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Mainland Marine Facilities

Santos | PETRONAS

Report

GLNG Mainland Marine Facilities

NOVEMBER 2009

Prepared for

Santos

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URS

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Introduction and Background

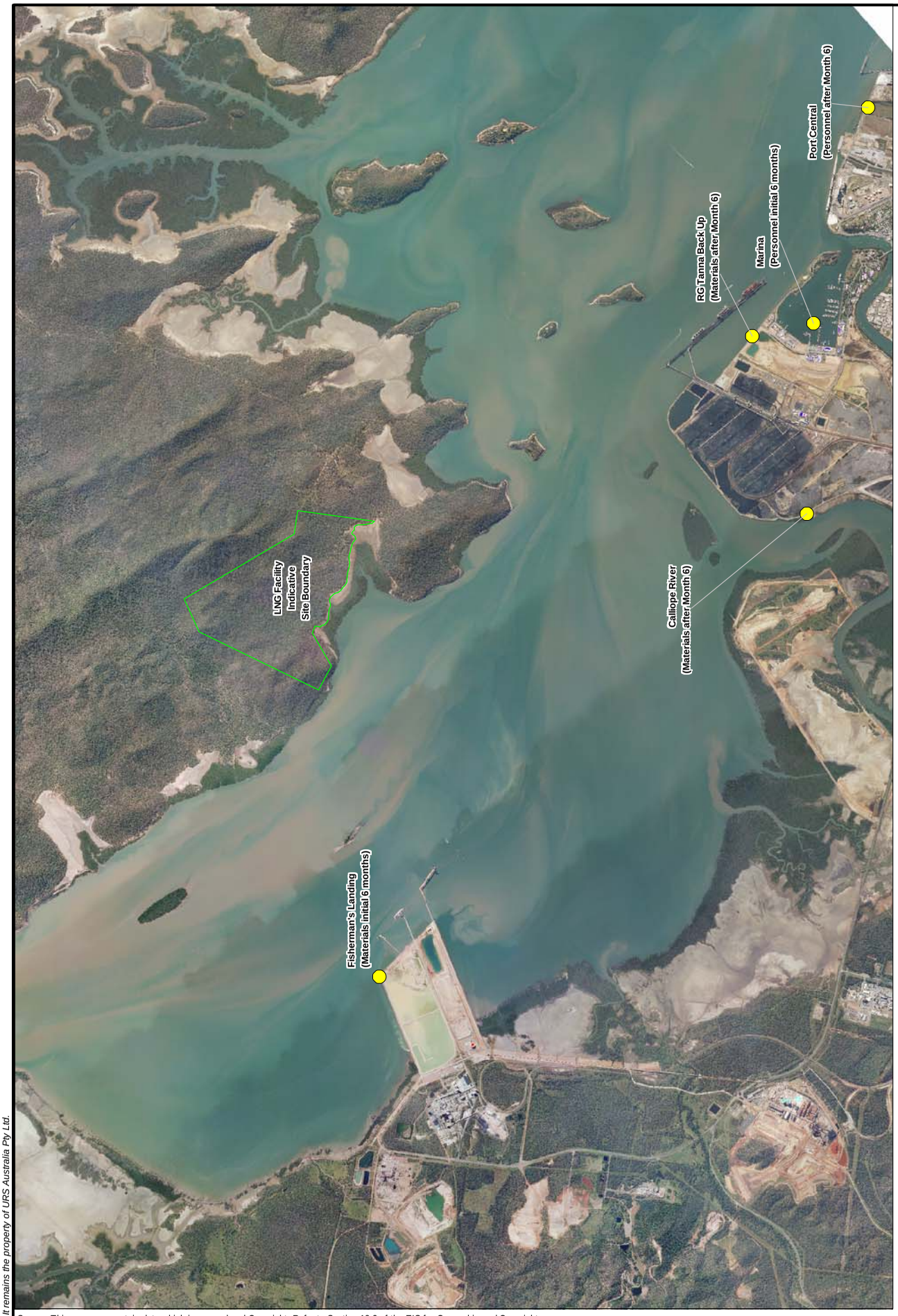
Santos Limited (Santos) and its joint venture partner PETRONAS are proposing to develop their Queensland Coal Seam Gas (CSG) resources in the Bowen and Surat Basins as feed gas for a Liquefied Natural Gas (LNG) liquefaction and export facility on Curtis Island, near Gladstone, Queensland.

The LNG facility proposed for Curtis Island is intended to be accessed either by construction of a road and bridge from the mainland (Gladstone) or by barge/ferry. If the bridge is built, it is not expected to be available for use until after the construction of Train 1. Hence, during this period, construction material, equipment and personnel will be transferred from the mainland to Curtis Island by the barge/ferry operations.

In the Environmental Impact Statement (EIS) it was proposed that the material and equipment would be barged to Curtis Island from Auckland Point (Port Central). Most of the imported equipment (approximately 80%) was to be unloaded at the Materials Offloading Facility (MOF) directly from export vessels. The balance of the imported equipment was to be unloaded at Port Central and store in a secured laydown area adjacent to the wharf. It was then to be loaded onto contracted barges for transfer to the MOF on Curtis Island.

In regards to personnel movements the EIS proposed that all workforce ferries were to leave from Port Central. The EIS stated that if the bridge was not built, site access for the construction of Trains 2 and 3 were to utilise the transport methods described above.

Since the release of the EIS, and in response to stakeholder concerns about the use of Port Central for the transport of personnel and materials, a draft transport and logistics strategy has been developed. In the first six months material and equipment will be barged from Fisherman's Landing and personnel from the Gladstone Marina. During this initial six month period, permanent facilities will be constructed so that material and equipment departs from either a site located on the south bank of the Calliope River or alternatively the RG Tanna facility (this is still to be confirmed) and personnel will travel from Port Central. Refer to Figure 1-1 for reference to these locations.



Client

Project
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
MAINLAND MARINE FACILITIES ASSESSMENT

Title
PROPOSED GLADSTONE MAINLAND MARINE FACILITIES

Drawn: RG	Approved: JB	Date: 19-10-2009
Job No: **4262 6440** /6220	File No: 42626440-g-2135.wor	

Figure: **1-1**

Rev:A

A4

2

Description of Proposed Activities

2.1 Daily Marine Traffic Movements to/from Curtis Island

Santos has based this assessment on the assumption that at the peak of activities, on any given working day the following approximate volumes of traffic will pass between the Port Central facility and Curtis Island; and the Calliope River facility and Curtis Island.

- The shipping channel between Port Central facility and Curtis Island:
  - Ferries: two ferries will be scheduled to operate two return trips each in the morning and evening. This equates to a total of 16 channel crossing each work day; and
  - Water Taxi: one water taxi will be scheduled to operate eight return trips every day. This equates to 16 channel crossings each work day.
- The shipping channel between Calliope River barge ramp facility and Curtis Island:
  - Standard Dumb Barges: three standard dumb barges will be scheduled to operate three return trips every work day. This equates to 18 channel crossings each work day.
  - Raw Material Bulk Cargo Dumb Barges: one raw material bulk cargo dumb barge will be scheduled to operate two return trips each work week. This equates to four channel crossings each week or on average one per day.

