose to use of stack flares which will create a highly visible effect when the stack flares are in use. Australia Pacific LNG will not contribute significantly to this impact as it proposing ground flares.

Views from the western and southern sectors will be the most affected from the development of the three LNG facilities proposed for Curtis Island. The eastern sector is visually screened from the LNG facilities by a ridgeline which adjacent to the eastern boundaries of the facilities. Populated areas within the eastern sector, in particular South End, will be affected by a reflective glow effect on

surrounding ridge and night sky landscapes, however due to the distance from the flares and the intermittent use of the flares these impacts are considered negligible. The northern sector does not contain many sensitive receptors and views will be limited to acute angles.

Views from the western sector will be most affected by the introduction of industrial development within the Curtis Island Industry Precinct. The LNG facilities would appear adjacent to each other and are generally well integrated by the background hills. The visual effect could be high up to a distance of 3km with moderate impact potentially occurring up to 5km.

The cumulative effect to the south is limited by distance and the acute angles of view to all of the LNG plants. Similar visual effect would be achieved with high effects experienced out to 3km and moderate effects out to 5km. These effects are therefore restricted to the waters of Gladstone Harbour with low visual effects at sensitive areas of Gladstone. The effect of night lighting on the Gladstone area will potentially be higher than the day time effects. This is the result of the stronger contrast created by direct lighting effects. However due to distance the effects generally remain low. This contrast is weakened by the night lights within existing port facilities between Curtis Island and Gladstone.

Terrestrial ecology

Vegetation clearing associated with the Project and surrounding industry has the potential to reduce the overall extent in Queensland of those REs present on site. Of the proposed cumulative total cleared, the LNG facility would contribute to almost two-thirds of saltpan vegetation and about one-third of blue gum-ironbark forests and paperbark woodlands to be cleared in the greater Gladstone area. And whilst, the Project would account for about one-quarter of all mangrove shrublands and less than 15% of spotted gum-ironbark forests of the cumulative total proposed to be cleared in the greater area, the combined impact of the projects outlined above would not result in any of these REs falling into a higher conservation status.

The majority of Curtis Island is well vegetated with similar vegetation communities to those present on site and holds significant corridor and connectivity values as surrounding industry in the greater Gladstone area has led to a significant loss of broad, contiguous tracts of vegetation. The proposed Project would contribute to the loss and fragmentation of vegetation communities in the south-western corner of Curtis Island resulting in an increase in vegetation degradation through edge effects and changes to the floristic structure and composition and hydrological regimes. Increased road and personnel traffic may also promote the introduction and/or spread of weed species. Further information on loss and fragmentation can be found in Volume 5 Attachment 16.

Industry development in the greater Gladstone area particularly on Curtis Island has the potential to significantly impact upon coastal wetlands. The development of Curtis Island would result in an increase in mangrove fragmentation and a decrease in wetland vegetation in this region.

As no EVR or regionally significant flora species were recorded on site during field surveys, the Project is unlikely to significantly contribute to the loss or harm of these in the greater Gladstone area and is unlikely to compound the potential impacts on these species from surrounding industry. The LNG facility and surrounding industry do however, have the potential to impact upon suitable habitat for these species through direct clearing of preferred habitat areas or degradation through changes in hydrological and fire regimes and weed invasion.

The LNG facility may contribute to the overall loss of vegetation considered of cultural, recreational and economic value on Curtis Island. However, with its active involvement in the management of the Curtis Island Environmental Management Precinct, Australia Pacific LNG seeks to preserve and enhance the habitat quality on Curtis Island.

The clearing of habitat required for the development of the facility will contribute to the cumulative loss of habitat within the Gladstone area. There is currently no significant development on Curtis Island as such the range of disturbance factors affecting this area is limited. Historic use for cattle grazing and the current disturbance of the area by feral cattle and horses, has affected habitat within the study area. However, habitat within the project area is suitable for a range EVR and common fauna species. The establishment of the Curtis Island Industry Precinct, within which this facility is located, will result in the direct loss of habitat (including features such as tree hollows, mangroves and tidal mudflats) and indirect habitat loss through increased fragmentation, artificial lighting, noise, traffic, human activity, potential sedimentation and pollutants. The cumulative impacts potentially reduce the dispersal opportunities for a range of small birds, mammals and reptiles.

The effect of artificial lighting on faunal behaviour and community ecology well documented. The disorientation of marine turtles and nocturnally migrating birds, due to artificial lighting is reasonably well known. However, research and anecdotal evidence indicate the potential for artificial lighting to influence the behaviour of other nocturnal and diurnal species (Longcore and Rich 2004). Frogs have been observed to stop mating when exposed to artificial lighting. Their calls resuming once the area was shielded from the light (Longcore and Rich 2004). Small mammals have been observed to alter foraging behaviour in response to artificial light. The behavioural changes associated with illumination are likely to be an anti-predator response because the perceived risk of predation increases with increasing light (Bird et al 2004). Insectivorous bat species have been observed to congregate around artificial lights to feed on insects. It is, however, only the faster flying bats exploiting this niche while other slower flying insectivorous bat species tend to avoid artificially lit areas (Longcore and Rich 2004). The potential impacts of artificial lighting on any particular species and their severity will vary depending on the ecology of the species, their predator-prey relations, the distance of the core population from the source of light and the reaction of that species to light disturbance. A potentially significant cumulative impact of the developments within the wider study area is the increase of artificial lighting. The implications of this for terrestrial fauna in the area are unknown. To mitigate the effect of night lighting Australia Pacific LNG is committed to use a sensitive lighting approach to reduce light spill.

Wetlands within Port Curtis are utilised by a range of migrating shorebirds for foraging and roosting habitat. Migratory shorebirds are sensitive to disturbance that causes them to stop foraging or waste energy, which is otherwise stored for migration (Geering et al. 2007). The project area has not been identified as a major feeding or roosting ground for migratory shorebirds. However, the cumulative impact of development within the intertidal zone around Port Curtis is likely to increase disturbance to this fauna group. Sensitivity to disturbance varies between species, with some species such as the bar-tailed godwit being particularly sensitive (Davidson and Rothwell 1993). Buffer zones of 150 – 200m around identified important habitat have been determined as a requirement to minimise disturbance to more nervous shorebird species (Paton et al. 2000). If buffers are provided, excluding boating activity around the identified important feeding and roosting sites is maintained, it can be reasonability determined that there will be minimal disturbance to the identified major roosting and feeding areas as a result of the activities of these projects.

The powerful owl has been observed in eucalypt woodland adjacent to the southern boundary of the LNG facility (Sandpiper 2008). This species is a nocturnal hunter, which preys on arboreal mammals (such as possums and gliders). Powerful owls occupy large home ranges. They require large tree hollows for their own nesting requirements and for their prey species (Webster et. al. 2004). The powerful owl is listed as vulnerable under the *Nature Conservation Act 1992* (Qld). Based on the current understanding of this species on Curtis Island, the cumulative impact of the proposed developments within the Curtis Island Industry Precinct could result in the displacement of a potential

breeding pair. Powerful Owls are known to occur at Mount Larcom west of Gladstone however, their distribution on Curtis Island is unknown.

