8.17 Marine Dredging and Material Placement Facility

8.17.1 Introduction

As part of the GLNG Project, capital dredging will be required to provide access and safe navigation for LNG carriers (LNGC). The dredging will include increasing the depth and providing channel access from the existing Targinie Channel in Port Curtis and development of a swing basin so that LNG carriers can gain access to the product loading facility (PLF), as well as possible minor dredging adjacent to the materials offloading facility (MOF) so that construction shipping can access the facility as required. Further maintenance dredging will be required for the life of the LNG facility. Without suitable dredging for LNGC access and MOF development, the construction and operation of the LNG facility would not be viable. A full discussion of the dredging activities and potential impacts is presented in Section 3.10 and Section 8.7.

The Queensland Government and the GPC are presently reviewing the dredged material management plan for Port Curtis to plan for the long term dredging and dredged material disposal that may be required to provide safe and efficient access to existing and proposed port facilities in the harbour for the foreseeable future. The plan considers dredging and dredged material disposal required for industrial and port related projects currently proposed for Gladstone. As part of the plan, the GPC is considering a single dredged material disposal area which will be large enough to accommodate the combined dredged material from all of these projects in a manner which is consistent with GPC's long term port development objectives.

The GPC and the Queensland Government propose to undertake an environmental assessment of the overall plan and to obtain the necessary approvals before adopting and implementing the plan. If the plan is approved, the dredging and the associated dredged material placement for the GLNG Project will be undertaken in accordance with the plan provided the timing of the approval is consistent with the GLNG Project requirements.

If for some reason the GPC's strategic dredging and disposal project is delayed or does not proceed, a plan specific to the GLNG Project has been prepared to manage the project's dredge material. This plan is to develop a dredge material placement facility south of Laird Point on Curtis Island.

Santos considered a number of options prior to the selection of the site south of Laird Point. Three locations on Curtis Island were originally identified via desktop studies, including the area to the south of Laird Point; an area adjacent to Boatshed Point and part of the valley directly to the north of the LNG facility site and to the east of the proposed gas transmission pipeline corridor. Two of these options (Boatshed Point and the valley area) were dismissed by Santos prior to conducting field investigations, due to the perceived environmental sensitivity (refer to Section 2.3.9, particularly Table 2.3.1.1 which sets out the advantages and disadvantages of these options). Santos' preferred dredge material placement facility location is an area of low lying land to the south of Laird Point on the south west coast of Curtis Island.

Santos recognises that use of Laird Point as a dredge material placement facility site would require approval by the Queensland Coordinator General for a material change of use of the site to allow for dredged material disposal. At the time of this EIS submission, Laird Point, while declared for LNG industry use, had not been formally acquired by a specific proponent for LNG industry use.

The following section deals with the assessment of the placement of the dredge material at the Laird Point dredge material placement facility. The description of the proposed dredging methodology and anticipated layout of the dredge material placement facility is summarised in Section 8.17.3, below. Figure 8.17.1 provides an overview of the locations of the dredging activity and dredge material disposal facility. Figure 8.17.2 provides a conceptual design of the dredge material placement facility. A photograph of the site is provided in Figure 8.17.3.

The development of the dredge material placement facility will result in the creation of a relatively level and elevated area available for further development within the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA).

A dredge management plan (DMP) will be developed to provide input into the design, construction and operation of the dredging and dredge material placement facility. Targeted investigations will be undertaken to support this DMP, to ensure that appropriate baseline data are available.

8.17.2 Methodology

The proposed dredging activities and dredge material placement facility are currently in the conceptual design stage, and as such specific details about the construction, operation and management of the facility have not been finalised. A description of the dredging and dredge material placement facility is provided below (also refer to the "Laird Point Placement Facility Concept Description" in Appendix DD).

This assessment has focused on the key aspects of the dredge material placement facility where there is potential for significant environmental impacts, with specific studies being undertaken to assess these areas. Additionally, reference has been made to other studies undertaken as part of the GLNG EIS, which provide relevant supporting information on existing environmental values or potential impacts that could occur.

The EIS Terms of Reference (Section 2.2.1.4) states that if all of the dredge material is proposed to be disposed of on land, then a detailed DMP can be developed subsequent to the EIS. The DMP will describe in detail the activities to be undertaken and the mitigation measures to be implemented. This DMP will require approval prior to commencement of activities.

Further details of DMP requirements are contained within the "Approval of a Dredge Management Plan Guideline" (http://www.epa.qld.gov.au), detailing requirements to address key coastal plan policies including:

- Policy 2.1.1 Areas of state significance (social and economic);
- Policy 2.1.6 Extractive industry;
- Policy 2.1.8 Dredging;
- Policy 2.3.1 Future need for access;
- Policy 2.4.1 Water quality management;
- Policy 2.4.5 Groundwater quality;
- Policy 2.8.1 Areas of state significance (natural resources);
- Policy 2.8.2 Coastal wetlands; and
- Policy 2.8.3 Biodiversity.

Targeted studies (comprising desktop and field investigations and assessments) have been conducted to identify the potential impacts of the dredging and dredge material placement facility activities. These studies are summarised in the following subsections, with supporting technical reports provided in Appendix DD. Where relevant, reference to these studies has been made.

The following targeted studies have been undertaken:

- **Traffic and Transport** – to asses the potential impacts of the ferrying of workforce and barging of equipment and material to the dredge material placement facility;
- **Land, Terrain and Soils** – provides a summary of the local topography and soils;
- **Nature Conservation** – a site specific terrestrial flora study and review of fauna including a targeted investigations into the possible presence of the Water Mouse and wader birds along the coastal margins of the area;

Client

URS

Project

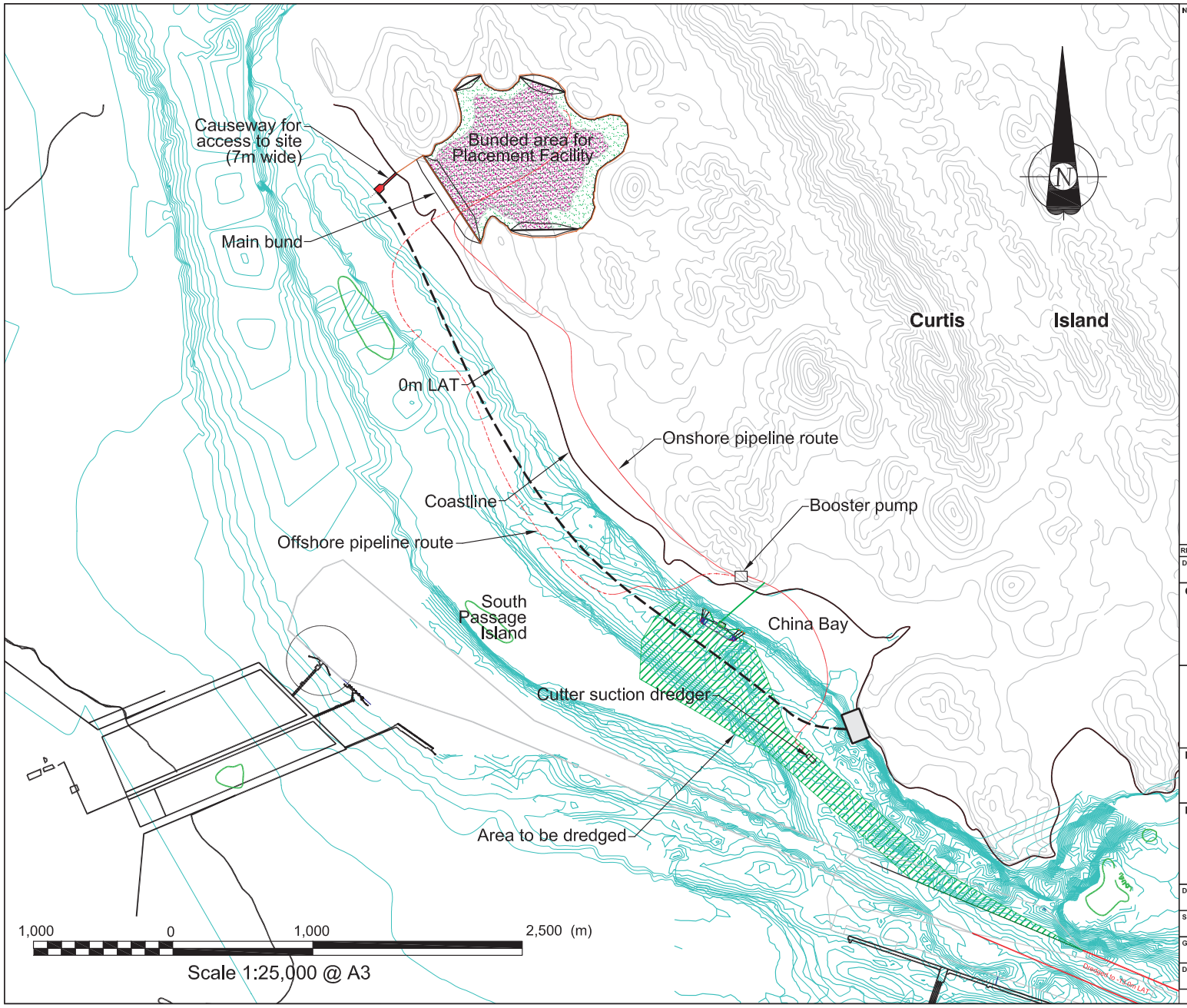
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT

Job No.: 4262 6220 | Drawn: CA | Approved: JB | Date: 10-03-2009 | File No. 4262620-g-1029.cdr

Title

DREDGING OPERATIONS AND DREDGE MATERIAL PLACEMENT FACILITY LAYOUT

Figure: 8.17.1 | A4 | Rev. A



NOTES:

Depths are in metres relative to LAT

Land contours are in metres relative to AHD

All dimensions in metres

All co-ordinates in MGA Zone 56, Datum GDA94

Bathymetry supplied by GPC in drawing no. 906-0014, dated 28/05/08.

Layout of dredged areas is provisional and indicative

Extents of phase 1

Extents of phase 2

REVISION	DESCRIPTION	DATE

Drawing Status: DRAFT

CLIENT:

HR Wallingford

HR Wallingford Ltd, Howbery Park, Wallingford, Oxon, OX10 8BA, UK.
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233
http://www.hrwallingford.co.uk

PROJECT: GLNG

DRAWING TITLE: Dredging and placement of dredged material, general layout

DRAWN BY:	CHECKED BY:
RER	SDU
SCALE: 1:25,000 @ A3	DATE: 05-Mar-09

GLNG DRAWING No: 1603-HRW-2-3.3-9039-PDF

DRAWING No: EBR4320\108\D001 | REV: B

Proposed Barge/Ferry Route between Hamilton Point MOF Jetty and Laird Point MOF Jetty

Client

Project

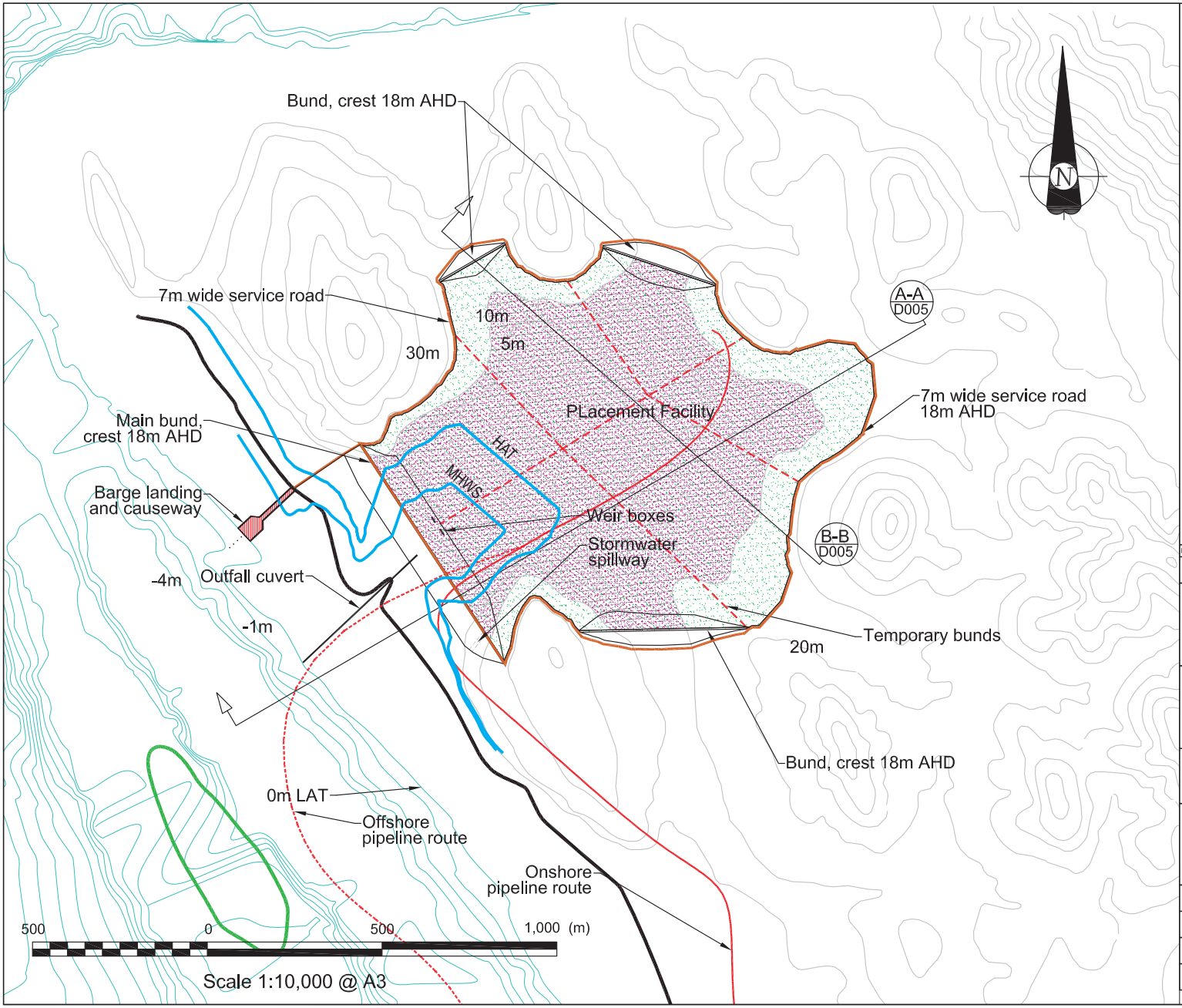
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT

Title

LAIRD POINT
DREDGE MATERIAL
PLACEMENT FACILITY

Job No.: 4262 6220 | Drawn: AA/CA | File No. 4262620-g-1026.cdr | Approved: JB | Date: 12-05-2009

Figure: 8.17.2 | A4 | Rev. B



NOTES:

Depths are in metres relative to LAT

Land contours are in metres relative to AHD

All dimensions in metres

All co-ordinates in MGA Zone 56, Datum GDA94

Bathymetry supplied by GPC in drawing no. 906-0014, dated 28/05/08.