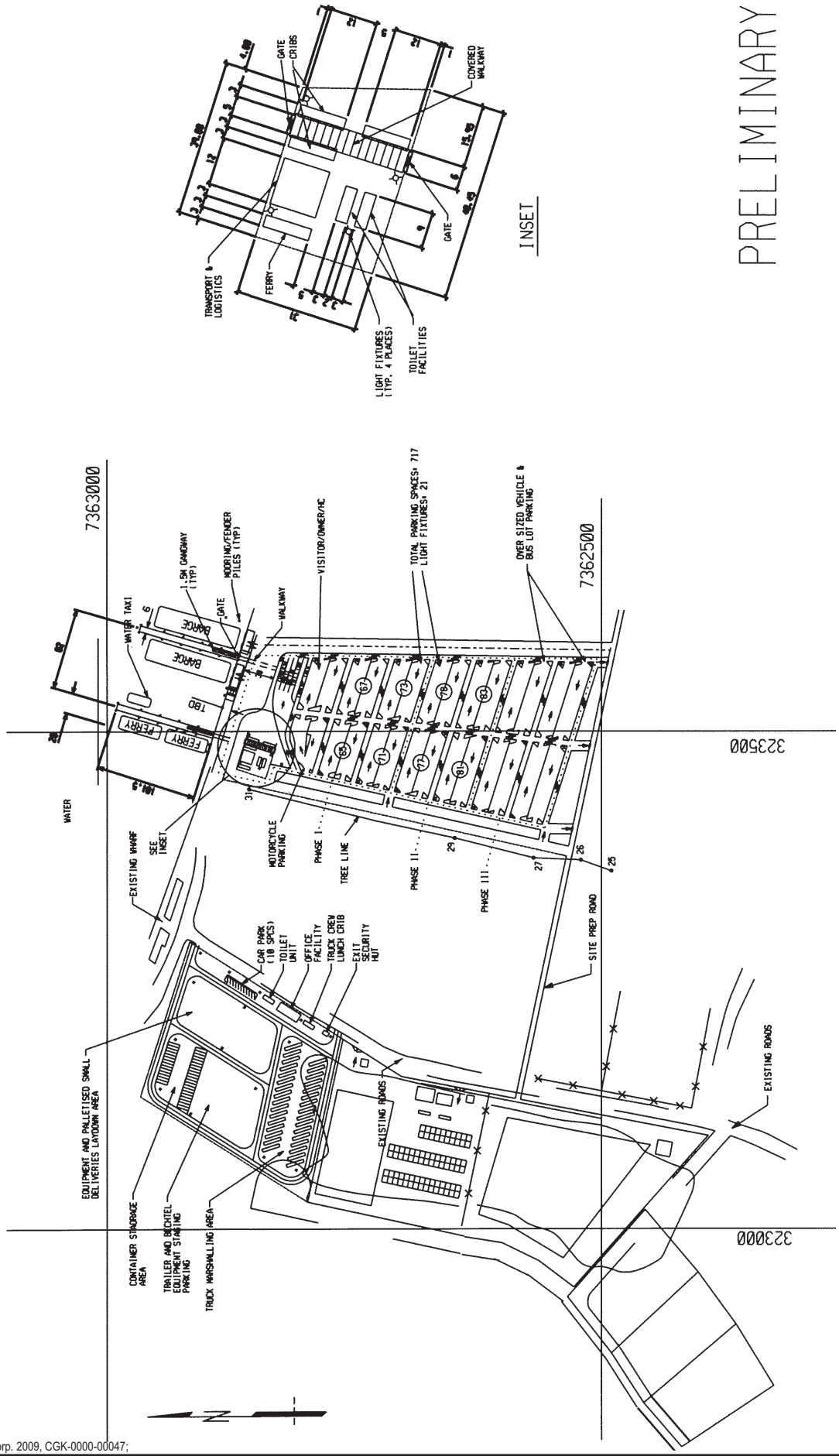
Based on the above assumptions, an average of 51 channel crossings is estimated to occur every work day (note that this does not include tug movements starting from or returning to the tug mooring points at the start and end of each day).

2.2 Personnel Movements to/from Curtis Island

2.2.1 Initial six months

Santos proposes to utilise the existing ferry terminal within the Gladstone Marina while developing a long term facility at Port Central (Lot 300 Auckland Point). Refer to Figure 1-1 for location. A temporary car park will be allocated during this initial six month period. The location of this car park is yet to be determined; however ideally it will be located at a sufficient distance from the Marina not to cause any local traffic congestion. Depending on the location, a shuttle bus service to the marina may also be required.

It is proposed to utilise the existing ferry operators located within the marina for the initial six month period. Existing operators have access to 12, 25 and 170 person ferries already moored within the marina. The 12 and 25 person ferries are considered appropriate for transferring personnel to the landing facilities at Hamilton Point on Curtis Island. However, a new temporary ferry terminal will be required to facilitate landing and safe demarcation of personnel from the 170 person ferry during all tidal variations. During the first four months, ferry services will mostly be operating between 5.30 am and 7.00 am in the morning and 4.30 pm and 6.00 pm in the evenings, Monday through to Saturday. A small “water taxi” (12 seat capacity) will also be utilised throughout each working day, Monday through to Saturday. Four months into construction, ferry hours will be extended approximately two hours to cater for the shift change for bulk earthworks operations (i.e. 5.00 am to 7.00 am in the mornings and 4.30 pm to 6.30 pm in the evenings), Monday through to Saturday.



Source: Bechitel Corp. 2009, CGK-0000-00047;

Client: LNG	Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT MAINLAND MARINE FACILITIES ASSESSMENT	Title: **PORT CENTRAL FERRY TERMINAL**
URS	Drawn: LL | Approved: JB | Date: 11-11-2009 Job No.: **4262 6440** /6220 | File No. 42626440-g-2184.cdr	Figure: **2-1** Rev A A4

The following temporary facilities will be provided at the marina:

- Undercover ferry waiting area;
- Ablutions (various locations);
- Ferry operations office (existing); and
- Site control /security office.

2.2.2 After month six

After the initial six months of construction, Santos proposes to utilise the new ferry terminal at Port Central (at Auckland Point) for transferring personnel from the mainland to Curtis Island. This is shown in this report in Figure 2-1.

Santos will utilise the ferry terminal at Port Central by further developing the existing facilities.

For those who live in Gladstone and choose to drive to the Port Central facility, a short term daily car park will be provided. For those who do not live in Gladstone and choose to drive to the Port Central facility a long term car park will be provided. The location and size of the long term car park has not yet been identified but preferably will be located somewhere on route between Port Central and the Gladstone Airport. A shuttle bus service will be provided to transport personnel between the long term car park and Port Central. Sufficient bus pick up and let down areas will be established at the Port Central facility for shuttle buses and scheduled bus services. Up to 40 buses are anticipated to be required during the daily peaks.