The beach stone-curlew has been sited within the project area, north of the project area at Laird Point and a various locations within the Curtis Island Industry Precinct. The beach stone-curlew is listed as vulnerable under the *Nature Conservation Act 1992*. This species inhabits isolated beaches and is sensitive to disturbance of this habitat. The cumulative impacts of the proposed developments within the Curtis Island Industry Precinct are likely to result in the observed individuals moving away from this section of coastline.

Marine ecology

Conceptually, cumulative impacts in the marine environment range from existing impacts from recreational and industrial uses i.e. prior impacts of similar types, to complex interactions of environmental stresses due to multiple (and differing) impacts. The latter is the norm and is relevant for considering cumulative impacts generated from the proposed LNG facilities on Curtis Island.

A number of potential direct impacts on marine assemblages have been identified and need to be considered in a cumulative sense:

- Dredging and reclamation (discussed further below)
- Discharges to the marine environment from seawater desalination, sewage and stormwater treatment
- Transport of personnel and materials to project areas
- Noise from construction activities in or near marine areas
- Project lighting.

Dredging and reclamation works for the Western Basin

The GPC is currently assessing the cumulative impacts associated with the dredging of the Western Basin in the Western Basin Dredging and Disposal Project EIS. The volume of dredging for the Western Basin is in the order of 50 million m^3 (GPC 2009) from the development of the Western Basin to provide for port facilities for multiple proposed developments. This volume of dredging makes it one of the largest dredging campaigns ever proposed for Queensland and Australia. The cumulative impact of this dredging and reclamation is expected to result in:

- A longer period (four to six years) over which turbidity will be generated and suspended sediment transported
- A considerable increase in the spatial scale of the marine habitat disturbed as a result of dredging activities
- Significant increase in the area of intertidal and shallow sub-tidal habitat reclaimed. An estimate of the total area to be impacted is in the order of approximately 700 hectares and this includes areas of high value habitat including seagrass, mangrove and saltmarsh/saltpan
- Hydrodynamic impacts including flow obstruction due to the reclamation footprint
- Increased duration of decant water release from the reclamation areas.

To mitigate the impacts of ongoing dredging, GPC propose to monitor the actual deposition rates and devise a maintenance dredging plan which does not interrupt ship movements. Additionally, the rate of

siltation of fine silts could be accommodated by an over-dredging allowance to extend the time between maintenance dredging campaigns.

The material dredged as part of the Western Basin Dredging and Disposal Project is proposed to be placed into bunded reclamation areas, namely the Fisherman's Landing northern expansion and the Western Basin reclamation area. The approximate footprints for the Fisherman's Landing northern expansion and the Western Basin reclamation area are 173.5ha and 235ha respectively. This equates to a total area of 408.5ha which has the capacity to accommodate approximately 55 million m3 of dredge material (GPC 2009). The capacities of the reclamation areas are designed to cater for dredging material to enable the development of industries in the Port of Gladstone (GPC, 2009). By comparison, Australia Pacific LNG's local dredging requirements for the construction of the MOF and marine facilities are minor and approximately 100,000m3 and the material is to be located within the reclamation areas.

In addition to the Western Basin Dredging and Disposal Project, there is dredging proposed by LNG facility proponents for pipeline crossings from the mainland to Curtis Island and local dredging for the marine facilities.

Australia Pacific LNG will continue to address potential impacts from the dredging and reclamation associated with the construction of the MOF and includes marine ecology impact mitigation in the design and construction philosophies. It is anticipated that proposed projects within Port Curtis will adopt mitigation measures to reduce impacts on the marine environment.

Discharges to the marine environment

A number of point source discharges related to seawater desalination, sewage and stormwater are proposed for the projects under consideration in Port Curtis. The discharges of brine from desalination plants from three proposed LNG facilities on the western side of Curtis Island have been modelled. While the predicted impact to the marine environment was minimal there remain significant uncertainties regarding the exact nature and location of these discharges, and these factors are outside the control of Australia Pacific LNG

When considered in concert, it is plausible that all proposed discharges to Port Curtis may result in long term impacts that are greater than those estimated for individual projects. A diversity of constituents is contained in these discharges and it is currently uncertain how they would accumulate and interact in Port Curtis over time.

Transport of personnel and materials to project areas

Slow moving vessels such as tugs, barges, and LNG ships are considered to pose an inherently low risk of boat strike to dugong and marine turtles in Port Curtis. However, the number of projects proposed within Port Curtis relying on shipping increases the potential of boat strike.

Australia Pacific LNG are committed to working with GPC and other port users to develop an industry wide approach to minimise boat strikes to marine mammals and turtles.

Noise from construction activities

Activities associated with construction in the marine environment and operations, in particular vessel movements, have the potential to displace dugong and cetaceans from critical habitat and interrupt critical behaviours through the creation of underwater noise. Cetaceans have been found to avoid some human sound sources for ranges of several kilometres, abandoning valuable habitat in the

process (Tyack 2008). There are a number of underwater noise sources that may impact on cetaceans and dugong. These include pile driving and vessel traffic.

The cumulative impacts of projects affecting Port Curtis will increase the number of noise sources and duration of noise created within Port Curtis. This in turn has the potential to displace marine population from habitat areas for longer periods of time.

Australia Pacific LNG seeks to work collaboratively with other Western Basin projects to establish a process for visual observations and recording of dugongs and cetaceans and to offset the loss of sensitive marine habitats.

Project lighting

Although the nearest nesting beach is in the vicinity of South End on Curtis Island, it is plausible lighting glow from the operational LNG facilities, compounded by the heavily lit Gladstone coastline and other proposed projects, could impact sea finding behaviour of hatchlings and the selection of nesting areas by adult flatback turtles.

Australia Pacific LNG will use a sensitive lighting approach to reduce light spillage impact on marine fauna.

Water resources

Potential impacts on surface water resources on Curtis Island are primarily related to:

- Changes in drainage behaviour from the area due to diversion of runoff
- Increased volumes of runoff and peak flows discharged from the area due to creation of impervious areas and improved drainage characteristics
- Changes in storm runoff water quality due to conversion from rural/forest to industrial catchment conditions.

Increased flows and volumes of runoff discharged from an individual facility are likely to have a negligible impact on water levels in Port Curtis due to the relatively insignificant volumes of runoff compared to the volume of Port Curtis. It is considered that the cumulative impacts on water quality are likely to be relatively minor in magnitude but may be distributed over an extensive area due to tidal action.

Hydrodynamic modelling results presented in Volume 4 Chapter 12 indicate that the flushing time for Port Curtis between The Narrows and Gatcombe Head is approximately 60 days. Thus, storm runoff discharged to Port Curtis may persist for significant durations following runoff events until finally flushed out of the system.