Layout of dredged areas is provisional and indicative

Extents of phase 1

Extents of phase 2

REVISION	DESCRIPTION	DATE

Drawing Status: DRAFT

CLIENT:

HR Wallingford
HR Wallingford Ltd, Howbery Park, Wallingford, Oxon, OX10 8BA, UK.
Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233
http://www.hrwallingford.co.uk

PROJECT: GLNG

DRAWING TITLE: Detail of Laird Point Placement Facility

DRAWN BY:	CHECKED BY:
RER	SDU
SCALE: 1:10,000 @ A3	DATE: 05-Mar-09

GLNG DRAWING No: 1603-HRW-2-3.3-9041-PDF

DRAWING No: EBR4320\108\D003 | REV: B

MHWS Mean High Water Spring

HAT Highest Astronomical Tide

Source: This map may be sourced and Copyright. See Section 18.2 of the EIS for Ownership and Copyright.

Client

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

PHOTOGRAPHIC VIEWS OF DREDGE MATERIAL PLACEMENT FACILITY

Drawn: RG	Approved: JB	Date: 20-03-2009	Figure: **8.17.3**	Rev. A
Job No.: **4262 6220**	File No. 42626220-g-1046.cdr			A4

- **Surface water** – an assessment of the potential impacts from surface water discharges and failure of the proposed facility bund walls;
- **Groundwater** – a hydrogeological assessment of the suitability of the dredge material placement facility;
- **Coastal Environment** – a summary of the local coastal environment and a comparative assessment of marine sediment studies undertaken for the GLNG Project and other local projects where dredging has been undertaken;
- **Air Quality** – a summary of the potential air quality impacts and mitigation measures;
- **Noise and Vibration** – an assessment of the potential impact of construction of the dredge material placement facility on local noise levels;
- **Land Use and Infrastructure** – an assessment of the impacts on land use resulting from construction and operation of the proposed facility;
- **Visual Impact** – a description of the existing environmental values, assessment of potential visual impacts and proposed mitigation measures;
- **Cultural Heritage** – an assessment of existing non indigenous cultural heritage values in the vicinity of the proposed facility; a review of potential impacts and development of mitigation measures. In addition, a summary of Santos' approach to Indigenous cultural heritage management of the site is provided;
- **Social Impact Assessment** – a review of possible effects on local values; and
- **Rehabilitation and Decommissioning**– a summary of Santos' approach to site decommissioning and rehabilitation, including assessment and mitigation measures.

8.17.3 Description of Dredging Activities and Development of the Dredge Material Placement Facility

The dredging operations are proposed as part of the development of the MOF and PLF facilities. These operations are further described in Section 3.10, with a supporting concept design provided in Appendix DD. Two initial phases of dredging will be undertaken including:

- Dredging required to ensure suitable barge and ferry access to the MOF, where approximately 100,000 m^3 (in-situ) of dredge material may be removed (this is not assessed as part of this section); and
- Dredging of the navigation approach channel, berthing and swing basin areas, where approximately 8,000,000 m^3 (in-situ) is anticipated to be dredged.

The dredging program for the MOF will be limited and will result in a relatively small quantity of dredge material. The majority of the dredge material associated with the MOF is expected to be suitable for engineering re-use and will be used as fill material for the construction of the MOF and laydown area More substantial dredging will be required to provide vessel access to the PLF. These main dredge operations comprise the formation of a swing basin dredged to -13.5 m LAT linked to the Targinie Channel by a 200 m wide channel dredged to -13 m LAT. Material arising from the main dredge is to be placed ashore at the proposed dredge material placement facility, to the south of Laird Point.

The areas to be dredged for the swing basin, PLF berth pocket and berth approach channel are shown in Figure 8.17.1. These areas are generally in sheltered waters and therefore, they are suited to being dredged by cutter suction dredge (CSD).

8.17.3.1 Development of the Dredge Material Placement Facility

In summary, the dredge material placement facility is proposed to cover an area of approximately 120 ha, and provide air space for approximately 13.2 million m^3 of material. Bunds (embankments) will be constructed up to a height of 18 m AHD (in two of more phases), with the dredge material being pumped into a series of internal ponds separated by bunds with strategically located weirs to allow the seawater to

flow from one pond to the next. The dredged material will pass slowly through these structures, allowing the solid material (sand, silt etc) to settle out of the seawater. Following a period of controlled settlement and monitoring, the seawater will be discharged back into the marine environment subject to meeting EPA approved discharge limits.

The placement facility will have a capacity of approximately 10.7 million m3 of consolidated dredged material. Allowing for bulking of the dredge material this is more than adequate for the capital dredging of the swing basin and access channel. It could therefore also provide some capacity for ongoing maintenance dredging. In time however, maintenance dredging material will have to be placed in other dredge material placement facilities, the authority for which will be sought by GPC. Studies are ongoing to assess the likely rates of siltation in the swing basin and will inform likely future maintenance dredging volumes.

The area selected for the dredge material placement facility is a low lying valley area, with elevated areas to the north, south and east. To the west the valley opens up into Port Curtis, with a margin of mangroves separating the valley floor from the sea. The base of the valley is broad and is predominantly salt pan, which is inundated with sea water during higher tides.

To facilitate development of this area into the dredge material placement facility, a main bund will be required on the western side to contain the volume of dredged material and separate it from the inter-tidal area. Three additional smaller bunds (two on the northern side and one on the southern side) will be required in the saddles between hills around the perimeter of the basin. The scale and nature of these bund structures will require detailed engineering design based upon a thorough site investigation program. Figure 8.17.2 shows the proposed dredge material placement facility location and identifies the proposed bunds.

A 4 m wide access track will be located on top of the bunds facilitating construction, working progressively from one side of the opening. Generally, the bund construction will be comprised of sand, clay, rock and geotextile lining.

The bunds will be developed in stages, with all material to be sourced locally from within the footprint of the facility or from the dredge material. The initial phase of bund construction will involve the construction of a 10 m (AHD) high wall with a batter slope of approximately 1:5. Approximately 200,000 m^3 of material will be required to develop the initial bunds. Phase two construction will involve increasing the bund height to approximately 18 m (AHD), with suitable construction material being sourced from the dredged material.

As it is proposed to source all bund construction material from within the facility footprint detailed studies will be undertaken to assess the availability of suitable material. An assessment of the local geology, including the results of initial geotechnical studies indicate that supplemental rock material could be sourced from the proposed LNG facility site at Hamilton Point West, if required. As a result, no additional assessments have been undertaken on traffic and transport related impacts associated with the import of material by barges from the mainland. In the event that insufficient suitable material is sourced from on site, then there may be a need to transport some material (potentially up to 10%) from the Hamilton Point West site. However, the volume of material is unlikely to be significant, and a 500 - 2,000 tonne barge will be used for this purpose, if needed.

Construction of the dredge material placement facility is proposed to commence in the second half of 2010. Construction is likely to continue for 18 to 24 months, with the majority of equipment and other materials being delivered to site within the first six months.

A workforce of up to 50 personnel is anticipated for the construction period, and it is planned that they be ferried to the site daily from the mainland. It is likely that this will be the same ferry services as used for the LNG facility construction workforce.

Importing construction equipment by barge to site will require the construction of a rock causeway. Use of the Hamilton Point MOF has been discounted, as moving equipment and material from the MOF to the dredge material placement facility site will require construction of a haul road across undisturbed parts of

Curtis Island for which access may not be available. The causeway will also provide ferry access to the site for the transfer of construction workers.

The causeway will be constructed on the existing intertidal surface. A robust geotextile material may be required as a base for the rock construction material. The design, location and length of the causeway have not been finalised. The design will be developed to minimise the footprint and provide for removal of the structure (if necessary) once the dredge material placement facility is completed. Once removed, the footprint will be remediated and allowed to rehabilitate.

It is likely that construction of a perimeter haul road will also be required to transport construction material and move equipment around the site and between bunds. Construction of the haul road, site clearance, and construction of the bunds will require suitable plant to be available on site. Typically, the equipment required for site clearance and the construction phase will include:

- 3 x 50 tonne excavators;
- 6 x 80 tonne dump trucks; and
- 3 x D8 dozers.

Working on the basis of 500 m^3 of material being moved per hour (loading, placing and compaction), it will be necessary to allow five months for construction of the phase 1 bunds.

The initial western bund height of 10 m AHD will be similar to the existing perimeter bund at Fisherman's Landing. Subsequent raising of the bund to 18 m AHD is proposed, utilising selected dredged material. The coarser components of the dredged material, such as gravels and sands collect immediately around the discharge point, which can be readily separated for bund construction.

8.17.3.2 Transport of Dredged Material to Laird Point Placement Facility

A temporary pipeline will be used to transport the dredged material from the dredging location to the dredge material placement facility. It is anticipated that at least one booster pumping station will be required. Two options have been considered for the path of the temporary pipeline including land based (located on the landward side of the mangrove fringe) and offshore based in deeper water. The route will be refined as part of the preparation of the DMP, with an emphasis on minimising the potential impacts on the environment and other proposed LNG developments (dredge, construction traffic etc) as well as maintaining access for maintenance, monitoring and removal. It should be noted that the land based installation option has the added benefit of ease of maintenance; however the offshore route is most likely to be adopted due to the potential for concurrent development with other LNG proponents.

Dredging of the channel, berth and swing basin is estimated to take approximately 14 months. This assumes a dredging rate of approximately 150,000 m^3/week, which can be achieved for silty sand in the area.

The dredged materials will be transported hydraulically. The mixture of water and sediment (a maximum of 30% solids in the seawater) will be pumped directly from the dredge through a pipeline into the dredge material placement facility. The pumping rate will allow approximately 150,000 m^3 (in-situ) of silty sand dredged material to be pumped along with at least 500,000 m^3 of water.

The discharge of dredged material into the dredge material placement facility will need to be controlled to maximise the settling of the finer fractions, which take longer to settle out of the seawater. In order to limit suspended solids from the dredged materials re-entering the marine environment, two factors need be considered, including:

- The rate of settlement of the solid materials, which is determined by the distance between the discharge pipeline, the area and shape of the enclosed area, and the discharge location where the water returns to the marine water body. Therefore, it is proposed that the end of the pipeline be positioned at the northern end of the placement area furthest away from the closure bund, or at other selected locations which maximise the flow distance (see Figure 8.17.2).

- The velocity of the sediment/water mixture as it flows through the placement facility. The lower this velocity, the more the solids will settle out. To achieve this, intermediate bunds will be constructed within the facility for land raising (by trenching). This will have the effect of both enlarging the settlement distance (if the water is forced to flow along an extended path through the facility between control points, rather than along the shortest direct route) and when coupled with effective use of weir boxes will result in an increased settlement time for the soil particles.

The longer the period that the transport water can be retained on site and the lower the velocity of the water movement the greater the proportion of fine suspended sediment that will settle out. This in turn will limit the release rate of fine particulate matter and associated turbidity back into the marine environment.

Due to the initial low consolidation rates of the dredge material within the dredge material placement facility the sediment will occupy a greater volume than it did in-situ (i.e. prior to dredging. Thus, the capacity of the bunded area, at any time, will take into account the total unconsolidated volume (or bulking factor) of the placed material and a proportion of the transport sea water, to allow for settlement of fines into the bunded area.

Management and mitigation measures for the construction and operation of the dredge material placement facility will be developed as part of the DMP. This will include contingency measures such as use of silt curtains within the settlement ponds prior to discharge from the sea outlet.

8.17.3.3 Dredge Material Pipeline

Figure 8.17.1 provides two preliminary routes for the dredge material pipeline. These both require a booster pump station located on land on the edge of China Bay. The first option is to align the pipeline on-shore along the coast (above high tide level) from China Bay to the dredge material placement facility. This route will be developed to minimise disturbance to mangroves and other sensitive environments. The second option is to submerge the pipeline off-shore in the marine environment, locating it in relatively deep water to minimise the potential for interference to/from watercraft. This second option will require laying a portion of the pipeline across the intertidal zone to access the dredge material placement facility.

If an on-shore dredge material pipeline route is selected, a suitable route will be identified to minimise the potential impacts. Additionally, permissions/permits for any required access to third party properties will be sought.

8.17.3.4 Facility Design

Prior to the development of the DMP, a number of further studies will be undertaken to further assess the site and potential construction and operational impact for the purposes of the detailed design of the dredge material placement facility. Ground proofing/geotechnical surveys will be undertaken to assess for underground voids or other potential subsidence issues that may undermine bunds or cause slippage. Additionally, this will be necessary to confirm drainage management for the area during construction, placement and post placement of the dredged materials.

Given the need to manage the discharge of fine sediment into the marine environment, it is proposed to establish a thorough understanding of background turbidity (suspended sediment) levels in the waters adjacent to Laird Point. An initial assessment, including modelling of the dredging discharges, has been undertaken (see Section 8.7.3).

8.17.4 Transport and Traffic

The overall transport and traffic assessment of the GLNG Project (CEO, 2009) included the determination of trips associated with the GLNG Project, including the heavy vehicle component. The cumulative impact of trips associated with other regionally significant projects was also considered. As part of this broad traffic assessment (refer Section 4), an assessment of the marine traffic related to the dredge material placement facility was undertaken.

This summary of the traffic and transport assessment has concentrated on the conclusions and mitigation measures relevant to the marine transportation associated with the proposed dredge material placement facility.

8.17.4.1 Methodology

Traffic generation for the overall GLNG Project has been estimated for both the construction and operational phases of the project. Within this, an allowance has been made for the construction of a dredge material placement facility at Laird Point on Curtis Island.

Access to the LNG facility may ultimately be provided by an access road and bridge. However, the majority of traffic and transport impacts associated with capital dredging and the dredge material placement facility are likely to occur during the initial construction phase, prior to bridge construction.

Construction of the dredge material placement facility will begin in the second half of 2010 and last for approximately 18 to 24 months. Delivery of equipment and material to the site will occur for the first 3-6 months. Traffic associated with this period of construction will thus be limited to transportation of materials, equipment and construction workforce personnel to the site via barges and ferries.

A report on the conceptual design, construction and operation of the dredge material placement facility is provided in Appendix DD.

Access arrangements for workforce, equipment and materials to Curtis Island for the construction of the dredge placement facility will be similar to that for the LNG facility, although barges and ferries will extend their route from the mainland to Hamilton Point, to include a proposed causeway to be constructed at Laird Point.

Approximately 50 personnel are expected to work on the construction of the dredge material placement facility. These workers are expected to travel by ferry from the mainland to the construction site daily, and are assumed to be 100% local workforce (living in Gladstone and surrounds).

It should be noted that the total labour force for the LNG facility on Curtis Island has been estimated at up to 3,000. Although many of these workforce personnel will be required to reside in a workforce accommodation facility on Curtis Island, ferries will be required to regularly transport construction workforce personnel between the mainland and Hamilton Point (as part of general shift change operations). The inclusion of the dredge material placement facility workforce in the overall project workforce is a minor addition, with this workforce assumed to reside on the mainland.