The ferry terminal will be sized to adequately berth a number of ferries/taxis (20-60 seat) and at least two large (250-300 seat) personnel transfer ferries at peak times.

A general barge ramp will be constructed at the Port Central facility for transporting specific bulk materials or construction equipment from the mainland to Curtis Island. The barge ramp will also be used for daily delivery services such as catering, diesel fuel and waste management trucks.

The following facilities will be provided at the Port Central facility:

- Undercover ferry waiting area;
- Ablutions (various locations);
- Site control/security office;
- Traffic and logistics office;
- Car parking (short term);
- Crib areas (various locations);
- Training/Induction facility;
- Visitor centre; and
- Ferry operations office.

2.3 Raw and Bulk Material Deliveries to Curtis Island

2.3.1 Initial six months

Santos proposes to utilise the existing barge load out facility at Fisherman's Landing, while the permanent Calliope River barge ramp and the Curtis Island barge ramp/ferry terminal is under construction (refer Figure 2-2). However, if Calliope River barge ramp not be ready in time, then an existing ramp at RG Tanna would be used for bulk materials.

Fisherman's Landing Barge Load Out Facility

(Initial 6 Month Period Only)

1. Hardstand Area Allocated to Other LNG Projects
2. Proposed GLNG Hardstand Area And Temporary Facilities (1.8 Ha)
3. Proposed Laydown Area & Truck Marshalling (1.3 Ha)
4. Fisherman's Landing Barge Load Out Facility
5. Proposed Haul Route
6. Alternative Haul Route

Temporary Facilities:

• Site Control Office	(18m2)
• T&L Office	(72m2)
• Crib Rooms	(72m2)
• Ablutions	(36m2)

Source: Google Earth Imagery 2009.

URS

Client: LNG

Project: GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT MAINLAND MARINE FACILITIES ASSESSMENT

Drawn: LL | Approved: JB | Date: 27-10-2009

Job No.: 4262 6440 /6220 | File No. 42626440-g-2167.cdr

Title: FISHERMAN'S LANDING BARGE LOAD OUT FACILITY

Figure: 2-2 | Rev. A | A4

2 Description of Proposed Activities

Raw materials such as road base, rock armour, rip rap, sand and concrete batch plant aggregates will be sourced from local quarries and stockpiled at a Fisherman's Landing hardstand area located at the rear entrance of the Cement Australia facility. Articulated dump trucks will then be used to transport reclaimed material from the stockpile and transfer this material to a dumb barge at Fisherman's Landing. Haul routes will be selected to align with or avoid the Gladstone Ports Corporation (GPC) truck operations planned for the area at the same time. Loaded articulated dump trucks will be transported via dumb barge to Curtis Island for unloading at the Hamilton Point landing site. Truck loading and hauling, barge movements and truck unloading activities on Curtis Island may operate on a 24 hour, six day per week basis.

Bulk materials such as rolls of geotextile and/or geogrid reinforced concrete pipes, box culverts, precast concrete headwalls, steel reinforcement bar, poly pipe and fittings, pumps, temporary construction utilities, waste water treatment plant, water tanks, construction water plant etc, will be sourced from Australian suppliers where possible and transported to Curtis Island on road transport trucks via dumb barges. Road transport trucks will be marshalled at a Fisherman's Landing hardstand area located at the rear entrance of the Cement Australia facility or along the Fisherman's Landing entrance road. As per raw materials, the haul routes will be selected to align with or avoid the GPC truck operations planned for the area at the same time. Santos will liaise with GPC about these arrangements. Transport of bulk materials to Curtis Island will be as per the raw material transport process discussed above. Empty road transport trucks will be returned from Curtis Island to Fisherman's Landing via dumb barge.

The following temporary facilities will be provided at Fisherman's Landing:

- Ablutions;
- Traffic and logistics office;
- Light vehicle car park;
- Crib rooms; and
- Truck marshalling area.

Preliminary estimates indicate that the operational time for a barge trip from loading of the first truck at Fisherman's Landing to offloading the last truck at Hamilton Point is approximately a 2.5 hours. The return trip would add another 1 to 1.5 hours, depending on whether or not the trucks returning were empty or full, resulting in a 4 hour cycle time.

2.3.2 After month six– Alternative 1

After the initial six months, raw and bulk material deliveries from the mainland to Curtis Island will use the new Calliope River twin barge ramp facility to be located behind Wiggin's Island (refer Figure 2-3). The same materials as outlined above (in Section 2.3.1) would transit through this facility to Curtis Island, but materials would also be transported from Curtis Island and stockpiled at this facility, including: merchantable timber, unsuitable soil, mulch and topsoil.

Calliope River Barge Ramps
(Raw & Bulk Material Transfer)

1. Topsoil Stockpile (12 Ha)
2. Mulch Stockpile (6 Ha)
3. Unsuitable Stockpile (2.5 Ha)
4. Temporary Facilities (2.5 Ha)
5. Aggregate/Sand/Rock Armour Stockpiles (1.5 Ha)
6. Road-base Stockpiles (1.5 Ha)
7. Barge Ramps

- Fenced Compound	(200m x 150m)
- Site Control Office	(18m2)
- T&L Office	(72m2)
- Crib Rooms	(72m2)
- Ablutions	(36m2)
- Car Park	(600m2)
- Truck Parking Area	(1000m2)
- Hardstand Area	(10,000m2)

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Source: Google Earth Imagery 2009.

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
MAINLAND MARINE FACILITIES ASSESSMENT

Drawn: LL | Approved: JB | Date: 27-10-2009

Job No.: 4262 6440 /6220 | File No. 42626440-g-2168.cdr

Title

CALLIOPE RIVER
BARGE LOAD OUT FACILITY

Figure: 2-3 | Rev. A | A4

The following facilities are proposed for the Calliope River barge ramp facility:

- Ablutions;
- Traffic and logistics office;
- Light vehicle car park;
- Crib rooms;
- Site control/security office; and
- Truck marshalling area.

The journey time from Calliope River barge ramp to Curtis Island is estimated to be the same from Fisherman's Landing to Curtis Island.

2.3.3 After month six – Alternative 2

As an alternative to the Calliope River barge ramp facility, a new barge ramp facility could potentially be built at RG Tanna facility to transfer raw and bulk materials from the mainland to Curtis Island (Refer Figure 2-4). GPC has advised Santos that the proposed location has already been allocated to another LNG project; however it is believed to be a relatively small area (still to be confirmed).

The following facilities would be proposed for the RG Tanna Barge ramp facility:

- Ablutions;
- Traffic and logistics office;
- Light vehicle car park;
- Crib rooms;
- Site control/security office; and
- Truck marshalling area.

The journey time from the RG Tanna facility to Curtis Island is considered the same as from Fisherman's Landing to Curtis Island.

2.4 Raw and Waste Material Removal from Curtis Island

2.4.1 Initial six months

Santos proposes: to utilise the existing barge load out facility at Fisherman's Landing for an initial six months while Port Central, Calliope River barge ramp and Curtis Island barge ramp/ferry terminal is under construction.