Should well established practices and/or regulatory requirements be implemented by proposed projects, it is considered that the cumulative impact of the proposed projects with respect water resources will be a low.

Shipping

With a probable cumulative LNG capacity of 28Mtpa in the Western Basin (numbers based on Blueprint for Queensland's LNG Industry, Department of Employment, Economic Development and Innovation, 2009) approximately 400 LNG ship visits per year are anticipated. This equates to slightly more than one LNG ship per day. The GPC's Strategic Plan envisages an increase in planned port capacity to 300 million tonnes per year within the next 50 years, which is nearly four times the 2008

throughput. The proposed addition of approximately 400 LNG ship visits per year equates to an increase in harbour traffic of approximately 7 percent of the predicted increase in shipping as defined in the Port's Strategic Plan.

A model simulating Gladstone's shipping operations was undertaken in 2009. This assessed the traffic flow within the Gladstone Harbour and included a number of LNG cumulative projects. The report concludes that using improved management logic, only a marginal decrease in average port performance (with the introduction of LNG trades), is expected.

There is expected to be an increase in small craft movement, mainly in the Fisherman's Landing northern expansion area. The impact of increased small craft traffic will depend upon the number of projects being constructed at the same time.

An initial appraisal of the marine traffic inside the Port of Gladstone suggests that congestion within the Western Basin/Clinton and Auckland channel areas is likely to be a significant issue for the cumulative case because of the proposed dredging operation, which will have to be carefully managed by GPC.

23.4.7 Impact management

An EM Plan for the LNG facility has been developed in accordance with the TOR issued for the Project and is included at Volume 4 Chapter 24. The EM Plan provides measures for the management of impact to MNES for the construction, operation and decommissioning of the LNG facility. It has been designed to:

- Summarise all of the environmental values, potential impacts and management strategies for the LNG facility identified in the EIS
- Detail the proposed performance criteria and implementation strategies to prevent or minimise environmental impacts
- Provide the government authorities and stakeholders with evidence that the environmental management for the Project is acceptable through demonstrating how Australia Pacific LNG environmental protection commitments will be achieved.

The EM Plan provides a summary of the environmental values and potential impacts for the following elements:

- Land management
- Terrestrial ecology
- Aquatic ecology
- Marine ecology
- Water resources
- Coastal environment
- Air quality
- Greenhouse gases
- Noise and vibration
- Waste management

- Traffic and transport
- Indigenous cultural heritage
- Shared cultural heritage
- Safety
- Social.

Each element has performance criteria, implementation strategies, monitoring, auditing, reporting and corrective actions as per Table 23.19.

Table 23.19 Environmental management plan structure

Element/issue	Aspect of construction or operation to be managed (as it affects environmental values)
Operational policy	The operational policy or management objective that applies to the element
Performance criteria	Measurable performance criteria (outcomes) for each element of the operation
Implementation strategy	The strategies, tasks or action program (to nominated operational design standards) that would be implemented to achieve the performance criteria
Monitoring	The monitoring requirements to measure actual performance (i.e. specified limits to pre-selected indicators of change)
Auditing	The auditing requirements to demonstrate implementation of agreed construction and operation environmental management strategies and compliance with agreed performance criteria
Reporting	Format, timing and responsibility for reporting and auditing of monitoring results
Corrective action	The action (options) to be implemented in case a performance requirement is not reached and the person(s) responsible for action (including staff authority and responsibility management structure)

23.4.8 Environmental offsets

Environmental offsets may be considered for compensation of impacts which can not be adequately reduced through avoidance and mitigation. The regulatory and policy framework for environmental offsets that may be relevant to this Project includes Commonwealth and Queensland government policy and requirements.

Use of environmental offsets under the EPBC Act

The Commonwealth Government has developed a policy relevant to the use of environmental offsets; 'Draft Policy Statement: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999*'. The policy indicates that:

Environmental offsets can be used under the EPBC Act to maintain or enhance the health, diversity and productivity of the environment as it relates to matters protected by the EPBC Act (i.e. MNES). Environmental offsets can be applied as an approval condition under the EPBC Act for developments that have undergone assessment. They may be used when a development will result in impacts on a matter protected by the EPBC Act.

The draft policy indicates that eight principles for the use of environmental offsets under the EPBC Act have been identified. These eight principles are to be used to assess any proposed environmental offsets to ensure consistency, transparency and equity under the EPBC Act. The Australian Government's position as per the draft policy is that:

- Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted
- A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents
- Environmental offsets should deliver a real conservation outcome
- Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets
- Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'
- Environmental offsets should be located within the same general area as the development activity
- Environmental offsets should be delivered in a timely manner and be long lasting
- Environmental offsets should be enforceable, monitored and audited.

Use of offsets under the Queensland Government framework

The Queensland Government environmental offsets policy establishes a framework for using environmental offsets in Queensland. The policy is based on the premise that offsets should only be considered after all environmental impacts have been avoided and minimised.

The policy is based on seven policy principles that direct the way offsets must be used to contribute to ecologically sustainable development:

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

The Queensland Government has several specific-issue offsets policies that indicate where environmental offsets are needed, and what form they should take. The specific-issue offsets policies, and their regulating agencies are for:

- Vegetation Management (Policy for Vegetation Management Offsets, September 2007, DERM)
- Marine Fish Habitat (Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss, 2002, Department of Primary Industries and Fisheries)
- Koala Habitat (Offsets for Net Benefit to Koalas and Koala Habitat, 2006, DERM)

Specific-issue policies are currently in development to address impacts on waste water quality and biodiversity.

Use of offsets

Biodiversity offsets

The objectives of the Queensland Government's draft Policy for Biodiversity Offsets (EPA 2008b) are to improve the long-term protection and viability of the State's biodiversity, to increase the area of habitat restored and enhanced and to ensure development in Queensland is ecologically sustainable. It provides criteria for identifying and utilising biodiversity offsets to counterbalance an impact that causes a loss of biodiversity values.

Under the draft policy, biodiversity offsets must achieve an equivalent or better environmental outcome for the biodiversity values impacted and may include direct offsets (such as acquiring lands to be included in a protected estate or rehabilitation and protection of regrowth vegetation), or indirect offsets including removing threats to biodiversity values, providing fauna assisted crossings and implementing actions of a recovery plan, biodiversity action plan or management plan.

The draft policy may provide a useful guide to calculate potential offsets based on the conservation status of the values impacted. However, the policy in its present form is a consultation draft and is subject to considerable change. Therefore, it is not considered further here.

Marine habitat offsets

For the marine fish habitat that is to be disturbed, consideration of mitigation and offsets are guided by the Queensland Government's Fish Habitat Management Operational Policy FHMOP (2002) Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss.