Road traffic associated with the dredge material placement facility workforce has been included in the overall traffic assessment (CEO, 2009), and, due the relatively minor additional workforce related to the dredging and dredge material placement facility, has not been discussed further in this summary.

All the rock and construction material for the dredge material placement facility is expected to be sourced locally from Curtis Island such that road transport and barging of rock materials from the mainland is unlikely.

8.17.4.2 Potential Impacts and Mitigation Measures

A traffic peak has been estimated to occur in 2012 and will result predominantly from the LNG facility, as the dredge material placement facility construction will be completed by this stage. No major impacts related to marine traffic have been identified, with the key major impacts being related to road traffic on the mainland. However, mitigation measures to reduce marine transport traffic have been identified, including the use of worker accommodation for the LNG facility on Curtis Island.

Transport of materials to the dredge material placement facility will be limited to the initial 3-6 months of construction. To minimise barge traffic for material transport, rock and materials for bund construction will be sourced locally on Curtis Island, although the equipment and other materials will require barging.

During initial construction of the LNG facility and dredge material placement facility, the workforce will be required to travel by ferry to Curtis Island, with total travel time taking up to one and a half hours (return).

It is assumed that these workers will travel to the site early in the morning, returning back to the mainland during peak afternoon periods. For the LNG facility, construction workers will be transferred to Curtis Island for 10 days at a time, utilising the worker accommodation and so travel to and from Curtis Island will not necessarily be confined by shift times.

Based on this there is likely to be substantial demand for ferries during certain periods of the day (early morning and afternoons). As a result, ferries to the dredge material placement facility site should be scheduled in coordination with other LNG facility construction activities to include a triangular route between Gladstone Point, Hamilton Point and Laird Point and thus minimise the number of vessels travelling to or from the Port of Gladstone on any one day.

8.17.5 Land, Terrain and Soils

The dredge material placement facility is located to the south of Laird Point in a low lying valley area, with elevated areas to the north, south and east separated by some lower lying sections (saddles). To the west the valley drains into Port Curtis, with a margin of mangroves separating the valley floor from the sea. The base of the valley is broad and is predominantly saltflats.

8.17.5.1 Existing Environmental Values

The underlying geology of the area has been assessed and includes lithic sandstone and other sedimentary rocks sequences, including greywacke and in places meta-sediments associated with the Carboniferous Wandilla Formation. The footprint of the facility includes supra-tidal estuarine/marine flats and tidal mangrove flats. The soils comprise deep soft saline clays, silt and muddy sand soils on the estuarine flats (Inter-tidal and Extra-tidal Hydrosols), with deep uniform clay soils and silty loamy surface duplex soils (Dermosols and Sodosols) on the alluvial flats and drainage-ways. Medium to deep gravelly loamy surface duplex soils (Chromosols and Sodosols) and uniform or gradational gravelly clay soils (Dermosols) occur on the lower hill slopes and the valley plains. For a more detailed regional description of the soils and geology refer to Section 7.3.

As part of this EIS, an acid sulphate soils (ASS) investigation was undertaken in selected low lying areas along the south-west coastline of Curtis Island. This included collection and analysis of soil samples from the proposed dredge material placement facility location. Appendix L4 presents a report on ASS for the LNG facility that also includes a preliminary assessment of the proposed dredge material placement facility in the associated Appendix D. Very high levels of PASS have been identified within the top one metre of sediment in this mangrove fringed embayment, with low level Actual ASS. Mapping of the distribution of low but actionable levels of AASS within the top 1 m indicates that it is present at a number of locations in the area, but only one area appears to extend under the location of the proposed main bund wall, with most being present within the proposed bunded facility.

8.17.5.2 Potential Impacts and Mitigation Measures

Construction of the placement facility will include stripping of surface soils and use of suitable underlying soil/rock materials from within the facility footprint to construct the bund walls. The volume of material to be removed from the facility footprint for this purpose will be dependent on the soil's engineering properties, and will be determined following detailed geotechnical investigation. The management of this material, including mitigation measures to minimise off-site impacts such as erosion and sedimentation, will be detailed in the DMP.

Effective management of ASS within the footprint of the dredge material placement facility will be required. Surcharging of the facility area with dredge material could lead to the activation of PASS through the creation of bulges around the facility's boundary. This could potentially create blowouts with associated environmental impacts. As a result, strategies will be required to minimise this potential (these are discussed in Section 2.3.1 of Appendix L4). Mitigation and management of the ASS will be required from the design phase through to the construction of the facility. Prior to construction of the dredge material placement facility, engineering solutions will need to be incorporated to ensure that ASS is

appropriately identified and managed throughout the construction period. Potential impacts and mitigation measures for managing ASS are presented in Section 2.1 of Appendix L4.

The DMP will include measures to address potential acid sulfate soil impacts, including the development of an acid sulphate soils management plan if required.

8.17.6 Nature Conservation

8.17.6.1 Terrestrial Flora

This section includes information on the terrestrial flora survey of the dredge material placement facility. Included is a summary of survey methodology, species diversity, a description of the Regional Ecosystems (RE) of the site, potential impacts and mitigation measures. As part of the GLNG Project EIS, flora surveys and literature reviews have been conducted for both the gas transmission pipeline corridor (Section 7.4) and the LNG facility (Section 8.4). The results from these studies are referenced throughout this section where applicable.

Methodology

The flora survey employed an assessment of floral taxa and vegetation communities and utilised the same methodology consistent with the gas transmission pipeline corridor and LNG facility on Curtis Island. Methods utilised were in keeping with the methodology employed by the Queensland Herbarium for the survey of Regional Ecosystems and vegetation communities (Neldner *et al.,* 2005). Preliminary identification of the vegetation communities of the project areas was conducted prior to the commencement of fieldwork. Preliminary identification included vegetation community definition from stereo image 1: 6,000 colour aerial photography (DNRW, 2005) and interpretation of 1:100,000 Regional Ecosystems coverage Version 5.0 for the region (DERM, 2009).

The dredge material placement facility flora field survey was conducted on the 15th April 2009 and involved a botanical assessment of representative sites within each vegetation community employing a number of random meander searches, three quaternary sites and five modified-secondary sampling transects. Community structural formation classes were assessed according to Specht (1970). Regional ecosystem classification of communities was determined as per Sattler and Williams (1999) and in accordance with the Regional Ecosystems Description Database (REDD v. 5.2 [EPA, 2007]). Further description of the field survey methodology employed is provided in Appendix N3.

Existing Environmental Values

This section documents the floristics and vegetation communities of the dredge material placement facility footprint. Detailed community descriptions and quantitative floristic and structural data for each survey site, including a complete flora species list for all taxa identified, are provided in Appendix DD.

Species Diversity

The survey identified the presence of 75 taxa representing 33 families and 69 genera. There was a relatively low diversity of weed species within the site, with 9 species found. A full flora species list of native and exotic species is provided in Appendix DD.

Weeds of Concern

Of the 9 exotic weed species described in this survey, two were identified as being of management concern. *Lantana camara** (lantana) and *Cryptostegia grandiflora** (rubber vine) are listed as pest species under the Queensland Land Protection (Pest and Stock Route Management) Act (2002) and are listed as Weeds of National Significance (WONS). Developed by the Australian and New Zealand Environment Conservation Council (ANZECC), WONS are exotic weed species identified as causing significant environmental damage on a national scale (Thorp and Lynch, 2000).

Rubber Vine*: Cryptostegia grandiflora** was identified at only one location across the proposed dredge material placement facility footprint. Rubber vine is a WONS and is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts. Rubber vine is a native of south-west Madagascar, although the exact date of its introduction into Australia is not known.

Lantana*: Lantana camara** was identified at only one location across the proposed dredge material placement facility footprint. Lantana is a WONS and is also regarded as one of the worst weeds in Australia. Lantana forms dense, impenetrable thickets that take over native bushland and pastures throughout the east coast of Australia. It competes for resources with, and reduces the productivity of, pastures and forestry plantations. It adds fuel to fires, and is toxic to stock (Weed Management CRC, 2003).

Vegetation Communities

Five Regional Ecosystems were described and mapped for the dredge material placement facility site, based upon the field survey results and interpretation of aerial photo stereo images (1: 6,000) (Figure 8.17.4). Table 8.17.1 details the total area of each RE identified within the dredge material placement facility study area. It also shows the area for each RE within the Burnett-Curtis Hills and Ranges sub-region. Full community descriptions including floristics, structure, location, ecological integrity and disturbance notes are given in Appendix DD.

Table 8.17.1 Regional Ecosystems recorded at the dredge material placement facility

Regional Ecosystem (RE)	Vegetation Community Description	Area within Dredge Material Placement Facility footprint (ha)	Area within subregion (ha)[1]	% of subregional extent represented within study area
12.1.2	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland on Quaternary estuarine deposits	31	15,181	0.2
12.1.3	Mangrove shrubland to low closed forest on Quaternary estuarine deposits	6	16,544	0.04
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains	20	26,250	0.08
12.11.6	*Corymbia citriodora* and *Eucalyptus crebra* open forest to woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics	35	178,525	0.02
12.11.14	*Eucalyptus crebra*, *E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics	28	4,620	0.6

1 Derived from RE data for the Burnett-Curtis Hills and Ranges sub-region as per Accad *et al.* (2008).

The saltpan vegetation community (RE 12.1.2) is situated in the centre of the site and covers an area of approximately 31 ha. Mangrove shrubland (RE 12.1.3) is found on the west of the saltpan and supports several mangrove species including *Avicennia marina* (grey mangrove), *Rhizophera stylosa* (spotted mangrove) and *Ceriops tagal* (yellow mangrove). The low-lying alluvial plains associated with the main drainage lines of the site are located towards the south-east of the saltpan and support *Eucalyptus tereticornis* open forest to woodland (RE 12.3.3). The remaining geology of the study site is predominantly metamorphic substrate which forms low-rising hills and slopes and supports two vegetation

communities. The surrounding low slopes to the north and north-east of the site are characterised by *Eucalyptus crebra* and *Eucalyptus tereticornis* grassy woodland (RE 12.11.14). Hilltops and slopes in the north-east and south-east of the site support an open forest to woodland community dominated by *Corymbia citriodora* subsp. *citriodora* (lemon-scented gum) and *Eucalyptus crebra* (narrow-leaved ironbark) (RE 12.11.6).

Vegetation of Conservation Significance

Two regional ecosystems are identified as having conservation significance under state legislation as listed under the Queensland *Vegetation Management Act 1999*. The conservation status of these communities is detailed in Table 18.17.2. Refer to Appendix N3 for details regarding the classification of the conservation status of regional ecosystems.

Table 8.17.2 Regional Ecosystems of Conservation Significance

Regional Ecosystem (RE)	Vegetation Community Description	Vegetation Management Act Status	Qld DERM Biodiversity Status	EPBC Act Status
12.3.3	*Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains	Endangered	Endangered	Not Listed
12.11.14	*Eucalyptus crebra*, *E. tereticornis* grassy woodland on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics	Of Concern	Of Concern	Not Listed

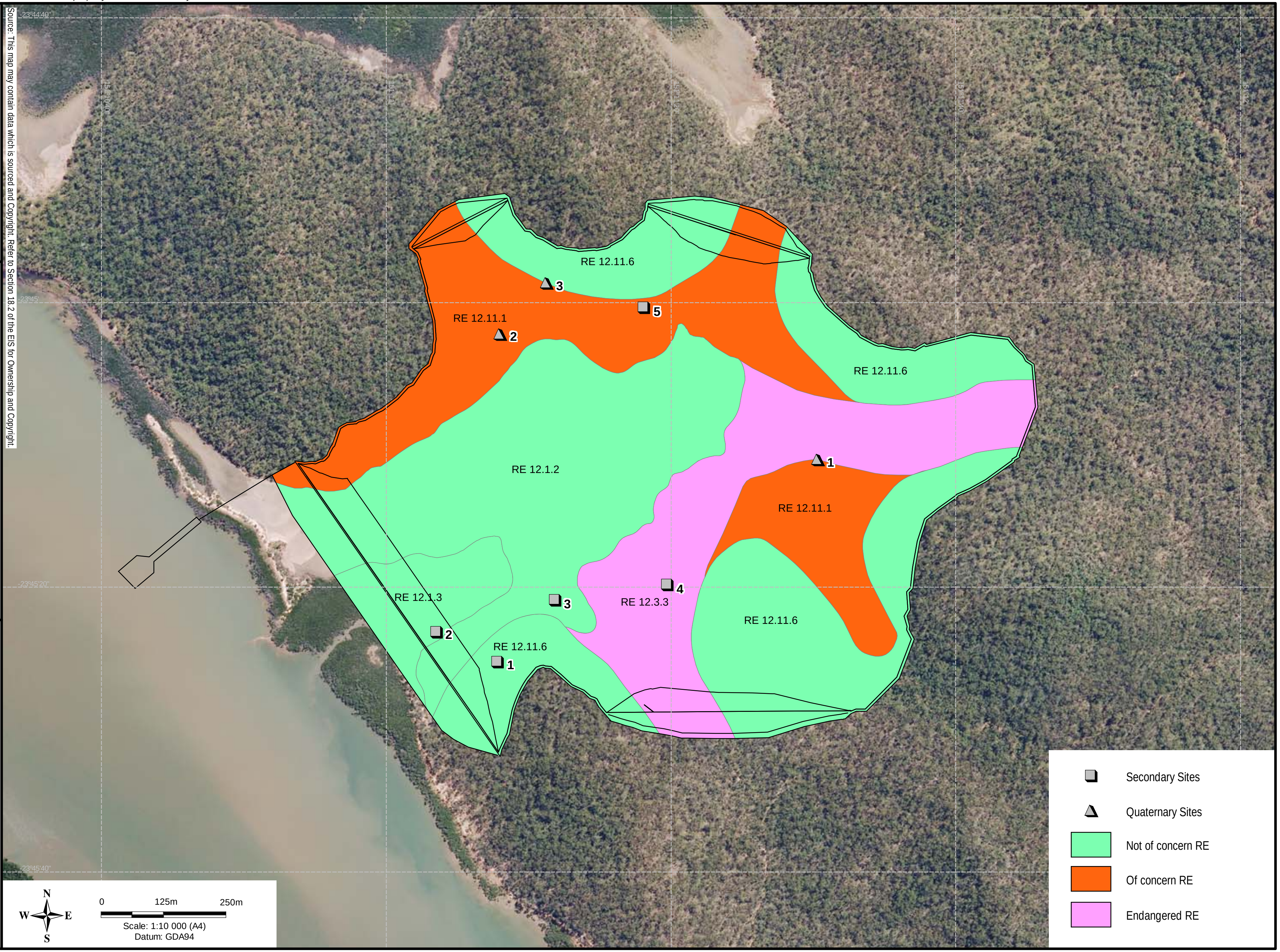
Potential Impacts and Mitigation

The construction of the dredge material placement facility will impact an area of approximately 120 ha and the vegetation communities within this area will be removed. The areas of disturbance associated with each of the regional ecosystems present is presented above in Figure 8.17.4.