Raw and waste materials such as millable timber, excess subsoil, mulch and topsoil will be removed from Curtis Island and transported to the mainland. Articulated dump trucks and logging trucks will be used to transport materials from Curtis Island to the mainland via dumb barges. Loaded dumb barges will moor at the Fisherman's Landing barge load out facility for subsequent unloading onto trucks. Excess subsoils, mulch or topsoil, will be subsequently unloaded and stockpiled on a hardstand area to be located at the rear entrance of the Cement Australia facility. Loaded logging trucks will proceed to a reputable merchantable timber mill for milling. Haul routes will be selected to align with or avoid the GPC truck operations planned for the area at the same time. Truck unloading and hauling, barge movement and truck loading activity on the facility may operate on a 24 hour, six days per week basis.

1. PROPOSED BG QCLNG TRUCK MARSHALLING & TEMPORARY FACILITIES
2. PROPOSED BG QCLNG SCALES
3. PROPOSED BG QCLNG TEMPORARY FACILITIES
   A. SITE CONTROL OFFICE
   B. T & L OFFICE
   C. CRIB ROOMS
   D. ABLUTIONS
4. PROPOSED BG QCLNG BULK MATERIALS AREA (CRUSHED STONE & AGGREGATE)
5. PROPOSED BG QCLNG PROJECT BARGE
6. PROPOSED GLNG TRUCK MARSHALLING & TEMPORARY FACILITIES
7. PROPOSED GLNG SCALES
8. PROPOSED GLNG TEMPORARY FACILITIES
   A. SITE CONTROL OFFICE
   B. T & L OFFICE
   C. CRIB ROOMS
   D. ABLUTIONS
9. PROPOSED GLNG BULK MATERIALS AREA (CRUSHED STONE & AGGREGATE)
10. PROPOSED GLNG PROJECT BARGE
11. PROPOSED HAUL ROUTES
12. BARGE LOADER

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Source: Bechitel Corp. 2009, CGK-0000-00046; Google Earth Imagery 2009.

Client: LNG

URS

Project: GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
MAINLAND MARINE FACILITIES ASSESSMENT

Title: **RG TANNA (ALTERNATE)**
BARGE LOAD OUT FACILITY

Drawn: VH	Approved: JB	Date: 11-11-2009
Job No.: **4262 6440** /6220	File No. 42626440-g-2169b.cdr	

Figure: **2-4**

Rev. B
A4

2.4.2 After month six

After the initial six months Santos proposes to utilise the new twin barge loading facility at Calliope River to transport merchantable timber, excess soils and mulch from Curtis Island to the mainland. Stockpile facilities similar to those described above will be developed and used.

2.5 Construction Equipment and Construction Facility Deliveries

2.5.1 Initial six months

Santos proposes to utilise the existing barge load out facility at Fisherman's Landing for an initial six months while Port Central, Calliope River barge ramp and Curtis Island barge ramp/ferry terminal is under construction.

2.5.2 After month six

After the initial six months Santos proposes to utilise the new twin barge loading facility at Calliope River behind Wiggin's Island to transport merchantable timber, excess soils and mulch from Curtis Island to the mainland.

2.6 Approvals for the Mainland Marine Facilities

The proposed sites for the Mainland Marine Facilities have been chosen for their capacity to assist in the construction and ongoing operation of the LNG facility and are an intrinsic component of the GLNG Project providing storage, lay down areas for the storing and transporting of materials and personnel.

The proposed locations of the Mainland Marine Facilities fall predominantly within land designated as strategic port land with the remainder within the Gladstone State Development Area (GSDA) land designation. The environmental values discussed and impact assessments undertaken as part of this report will be used as a basis for the key statutory approvals required for the establishment of the Mainland Marine Facilities. The environmental impacts that will need to be assessed using this approval process are:

- Marine ecology;
- Surface Water;
- Air Quality;
- Traffic and Transport;
- Noise and Vibration; and
- Visual impacts.

It is possible either Santos proposed pipeline licence or petroleum facility licence will extend to cover components of the Mainland Marine Facilities developments. Accordingly, the activities to be carried out for the construction and operation of components of the Mainland Marine Facilities developments will need to be assessed against the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) (P&G Act), GPC Land Use Plan, Development Scheme for the GSDA, *Integrated Planning Act 1997* (Qld) (IPA) and local planning scheme, being the Gladstone Planning Scheme or Calliope Planning Scheme. Santos will work with the appropriate regulatory authorities, GPC, the Coordinator-General, Gladstone Regional Council, DEEDI and the Department of Infrastructure and Planning in establishing the regulatory approvals required.

2 Description of Proposed Activities

2.6.1 Regulatory approvals framework options

There are alternative statutory approvals processes available to Santos for the development of components of the Mainland Marine Facilities, being processes related to:

- The assessment of:
  - Activities carried out wholly within the area of a petroleum authority (e.g. a pipeline licence or petroleum facility licence) under the P&G Act; or
  - Activities carried out outside the area of a petroleum authority and outside the area of the GSDA or strategic port land, under the *Integrated Planning Act 1997* (Qld) (IPA), the local planning scheme, being the Gladstone Planning Scheme or the Calliope Planning Scheme (these approvals processes are alternatives to each other and will be dependent on the location of activities (e.g. within or outside the area of a petroleum authority)); or
- The assessment of activities to be undertaken at the Port on strategic port land under the GPC Land Use Plan (for those components of development that fall within strategic port land); or
- The assessment of activities under the Development Scheme for the GSDA (for those components of development that fall within the GSDA land area).

These processes are described below as they relevant to the impact assessment processes that will be required for these developments.

2.6.2 Approvals processes

Where activities are authorised under the P&G Act certain exemptions from the application of the IPA approvals process apply within the area of a petroleum authority.

Where these proposed activities are located on land designated as either Strategic Port Land or being within the GSDA, then the exemptions under the IPA available to activities authorised under the P&G Act, will not be relevant.

For activities undertaken within Strategic Port Land, GPC is the assessment manager under IPA for applications for a material change of use under IPA.

For activities undertaken within land designated as GSDA land, approvals applications will need to be made to the Office of the Coordinator-General for a material change of use under the Development Scheme for the GSDA (which excludes the operation of the IPA process for these applications).

2.6.3 Approvals process under IPA, local planning schemes, GPC land use plan and GSDA

The components of the Mainland Marine Facilities developments will be assessed under the appropriate regulatory framework depending on the location of works:

- Development activities at Port Central, the RG Tanna Coal Terminal, Gladstone Marina and Fishermans Landing are all anticipated to fall within strategic port land. ;
- Development activities at the Calliope River facility (at the Clinton Precinct) are anticipated to fall within the GSDA.

The operations of the GPC Land Use Plan and the Development Scheme for the GSDA are outlined further below.

2 Description of Proposed Activities

However, regardless of the location of development activities, the following relevant uses of land will apply for the purposes of this report:

- The use of the port for loading and unloading of construction and waste materials - this activity will be undertaken by Santos; and
- The use of components of the Mainland Marine Facilities developments for the temporary storage of construction and waste materials.