The objectives of this policy are:

- To maintain fisheries values, including fish habitat values
- To seek to ensure the costs associated with fish habitat losses attributed to public or private works are matched with, or are less than, a level of mitigation and/ or compensation appropriate to the disturbance of fish habitat
- To promote maintenance of marine fish habitats through implementation of mitigation or compensation to meet the objective of the no net loss of marine fish habitat policy
- To recognise the natural capital of fish habitats
- To create public awareness of the value of fish habitats.

Compensatory activities may be carried out off-site but in the region where the disturbance is occurring, or may be part of a statewide compensation program. Australia Pacific LNG has investigated a number of compensatory options for marine fish habitat loss. Australia Pacific LNG have consulted widely with local fishing stakeholders on offset options and have identified a preference for offsets at the local/regional level as it is the local/regional stakeholders that will

potentially be impacted by the proposal. The specific options that have been considered to date include the following:

- Restoration and/or rehabilitation of 'like for like' habitats in the Gladstone region
- Creation of purpose built inshore artificial reefs which also serve to mitigate loss of fishing access
- Fish stocking of Awoonga Dam to further enhance the recreational fishery
- Financial and in-kind support for fish and habitat monitoring through recreational fishing groups specifically CapReef
- Financial and in-kind support for fish habitat or other relevant local marine research projects.

In terms of habitat restoration, Australia Pacific LNG has considered options in the Port Curtis region but has not identified any areas where restoration is necessary or likely to be effective. Australia Pacific LNG has considered options proposed in the Port Alma region to improve connectivity of saltmarsh/saltpan habitat to assist barramundi recruitment, but considered it too far removed from the project location, in addition to there being significant uncertainties regarding feasibility.

Australia Pacific LNG has considered the creation of inshore artificial reefs using purpose built materials to in part offset habitat loss, but principally to offset loss of recreational fishing access. No specific location for an artificial reef in the Port Curtis region has been identified, however Australia Pacific LNG commits to further investigation of inshore artificial reefs if the community desire for these is strong.

CapReef is a community program monitoring the status of fish resources and the use of fish habitat in Central Queensland. CapReef is a partnership between government agencies, researchers and fishing groups with a strong community focus. Australia Pacific LNG commits to providing resources for programs such as CapReef to undertake relevant components of monitoring associated with fisheries and fisheries habitats.

At the current time however, Australia Pacific LNG has not finalised all options for offsetting the loss of marine fisheries habitat, but APLNG continues to work through the options with stakeholders and relevant agencies to implement activities that effectively compensate for loss of marine habitat.

Australia Pacific LNG has shown through the stakeholder engagement process to date that it is committed to working with fishing stakeholders to minimise loss of fishing access. A number of options to offset loss of fishing access have been investigated, and these options have been considered in combination with those for addressing habitat loss. Australia Pacific LNG has consulted widely with fishing stakeholders to attempt to offset loss of fishing access. As well as further investigation of inshore artificial reef opportunities, Australia Pacific LNG will continue to consult with recreational fishing groups in the Gladstone region, relevant agencies and the GPC to further investigate opportunities for recreational fishing offsets. This may include providing support for the ongoing fish stocking activities at Awoonga Dam.

23.5 Approvals and environmental record

23.5.1 Relevant Commonwealth legislation

The principal approvals which may be required for the Project under Commonwealth legislation are listed in Table 23.20. A more detailed description of approvals is provided in Volume 1 Chapter 2.

Table 23.20 Project approvals which may be required under Commonwealth legislation

Project approval	Legislation	Government agency
Environmental approvals	*Environment Protection and Biodiversity Conservation Act 1999*	DEWHA
Section 31 agreement, Indigenous Land Use Agreements or other future Act approval process	*Native Title Act 1993*	DERM/National Native Title Tribunal
Notification of potential hazardous object.	*Civil Aviation Act 1988 and Civil Aviation Safety Regulation 1988*	Civil Aviation Safety Authority
Maritime security plan	*Maritime Transport and Offshore Facilities Security Act 2003*	Department of Infrastructure, Transport, Regional Development and Local Government

23.5.2 Relevant Queensland legislation

The principal project approvals required under Queensland legislation are:

- The Coordinator General's EIS evaluation report under the SDPWO Act
- Environment authorities (petroleum activities) under the *Environmental Protection Act 1994*
- Petroleum tenure and licences under the *Petroleum and Gas (Production and Safety) Act 2004*
- Development approvals under the *Sustainable Planning Act 2009.*

There are also a number of other approvals required under Queensland legislation before the construction and operation of the Project can begin. Principal approvals under Queensland legislation which have already been acquired or are likely to be required for the Project are listed in Table 23.21. A more detailed description of approvals is provided in Volume 1 Chapter 2.

Table 23.21 Project approvals which may be required under Queensland legislation

Project approval	Legislation	Government agency
Coordinator-General's EIS evaluation report	*State Development and Public Works Organisation Act 1971*	Coordinator-General/ DIP
Environmental authorities for petroleum activities.	*Environmental Protection Act 1994*	DERM
Petroleum survey licence	*Petroleum and Gas (Production and Safety) Act 2004*	Department of Employment, Economic Development and Innovation (DEEDI)
Petroleum facility licence	*Petroleum and Gas (Production and Safety) Act 2004*	DEEDI
Cultural heritage management	*Aboriginal Cultural Heritage Act 2003*	DERM

Project approval	Legislation	Government agency
plan		
Development approval for a material change of use (MCU) under a Development Scheme.	*State Development and Public Works Organisation Act 1971*	Coordinator-General
Development approval for a MCU for a major hazard facility.	*Dangerous Goods and Safety Management Act 2001* *Sustainable Planning Act 2009*	Department of Justice and Attorney General
Development approval for a material change of use of premises for environmentally relevant activities	*Environmental Protection Act 1994* *Sustainable Planning Act 2009*	DERM
Development Approval for an material change of use (MCU) on strategic port land	*Transport Infrastructure Act 1996* *Sustainable Planning Act 2009*	GPC
Development approval for operational works for removal, destruction or damage to a marine plant.	*Fisheries Act 1994* *Sustainable Planning Act 2009*	DEEDI
Development approval for operational works that are waterway barrier works if waterway barriers are required.	*Fisheries Act 1994* *Sustainable Planning Act 2009*	DEEDI
Development approval for operational works that are tidal works.	*Coastal Protection and Management Act 1995* *Sustainable Planning Act 2009*	DERM/local government
Development approval for operational works within a coastal management district.	*Coastal Protection and Management Act 1995* *Sustainable Planning Act 2009*	DERM
Approval for the removal or placement of quarry material below high water mark.	*Coastal Protection and Management Act 1995* *Sustainable Planning Act 2009*	DERM
Development approval for building works	*Building Act 1993* *Sustainable Planning Act 2009*	Local government/private certifier
Development approval for operational works for taking or interfering with water	*Water Act 2000* *Sustainable Planning Act 2009*	DERM