Impacts to REs

The RE subject to the greatest disturbance is the vegetation community of *Corymbia citriodora* and *Eucalyptus crebra* open forest to woodland (Not of Concern RE 12.11.6). Viewed in a regional context however, this disturbance represents only 0.02 % of this RE across the sub-region. This RE is found on slopes and hill tops in both the north-east and south-east of the site.

The saltpan community comprising *Sporobolus virginicus* grassland and samphire herbland (Not of Concern RE 12.1.2) situated in the centre of the site will be subject to the second greatest disturbance. When viewed in the broader context of regional biodiversity, this disturbance represents approximately 0.2 % of this RE within the sub-region. This RE has relatively sparse vegetative cover and is therefore, the least floristically diverse vegetation community present on the site.



Client

URS

LNG

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Drawn: RG

Approved: JB

Date: 27-04-2008

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Title

REGIONAL ECOSYSTEMS AND STUDY SITE LOCATIONS

Figure: **18.7.4**

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The mangrove shrubland community (Not of Concern RE 12.1.3) will be least impacted in terms of area affected. The 6 ha impacted represents approximately 0.04 % of this RE within the sub-region. Construction of the proposed dredge material placement facility will divide this RE due to placement of a bund along the south-west of the site. This may block estuarine water flow and decrease the ecological function of the mangroves as a water filtration system and nutrient recycler. Restriction of freshwater flushing and alteration of natural drainage may alter the composition and diversity of species within the mangrove vegetation community. Mitigation measures to reduce the impact upon this RE include developing the bund wall in a method conducive to mangrove re-colonisation. Further detail regarding impacts and mitigation measures to the mangrove community is provided in Appendix G.

Impacts to Conservation Significant REs

The RE subject to the third greatest disturbance is the RE *Eucalyptus crebra*, *Eucalyptus tereticornis* grassy woodland (RE 12.11.14). This RE is listed as Of Concern under state legislation. When viewed in a regional context this disturbance represents 0.6 % of the RE within the sub-region. This RE is located on lower slopes, predominantly down-slope of RE 12.11.6.

The community of *Eucalyptus tereticornis* open forest to woodland on Cainozoic alluvial plains (RE 12.3.3) is listed as Endangered under state legislation. This community is found on the low-lying alluvial plains present in the south-east of the site. Approximately 20 ha of this community is proposed to be disturbed. On a regional scale this represents 0.08 % of this RE across the sub-region.

A program to implement biodiversity offsetting of cleared vegetation communities will be undertaken for the Endangered / Of Concern vegetation communities of RE 12.3.3 and RE 12.11.14. A biodiversity offset strategy will be developed in consultation with DERM and DEWHA and in accordance with best practice. The development of a Dredge Management Plan (DMP) and Environmental Management Plans will be undertaken to manage potential impacts on the terrestrial environment resulting from construction and use of the dredge material placement facility. Further mitigation measures for impacts upon terrestrial vegetation are discussed in Section 8.4 and include the management of dust impacts, vegetation clearing schedules and rehabilitation plans.

8.17.6.2 Terrestrial Fauna

As part of the GLNG EIS, two separate full terrestrial vertebrate fauna survey programs were conducted over the course of 18 days on Curtis Island within the LNG facility and gas transmission pipeline study areas, both of which were undertaken in similar vegetation communities and habitats common to all of the south-west section of Curtis Island. Previous surveys were within close proximity to the dredge material placement facility and covered habitat directly comparable to that of the dredge material placement facility.

In addition, a separate two day species-specific survey program was undertaken in the vicinity of the dredge material placement facility area (particularly along the coastal fringe), targeting migratory wader birds and potential habitat for the presence of the conservation significant false water mouse (*Xeromys myoides*) (refer to Appendix DD).

The dredge material placement facility area is dominated by *Eucalyptus* and *Corymbia* woodlands on moderate to low slopes and alluvial plains as found throughout the south-west section of Curtis Island. Mangrove and saltmarsh communities are present within intertidal areas. Previous studies by URS for the GLNG Project on Curtis Island determined that the area displays impacts consistent with a long history of use that includes grazing, clearing, cropping, and selective timber felling. The presence of agricultural weeds and a history of fire have also affected the ecological values of the site. It would be expected that the dredge material placement facility area is similarly affected.

Full details of the terrestrial fauna surveys for the gas transmission pipeline and LNG facility on Curtis Island can be found in Section 7.4 and Section 8.4, respectively.

Methodology

The terrestrial fauna assessment for the dredge material placement facility was based on desktop and field studies as mentioned above. Aerial photograph interpretation of the site in conjunction with the results of the dredge material placement facility terrestrial flora assessment (refer to Section 8.17.6.1) were used to confirm vegetation and habitat values. In addition, the results of a separate targeted survey for the water mouse (*Xeromys myoides*) and powerful owl (*Ninox strenua*) as well as observational studies for wader birds were utilised (refer to Appendix DD).

Desktop database searches were undertaken in order to provide background information regarding the terrestrial vertebrate fauna known from the region and local area. The field program for the gas transmission pipeline and LNG facility involved a number of standard and non standard methods including trapping, spotlighting, bird census, habitat searches, call playback, opportunistic observation, scat and track analysis, and microchiropteran ultrasonic call analysis.

Existing Environmental Values

The terrestrial fauna values at the dredge material placement facility site have been extrapolated from the results of the gas transmission pipeline and LNG facility terrestrial fauna surveys, the targeted dredge material placement facility survey and the dredge material placement facility terrestrial flora assessment.

Given the similarity of vegetation types, landforms, previous disturbance and landuse across the south-west coast of Curtis Island, it is considered that habitat values and faunal usage are relatively consistent throughout. A low diversity of vertebrate fauna was recorded during the fauna surveys. It is probable that a similar lack of diversity would be present at and around the dredge material placement facility, as this area does not display any higher degree of habitat availability or ecological integrity than the other areas assessed in the south west of Curtis Island. Results from the previous surveys include:

- Thirteen reptiles including skinks, monitors, geckoes and pythonid and colubrid snakes were recorded;
- Six amphibians, including the exotic cane toad and five native species were recorded;
- Seventy bird species were recorded; and
- Nineteen mammals, including seven exotic species.

Conservation Significant Species – Potential Values

The database searches (including EPBC MNES, Queensland Museum, EPA Wildnet and Birds Australia) determined that 20 conservation significant fauna species were potentially present in the region. A desktop analysis of habitat requirements concluded that the following eight species are considered potentially present:

- Beach stone-curlew (*Esacus neglectus*);
- Squatter pigeon, southern form (*Geophaps scripta scripta*);
- Sooty oystercatcher (*Haematopus fuliginosus*);
- Black-breasted button-quail (*Turnix melanogaster*);
- Koala (southern Queensland bioregion (*Phascolarctos cinereus*);
- Water mouse (*Xeromys myoides*);
- Yakka skink (*Egernia rugosa*) ; and
- Brigalow scaly-foot (*Paradelma orientalis*).

Conservation Significant Species – Surveyed Values

Field work at the gas transmission pipeline, LNG facility, the dredge material placement facility and during the targeted water mouse survey, and subsequent habitat analyses determined the following with respect to the species listed above:

- The beach stone curlew (*Esacus neglectus*) was recorded near the LNG facility study area;
- The squatter pigeon was not recorded and there is only a slight chance that it is present as Curtis Island vegetation patterns are less suited to this species;
- The sooty oystercatcher was observed at the township of South End, located approximately 10 km to the east. It may utilise intertidal areas in the vicinity of the dredge material placement facility;
- The black-breasted button quail was not recorded and there is only a slight chance of presence as preferred habitat is not located within the dredge material placement facility site;
- The koala was not recorded and there is only a slight chance of presence due to a lack of recent verified records from the area;
- The water mouse may be present although dedicated searches did not locate the mouse or note signs of its presence along the south-west coast of Curtis Island;
- The yakka skink was not recorded and there is only a slight chance of presence due to a lack of preferred habitat; and
- The brigalow scaly-foot was not recorded and there is only a slight chance of presence due to a lack of preferred habitat.

Other Species of Significance

Wader/shorebirds were observed in relatively low numbers within the study area around the dredge material placement facility site. Habitat values appeared to be low for many species due to low foraging potential. There is abundant existing habitat elsewhere on Curtis Island and surrounds. The majority of the observed waders, both in terms of diversity and numbers of individuals, were recorded foraging on more suitable habitat (sand/mudflats) 10 km to the east of the study area near South End.

The powerful owl (*Ninox strenua*) and glossy black cockatoo (*Calyptorhynchus lathami lathami*) were recorded during the terrestrial fauna survey for the gas transmission pipeline on Curtis Island. These may utilise the dredge material placement facility area but it would act as marginal habitat only for these species.

Potential Impacts and Mitigation Measures

Beach stone-curlew: This species will not be significantly affected by the construction of the dredge material placement facility as abundant, suitable alternative habitat is common in the region.

Squatter pigeon: As the squatter pigeon favours open woodland with adjacent pasture, the dredge material placement facility site does not currently provide suitable habitat for this species. Therefore, impacts to this species will be negligible, especially in light of alternative suitable habitat on the mainland.

Sooty oystercatcher: The local population of this species will not be significantly affected by the construction of the dredge material placement facility as abundant suitable alternative habitat is common in the locality.

Black-breasted button-quail: Whilst small areas of preferred habitat are present on Curtis Island, they are not found within the dredge material placement facility area. Therefore, this species is not likely to be impacted by the proposal.

Koala: Essential habitat for the koala is mapped by the EPA within the dredge material placement facility site. However, it was not recorded from the area and anecdotal evidence suggests that it has not been seen on the south-west coast of Curtis Island for many years. The presence of koala is not discounted for

this area of the island, however the DMMP is not considered to be core habitat. Therefore, it is unlikely that it will be impacted by the proposal.

Water Mouse: Construction of the facility may remove available habitat for any local populations of water mouse. Where suitable habitat for the water mouse could be disturbed, targeted trapping surveys will be conducted to confirm the presence/absence of the species. If habitat is found to support water mouse populations then the proponent will minimise disturbance of these areas as far as practicable and seek management advice from state and commonwealth authorities.

Yakka skink: Fieldwork has confirmed that there is only a very slight chance that this species will be present within the dredge material placement facility area due to a lack of its preferred habitat type, the presence of feral predators and a lack of suitable microhabitat. Therefore, impacts on this species are unlikely.

Brigalow scaly-foot: Fieldwork has confirmed that there is only a very slight chance that this species will be present within the dredge material placement facility area due to a lack of its preferred habitat type and the presence of feral predators. Therefore, impacts to this species are unlikely.

Powerful owl: As the dredge material placement facility area will not act as a significant source of prey or nesting resources, the powerful owl would not be significantly impacted by the proposal. Targeted searches for the powerful owl revealed that due to past logging, eucalypts of a suitable age with large hollows were not abundant. Larger trees with hollows capable of supporting nesting powerful owls and arboreal mammals were sparsely scattered throughout the south-west coast.

Glossy black cockatoo: The dredge material placement facility area would not act as a significant source of food resources for the glossy black cockatoo and so it would not be significantly impacted by the proposal. The glossy black cockatoo feeds on the seeds of various species of *Casuarina* and *Allocasuarina*. These trees are distributed sparsely throughout the south-west coast of Curtis Island and are not in dense enough aggregations to act as a significant food resource.

Wader/shorebirds: The foreshore/intertidal zone areas outside of the immediate zone of works will be protected so that habitat loss is minimised. Overall habitat loss will be minor in relation to that present in region. The newly created shoreline will be constructed so that slope and substrate are conducive to mangrove colonisation.

8.17.6.3 Marine Ecology

Existing Environmental Values

Section 8.4.4.5 of the EIS summarises the work undertaken to describe and assess the intertidal and subtidal marine habitat adjacent to the south-western coastline of Curtis Island (including the dredge material placement facility). A series of marine survey field programs was carried out (refer to Figures 2-1 and 3-2 in Appendix R1, which identify the field survey sites), and the types of habitats found along the coastline have been described, including the saltflats, and mudflats typical of the area of the dredge material placement facility.

Baseline information, potential impacts and mitigation measures related to the proposed dredging and dredge material placement facility activities are summarised below. Section 8.4.5.3 provides a more detailed assessment of the potential impacts on the marine environment and mitigation measures proposed.

Habitats

The distribution of major habitat types within Port Curtis is described as exposed mud banks and sandbanks, mangrove communities, seagrass meadows and saltmarsh/saltpans.

Low tidal mudflats dominate the intertidal habitats of almost all sites surveyed on the southwestern side of Curtis Island. Saltflats dominated by salt tolerant herbs, grasses and algal mats were generally landward of the mangrove zones found on Curtis Island. Sandy substrates were limited to small areas at Hamilton

Point and Laird Point. Rocky foreshores in between the mangrove embayments at Hamilton Point and immediately south of Laird Point had a high silt content.

Subtidal substrates consist of a deep sandy channel at the crossing between Friend Point and Laird Point and silt/rubble embayments south of Laird Point, at China Bay and Boatshed Point. A rubble slope between China Bay and Hamilton Point joins a rock wall around Hamilton Point. Sediment types consist of silts and muds in the embayments, medium sands on the edge of channels through much of the inner harbour and coarse sands and gravels in the channel between the mainland and Curtis Island.

An ongoing seagrass monitoring program conducted by the Department of Primary Industries and Fisheries (DPI&F) indicates that seagrass meadows occur to the north of Fisherman's Landing, adjacent to Wiggins Island (Targinie Banks) and at Pelican Banks on the southern side of Curtis Island. No seagrass was observed adjacent to Curtis Island during the surveys carried for this project (see Section 8.4).

Of the 14 mangrove species previously recorded within the Port Curtis area, 11 were recorded during the intertidal survey. While mangroves mostly occur within small embayments and tidal flat settings, they also occur intermittently on rocky shores at mid to upper tidal levels.

The cheniers, which are supratidal in elevation, provide localised freshwater seepage at their margins with the surrounding mudflats and have a different substrate type of calcareous sands and shell gravel. These conditions have developed narrow mangrove habitats of mixed species woodland on the chenier crests. Chenier habitats were recorded amongst the seaward mangrove zone at Friend Point and at the small mangrove embayment approximately 1.5 km south of Laird Point at the preferred dredge material placement facility area.

Where growing conditions are favourable, porewater salinity and water content are thought to be the major parameters influencing mangrove habitat zonation. Areas of dead Ceriops trees between the mangrove and saltflat margins are possibly related to changes in tidalflat hydrology and resulting increases in porewater salinities (mangrove dieback).