A number of these key approvals are outlined as follows:

- Material Change of Use (planning) approvals

A development permit will be required for a material change of use under IPA or Development Scheme for the GSDA (whichever is relevant), which:

  - For the activities to be undertaken at the Port will if necessary be assessed against the GPC land use plan for areas within strategic port land, or the Development Scheme for the GSDA for areas within the GSDA; and
  - For activities outside the strategic port land and GSDA areas (if any), will be assessed by Gladstone Regional Council against the Gladstone or Calliope Planning Schemes.

- Material change of use for an environmentally relevant activity

A development permit for a material change of use for an environmentally relevant activity may be required for "assessable development" (ss 3.1.4(1) and 3.1.5(3) IPA). Loading or unloading bulk materials in connection with operations at a port at a rate of 100 tonnes or more a day or stockpiling bulk materials in connection with operations at a port is classified as an environmentally relevant authority. An approval will also be required to become a registered operator under the *Environmental Protection Act 1994* (Qld).

- Development permit for tidal work

A development permit will be required to carry out prescribed tidal works (being tidal works completely or partly in a local government tidal area being, relevantly, land between the high water mark and 50 m seaward) including construction of a jetty or wharf and works in tidal water necessarily associated with that construction under the *Coastal Protection and Management Act 1995* (Qld).

- *Vegetation Management Act 1999* (Qld)

A development permit will be required to clear vegetation under the *Vegetation Management Act 1999* (Qld).

Development within Strategic Port Land

The Land Use Plan for the Gladstone and Port Alma Ports is currently under review with a statement of proposals published for comment; as a result this report will provide assessment information based on the proposed recommendations to the Land Use Plan review.

The former Gladstone City Council adopted its planning scheme on the 12th December, 2006 with the scheme commencing on 29 December, 2006. A key element of the planning scheme in relation to Strategic Port Land recognises that Strategic Port Land is outside the jurisdiction of the planning scheme. It is important for contextual purposes to establish the relevant planning scheme in place

adjacent the Strategic Port land where options are located as the Port must consider the impacts to communities adjacent the port facilities in its assessment.

A number of the components of the Mainland Marine Facilities developments fall within strategic port land, including:

- Port Central;
- RG Tanna Coal Terminal;
- Gladstone Marina; and
- Fishermans Landing.

Whilst the designation of land as being strategic port land provides exemption from local government planning scheme requirements there are certain codes/criteria included in the Land Use Plan that will assess impacts from future development and will seek to minimise impacts on environmental features and values. These codes will include specific issues such as:

- Stormwater management;
- Energy efficiency including water re-use/recycling;
- Acid sulphate soils;
- Built design;
- Traffic, access and servicing; and
- Requirements for Environmental Management Plans (EMPs);

It is recognised that there is potential for ongoing conflict between Port facilities and activities and the natural features/ecological values of the region.

The following outlines the land use and development intent for existing and future proposed Port facilities relevant to the Mainland Marine Facilities locations. Assessment by GPC will take into account the strategic intent for the area as well as the physical and environmental constraints present at each site.

Port Central

This area provides for a mix of handling cargo, container storage, throughput of general cargo, coal, petroleum, grain and other miscellaneous items, including calcite and magnesite; the area also includes railway marshalling yards and deep channel access (panamax class) and has bulk handling facilities.

There are the established operations at the Auckland Point Wharves, as well as significant vacant land north of the railway in the Port Central area that provides future opportunities for expansion of the Port's activities and will play an important role as an inter-modal transfer and storage area particularly for the resources coming to/from the GSDA.

There are some existing activities in this area creating noise, dust, transport and traffic and visual impacts from existing users predominantly from stockpiling and other Port operations that occur there.

RG Tanna Coal Terminal Precinct and the Gladstone Marina

The RG Tanna Coal Terminal area graduates from heavy Industry operations to the lesser impact zones of Light Industry. The area was initially established through reclamation to accommodate the Coal Terminal and Marina facilities. Potential future reclamation may occur to accommodate a proposed alternate tug harbour and further areas for Light Industrial activity.

2 Description of Proposed Activities

Gladstone Marina

The Gladstone Marina waterfront and recreational area is an important Port planning tool but also local recreational, tourist and community facility. It acts as a graduated buffer between industry and the residential part of the city. It has deliberately been developed without residential to support this buffer function.

Fisherman's Landing

These wharves are a multi user, multi product facility which includes products from Cement Australia, Rio Tinto's Alumina Refinery and Orica as well as future industries in the GSDA. The demand for wharves and land based areas for assembling cargo etc has been anticipated by GPC and reclamation works are continuing.

This is the main growth area of the Port particularly because of its proximity to the GSDA. A materials transportation services corridor has been identified to provide a transport link between the industrial areas at the GSDA and the Port facilities.

Development within the GSDA

The relevant objectives of the Development Scheme for the GSDA for the Mainland marine Facilities are to:

- Provide land and plan for industrial development of national, State and regional significance and complementary industrial, infrastructure and service uses (within the Aldoga, Targinie, Yarwun, Clinton and Curtis Island Industry Precincts); and
- Provide land and plan for a dedicated and efficient means of access for materials, products, wastes and services between the Gladstone State Development Area (Aldoga, Targinie, Yarwun, Clinton, Curtis Island Industry and Restricted Development Precincts) and the Port of Gladstone.

The GSDA precinct applicable to activities for the Mainland Marine Facilities is the Clinton Precinct, where the option for the Calliope River facility may be located. This precinct provides for:

- The establishment of port related activities and industries necessary to support major industrial development;
- Encouraging the establishment of industrial development and other uses that support industrial development;
- The management of waste from industry; and
- Encouraging and promote industry having regard to the cultural heritage values of the Clinton Precinct.

It should be noted that an approval for a temporary use may be subject to conditions that may place a limit on how long a temporary use may continue or works remain in place, or require any necessary restoration of the premises and decommissioning works. Under Schedule 5 – Clinton Precinct, the proposed activities would be defined as being "Materials transport infrastructure" which is considered as highly likely to meet the purpose of the land use designation Where "Materials transport infrastructure" means:

2 Description of Proposed Activities

"Infrastructure used to transport materials and includes pipes used to transport materials (other than for utility purposes e.g. water, sewerage, electricity, telecommunications and gas), and conveyors used to transport raw material and products but does not include a road, railway or port."

3

Assessment of Environmental Values and Potential Impacts - Personnel Movements

An assessment has been conducted to review the existing environmental values associated with the locations designed for the movement of project personnel (Gladstone Marina and Port Central). This assessment has provided data to assess potential environmental impacts and develop proposed mitigation measures where required.

Summary tables are provided in this section, with supporting documentation (where required) provided in the appendices, including:

- Assessment of Potential Marine Ecological Impacts (refer Appendix A);
- Noise and Vibration (Terrestrial) report (refer Appendix B); and
- Marine Transport Strategy (refer Appendix C).