Project approval	Legislation	Government agency
Dredge management plan	*Coastal Protection and Management Act 1995*	DERM
Approval to damage vegetation on State coastal land.	*Coastal Protection and Management Act 1995*	DERM
Development permit for interference with native vegetation, protected plants or animals	*Nature Conservation Act 1992*	DERM
Licence to store flammable and combustible liquids.	*Dangerous Goods and Safety Management Act 2001*	Local government
Licence to use, store and transport explosives	*Explosives Act 1999*	DEEDI
Road closures	*Land Act 1994*	DERM
	Transport Operations (Road Use Management) Act 1995	Queensland Transport
Approval for night transfer	*Transport Operations (Marine Pollution) Act 1995*	'Authorised officer'
Approval under local law	*Local Government Act 1993*	Local government

23.5.3 Environmental record

ConocoPhillips will be responsible for the construction and management of the LNG facility on behalf of Australia Pacific LNG. ConocoPhillips is an international, integrated energy company. As of September 30 2009 ConocoPhillips was:

- The third-largest integrated energy company in the United States based on market capitalization, oil and natural gas reserves, and production. Our current net production is 2.2 million barrels of oil equivalent per day from an assets base valued at U.S $152 billion
- The fourth-largest refiner in the world
- The seventh-largest worldwide reserves holder of non government-controlled companies with 10 billion barrels of oil equivalent of reserves.

ConocoPhillips operates under an existing and comprehensive health, safety and environment policy (refer to Volume 1 Chapter 1) which governs efforts to improve health and safety performance as well as environmental stewardship. The health, safety and environment management system provides a structured approach to identity, assess and manage the risk associated with its business activities.

ConocoPhillips was recognised by the Northern Territory Minerals Council Resource Awards of Excellence, in the category of Environmental Management for the Darwin LNG facility in 2007. This was awarded as a result of the following:

- Minimisation of greenhouse gas emissions

- Wickham Point management of heritage values, terrestrial vegetation including mapping
- Darwin harbour conservation values.

In 2006, ConocoPhillips signed an agreement with the Northern Territory Government, Northern Land Council and Indigenous landowners to establish the West Arnhem Fire Management Agreement. The agreement has reduced greenhouse gas emissions (approximately 180,000 tonnes CO2-e/year) through the control of grass fires lit by Indigenous landowners. As a result, the agreement has won the Insurance Australia Group Eureka Prize for Innovative Solutions to Climate Change in 2007.

ConocoPhillips' operations in Australia and Timor-Leste (ConocoPhillips Australasia) commenced in 2004 and, through construction and steady-state operations, ConocoPhillips Australasia has not been fined or prosecuted for breaches of any environmental legislative requirements.

23.6 Conclusions

23.6.1 Listed threatened species and communities

Based on available mapping and confirmed through field assessment there is no vegetation on or adjacent to the LNG facility that is a threatened ecological community as defined under the EPBC Act. Therefore development of the proposed LNG facility will not impact upon threatened communities.

Potential impacts of the development of the LNG facility on terrestrial flora are likely to be primarily associated with the physical clearing of vegetation for infrastructure development. It is considered unlikely that development of the LNG facility would have a significant impact on either of the two threatened flora species for which suitable habitat was identified on Curtis Island.

Habitat associated with the site is not considered to be critical to the threatened fauna species that may use the site area from time to time. Potential impacts of the LNG facility on threatened terrestrial fauna species are likely to be primarily associated with habitat loss, degradation, fragmentation and loss of connectivity due to the physical clearing of vegetation for infrastructure development. Potential impacts to threatened marine fauna species are principally related to dredging and reclamation (for the purpose of the LNG facility), boat strikes, lighting and underwater noise. Given the implementation of mitigation measures it is considered unlikely that the development of the LNG facility will have a significant impact on the threatened fauna species which may use the general area.

23.6.2 Listed migratory species

Habitat associated with the site is not considered to be critical to the migratory bird species or migratory marine species that may use the site area.

Potential impacts of the LNG facility on migratory bird species are principally associated with habitat loss, degradation and fragmentation. Given the implementation of intended mitigation measures, such as the development of a biosecurity management plan, it is considered unlikely that the LNG facility will have a significant impact on the migratory bird species (41 species) which may visit the general area.

Potential impacts to migratory marine fauna species are as described for threatened marine species above. Given the implementation of mitigation measures described for these it is considered unlikely that the development of LNG facility will have a significant impact on the migratory fauna species (turtles, dugong, dolphins and crocodile) which may visit the general area.

23.6.3 World heritage and national heritage places

It is considered that construction and operations of the LNG facility will not cause any values of the GBRWHA to be lost, degraded or damaged. The construction and operations of the LNG facility is likely to cause minor modification to some of the attributes of the GBRWHA particularly in the Port Curtis area, which assists to make up the values of the GBRWHA. The area to be developed is excluded from the Great Barrier Reef Marine Park. The development is consistent with state and local planning regimes.

23.6.4 Consequential impacts relating to shipping access development

As an indirect impact of the undertaking of this and other Projects proposed to be developed in Port Curtis, GPC proposes to undertake the Western Basin Dredging and Disposal Project. This project is a controlled action for which GPC is the proponent and it is being assessed through a separate EIS. Impacts associated with the Western Basin Dredging and Disposal Project relevant to a consideration of consequential impacts for the LNG facility include impacts to water quality, modification of coastal processes, alteration of the visual landscape and amenity and modification of the seabed environment and the associated potential degradation of marine plant communities and intertidal habitats. These impacts are assessed in detailed in the EIS for the Western Basin Dredging and Disposal Project.

23.6.5 Cumulative impacts

Cumulative impacts have been assessed, taking into consideration those projects currently proposed for the Gladstone region.

For soils, topography, geomorphology and geology, landscape character and visual amenity, terrestrial ecology, water resources and shipping it is considered that there is only a low to moderate level of risk associated with potential cumulative impacts.

For marine ecology and coastal environment the following factors have led to a high rating in terms of impact significance and/or risk:

- There is a relatively high degree of complexity in relation to the characteristics of the values in question
- There is a relatively high degree of complexity in relation to the project-related cumulative impact mechanisms
- The available mitigation approaches are not standardised and require the ongoing cooperation of multiple parties.

However it is considered that the risks associated with marine ecology and coastal environment can be suitably managed if the various proponents and relevant regulatory authorities cooperate effectively in relation to the implementation of impact mitigations strategies.