Fauna Communities

A total of 76 species or groups of invertebrate fauna were recorded from intertidal habitats, mostly from low tidal mudflats, mangroves and rocky shores. Molluscs were the most diverse group taxonomically including 30 species of gastropods and 24 species of bivalves. Crustaceans, echinoderms and one species of polychaete were also found within the intertidal study sites. Species diversity was generally low, possibly due to low habitat diversity. The rocky foreshores had very high silt content with the lower intertidal areas entirely comprised of very silty mudflats. Some crab holes and mudwhelks were found adjacent to the mangrove zone on the seaward edge of the saltflats during the intertidal survey. Zonation of intertidal fauna on the rocky foreshores was not strong, possibly due to extensive siltation of the rocky foreshores. A fringe of oysters was present at mean sea level along the extent of the rocky shores surveyed. Thaid snails were also common as they feed on oysters and other species. Several species of nerites were also common.

The most complex and diverse subtidal communities were found at Hamilton Point. These communities were dominated by zoanthids, hydroids, sponges and soft corals interspersed with gorgonians, and macroalgae. This is indicative of species more tolerant to elevated levels of turbidity and generally found in areas of higher current strength. Soft corals, sea pens, macroalgae and sponges were sparsely scattered in the silted embayments and the channel crossing between Friend Point and Laird Point. Subtidal rocky slopes and outcrop areas are restricted to small headlands, drop-offs and rocky outcrops off Curtis Island, Facing Island, Tide Island and Picnic Island situated south of Curtis Island. Although hard corals were not recorded during the subtidal survey, coral reefs have been reported at Farmers Point and Manning Reef on the western side of Facing Island and Sable Chief Rocks on the ocean side of Facing Island.

A high diversity of fish species have been recorded from previous fish surveys conducted within Port Curtis and the Calliope River. A significant commercial mud crab fishery exists in Port Curtis with

commercial catch estimated at 143 tonnes in 2002. Recreational fishing is popular in Port Curtis, with whiting being the most common species caught.

Species of conservation interest protected under Commonwealth legislation are known to occur within Port Curtis. Marine turtles, dugong and dolphins frequent the waters within Port Curtis to forage and migrate. The Humpback Whale is known to breed in the region but has never been recorded within Port Curtis waters. Turtle nesting areas occur on the eastern side of Curtis and Facing Island for the flatback and green turtle. Migratory shorebirds also have important roosting grounds on mud banks north of Fisherman's Landing, Targinie Banks and Pelican Banks. These areas correlate with seagrass meadows and associated foraging grounds for dugong and turtles. Dead dolphins, dugong and turtles have been reported in the area over the last few years, attributed mostly due to netting and boat strike.

No marine pest species have been recorded within Port Curtis. However, low abundances of introduced marine species, found commonly throughout Australian waters, are known to inhabit these waters, including ascidians, bryzoans and hydrozoans.

Potential Impacts and Mitigation Measures

There is potential for impacts on the marine environment to occur as a result of dredging and material placement, including:

- Dredging – removal of subtidal, soft bottom communities at China Bay and in approach channel (see also Section 8.7); and
- Dredge material placement facility – covering approximately 37 ha of saltpan, saltmarsh, mangrove habitat.

The construction of a dredge material placement facility at Laird Point will cover an area of saltmarsh and mangrove habitat. This has been calculated to be approximately 0.09% of the mangrove and 0.68% of the saltmarsh communities that are found within Port Curtis. It should be noted that the formation of bund walls, and a new coastal margin will provide hard substrate for intertidal and supratidal species to attach to, which will in turn provide a food source and habitats for other species (e.g. fish, crabs).

The disturbance to these marine habitats will result in the displacement of those species directly dependant on these areas. The surface layers of the areas to be dredged provide habitats for a range of benthic (bottom dwelling) fauna such as worms and prawns. Some of these fauna are in turn prey species of fish and are therefore important for environmental and commercial reasons. As the majority of benthic fauna occur in the top 30 cm of the sediment, the dredging operation will be expected to completely remove all benthic fauna within the dredge site. Previous studies indicate relatively rapid rates of re-colonisation by marine organisms occur from larval dispersal and active colonisation from adjacent areas is very high (WBM, 2004).

The increase in suspended sediment loads in the water column are considered unlikely to have significant impacts on seagrass meadows as the region has naturally high suspended sediment levels and the nearest significant seagrass meadows are several kilometres away. The impacts are discussed in detail within Section 8.4.4 (Marine Flora and Fauna) and Section 8.7.3 (Coastal Processes). However, in recognition of potential impacts, suitable mitigation measures and a monitoring program will be developed and included within the approved DMP and discharge levels agreed with the EPA prior to dredging or material placement activities commencing. Impacts to seagrass meadows from increased turbidity and sedimentation may impact foraging behaviour of turtles and dugong.

The dredge material placement facility is proposed to comprise a bund wall 18 m high to minimise the facility surface area and footprint. It is proposed that beneficial reuse of dredge material will be possible for bund wall construction and possibly as road construction material, and this will reduce the amount of area required for material placement. Further details are provided in the Laird Point Placement Facility Concept Description, provided in Appendix DD.

Environmental Management Plans and a DMP will be developed collaboratively with Santos, selected contractors, the EPA, the DPI&F and the GPC to manage potential impacts to the marine environment resulting from construction and use of the dredge material placement facility.

8.17.7 Surface Water

The surface water assessment is provided in Appendix DD of the EIS. A summary of the assessment is presented below.

8.17.7.1 Methodology

A phased surface water assessment has been undertaken. This has focused on the key impacts of the placement facility in regard to the surface water environment. A review of potential impacts identified two such impacts that may result from poor surface water management, including:

- Non-compliant water quality discharge to the receiving surface water environment from insufficient treatment; and
- Catastrophic failure of the containment embankment due to deficient stormwater management and/or design.

8.17.7.2 Existing Environmental Values

The dredge material placement facility is located approximately 13 km northeast of Gladstone on Curtis Island. Curtis Island is within the Curtis coast region, which consists of Raglan Creek to the north, Colosseum Inlet to the south and the Capricorn Group of islands to the east. The western boundary is defined as the landward edge of the coastal catchments (the Boyne River, Calliope River and part of the Fitzroy River catchment) within the local government areas of Gladstone City and Calliope Shire. The Curtis Island Basin has a total catchment area of 576 km². Curtis Island is 45 km long and a maximum of 14 km wide (ANRA, 2007). The major drainage feature on Curtis Island is Graham Creek, located in the adjacent catchment to Laird Bay. The creek channels a significant portion of surface water runoff from the southern half of Curtis Island into The Narrows, an estuarine passage separating Curtis Island from the mainland.

The footprint of the dredge material placement facility covers approximately 120 ha, with approximately 35 ha of this inter-tidal area (mainly saltflat).

Review of topographical maps of the study area indicate that water features at the site are limited to minor drainage features comprising ephemeral watercourses such that the smaller upper catchments will result in water flow only occurring during and immediately after rain events. Downstream of the proposed dredge material placement facility are the intertidal flats vegetation communities of saltflat and mangroves.

8.17.7.3 Potential Impacts and Mitigation Measures

The DMP will include a surface water management strategy to provide a basis for the management of discharges from the facility (including dredge effluent from the dewatering process and stormwater runoff) prior to its construction. The strategy will be based on findings from a water quality model and will include several different treatment method options to meet appropriate background water quality guidelines (in Port Curtis) and site specific water quality objectives (yet to be identified), prior to discharge via a weir constructed within the main bund. Any guideline development will require input from the EPA and other stakeholders, and is likely to be in line with other similar activities in the area.

The concept design for the dredge material placement facility is based around the management of dredge effluent through a system of cascading settlement/treatment basins, which are designed specifically to reduce velocities and optimise the settlement of suspended solids and other potential contaminants, prior to discharge to the receiving environment. Likely sediment characteristics, based on investigations in the dredge area, are discussed in Section 8.17.9, It is possible (subject to the results from further water quality modelling) that stormwater runoff could be diverted around the settlement/treatment basins (i.e. thus separating dredge effluent and stormwater runoff) and discharged, unaffected, directly to the receiving environment. However, the settlement/treatment basins will be sized to manage the additional stormwater runoff.

The proposed sedimentation/treatment basins within the dredge material placement facility will be designed and constructed in accordance with accepted standards. Stormwater runoff and dredge effluent collected within ponds will be monitored and, if required, appropriately treated, prior to discharge to the marine environment.

Although considered unlikely, the failure of the proposed 18 m high containment embankment could result in discharge of both water and dredge material into the marine environment, potentially causing environmental harm. To mitigate this, the embankment will be designed, constructed and operated in accordance with accepted standards to minimise the likelihood of failure. This will include a formal spillway within the main bund (in addition to the weir boxes for 'normal' stormwater and dredge effluent discharge), and an appropriate design storage allowance (DSA) for significant runoff events. Furthermore, it is considered that effective stormwater management at the dredge material placement facility will assist in maintaining the integrity of the embankment (i.e. minimising erosion), and thereby reduce the potential for failure.

To inform the hydraulic design criteria (i.e. spillway capacity and DSA) of the main embankment, a hazard categorisation of the embankment was undertaken in accordance with the latest EPA Manual for Dams v.10, 21/08/09. The assessment identified a "high hazard" from the catastrophic failure of the embankment due to potential impacts on the marine environment. Whilst the categorisation of the structure should be consistent throughout the design, the assessment alternatively indicated that the impact of a failure-to-contain (i.e. spill event via the weir and/or formal spillway) incident was considered a "low hazard". The overall evaluation, combined with a review of other industrial discharge agreements within the Port, resulted in the adoption of a lower hazard category, "significant hazard", for the spillway capacity or design storage allowance criteria within this assessment.

8.17.8 Groundwater

A full groundwater report, "GLNG Project - Dredge Material Disposal Groundwater Assessment" is provided in Appendix DD of the EIS. A brief summary is provided below.

A high level evaluation of the proposed dredging and dredge material placement facility site was conducted to determine the site suitability from a groundwater perspective. The preliminary groundwater assessment was based on the available dredge material methodology details, the groundwater study for the LNG facility site (see Section 8.6), sediment physical and chemical characteristics (see Section 8.7.6, and the summary in Section 8.17.9), and a literature review. In order to assess the suitability of the proposed site for dredge material disposal from a groundwater perspective the Waste – Aquifer Separation Principle (WASP) methodology was used. This approach allowed for an assessment of the groundwater resources below and adjacent to the proposed site, the unsaturated zone below the proposed facility and the proposed dredge material. These are described below.

8.17.8.1 Existing Environmental Values

An evaluation of the groundwater resources indicates two separate groundwater regimes within the proposed dredge material placement facility footprint. These include:

- Shallow hyper saline groundwater resources within the intertidal zone, recognised within the mudflats. The groundwater associated with the mudflats has limited environmental value and have no beneficial use. This portion of the proposed site will not be markedly impacted by possible saline seepage from the dredge material placement facility;
- Discrete fractured and weathered aquifers within the competent Wandilla Formation. An existing bore within the proposed footprint indicates that the groundwater resources can provide limited quantities of poor quality groundwater, which is only suitable for stock watering. These discrete aquifers have limited beneficial value;
- An assessment of the unsaturated zone within the Wandilla Formation indicates that, due to permeability and the shallow depth to groundwater, there exists only a limited barrier between a possible surface contaminant source and the discrete groundwater resources; and

- The dredge material was recognised to comprise mainly uncontaminated sand with limited acid generating potential.

8.17.8.2 Potential Impacts and Mitigation Measures

The groundwater resources are recognised to be of limited environmental value and benefit. An assessment of the proposed dredge material activities was considered and the following possible impacts on the groundwater resources were identified:

- The dredge material placement facility site has the potential to generate seepage based on the ~ 120 ha footprint and the saturated nature of the dredge material. This seepage could potentially enter the groundwater resources and cause increased salinity; and
- Seepage from the dredge material could potentially alter groundwater flow patterns and cause waterlogged areas adjacent to the facility.

These impacts are not considered to be of significance in the mudflats area, due to the hyper saline nature of groundwater within this portion of the proposed facility footprint. Groundwater is utilised for stock watering within a portion of the site, which is underlain by altered Wandilla Formation units. The limited groundwater resources located within discrete aquifers may be vulnerable to saline recharge. Improving the barrier between the dredge material and the groundwater table in these areas will reduce groundwater vulnerability. However, there is limited potential for future use of this resource.

8.17.9 Coastal Processes

The existing coastal environment within Port Curtis and the areas where the GLNG Project could impact on existing environmental values is discussed in detail in Section 8.7. This includes an assessment of marine waters, marine sediment and local coastal processes. Within the following section the coastal process and marine waters are not described or discussed further in relation to the dredge material placement facility or dredging. However, this section presents a comparative discussion of the results of a number of marine sediment studies undertaken in and around the proposed GLNG Project area.

8.17.9.1 Marine Sediment

A description and assessment of the marine sediments in the project area is provided in “Environmental Investigations of Proposed Capital Dredging at China Bay and Pipeline Crossing at The Narrows”, Gladstone, URS, 2009. A summary of this is provided in Section 8.7 (the full report is presented in Appendix R3).

In July 2008, URS was commissioned by Santos to undertake a marine sediment investigation as part of the EIS. Prior to this, a number of other investigations had been conducted in the vicinity of the South Passage to characterise marine sediment quality in view of dredging activities. These included the following:

- Santos GLNG Dredge Area Study - GeoCoastal, 2008;
- Wiggins Island Coal Terminal EIS - Sediment Contamination Survey- Connell Hatch, 2006;
- Report on Soils Investigation, Proposed Dredging Works, Existing Shipping Channels, Gladstone. September 2005, Douglas Partners for Central Queensland Ports Authority; and
- Port Curtis Contaminants of Concern - Coastal Cooperative Research Centre (CCRC), 2005.

The studies looked at various parameters to characterise sediment quality. This included acid sulfate soils (ASS) investigation, metals, nutrients, organic compounds and radionuclides.

Geology and Lithology

Generally, sampling locations used in the various studies were within the same geological profile. These comprised shallow marine sediments (Holocene aged estuarine alluvial deposits) and residual material

overlying extremely weathered to fresh bedrock (Wandilla formation), which ranged from siltstones/sand stones to low grade metamorphosed argillite.

The marine sediments were a mixture of gravels, sand, silts and clays. The surface sediments in high current areas are typically of coarser fractions. Intertidal areas were generally a mixture of silts and sands.

It was noted in the URS study that the seabed surface lithology often contained shell fragments, which decreased with depth. Additionally, it should be noted that core depths for the various studies varied from 4 m to 16 m.

Guidelines

A number of guidelines were used to assess the level of possible contamination in the passage. Among these are:

- National Environment Protection Council Schedule B(1)- Guideline on the Investigation Levels (ILs) for Soil and Groundwater (1999) (NEPC Guideline)-Used in the reports of Connell Hatch, 2006;
- Health Investigation Levels (HILs) from Table 5-A of the National Environmental Protection Measure, 1999 (NEPM) from the National Environmental Protection Council (NEPC). Used in the reports of GeoCoastal, 2008, URS, 2009;
- Environmental Investigation Levels (EILs) from "Queensland Environmental Protection Agency (QEPA) Draft Guidelines for Assessment and Management of Contaminated Lands in Queensland 1998" (QEPA EILs)- Used in the URS (2008) and GeoCoastal (2008) reports;
- National Ocean Disposal Guidelines for Dredged Material (2002) (NODGDM)- Used in the reports of Connell Hatch(2006), GeoCoastal (2008), URS(2008), & Douglas Partners (2005); and
- ANZECC Interim Sediment Quality Guidelines (ISQG) –CCRC (2005), GeoCoastal (2008) and CCRC (2005).