3.1 Personnel Movements – Gladstone Marina (initial six months)

Table 3-1 Summary of environmental values, potential impacts and mitigation measures

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Surface Water	There are no surface water environmental values on the existing commercial ferry site at Gladstone Marina. However, the location of a potential car park site (not presently identified) could have surface water values. The Gladstone Marina is located within the Gladstone Port and is a valuable marine area used for recreation and commercial activities. The discharge of contaminants into this water could impact on water quality Regionally, Port Curtis is a designated wetland, and the cumulative impacts on local marine water quality from discharges into the area could impact on the marine ecosystem, which is part of the Great Barrier Reef World Heritage Area.	Potential impacts from site activities include: • Stormwater discharges from proposed car park, and onshore activities; and • Sediment mobilisation during earthworks to develop the car park (if required) and its operation. Vessel operations: • Exhaust emissions from increased vessel movements; • Bank wash from vessel movements; and • Oil and chemical spills.	The design of stormwater capture and treatment systems for the proposed car park should be undertaken to ensure that adequate treatment systems are incorporated into the car park and infrastructure design to minimise contaminant and sediment discharges to natural water. Sediment and erosion controls should include mitigation measures for the construction and operation of car parks and surface facilities to minimise the loss of sediment in any discharge to the marine environment. Stormwater Management Plan: to provide management, mitigation and measurement methods. Operational plan for vessel movements: to include mitigation measures to minimise potential environmental impacts of vessels through strict vessel maintenance requirements to ensure minimal emissions, and suitable management of routes and speed.
Air Quality	The air quality in the Port area is impacted by vessel activity, but with predominantly onshore winds, the air quality is considered	Existing activities at the ferry terminal will continue, with an increase in operational intensity. If the proposed car park is	Input into the design aspects of the proposed car park will enable any potential adverse impacts associated with dust

3 Assessment of Environmental Values and Potential Impacts - Personnel Movements

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	high. Operations will include an increase in ferry vessel activity and additional vehicles in the Marina area.	unsealed then dust could be an issue from vehicle activity. In the event that the proposed car parking area requires earthworks and construction, then there is potential for dust to be created from construction activities and exposed soil. Operation of the facility should have minimal impacts on air quality from the additional vessel and vehicle activities at the terminal.	generation to be minimised through the use of suitable controls including: • Minimise open exposed soil during construction; • Effective management of the construction phase to include dust suppression measures such as site watering combined with monitoring of wind and resultant soil stability; and • Sealing the car park area to minimise dust. During operation of the car park, enforce speed control limits (such as signage and speed bumps) to limit vehicle speeds, particularly on any unsealed surfaces. No management or mitigation is required for the operational phase of the ferry terminal.
Noise and Vibration	The marina includes an existing ferry terminal and other commercial operations. Environmental values are related to existing users of the facilities. No construction is planned for the ferry terminal, but possible construction of a car park may be required with associated short term construction noise. Locally the marina in Gladstone Port is a valuable marine area used for recreation and commercial activities. The sensitivity of the area to changes in the noise levels will be relatively minor, with most activity occurring in the daytime. Regionally, the Port area of Gladstone adjoins the City of Gladstone to the south,	Impacts of construction noise associated with a proposed car park are likely to be relatively minor due to the short term nature of construction. The location of the car park is still to be finalised. The potential noise impacts from the operation of the marina ferry terminal and its activities during the 6 month operational period are limited to the marina car park and bus depot. A daily traffic volume of 610 vehicles has been estimated travelling to and from the marina transport facility together with the assumption that a car park is provided, with shuttles to the ferry. It is predicted that the peak LAeq noise	Potential construction noise associated with a car park will need to be managed and restricted to day time hours in the event that it is located in close proximity to sensitive receptors. Based on the Port Central scenario, where similar activities are likely, noise levels in excess of the 50 dBA LAmax have been predicted. No noise mitigation measures are required for noise emission from the proposed temporary car park due to the sufficient buffer distance between the car park location and the nearest sensitive receivers (assumed). No noise mitigation measures are required for the temporary bus depot, provided an

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	over Auckland Inlet. The nearest parts of Gladstone to the marina include the commercial/industrial areas along Hanson Road, and to the east, Flinders Parade area. The only assessable operational noise associated with the marina facilities is associated with the car park. The location of a suitable car park is yet to be determined, however, it is anticipated to be relatively close to the marina. The proposed ferry operations will occur through daytime periods, but will start at 5.30 am (possibly 5.00 am after the initial four months).	levels from vehicles travelling within the car park to be 19 dBA at the nearest sensitive receptors (Off Street). This level achieves compliance with the operational criteria of 40 dBA. Noise levels associated with car door slamming and engine starts are predicted to be 27 dBA at the nearest sensitive receptors (Off Street). This level achieves compliance with the 50 dBA LAmax sleep disturbance noise criteria. At a maximum bus depot capacity of approximately 40 vehicles, an offset buffer distance of 180 m for low speed traffic noise would be required to achieve compliance with the operational noise criteria of 40 dBA. An offset buffer distant of 55 m for engine starts would be required to achieve compliance with the 50 dBA LAmax sleep disturbance noise criteria. The expected increase in road traffic noise levels associated with operational activities for the marina facilities is predicted to be less than 2 dBA; therefore no adverse impact is anticipated.	offset buffer distance of 80 m is used to achieve compliance with both the operational noise criteria of 40 dBA as well as the 50 dBA LAmax sleep disturbance noise criteria. No mitigation measures are required for increases in road traffic noise levels associated with operational activities from Gladstone Marina, as all predicted increases are less than 2 dBA.
Land Use / Planning	The site for the proposed logistics facilities (personnel transfer) is located on land designated as Strategic Port Land within the R G Tanna Coal facility and Marina area of the Gladstone Ports Corporations Land Use Plan. The proposed activities are defined as assessable development within the Gladstone Ports Corporation's Land Use Plan (currently under review); the port corporation being the assessment manager	Impacts will be limited to the transfer of personnel and essential items to Curtis Island with the following temporary facilities provided for this purpose: • Undercover ferry waiting area; • Ablutions (various locations); • Ferry operations office (existing); and • Site control /security office. There will be only shallow excavations	The site is designated for Port purposes and the proposed use is in accordance with the designated purpose of the land, therefore there are no planning or land use impacts that require mitigation or management.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	for all proposals within the strategic land designation, There is currently a statement of proposals prepared for the review of the Land Use Plan that provide strategic direction and guidance on the preparation of the plan and the future development of the ports (i.e. Gladstone and Port Alma). The statement of proposals provides that the *"Gladstone Marina waterfront and recreational area is an important port planning tool but also local recreational, tourist and community facility"* with these activities being predominantly outside (to the south east) of the area proposed. Reference is also made to the area providing a deliberate (developed for this purpose) buffer function between the industrial and residential precincts. The proposed activities involve the transfer of personnel and will not create adverse impacts to the recreational use recognised by the Port. Consultation with the Port Corporation will be undertaken to ensure issues of concern are tracked and monitored during the timeframe this site is required for the GLNG Project. There are several physical constraints to the site that include: • Susceptibility to flood and storm surge; • Within obstacle limit surface of Gladstone airport;	constructed on site, which will minimise the potential to expose acid sulphate soils.	