23.7 Commitments

For the construction, operation, and decommissioning of the LNG facility the following commitments by Australia Pacific LNG are relevant to MNES (refer to Volume 1 Chapter 6 for a detailed list of the Australia Pacific LNG Project commitments):

- Reduce, as far as practical, vegetation clearing required to support the construction and operation of the LNG facility

- Landscape cut and fill batters to reduce colour contrast with adjoining vegetation
- Ensure that the adjoining on site bushland is managed to achieve effective visual integration with surrounding coastal landscape
- Use a sensitive lighting approach to reduce light spill
- Utilise ground flares to reduce visual impact
- Be actively involved in the management of the Curtis Island environmental management precinct.
- Develop a biosecurity management plan in consultation with state and local government authorities and implemented prior to the construction
- Develop a vegetation offsets program in consultation with the DERM and the DEWHA
- Develop and implement species specific management plans for threatened flora species
- Undertake pre-clearing surveys, erosion controls measures and fauna management
- Use a sensitive lighting approach to minimise the potential impact of artificial night lighting on terrestrial fauna
- Establish a process for visual observations and recording of dugongs and cetaceans
- Use a sensitive lighting approach to reduce light spill impact on marine fauna
- Seek to work collaboratively with other Western Basin projects to offset the loss of sensitive marine habitat
- Work with the GPC and other port users to develop an industry wide approach to minimise boat strikes to marine mammals and turtles
- Design stormwater controls to divert runoff from external areas around LNG facility
- Prepare a stormwater management plan to ensure that the quality of stormwater discharged from the hydrotest pond and sediment basin of the LNG facility be monitored
- Continue to work collaboratively with Port Curtis Integrated Monitoring Program for whole of Port Curtis water quality monitoring.
- Continue to address potential impacts from the dredging and reclamation associated with the construction of the MOF and include mitigation in the design
- Develop and implement a dredge management plan for construction and ongoing maintenance of the MOF to reduce potential impacts
- Implement monitoring to identify shoreline and near shore impacts resulting from modified hydrodynamics
- Continue dispersion modelling to optimise the design of liquid discharges from the LNG facility to the marine environment
- Develop and implement construction noise and vibration management plan that address potential impacts including implementing construction techniques for noise reduction for high noise activities such as piling
- Continue to support and consult with GPC and relevant regulatory agencies on construction and operational shipping protocols and traffic management

- Continue negotiations with GPC and Gladstone Regional Council to determine the most appropriate methodology for managing construction and operational traffic associated with the LNG facility via Fisherman's Landing northern expansion
- Support additional modelling of ship movements within the Port of Gladstone.

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Appendix A EPBC Act Protected Matters Search

15/10/2009 9:13

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental

You may wish to print this report for reference before moving to other pages or

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas

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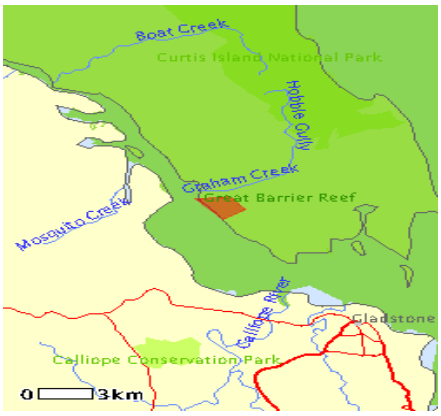

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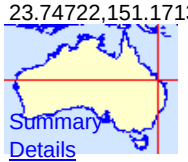

Summary
Details
Matters of NES
Other matters protected by the EPBC Act
Extra Information
Caveat
Acknowledgments

Report Contents:

Summary

Matters of National Environmental

This part of the report summarises the matters of national environmental

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Significance:	None
(Ramsar Sites)	
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	3
Threatened Species:	30
Migratory Species:	56

Other Matters Protected by the EPBC

This part of the report summarises other matters protected under the Act that

The EPBC Act protects the environment on Commonwealth land, the

Please note that the current dataset on Commonwealth land is not complete.

A permit may be required for activities in or on a Commonwealth area that may

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Places on the RNE:	4
Listed Marine Species:	110
Whales and Other Cetaceans:	11
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the

State and Territory Reserves:	3
Other Commonwealth Reserves:	None
Regional Forest Agreements:	1

Details

Matters of National Environmental Significance

World Heritage Properties [Dataset Information]
Great Barrier Reef QLD
National Heritage Places [Dataset Information]
Great Barrier Reef QLD

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Erythrotriorchis radiatus Red Goshawk	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern)	Vulnerable	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western)	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Turnix melanogaster Black-breasted Button-quail	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Vulnerable	Breeding known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox	Vulnerable	Species or species habitat may occur within area
Xeromys myoides Water Mouse, False Water Rat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Vulnerable	Species or species habitat may occur within area
Denisonia maculata Ornamental Snake	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Endangered	Species or species habitat may occur within area
Egernia rugosa Yakka Skink	Vulnerable	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle	Vulnerable	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Breeding known to occur within area
Paradelma orientalis Brigalow Scaly-foot	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Species or species habitat may occur within area
Rhincodon typus		

Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Bosistoa selwynii		
Heart-leaved Bosistoa	Vulnerable	Species or species habitat likely to occur within area
Bosistoa transversa		
Three-leaved Bosistoa	Vulnerable	Species or species habitat likely to occur within area
Bulbophyllum globuliforme		
Miniature Moss-orchid	Vulnerable	Species or species habitat likely to occur within area
Cupaniopsis shirleyana		
Wedge-leaf Tuckeroo	Vulnerable	Species or species habitat likely to occur within area
Cycas megacarpa	Endangered	Species or species habitat likely to occur within area
Parsonsia larcomensis	Vulnerable	Species or species habitat likely to occur within area
Quassia bidwillii		
Quassia	Vulnerable	Species or species habitat likely to occur within area
Taeniophyllum muelleri		
Minute Orchid, Ribbon-root Orchid	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster		
White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus		
White-throated Needletail	Migratory	Species or species habitat may occur within area
Hirundo rustica		
Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch	Migratory	Breeding may occur within area
Monarcha trivirgatus		
Spectacled Monarch	Migratory	Breeding likely to occur within area
Myiagra cyanoleuca		
Satin Flycatcher	Migratory	Species or species habitat likely to occur within area
Rhipidura rufifrons		
Rufous Fantail	Migratory	Breeding may occur within area
Migratory Wetland Species		
Birds		
Actitis hypoleucos		
Common Sandpiper	Migratory	Roosting known to occur within area
Ardea alba		
Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis		
Cattle Egret	Migratory	Species or species habitat may occur within area
Arenaria interpres		
Ruddy Turnstone	Migratory	Roosting known to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper	Migratory	Roosting known to occur within area
Calidris alba		
Sanderling	Migratory	Roosting likely to occur within area
Calidris canutus		
Red Knot, Knot	Migratory	Roosting known to occur within area
Calidris ferruginea		
Curlew Sandpiper	Migratory	Roosting known to occur within area
Calidris ruficollis		
Red-necked Stint	Migratory	Roosting known to occur within area
Calidris tenuirostris		
Great Knot	Migratory	Roosting known to occur within area
Charadrius bicinctus		
Double-banded Plover	Migratory	Roosting known to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover	Migratory	Roosting known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover	Migratory	Roosting known to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe	Migratory	Roosting likely to occur within area