Sediment Quality

Most of the studies analysed marine sediment samples for a broad suite of parameters generally grouped as metals, nutrients, organic compounds, radionuclides and ASS analysis.

Metals

Levels of several metals including arsenic, chromium, copper, lead and nickel were recorded above the limit of reporting (LOR) but were less than the ISQG-low screening levels and were within the NODGDM (2002) screening levels (GeoCoastal,2008). These results were consistent with the findings of the Connell Hatch (2006) study which reported that at 95th percentile value, no exceedances were found for antimony, cadmium, chromium, copper, lead, mercury, nickel, zinc and arsenic. Sporadic exceedances were found for antimony, cadmium, copper, silver, zinc and arsenic but were found in depths greater than 1 m down core.

Manganese was found to have elevated concentrations with respect to the QEPA EILS (URS, 2009). However, manganese has been widely recognised as occurring naturally in marine sediments. In addition, manganese has been mined in several locations in and around Gladstone. Iron and aluminium levels were also found in notable concentrations, although no guidelines have been established for this (GeoCoastal, 2008) (URS, 2009). Iron and aluminium are generally not considered as toxic contaminants in marine sediments.

The occurrence of elevated arsenic levels in some samples was highlighted in the Douglas Partners (2005), CCRC (2005), and URS (2009) reports. NODGM (2002) notes an observation that sediments in eastern Australia commonly have natural levels of arsenic.

The elevated metal concentrations observed in the studies were suggested to be naturally occurring. This was noted in URS (2009) report where it was identified that several metals were consistently present

at higher concentrations within the deeper sediments when compared to levels found in the overlying sediment. (It should be noted that high metal concentrations were also reported in soils and groundwater present on the LNG facility site on Curtis Island). The CCRC (2005) report also indicated that chromium and nickel were associated with natural sources and were a "background presence."

Nutrients

The URS (2009) and GeoCoastal (2008) studies analysed for nutrients in the marine sediments. It should be noted that no ILs or screening levels were established under the guidelines adopted for the investigations.

It was observed that generally nitrate, nitrite, and ammonia levels in sediment samples reported concentrations less than the laboratory LOR.

Organic Compounds

Analyses of organic compound in the various studies were carried out and generally included the following parameters:

- Total petroleum Hydrocarbons (TPH);
- Benzene, Toluene, Ethyl-Benzene and Xylene (BTEX) compounds;
- Poly Aromatic Hydrocarbons (PAH);
- Organochlorine (OC) and Organophosphate (OP) pesticides;
- Phenolic Compounds;
- Tributyltin (TBT);
- Triazine Pesticides, Carbamates Pesticides and Phenoxyacetic acid Pesticides; and
- Polychlorinated Biphenyls (PCBs).

All PAHs, pesticides, and PCB results were less than the respective LORs as well as the NODGDM screening levels as reported in the Douglas Partners (2005) and the Connell Hatch (2006) studies. In the same reports, appreciable above-LOR TBT levels were reported. After statistical normalisation however, the results were determined to be below the guideline screening levels.

The GeoCoastal (2008) and URS (2008) reports have similar results with most of the parameters being below LOR. Phenol levels were recorded at above LOR in some samples, but levels were below the NEPC (1999) guidelines.

The presence of naphthalene was recorded in some samples reported in the URS (2008); it was below the NODGDM (2002) screening levels. CCRC (2005) reported naphthalene as a chemical of potential concern (COPC) and concluded that it is likely to have originated from natural sources.

Radionuclides

The presence of radionuclides were characterized in the URS (2008) and GeoCoastal (2008) reports. Analytical results were below the screening levels of both the NODGDM (2002) and the ISQG-low screening level.

Acid Sulfate Soils (ASS)

There was no indication of the presence of actual acid sulfate soils (AASS) throughout the area of investigation (URS, 2009). The Douglas Partners report (2005) also concluded that a management plan of ASS was not required and that any risk of environmental impact from oxidation of potential acid sulfate soils (PASS) during the dredging process was less than the threshold values presented in the published guidelines. It should be noted that the two study areas are approximately 1 km away from each other, with the latter being just off the Fisherman's Landing point, and situated more centrally in the channel.

PASS areas however, were identified to occur in certain areas such as the area near the coastline of China Bay and the northern and southern sections of the proposed dredge area (GeoCoastal,2008)(URS,2008). These studies also showed that marine sediments within the channel were comprised of Holocene silty clays and silty clayey sands which also contain high levels of shell (calcium carbonate) that acts as neutralising agent. Acid neutralising capacity (ANC) at shallow depth was attributed to megascopic carbonate forms such as these shells. ANC presence at depth was attributed to microscopic sources such as foraminifera. URS (2008) concluded that it is the availability of ANC in the marine sediments which will control the amount of net acidity and subsequently whether treatment (liming), is required.

Metals and ANC

Any proposed treatment or management of ASS must take into consideration the presence of naturally occurring levels of metals in the marine sediments as well as the acid neutralising capacity of the marine sediments. Over neutralisation may lead to the flocculation of metals in leachates from dredged materials or in dredging waters. The URS (2008) report specifically raises the possibility of formation of iron flocs or areas of high deposition of metals at the point of release into receiving waters. Iron flocs, though generally benign can be unsightly.

Conclusions

The various studies undertaken within the area of dredging for the GLNG Project and in close proximity to it have shown that levels of nutrients, organic compounds, and radionuclides are either below the screening levels of the guidelines adopted for the studies or were below the LOR, or both. Elevated metal levels were suggested by the studies to be naturally occurring. Exceedance to guideline levels were noted for antimony, arsenic, chromium, copper, manganese, mercury and nickel. Iron and aluminium levels were found in notable concentrations, although these metals are generally not considered to be toxic contaminants in marine sediments.

No sediment samples were classified as AASS, but a limited extent of PASS areas were identified. However, generally sediments were found to exhibit an available ANC which was attributed to megascopic carbonate forms such as shells and microscopic foraminiferal components.

The proposed management and treatment of dredged material must take into consideration the presence of naturally occurring levels of metals in the marine sediments as well as the acid neutralising capacity of the marine sediments. Metals inherent in the material may be mobilised from either sorbed metals or dissolved metals in the dredge slurry, potentially posing a risk to any receiving environment where dredging waters are released. Also, if not properly managed, over neutralisation may lead to flocculation of dissolved metals in leachates from dredged materials or in dredging waters. A dredge material leachate and discharge monitoring program will be established as part of the DMP to mitigate risks of potential metal mobilisation or flocculation in the receiving waters.

8.17.10 Air Quality

No specific air quality assessment has been undertaken for the dredge material placement facility. However, ambient air quality is expected to be similar to that of the LNG facility site. Impacts on air quality resulting from the construction and operation of the dredge material placement facility are likely to be minor and similar to those identified for construction of the LNG facility. These will include:

- Dust emissions, primarily from earthworks activities;
- Minor sources of combustion pollutants such as NOx due to diesel and petrol vehicles operating on site;
- The impacts of construction activities will be managed though the DMP. This will include strategies to prevent or minimise dust emissions during construction activities; and
- The relatively low number of vehicles spread out over the area of the site during the construction period is unlikely to result in adverse air quality. Mitigation of dust during the site construction could

potentially cause elevated particulate concentrations, however, simple mitigation measures can be utilised to minimise the potential for this to occur. Suitable mitigation measures will be included in the DMP, once developed, but will be similar to those proposed for the LNG facility (as outlined in Section 8.8).

8.17.11 Noise and Vibration

An assessment of noise and vibration impacts associated with the construction phase of the dredge material placement facility was undertaken by Heggies. The report is provided in Appendix DD of the EIS.

8.17.11.1 Methodology

A number of construction scenarios have been modelled using estimated sound power levels for relevant plant and equipment, such as bulldozers, and graders, and a slurry pump.

Noise levels associated with the construction and operational phases of the facility have been predicted at sensitive receptors in the surrounding community of Gladstone, and compared against the Construction Noise Criteria of 50 dBA.

8.17.11.2 Potential Impacts and Mitigation Measures

At the closest sensitive receptors predicted noise impacts ranged from 23 dBA at Gladstone to 19 dBA at Tide Island during all phases of construction. During operation of the material slurry pump and during worst case weather conditions the maximum predicted noise level of 17 dBA is predicted for Gladstone. All predicted noise levels at sensitive receptors were significantly below the construction noise criteria of 50 dBA, and the impacts will be insignificant.

Construction vibration from traffic utilising the haul roads on site is expected to be significantly below both “building damage” and “human comfort” criteria (it is expected that any vibration from truck movements will be imperceptible).

Based on predicted noise and vibration levels, no noise mitigation measures will be required for the dredge material placement facility.

8.17.12 Land Use

8.17.12.1 Existing Environmental Values

Laird Point is in a generally well sheltered area, located approximately 5.5 km north of the LNG facility site and within the GBRWHA. The dredge material placement facility is located within the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA). The site is partially within an inter-tidal area and features established vegetation communities including mangroves. A description of the general land use within Curtis Island is provided in Section 8.11. Figure 8.17.3 provides an aerial photograph of the site and the local environment.

The site is in a low lying valley area, with elevated areas to the north, south and east. To the west the valley opens up into Port Curtis, with a margin of mangroves separating the valley floor from the sea. The base of the valley is broad and is predominantly salt pan, which is inundated with sea water during higher tides. The vegetated valley and sides appear to have been used at various times for livestock grazing and selective timber felling. Future industrial use of this site in its present state would be limited, due to the nature of the low lying land, its intertidal nature, and the sloped valley sides. Substantial reclamation, to elevate and level the area, would be required to develop a potential it into an industrial site.

8.17.12.2 Potential Impacts and Mitigation Measures

The placement of the dredge material at this site will result in a change in the topography, creating a land use impact. The shore-based placement of materials will result in the covering of approximately 120 ha of land.

The site will have the potential for future use once settlement has occurred to a level that allows construction to proceed. Although likely future use is not yet known, the layout and general arrangement of the facility will be developed in consultation with GPC such that, where reasonably possible, it provides a facility for potential future use. The dredge material will also be treated and placed in such a manner to facilitate such future use, taking cognizance of likely settlement duration to meet the timespan for future use of the site (see Section 8.17.16).

Following settlement the site may be suitable for future land use options such as storage (non-hazardous materials), development of environmental buffers (vegetative or for water management) and temporary light industrial uses (dependant on landform stability). Any permanent uses or storage of hazardous materials (notifiable activities) will require further investigations to confirm the capacity and suitability of the land.

Construction and operations will be required to comply with:

- Approved Dredge Management Plan;
- State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (Queensland Government, 2002) (and associated guidelines);
- State Planning Policy 1/03 Guideline: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (and associated guidelines); and
- Other relevant planning schemes / policies and legislative requirements.

8.17.13 Visual

A visual amenity assessment was conducted for the dredge material placement facility proposed to be located in an area of low lying land to the south of Laird Point, on the south-west coast of Curtis Island. The following section provides the assessment findings, including a description of the existing environmental values, assessment of potential visual impacts and proposed mitigation measures.

8.17.13.1 Methodology

The visual assessment methodology adopted in relation to the dredge material placement facility generally follows that detailed in Section 8.12, Visual Amenity. The existing landscape character of the facility location was assessed to provide a baseline against which the potential impact of the proposed development could be determined. The likely view shed or area from which the facility is likely to be visible was determined and the landscape character described below.

The levels of significance of potential visual impact were assessed through consideration of the combination of magnitude of visual change in the visual landscape character, and the sensitivity of viewers who would see the change. Viewer sensitivity is the extent to which a viewer is willing to accept the change to the landscape character that will result from the development without perceiving it as an adverse impact on the existing landscape character or the values attributed to the current view.

The levels of visual impact significance are defined as:

- **Negligible visual impact** - only a very small part of the development will be discernible and/or it will be located at such a distance that it will be scarcely visible.
- **Low visual impact** – the development will constitute only a minor component of the wider view and might be missed by the casual observer; awareness of the development will not have a marked effect on the overall quality of the view.

- **Moderate visual impact** - the facility development may form a visible and recognisable new element within the overall scene and may be readily noticed by an observer.
- **High visual impact** - the facility development will form a significant and immediately apparent part of the view that will affect and change its overall character (the change may be positive or negative).

The level of visibility was confirmed by visiting the sections of public road and areas of waterway from which the site is visible. In addition, visual simulations of the dredge material placement facility were generated to assist in the assessment of potential visual impacts from potential view situations.

8.17.13.2 Existing Environmental Values

The dredge material placement facility is proposed to be located approximately 5.5 km from the LNG Facility, to the south of Laird Point in a low lying, well-sheltered valley area. The site has a predominantly westerly aspect, and is surrounded on three sides by vegetated ridges (north, south and east), separated by some lower lying sections (saddles). To the west the valley drains into of Port Curtis, with a margin of mangroves separating the intertidal part of the valley floor from the sea. The base of the valley is broad and predominantly comprises saltflats.

As a result of its enclosed nature, views of the dredge material placement facility will be limited to boats travelling between Fishermans Landing and The Narrows, and from the mainland from Fishermans Landing northwards. Fishermans Landing and the low hills to the south of the site provide a visual buffer to the dredge material placement facility when viewed from locations to the south of Fishermans Landing. Public access to the coast to the north of Fishermans Landing is limited, and the mangrove fringe in this area provides a visual buffer in the lower lying areas. As a result, the only accessible mainland location from where the proposed site is visible is Landing Road (north end), to the northwest of Fishermans Landing.

Landscape Character Zones

This is described in detail in Section 8.12.3.1. However, in summary, a number of Landscape Character Zones (LCZs) were identified as applicable to the site development, which are described below. LCZs are areas that are relatively consistent in terms of their combination of landform, vegetation, land use and development and they provide a broad baseline landscape context in which the dredge material placement facility will be located. The dredge material placement facility location is characterised as LCZ2 with the surrounding area characterised as LCZ1 (as shown in Figure 8.12.1). These LCZs are briefly described below.

- LCZ1 - Forest-Covered Hills and Ridges: slopes and high elevation landforms with natural forest cover, natural landscape character with no buildings and structures (see Plate 8.17.1)
- LCZ 2 - Mangroves and Tidal Mud-flats: flat landform in tidal zone along shoreline visible from waterways and adjoining sections of foreshore; created by tidal fluctuation covering the lowest elevation areas with water during high tide; containing mangrove stands which provide some visual screening to views from surrounding areas (see Plate 8.17.2).