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	• Site disturbance may expose acid sulphate soils; and • The site is prone to erosion if disturbed.		
Visual Amenity	The regional landscape setting of Gladstone is strongly defined by mountain ranges that form the skyline to views to the west from the city and by the tree-covered central ridge of Curtis Island to the north. These visually prominent natural landforms are often seen in the context of the water surface of Gladstone Harbour and Port Curtis, which contributes to the visual quality of many views. The existing Gladstone Marina has jetty structures and moored boats/yachts contrasting with foreshore vegetation and water surface. Yacht masts form a distinctive visual vertical element. Boat movement creates visual interest within the well defined space of the marina. The marine is visually enclosed by vegetation located in Spinnaker Park to the north and by buildings along the southern and western foreshore.	Potential impacts resulting from site activities may include: • Exhaust emissions/haze resulting from increased vessel movements; • Increased vessel movements on the local waters; and • Oil and chemical spill.	The limited nature of these potential impacts does not require additional mitigation or controls. However, the EMP will require that spills kits are provided on vessels to enable rapid response to any spills.
Stakeholder Liaison			In recognition of the logistical challenges identified to transport the materials and workforce required for the project, Santos has been working GPC and other LNG proponents to identify alternative facility locations to mitigate the impacts of

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
			transferring people and materials from the mainland to the LNG facility site on Curtis Island.
Traffic and Transport	The Gladstone Marina is located on Brian Jordan Drive and vehicle and bus access can be gained via Dawson Highway, Glenlyon Road and Brian Jordan Drive through Gladstone or via Hanson Road and Alf O'Rourke Drive from the west. Adequate bus manoeuvring, drop-off and turn-around space is provided at the Ferry Terminal. As 100 % of personnel will require transport to and from Curtis Island during the initial phase, all will need to travel out daily from Gladstone Marina. The Gladstone Marina services a mix of private and commercial vessels and contains several barge/ferry ramps. Ferry cycle times to Curtis Island is approximately 69 minutes. As Gladstone Marina allows easy access to the Port of Gladstone via Auckland Creek, there is potential for conflicts with other vessels using the facilities to occur. Limited amenities for passenger exist. The vast majority of personnel transported to Curtis Island would need to arrive via bus or be dropped off at the ferry location because of lack of parking.	It has been assumed that 40 % of workers will take a bus to the terminal and 40 % will drive and park, which will require approximately 20 bus trips per average shift change or 40 trips per day. Additionally, with a proposed car park and shuttle service, there will be an additional 700 vehicle movements from Gladstone to the car park, and associated shuttle buses to the ferry terminal. It is also likely that additional vehicle movements will be required by workers being dropped off and picked up at the ferry terminal. Conflicts with existing barge/ferry traffic may present issues, due to the limited available amenities, such as parking. Existing ferry services presently utilise 12, 25 and 170 passenger ferries, and these will be used for the initial phase, with potentially larger capacity ferries (250 passenger) being utilised as the project progresses. As Gladstone Marina allows easy access to the Port of Gladstone via Auckland Creek, there is potential for conflicts with other vessels using the facilities to occur. Adequate space is generally available for manoeuvring and docking within the marina area. The assessment of the GLNG Project indicates that the Gladstone Marina Ferry Terminal will not be impacted to any major	Management of potential traffic issues and mitigation measures that will be required include: • Road vehicle management and congestion: a temporary car park will be developed and buses/shuttles will be used to transport the majority of workers to and from the ferry terminal daily. Both scheduled bus routes and shuttle buses from the car park to be located nearby; and • Ferry services will need to be scheduled to avoid congestion in the port and marina area.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
		degree. This is due to the low numbers of workers that will be travelling to Curtis Island during the initial six month period. Assuming the worst case where all workers are accommodated on the mainland and need to travel across to Curtis Island daily, there will be a maximum of 360 workers, with 290 workers in the day shift and 70 workers in the night shift. Based on these numbers, there will be two return ferry trips required in each peak period. Based on the movement of these 360 workers there will be an additional 72 car trips to the Marina per peak hour with eight additional bus trips per peak hour.	

3.2 Personnel Movements – Port Central (after month six)

Table 3-2 Summary of environmental values, potential impacts and mitigation measures

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Surface Water	There are limited existing environmental values on site, which includes existing wharfs. No surface water bodies are located on the existing site. Locally, Gladstone Port is a valuable commercial area. The discharge of contaminants into this water could impact on water quality. Regionally, Port Curtis is a Designated Wetland, and the cumulative impacts on local marine water quality from discharges into the area could impact on the marine ecosystem, which is part of the Great Barrier Reef World Heritage Area.	Site activities: • Stormwater discharges from proposed car park, and onshore activities, during operation; • Sediment mobilisation during earthworks and operation; and/or • Emissions from ablutions facilities. Vessel operations: • Discharges from increased vessel movements; • Bank wash from vessel movements; and/or • Oil and chemical spills. Wharf construction/modification: • Disturbance of the shoreline and sea bed and potential mobilisation of sediment; • Smothering of habitat; • Prop-wash mobilisation of sediment; • Increased turbidity; and/or • Impacts on water flows from new structures.	Stormwater capture and treatment systems should be designed, constructed and maintained to ensure that adequate treatment systems are incorporated into the car park, infrastructure, loading ramp and wharf to minimise unauthorised discharges to land and water ways. Sediment and erosion control plan: to include mitigation measures for the construction and operation of car parks and other facilities to minimise the loss of sediment in any discharge to the marine environments. This should include the use during construction of silt curtains. Stormwater Management Plan: to provide management, mitigation and measurement controls Operational plan for vessel movements: to include mitigation measures to minimise potential environmental impacts of vessels through effective vessel maintenance to ensure minimal emissions, and suitable management of routes and speed. Ablutions facilities to be connected to exiting sewerage system to ensure that there are no unauthorised discharges into surface water or the marine environment.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Air Quality	The air quality in the Port area is impacted by vessel activity, but with predominantly onshore winds, the air quality is considered high. Operations will include an increase in ferry vessel activity and additional vehicles in the area. Car park and wharf construction activities will be undertaken on areas that have had historic port activities.	The construction of a proposed car parking area and terminal facilities will require earthworks and construction activities, with the potential for dust to be created from vehicle activities and exposed soils. Operation of the facility should have minimal impacts on air quality from the additional vessel and vehicle activities. If the car park is unsealed then there is potential for ongoing dust from the open unsealed area, and associated vehicle movements.	Input into the design aspects of the proposed car park will enable any potential adverse impacts associated with dust generation to be minimised through the use of suitable controls including: • Minimise open exposed soil during construction; • Effective management of the construction phase to include dust suppression measures such as site watering combined with monitoring of wind and resultant soil stability; and • Sealing the car park area to minimise dust. During operation of the car park, enforce speed control limits (such as signage and speed bumps) to limit vehicle speeds, particularly on any unsealed surfaces. No management or mitigation is required for the operational phase of the ferry terminal.
Noise and Vibration	The Port Central site has existing facilities including wharfs. Environmental values are related to existing users of the facilities. Locally the site is a valuable marine area used for recreation and commercial activities. The sensitivity of the area to changes in the noise levels will be relatively minor, with most activity occurring in the daytime. Regionally, the Port area of Gladstone adjoins the City of Gladstone. The only assessable operational noise associated with the site is associated with car park activities (i.e. low speed traffic noise, door slams and engine	Proposed construction activities, including a car park and facilities, will be of a similar nature to other noise generating activities in the general port area, with only a 2 dBA increase in local noise. The potential impacts on noise from the operation of the ferry terminal and its activities are limited to: • Marina Car Park; and • Bus Depot. A daily traffic volume of approximately 700	No noise mitigation measures are required for noise emissions from the Port Central car park due to the sufficient buffer distance between the car park location and the nearest sensitive receivers. An offset buffer distance of 180 m would be required to achieve compliance with both the operational noise criteria of 40 dBA and the 50 dBA LAmax sleep disturbance noise criteria. At this distance, no noise mitigation measures are required. No mitigation measures are required for