Glareola maldivarum		
Oriental Pratincole	Migratory	Roosting likely to occur within area
Heteroscelus brevipes		
Grey-tailed Tattler	Migratory	Roosting known to occur within area
Limicola falcinellus		
Broad-billed Sandpiper	Migratory	Roosting known to occur within area
Limosa limosa		
Black-tailed Godwit	Migratory	Roosting known to occur within area
Nettapus coromandelianus albipennis		
Australian Cotton Pygmy-goose	Migratory	Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew	Migratory	Roosting known to occur within area
Numenius minutus		
Little Curlew, Little Whimbrel	Migratory	Roosting likely to occur within area
Numenius phaeopus		
Whimbrel	Migratory	Roosting known to occur within area
Pluvialis fulva		
Pacific Golden Plover	Migratory	Roosting known to occur within area
Pluvialis squatarola		
Grey Plover	Migratory	Roosting known to occur within area
Rostratula benghalensis s. lat.		
Painted Snipe	Migratory	Species or species habitat may occur within area
Tringa glareola		
Wood Sandpiper	Migratory	Roosting likely to occur within area
Tringa nebularia		
Common Greenshank, Greenshank	Migratory	Roosting known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank	Migratory	Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper	Migratory	Roosting known to occur within area
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis		
Cattle Egret	Migratory	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Sterna albifrons		
Little Tern	Migratory	Species or species habitat may occur within area
Migratory Marine Species		
Mammals		
Balaenoptera edeni		
Bryde's Whale	Migratory	Species or species habitat may occur within area
Dugong dugon		Species or species habitat likely to occur within
Dugong	Migratory	area
Megaptera novaeangliae		
Humpback Whale	Migratory	Breeding known to occur within area
Orcaella brevirostris		
Irrawaddy Dolphin	Migratory	Species or species habitat may occur within area
Orcinus orca		
Killer Whale, Orca	Migratory	Species or species habitat may occur within area
Sousa chinensis		
Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle	Migratory	Species or species habitat may occur within area
Chelonia mydas		
Green Turtle	Migratory	Species or species habitat may occur within area
Crocodylus porosus		Species or species habitat likely to occur within
Estuarine Crocodile, Salt-water Crocodile	Migratory	area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth	Migratory	Species or species habitat may occur within area
Eretmochelys imbricata		
Hawksbill Turtle	Migratory	Species or species habitat may occur within area
Lepidochelys olivacea		

Olive Ridley Turtle, Pacific Ridley Turtle	Migratory	Species or species habitat may occur within area
Natator depressus		
Flatback Turtle	Migratory	Breeding known to occur within area
Sharks		
Rhincodon typus		
Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper	Listed	Roosting known to occur within area
Anseranas semipalmata		
Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis		
Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Arenaria interpres		
Ruddy Turnstone	Listed	Roosting known to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper	Listed	Roosting known to occur within area
Calidris alba		
Sanderling	Listed	Roosting likely to occur within area
Calidris canutus		
Red Knot, Knot	Listed - overfly marine area	Roosting known to occur within area
Calidris ferruginea		
Curlew Sandpiper	Listed - overfly marine area	Roosting known to occur within area
Calidris melanotos		
Pectoral Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Calidris ruficollis		
Red-necked Stint	Listed - overfly marine area	Roosting known to occur within area
Calidris subminuta		
Long-toed Stint	Listed - overfly marine area	Roosting likely to occur within area
Calidris tenuirostris		
Great Knot	Listed - overfly marine area	Roosting known to occur within area
Charadrius bicinctus		
Double-banded Plover	Listed - overfly marine area	Roosting known to occur within area
Charadrius dubius		
Little Ringed Plover	Listed - overfly marine area	Roosting likely to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover	Listed	Roosting known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover	Listed	Roosting known to occur within area
Charadrius ruficapillus		
Red-capped Plover	Listed - overfly marine area	Roosting known to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Roosting likely to occur within area
Gallinago megala		
Swinhoe's Snipe	Listed - overfly marine area	Roosting likely to occur within area
Gallinago stenura		
Pin-tailed Snipe	Listed - overfly marine area	Roosting likely to occur within area
Glareola maldivarum		
Oriental Pratincole	Listed - overfly marine area	Roosting likely to occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Heteroscelus brevipes		
Grey-tailed Tattler	Listed	Roosting known to occur within area
Heteroscelus incanus		
Wandering Tattler	Listed	Roosting likely to occur within area
Himantopus himantopus		
Black-winged Stilt	Listed - overfly marine area	Roosting known to occur within area
Hirundapus caudacutus		

White-throated Needletail Hirundo rustica	Listed - overfly marine area	Species or species habitat may occur within area
Barn Swallow Limicola falcinellus	Listed - overfly marine area	Species or species habitat may occur within area
Broad-billed Sandpiper Limnodromus semipalmatus	Listed - overfly marine area	Roosting known to occur within area
Asian Dowitcher Limosa limosa	Listed - overfly marine area	Roosting likely to occur within area
Black-tailed Godwit Macronectes giganteus	Listed - overfly marine area	Roosting known to occur within area
Southern Giant-Petrel Merops ornatus	Listed	Species or species habitat may occur within area
Rainbow Bee-eater Monarcha melanopsis	Listed - overfly marine area	Species or species habitat may occur within area
Black-faced Monarch Monarcha trivirgatus	Listed - overfly marine area	Breeding may occur within area
Spectacled Monarch Myiagra cyanoleuca	Listed - overfly marine area	Breeding likely to occur within area
Satin Flycatcher Nettapus coromandelianus albipennis	Listed - overfly marine area	Species or species habitat likely to occur within area
Australian Cotton Pygmy-goose Numenius madagascariensis	Listed - overfly marine area	Species or species habitat may occur within area
Eastern Curlew Numenius minutus	Listed	Roosting known to occur within area
Little Curlew, Little Whimbrel Numenius phaeopus	Listed - overfly marine area	Roosting likely to occur within area
Whimbrel Phalaropus lobatus	Listed	Roosting known to occur within area
Red-necked Phalarope Philomachus pugnax	Listed	Roosting likely to occur within area
Ruff (Reeve) Pluvialis fulva	Listed - overfly marine area	Roosting likely to occur within area
Pacific Golden Plover Pluvialis squatarola	Listed	Roosting known to occur within area
Grey Plover Recurvirostra novaehollandiae	Listed - overfly marine area	Roosting known to occur within area
Red-necked Avocet Rhipidura rufifrons	Listed - overfly marine area	Roosting known to occur within area
Rufous Fantail Rostratula benghalensis s. lat.	Listed - overfly marine area	Breeding may occur within area
Painted Snipe Sterna albifrons	Listed - overfly marine area	Species or species habitat may occur within area
Little Tern Stiltia isabella	Listed	Species or species habitat may occur within area
Australian Pratincole Thinornis rubricollis	Listed - overfly marine area	Roosting likely to occur within area
Hooded Plover Tringa glareola	Listed - overfly marine area	Roosting likely to occur within area
Wood Sandpiper Tringa nebularia	Listed - overfly marine area	Roosting likely to occur within area
Common Greenshank, Greenshank Tringa stagnatilis	Listed - overfly marine area	Roosting known to occur within area
Marsh Sandpiper, Little Greenshank Tringa totanus	Listed - overfly marine area	Roosting known to occur within area
Common Redshank, Redshank Xenus cinereus	Listed - overfly marine area	Roosting likely to occur within area
Terek Sandpiper	Listed - overfly marine area	Roosting known to occur within area
Mammals		
Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area
Ray-finned fishes		
Acentronura tentaculata Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma		