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Plate 8.17.1 Forest Covered Hills and Ridges on Curtis Island (LCZ1)

Plate 8.17.2 Mangroves and Tidal Mudflats on Curtis Island (LCZ2)

Landscape Character of the Dredge Material Placement Facility

Viewed from the west, the dredge material placement facility site is characterised by coastal flats, backed by a visually prominent tree-covered central ridge. These natural landforms are generally seen in the context of the water surface of Gladstone Harbour and Port Curtis, which contribute to the visual quality of many views.

The visual character of the dredge material placement facility site reflects a particular combination of landform and natural vegetation. The valley landform of the site is defined by a prominent hill to the north and a series of lower hills that extend east and south around the valley saltflats to the shoreline. The extensive tree cover on the hills surrounding the site, and foreshore mangroves, together with the absence of structures or buildings, result in the site having a very natural landscape character.

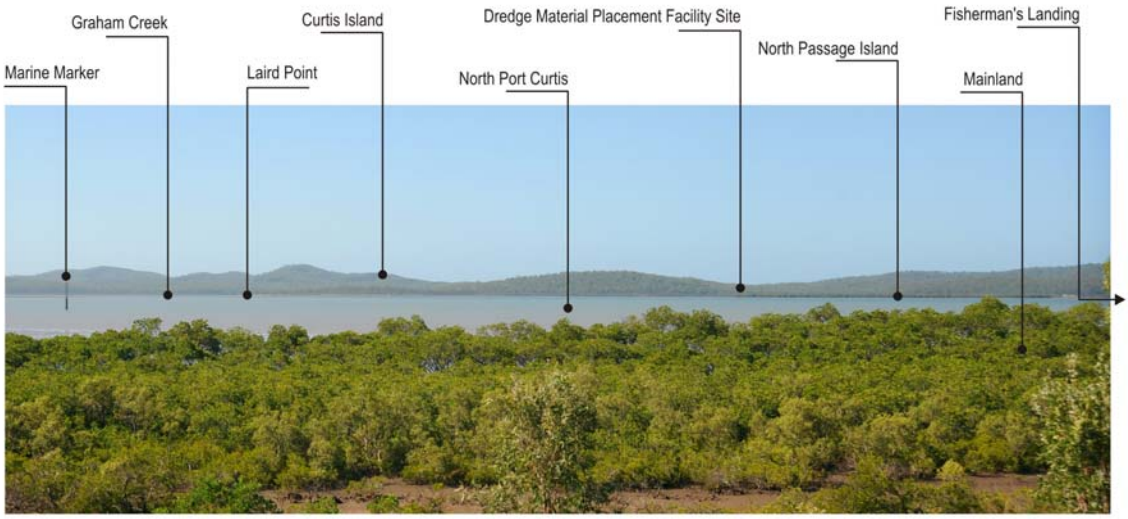

Plate 8.17.3 and Plate 8.17.4 below, photographed from the Landing Road (north end) foreshore on the mainland and from a vessel in Northern Port Curtis respectively, illustrate the natural landscape character of the area and indicate the approximate location of the development.

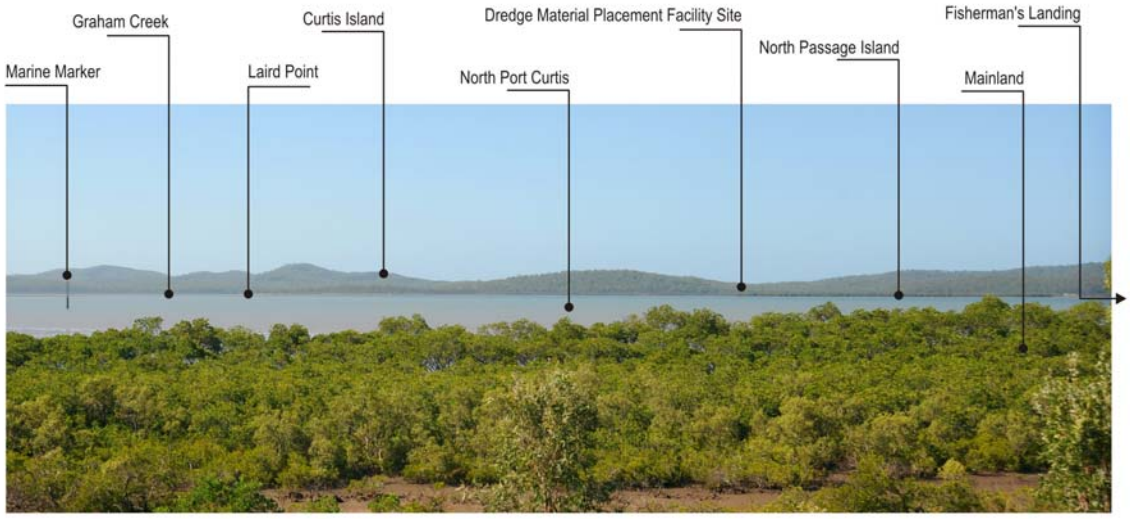

Plate 8.17.3 View to Facility Site on Curtis Island (looking east from Landing Road, north end))

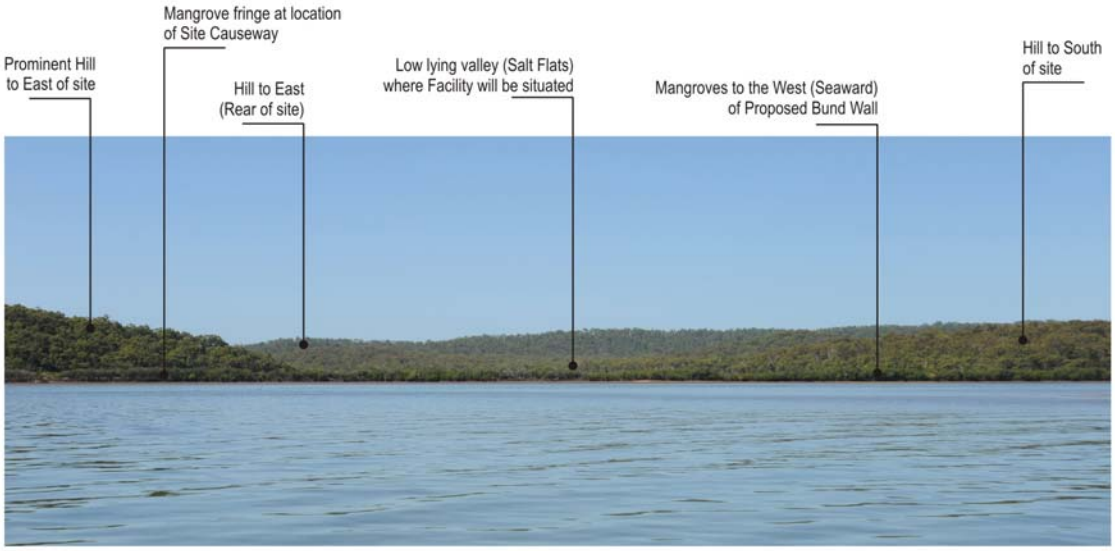

Plate 8.17.4 View to Facility Site from Northern Port Curtis (looking east from a position to the north of North Passage Island)

Landscape Quality and Significance of the Site

Quality

The scenic quality rating of the dredge material placement facility location on Curtis Island is considered to be high, as is that of the LNG Facility site located to the south (and discussed in Section 8.12). This assessment is based on factors including landform components, vegetation and water characteristics, influence of adjacent scenery, scarcity, and cultural modifications to the landscape. Section 8.12.3.3 provides more detail on the landscape quality of the area.

Significance

At the local level, the dredge material placement facility site is significant as it is currently undeveloped and is dominated by the natural landscape of the western coast of Curtis Island. This part of Curtis Island can be viewed to the east from the Landing Road (north end) foreshore and from boats on Northern Port Curtis. As with the LNG facility site, the dredge material placement facility site is significant at a regional level due to its location on a visible portion of Curtis Island, which is a significant natural feature of the Gladstone regional landscape (refer Section 8.12.3.4). It is not, however, located within a landscape that is significant at a national and international level. Although the dredge material placement facility is located within the GBRWHA (which is of national and international significance), the site is encompassed within the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA).

Capacity of Site to Visually Absorb Change

In general, the natural landscape character of the dredge material placement facility site limits the capacity for it to visually absorb significant change. The construction of bunds higher than the existing tree layer (approximately 18 m ADH) will introduce a man-made element that contrasts with the adjacent seaward mangrove forests and the surrounding tree covered slopes. However, the hills which define the eastern, northern and southern edges of the low lying valley in which the facility will be located generally block views from most directions, except from the west. As a result, the site has significant capacity to visually absorb change in relation to views from the east, north and south given that structures will not extend above the level of the adjoining landforms. Views of the site from the west have the capacity to

visually absorb some change, due to the occurrence of mangrove margins located seaward of the main bund, which will screen views of the lower parts of the bund.

8.17.13.3 Potential Impacts and Mitigation Measures

Section 8.17.3 above, provides a discussion on the construction of the dredge material placement facility. In summary the key visual elements created by the construction of the facility are:

- Construction of a main bund (from rock, sand and clay) on the western side of the site to a height of 18 m AHD (and three smaller bunds) in two or more phases over the first year of construction.
- Development over 18 to 24 months of the facility covering an area of approximately 120 ha, providing air space for approximately 13.2 million m3 of dredge material.

Figure 8.17.2 presents the proposed dredge material placement facility location and identifies the bund locations.

The development of the facility, which will include a small rock causeway on the shore, will result in disturbance to the lower lying saltmarsh communities, margins of the mangrove areas and also terrestrial woodland, elevating the ground surface over the area of the facility by up to 18 m. The construction of the main bund wall will provide the main visual intrusion, with the majority of activities being undertaken behind this screen once it is constructed.

View Situations/View Sheds and Visibility

As noted earlier in this section, views of the dredge material placement facility will be limited to the west, due to the enclosing nature of the landscape. As a result, only two view situations were identified for the dredge material placement facility site:

- Landing Road (north end) foreshore (view situation 22 on Figure 3-1 EIS Appendix W); and
- The Northern Port Curtis (The Narrows shipping channel) (view situation 24 on Figure 3-1 EIS Appendix W).

The view shed from Landing Road (north end) foreshore encompasses the open water of Northern Port Curtis and much of the western/south-western coast of Curtis Island. Visibility of the dredge material placement facility site however, will be limited from the Landing Road (north end) foreshore as a result of the long distance across the channel to the site (approximately 5 km) and the screening effect of vegetation, both on the foreshore itself (shrubs and tall trees) and on the seaward side of the facility main bund (mangrove) and by North Passage Island.

Views from vessels on Northern Port Curtis will depend on their proximity to Curtis Island, but will in general be across a shorter distance (less than 5 km). Vessels moored at Fishermans Landing wharf are anticipated to have a view of the dredge material placement facility bund, which is limited due to landforms to the south of the site and the location of North Passage Island. Vessels operating to the north or east of North Passage Island or in the vicinity of Friend Point will have views of the main facility bund which are limited to some degree by the hill to the north and mangroves on Curtis Island shoreline.

Significance of Potential Visual Impact

For each of the two view situations above, significance of the potential visual impact of the dredge material placement facility was assessed using the criteria and matrix presented in Tables 8.12 5 and 8.12 6.

Landing Road (north end) Foreshore - View Situation 22

The view distance from the Landing Road (north end) foreshore to the dredge material placement facility site was assessed as long, (approximately 5 km), with the period of view determined to be short to moderate term (less than 1 minute to 2 hrs). The number of viewers was determined to be very low to low (less than 100 to 1,000 people per day), depending on usage of the area, which appears to be low at

present. The magnitude of visibility impact (as defined in Section 8.17.13.1) therefore was assessed as being negligible.

Viewer sensitivity at this view situation was determined to be low as the majority of viewers are likely to be motorists commuting to and from work, possibly at Fisherman's Landing wharf.

The significance of potential visual impact at the Landing Road (north end) foreshore was therefore determined to be negligible (only a very small part of the development will be discernible and/or it will be located at such a distance that it will be scarcely visible) (refer Table 3-6 EIS Appendix W).

The Northern Port Curtis (The Narrows shipping channel) - View Situation 24

The primary view situation from which the dredge material placement facility will be visible is from vessels travelling within Northern Port Curtis or moored at Fisherman's Landing wharf. The likely level of significance of visual impact for crews and passengers on vessels will vary depending on the nature of their activities and their location.

The view distance from vessels will vary from long (5 km) to very short (less than 200 m) depending on their location in Northern Port Curtis. However, it can be assumed that the majority of vessels (and thus viewers) would operate within the deep channel, giving a medium view distance to the site of 1 to 5 km. The period of viewing will vary depending on the activity, and for tourism and other commercial operations undertaken in Northern Port Curtis area (including fishing) it was assumed that the view period would be 2 hrs or less (moderate term). The number of viewers would be low (100 – 1,000 people per day). The magnitude of visibility (as defined in Section 8.17.13.1) therefore would be low. Viewer sensitivity depends on location, expectations and activity and would vary in this case from high sensitivity for tourists sight-seeing in Port Curtis to low for commercial fisherman operating in the area.

Based on a high level of sensitivity and low magnitude of visibility, the significance of potential visual impact to viewers on Northern Port Curtis was determined to be **moderate** (refer Table 3-6 EIS Appendix W).

Visual Simulations

Visual simulations of the potential dredge material placement facility have been prepared. The simulations present a view looking east from Landing Road (northern end) and for Northern Port Curtis, and a simulated main bund for the dredge material placement facility has been simulated. Two simulations provide for the recently constructed bund wall, and for a vegetated bund wall after a number of years of vegetation growth.

Plate 8.17.5 Visual Simulation Looking East from Landing Road towards Curtis Island with the Dredge Material Placement Facility (following construction of main bund)

Plate 8.17.6 Visual Simulation Looking East from Landing Road towards Curtis Island with the Dredge Material Placement Facility (following vegetation of main bund wall)

Plate 8.17.7 Visual Simulation Looking North from Northern Port Curtis towards the Dredge Material Placement Facility (following construction of main bund)

Plate 8.17.8 Visual Simulation Looking North from Northern Port Curtis towards the Dredge Material Placement Facility (following vegetation of main bund wall)

Potential cumulative visual impacts have not been discussed in this section, but are discussed in Section 8.12.4.4.

Mitigation Measures

As discussed above, the significance of the potential visual impact will vary from moderate to negligible. Visual impact during construction is expected to be greater than during the ongoing life of the completed facility due to the need for machinery and personnel on site to complete the works, and the exposed soil surfaces. Vegetation clearance will predominantly be in the lower lying areas initially, until the first phase of the main bund is constructed (to approximately 10 m AHD), which will then provide visual screening for ongoing activities. The visibility of the bund itself will be dependant on the colour of the facing material. Bund construction material will include rock and sand, but the exterior of the bund will overtime become vegetated, providing a more natural appearance. Mitigation measures will, however, be implemented to mitigate the potential visual impact of the operational dredge material placement facility. Such measures will include:

- Establishing a vegetation cover on the seaward slope of the main bund to reduce the contrast of the facility with surrounding vegetation and to blend into the existing landscape;
- Revegetating areas (such as construction roads) disturbed by construction activities once construction is complete; and
- Rehabilitating areas disturbed by decommissioning of the rock causeway as required.