Pacific Short-bodied Pipefish, Short-bodied Pipefish Corythoichthys amplexus	Listed	Species or species habitat may occur within area
Fijian Banded Pipefish, Brown-banded Pipefish Corythoichthys flavofasciatus	Listed	Species or species habitat may occur within area
Yellow-banded Pipefish, Network Pipefish Corythoichthys haematopterus	Listed	Species or species habitat may occur within area
Reef-top Pipefish Corythoichthys intestinalis	Listed	Species or species habitat may occur within area
Australian Messmate Pipefish, Banded Pipefish Corythoichthys ocellatus	Listed	Species or species habitat may occur within area
Orange-spotted Pipefish, Ocellated Pipefish Corythoichthys paxtoni	Listed	Species or species habitat may occur within area
Paxton's Pipefish Corythoichthys schultzi	Listed	Species or species habitat may occur within area
Schultz's Pipefish Doryrhamphus excisus	Listed	Species or species habitat may occur within area
Indian Blue-stripe Pipefish, Blue-stripe Pipefish Festucalex cinctus	Listed	Species or species habitat may occur within area
Girdled Pipefish Filicampus tigris	Listed	Species or species habitat may occur within area
Tiger Pipefish Halicampus dunckeri	Listed	Species or species habitat may occur within area
Red-hair Pipefish, Duncker's Pipefish Halicampus grayi	Listed	Species or species habitat may occur within area
Mud Pipefish, Gray's Pipefish Halicampus nitidus	Listed	Species or species habitat may occur within area
Glittering Pipefish Halicampus spinirostris	Listed	Species or species habitat may occur within area
Spiny-snout Pipefish Hippichthys cyanospilos	Listed	Species or species habitat may occur within area
Blue-speckled Pipefish, Blue-spotted Pipefish Hippichthys heptagonus	Listed	Species or species habitat may occur within area
Madura Pipefish, Reticulated Freshwater Pipefish Hippichthys penicillus	Listed	Species or species habitat may occur within area
Beady Pipefish, Steep-nosed Pipefish Hippocampus bargibanti	Listed	Species or species habitat may occur within area
Pygmy Seahorse Hippocampus kuda	Listed	Species or species habitat may occur within area
Spotted Seahorse, Yellow Seahorse Hippocampus planifrons	Listed	Species or species habitat may occur within area
Flat-face Seahorse Hippocampus zebra	Listed	Species or species habitat may occur within area
Zebra Seahorse Lissocampus runa	Listed	Species or species habitat may occur within area
Javelin Pipefish Micrognathus andersonii	Listed	Species or species habitat may occur within area
Anderson's Pipefish, Shortnose Pipefish Micrognathus brevirostris	Listed	Species or species habitat may occur within area
Thorn-tailed Pipefish Nannocampus pictus	Listed	Species or species habitat may occur within area
Painted Pipefish, Reef Pipefish Solegnathus hardwickii	Listed	Species or species habitat may occur within area
Pipehorse Solenostomus cyanopterus	Listed	Species or species habitat may occur within area
Blue-finned Ghost Pipefish, Robust Ghost Pipefish Solenostomus paradoxus	Listed	Species or species habitat may occur within area
Harlequin Ghost Pipefish, Ornate Ghost Pipefish Syngnathoides biaculeatus	Listed	Species or species habitat may occur within area

Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus		
Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii		
Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus duboisii		
Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii		
Spine-tailed Seasnake	Listed	Species or species habitat may occur within area
Aipysurus laevis		
Olive Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii		
Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle	Listed	Species or species habitat may occur within area
Chelonia mydas		
Green Turtle	Listed	Species or species habitat may occur within area
Crocodylus porosus		Species or species habitat likely to occur within
Estuarine Crocodile, Salt-water Crocodile	Listed	area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat may occur within area
Disteira kingii		
Spectacled Seasnake	Listed	Species or species habitat may occur within area
Disteira major		
Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus		
Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Eretmochelys imbricata		
Hawksbill Turtle	Listed	Species or species habitat may occur within area
Hydrophis elegans		
Elegant Seasnake	Listed	Species or species habitat may occur within area
Lapemis hardwickii		
Spine-bellied Seasnake	Listed	Species or species habitat may occur within area
Laticauda colubrina		
a sea krait	Listed	Species or species habitat may occur within area
Laticauda laticaudata		
a sea krait	Listed	Species or species habitat may occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle	Listed	Species or species habitat may occur within area
Natator depressus		
Flatback Turtle	Listed	Breeding known to occur within area
Pelamis platurus		
Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata		
Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni		
Bryde's Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis		
Common Dophin, Short-beaked Common Dolphin	Cetacean	Species or species habitat may occur within area
Grampus griseus		
Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae		
Humpback Whale	Cetacean	Breeding known to occur within area
Orcaella brevirostris		
Irrawaddy Dolphin	Cetacean	Species or species habitat may occur within area
Orcinus orca		
Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Sousa chinensis		
Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
Stenella attenuata		
Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus		

Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.
Natural
Balaclava Island and The Narrows QLD
Curtis Island (part) QLD
Garden Island Environmental Park QLD
Great Barrier Reef Region QLD

Extra Information

State and Territory Reserves [Dataset Information]
Garden Island Conservation Park, QLD
Mackay/Capricorn Marine Park, QLD
Rodds Bay Dugong Protection Area, QLD
Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.
South East Queensland RFA, Queensland

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

threatened species listed as extinct or considered as vagrants
some species and ecological communities that have only recently been listed
some terrestrial species that overfly the Commonwealth marine area
migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

non-threatened seabirds which have only been mapped for recorded breeding sites;
seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

New South Wales National Parks and Wildlife Service
Department of Sustainability and Environment, Victoria
Department of Primary Industries, Water and Environment, Tasmania
Department of Environment and Heritage, South Australia Planning SA
Parks and Wildlife Commission of the Northern Territory
Environmental Protection Agency, Queensland
Birds Australia
Australian Bird and Bat Banding Scheme
Australian National Wildlife Collection
Natural history museums of Australia
Queensland Herbarium
National Herbarium of NSW
Royal Botanic Gardens and National Herbarium of Victoria
Tasmanian Herbarium
State Herbarium of South Australia
Northern Territory Herbarium
Western Australian Herbarium
Australian National Herbarium, Atherton and Canberra
University of New England
Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.