Once the revegetation works have been undertaken and vegetation cover has been established on the bund wall, it is anticipated that the visibility of the dredge material placement facility from view situations identified above will substantially reduce, as will the potential visual impact.

8.17.14 Cultural Heritage

8.17.14.1 Indigenous

The Indigenous culture heritage values of the site will be managed in accordance with an agreed Cultural Heritage Management Plan (CHMP). Refer to Section 8.13 for a description of this process.

8.17.14.2 Non Indigenous

To assess potential impacts on sites of non indigenous cultural heritage within the footprint of the dredge material placement facility, a review of the following was undertaken:

- Previous GLNG EIS search results conducted for all of Curtis Island; and
- Additional searches of selected national, state and local authority registers (e.g. Register of the National Estate, Commonwealth Heritage List, National Heritage List and World Heritage List, Queensland Heritage Register and local council schedules).

No sites were identified as being listed within the vicinity of the dredge material placement facility, or the southern half of Curtis Island other than sites of natural significance (i.e. Environmental parks).

8.17.15 Social and Community

Available information from stakeholders indicates that the area around Laird Point and Graham Creek warrants maintaining in its present state. Individuals have undertaken selected beatification works, including planting trees and supplying picnic benches, tables and barbecues.

Recreational and commercial fishing is popular in the area, with a high participation rate within Port Curtis (Connolly et al., 2006) as evidenced by the long term establishment of a number of recreational fishing clubs, such as the Yaralla Fishing Club (mainly fishing in offshore waters of the Capricorn Bunker Group) and the Wanderer's Fishing Club (operating mainly in inshore locations within Port Curtis).

Commercial fishing is known to occur in the vicinity of the site, however commercial catch data is not sufficiently detailed to identify specific fishing areas. An established mud crab fishery exists in Port Curtis and it is thought to be one of the largest in Queensland, with about eight commercial fishers operating in the harbour (pers comm. Steve Platt, QBFP Gladstone).

Much of Gladstone around the Calliope River up to Fisherman's Landing is reclaimed land that was built from dredge material. Therefore, the disposal of dredge material is not a new concept in the area.

Potential impacts from the construction and operation of the facility include:

- Loss of access to the area for recreation purposes; and
- Off site impacts from the management of the dredge material including disruption or interference to fishing and recreational activities in the area. This could primarily occur during construction, when the bulk of the dredge material will be transferred.

Santos will consult with relevant stakeholders and provide information on the site selection process. The focus will be on project issues relating to material placement, logistics, economics and disruption to marine traffic plus any other issues of concern as raised by stakeholders during the consultation program. Santos will also continue to consult directly with State Government on site issues and alternatives stemming from the master planning process currently under development by GPC. Commitments made through the consultation process will be formalised in the DMP.

As part of the facility rehabilitation process the opportunity to beneficially reuse the site as industrial or buffer land will be investigated in consultation with relevant stakeholders.

8.17.16 Rehabilitation and Decommissioning

No specific rehabilitation and decommissioning study has been undertaken for the proposed dredge material placement facility. Conceptual design and operational details are discussed in the "Laird Point Placement Facility Concept Design (HR Wallingford 2009)" which is provided in Appendix DD. At this conceptual stage, a program of rehabilitation for the facility (once filled) has not been developed. A rehabilitation procedure will be developed in conjunction with regulatory agencies and other relevant stakeholders prior to closure and incorporated into the DMP.

It should be noted that final use for the dredge material placement facility could include industrial or buffer land within the Curtis Island Industry Precinct of the Gladstone State Development Area (GSDA).

8.17.17 Summary of Findings

The following section provides a summary of relevant findings for the assessments undertaken relating to material dredging and construction and operation of the dredge material placement facility. It includes some general mitigation measures related to minimising the potential for impacts on the environment. However, it should be noted that the proposed dredging and facility activities are at a conceptual stage and specific mitigation measures have not been fully developed. The DMP, to be completed following the EIS in accordance with the ToR, and coordinated with the final design of the activities and facilities, will incorporate a table of specific mitigation measures.

The Queensland Government is currently undertaking a master planning exercise to ensure a coordinated approach to the planned development of Port Curtis, including the dredging and dredge material placement activities required for future development, including the LNG precinct on Curtis Island and the further development of Fisherman's Landing. In parallel with this process the GPC have commenced the planning and environmental assessments required to implement a project which will deliver the dredging required for the first stages of this development. The GPC project proposes a single dredge material placement area of sufficient capacity to accommodate the combined dredge material from all of these projects. Santos and other relevant stakeholders are participating in the plan development with the Queensland Government. The cumulative impacts of the proposed dredging and dredge material placement will be assessed as part of this ongoing process.

8.17.17.1 Dredging and Facility Development

Detailed management and mitigation measures for dredging and dredge material placement will be developed and provided in the DMP. This DMP will be prepared in accordance with the EPA's Coastal Development Guideline: Approval of a Dredge Management Plan). The DMP will describe in detail, the activities and the management measures to be implemented and will need to be approved separately to the EIS before dredging could commence. It will include:

- Specific details on the dredging methodology,
- Dredge material placement facility design (including detailed design plans for the various stages of development) and operational details;
- A water management strategy including assessment of dredge material settlement rates, residence time within settling ponds and modelling of sediment plumes within discharge waters to ensure that water quality objectives and receiving water environment values are maintained;
- Operational procedures to limit channelling and sediment re-suspension in settling ponds, and erosion and sediment re-suspension during discharge; and
- Mitigation, contingency and monitoring measures designed to ensure that water quality and other environmental objectives are met and appropriate actions are planned for and undertaken in the event of upset conditions.

Conceptual plans for the dredging and dredge material placement facility have been developed for the EIS. However, prior to the development of the DMP for these activities, some further studies will be undertaken to fully understand the site and potential construction and operational issues, including geotechnical and possibly drainage studies.

Effective management of discharge water back into the marine environment is key to the operation of the facility, and a thorough understanding of background levels of suspended sediment and turbidity in the waters adjacent to Laird Point will be required. Additional monitoring and assessments including modelling will be undertaken as part of the DMP controls.

If the dredge material pipeline route is to cross land, a suitable route will be refined to minimise the potential impacts, and permissions from landholders obtained during the DMP process.

8.17.17.2 Traffic and Transport

The transport of materials and equipment to the dredge material placement facility will have limited duration (3-6 months) and intensity, when compared to the overall project. By sourcing the rock and other construction material locally on Curtis Island, the transport of materials from the mainland will be minimised.

Mitigation measures to reduce marine transport traffic for the project have been identified, including the use of worker accommodation for the LNG facility on Curtis Island. This will reduce ferry transport for the overall project. However, the dredge material placement facility will require the daily ferrying of workers to and from the site. To reduce the impact of this on overall transport movement in the area, ferries to the dredge material placement facility construction site should be scheduled in coordination with other LNG facility activities.

8.17.17.3 Land, Terrain and Soils

The dredge material placement facility is located in a broad, low lying valley area of saltflats, with elevated areas to the north, south and east. It opens onto Port Curtis, where a margin of mangroves separates the valley floor from the sea. Soils in the area are characterised by deep soft saline clays, silt and muddy sands on the estuarine flats, deep uniform clay and silt loamy surface duplex soils on the alluvial flats, and gravelly loamy surface duplex soils and gravelly clay soils on the lower hill slopes.

Potential Acid Sulfate Soils (PASS) are located on the site and will require management via an acid sulfate soils management plan.

Construction of the placement facility will include stripping of surface soils and use of suitable underlying soil/rock materials from within the facility footprint to construct the bund walls. The management of this material, including mitigation measures to minimise off-site impacts such as erosion and sedimentation, will be detailed in the DMP. The DMP will also include measures to address potential acid sulfate soil impacts, including the development of an acid sulphate soils management plan if required.

8.17.17.4 Terrestrial Flora

Areas of vegetation communities associated with a number of REs, including saltpan community, mangrove scrubland, eucalyptus woodland and grassy woodland are present in the footprint of the dredge material placement facility, and will be lost as a result of the development. Each of these REs represents a small fraction (ranging from 0.02% to 0.6%) of the respective REs present within the sub-region.

Mitigation measures to reduce the impact upon the REs in the area that will remain around the facility will include: development of a biodiversity offset strategy (in consultation with DERM and DEWHA) for Endangered/Of Concern vegetation communities; and development of a DMP and EMP to manage potential impacts on the terrestrial environment resulting from construction and operation of the dredge material placement facility.

Further mitigation measures for impacts upon terrestrial vegetation are discussed in Section 8.4 and include the management of dust impacts, vegetation clearing schedules and rehabilitation plans. Further detail regarding potential impacts and mitigation measures are provided in Appendix G.

8.17.17.5 Terrestrial Fauna

A low diversity of vertebrate fauna has been recorded during fauna surveys within similar habitats along the southwest of Curtis Island. The typical Eucalyptus and Corymbia woodlands on the site's slopes and alluvial plains is present throughout the south-west coast of Curtis Island and has been impacted by grazing, clearing , cropping and selective logging.

A number of potential conservation significant species could be present in the region, but only the beach stone curlew, and sooty oystercatcher were recorded during related surveys on Curtis Island, and neither near to the site, although habitat may be suitable.

Habitat suitable for the water mouse is present in the area around the site, and along most of the coast in this area, although no definite evidence of the water mouse was found. Low numbers of wader/shorebird species were observed and habitat values appear to be low for many species due to low foraging potential.

Construction of the facility may remove available habitat for any local populations of water mouse. Where suitable habitat for the water mouse could be disturbed, targeted trapping surveys will be conducted to confirm the presence/absence of the species. If habitat is found to support water mouse populations then the proponent will minimise disturbance of these areas as far as practicable.

The foreshore/intertidal zone areas outside of the immediate zone of works will be protected so that habitat loss is minimised. The newly created shoreline is to be constructed so that slope and substrate is conducive to mangrove colonisation. In the event that activities may impact on potential wader bird habitat, a more detailed study will be conducted to ascertain the use of the study area by wader species, particularly in regards to use of the area for roosting at high tide.

8.17.17.6 Marine Ecology

Dredging activities and the construction of the dredge material placement facility will impact on the marine and intertidal zone with subsequent loss of marine fauna and flora. Localised impacts on water quality may result from the associated discharges, which have the potential to impact on foraging dugongs and turtles, although monitoring and controls will limit this potential. Reducing the footprint of the facility, through use of an elevated bund wall will minimise the loss of intertidal area and effective management of the discharges will minimise impacts on the local marine environment.

Santos will develop a DMP and Environmental Management Plans to manage potential impacts to the marine environment resulting from dredging, construction, and management of the placement facility.

8.17.17.7 Surface Water

The impacts of discharges to the marine environment during dewatering of the dredge material can be managed and controlled to ensure that waste discharges meet suitable guidelines, based on other similar activities in the port, such as those at Wiggins Island Coal Terminal reclamation.

The potential failure of the proposed 18 m high containment embankment could result in dredge material being released to the local marine environment. Effective management of water is essential to the integrity of the embankment, and appropriate measures will reduce the potential for collapse. The facility and embankment will be designed, constructed and operated in accordance with accepted standards to minimise the likelihood of failure.

A dam hazard evaluation characterised the facility at the “significant hazard” level, and will thus require commensurate design and construction.

8.17.17.8 Groundwater

The groundwater resources in the area are of poor ambient quality, have little or no current usage, and have restricted future development potential. Based on the evaluation of the groundwater resources it is recognised that only limited to low levels of groundwater protection are required. The inclusion of groundwater protection measures in the final dredge material placement facility design will allow for an acceptable reduction of the risk to groundwater resources.

8.17.17.9 Coastal Processes – Marine Sediment

Recent and historic sediment studies around the dredging area indicate that levels of nutrients, organic compounds, and radionuclides are either below the screening levels of the guidelines adopted for the studies or were below the LOR, or both, although naturally occurring metals appear elevated. No AASS was identified although limited areas of PASS were identified, but generally there is available ANC from shells and foraminifera in the sediment.

The proposed management or treatment of dredged material must take into consideration the presence of naturally occurring levels of metals in the marine sediments as well as the acid neutralising capacity of the marine sediments. Metals inherent in the dredged material may be mobilised from either sorbed metals or dissolved metals in the dredge material slurry waters, potentially posing a risk to any receiving environment where dredging waters are released. Also, if not properly managed, over neutralisation may lead to flocculation of dissolved metals in leachates from dredged materials or in dredging waters. A leachate and discharge monitoring program will be established as part of the DMP to mitigate risks of potential metal mobilisation or flocculation in the receiving waters.

8.17.17.10 Air Quality

Potential impacts from the construction of the dredge material placement facility include dust emissions from earthworks activities and combustion pollutants from vehicles operating on the site. These impacts are likely to be minor and restricted to the site. Activities will be managed though the DMP to minimise these effects through strategies similar to those for the LNG facility.

8.17.17.11 Noise and Vibration

Noise impacts on sensitive receptors will be insignificant based on the results of modelling undertaken.

8.17.17.12 Land Use

The dredge material placement facility, once completed, may be suitable for a variety of future land uses, including industrial or environmental buffer. Future uses will need to comply with relevant State Planning Policies and guidelines.

8.17.17.13 Visual

The significance of the potential visual impact of the dredge material placement facility will vary from moderate to negligible, depending on the view location and phase of the development. The facility will be visible from limited locations due to its aspect and its nature, being within an enclosed valley. As a result it will be visible from a limited stretch of coast to the north of Fisherman's Landing and from the Northern Port Curtis. During construction it is expected to have a greater visual impact than during the ongoing life of the completed facility, when the bund will be vegetated.

Mitigation measures for the potential visual impact will include: establishment of vegetation cover on the seaward slope of the main bund to blend it into the surrounding landscape; rehabilitation of disturbed areas such as roads and the causeway. The rehabilitation will be developed as part of the rehabilitation procedures (see Section 8.16).

8.17.17.14 Cultural Heritage - Non Indigenous

No sites of heritage value are present in the area of the site.

8.17.17.15 Cultural Heritage – Indigenous

The development of the site will be undertaken in accordance with the applicable Cultural Heritage Management Plan.

8.17.17.16 Social and Community

Potential impacts from the construction and operation of the facility include loss of access to the area for recreational purposes and disruption or interference to fishing and recreational activities in the area. Santos will consult with relevant stakeholders on project issues relating to material placement, logistics, economics and disruption to marine traffic plus any other issues of concern as raised by stakeholders during the consultation program. Santos will also continue to consult directly with State Government on

site issues and alternatives stemming from the master planning process currently under development by GPC. Commitments made through the consultation process will be formalised in the DMP.

8.17.17.17 Rehabilitation and Decommissioning

The dredge material placement facility will be decommissioned and rehabilitated for beneficial use, which could include industrial or buffer land. Rehabilitation procedures will be included in the DMP and will be developed following consultation with stakeholders, including regulatory agencies.