3 Assessment of Environmental Values and Potential Impacts - Personnel Movements

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	starts etc). The proposed ferry operations will occur through daytime periods, but will start at 5.30 am (possibly 5.00 am after the initial four months. The limiting noise criteria for the operational phase of the site relates to sleep disturbance and design criteria and are 50 dBA LAmax and 40dBA Leq respectively. As there will be an addition of vehicles to an existing roading system, incremental changes in noise traffic need to be considered.	vehicles has been estimated travelling to and from the facility together with the assumption that a car park is provided, with shuttles to the ferry. It is predicted that the peak LAeq noise levels from vehicles travelling within the car park to be 19 dBA at the nearest sensitive receptors. This level is achieves compliance with the operational criteria of 40 dBA. Noise levels associated with car door slams and engine starts are predicted to be 27 dBA at the nearest sensitive receptors. This level achieves compliance with the 50 dBA LAmax sleep disturbance noise criteria. At a maximum bus depot capacity of approximately 40 vehicles, an offset buffer distance of 180 m for low speed traffic noise would be required to achieve compliance with the operational noise criteria of 40 dBA. An offset buffer distant of 55 m for engine starts would be required to achieve compliance with the 50 dBA LAmax sleep disturbance noise criteria. The expected increase in road traffic noise levels associated with operational activities for the marina facilities at Port Central is predicted to be less than 2 dBA; therefore no adverse impact is anticipated.	increases in road traffic noise levels associated with construction activities for the mainland marine facilities at Port Central, Gladstone Marina and RG Tanna, as well as operational activities from Port Central as all predicted increases are less than 2 dBA.
Land Use / Planning	The site for the proposed logistics facility (personnel transfer) is located on land designated as Strategic Port Land within the Port Central area of the Gladstone Ports Corporations Land Use Plan. The proposed activities are defined as assessable development within the Gladstone Ports	Impacts will be limited to the transfer of personnel and essential items to Curtis Island with the following facilities provided for this purpose: • Undercover ferry waiting area;	As the site is designated for Port purposes and the proposed use is in accordance with the designated purpose of the land there are no planning or land use impacts that require mitigation or management.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	Corporation's Land Use Plan (currently under review); the port corporation being the assessment manager for all proposals within the strategic land designation, There is currently a statement of proposals prepared for the review of the Land Use Plan that provide strategic direction and guidance on the preparation of the plan and the future development of the ports (i.e. Gladstone and Port Alma). The statement of proposals provides that the *"While there are established operations at the Auckland Point Wharves, there is significant vacant land north of the railway in the Port Central area that provides future opportunities for expansion of the Port's activities".* There is also recognition that the area will play a key role as an inter-modal transfer and storage area particularly for resources coming into and from the GSDA. The proposed activities involve the transfer of personnel and will not create adverse impacts to the existing activities within the area which are predominantly industrial in nature. Consultation with the Port Corporation will be undertaken to ensure issues of concern are tracked and monitored during the timeframe this site is required for the GLNG Project. There are several constraints to the site that include: • Susceptibility to flood and storm surge; • Within obstacle limit surface of Gladstone airport; • Site disturbance may expose acid sulphate soils; and • The site is prone to erosion if disturbed.	• Ablutions (various locations); • Site control/security office; • Traffic and logistics office; • Car parking (short term); • Crib areas (various locations); • Training/Induction facility; • Visitor centre; and • Ferry operations office. There will be only shallow excavations constructed on site, which will minimise the potential to expose acid sulphate soils.	It should be noted that an ASS management plan will provide guidance for excavations.

3 Assessment of Environmental Values and Potential Impacts - Personnel Movements

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Visual Amenity	The regional landscape setting of Gladstone is strongly defined by mountain ranges that form the skyline to views to the west from the city and by the tree-covered central ridge of Curtis Island to the north. These visually prominent natural landforms are often seen in the context of the water surface of Gladstone Harbour and Port Curtis, which contributes to the visual quality of many views. Port Central earthworks have created extensive areas of exposed coloured soil that visually contrast with adjoining water surface. Vegetation cover is generally grassland with few scattered trees and shrubs.	The facility is within a port setting, and will be visible from certain viewpoints. Potential impacts from construction activities include: • Sediment mobilisation during earthworks resulting in turbid stormwater discharges and visual impacts on port water. Potential impacts from operational activities include: • Exhaust emissions/haze resulting from increased vessel movements; • Increased vessel movements on the local waters; • Oil and chemical spills; and • Lighting spillage.	Design of the facilities to minimise the visual bulk and lighting spillage particularly when viewed from Port Curtis waterway. The limited nature of these potential operational impacts does not require additional mitigation or controls. However, controls proposed for surface water (above) will minimise potential turbidity issues.
Stakeholder Liaison			In recognition of the logistical challenges identified to transport the materials and workforce required for the project, Santos has been working with GPC and other LNG proponents to identify alternative facility locations to mitigate the impacts of transferring people and materials from the mainland to the LNG facility site on Curtis Island.
Traffic and Transport	Vehicle access to Port Central from Gladstone and from the south would likely be via Dawson Road, Glenlyon Road and Port Access Road. Access from the west would be via Gladstone-Mount Larcom Road to Glenlyon Road and Port Access Road. Using these routes, most traffic would be travelling	Construction traffic associated with facilities and car park development is likely to have a minimal impact on local traffic volumes, due to the limited number of truck movements that will be required. Port Central Wharf will be used, following the	Long term and short tem parking, buses and shuttles have been proposed to limit the impacts on road traffic associated with the ferry terminal. Associated management of potential traffic issues and mitigation measures are as follows:

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	on highways or arterial roadways. There appears to be adequate space for bus drop-off and passenger queuing and loading. Private vehicle parking would not likely be available; therefore all workers would need to be transported to the site by bus or shuttles. A long term car park (over 200 spaces) is also proposed for workers who live on Curtis Island. They will drive from either the airport or from areas external to Gladstone. Based on the above, there will be a maximum of approximately 800 vehicle trips a day with a total of 756 vehicle parks. 394 car parking spaces will be required at the park and ride facility at Blain Drive, with 362 spaces required at Port Central.	initial six months, as the location for the movement of personnel to and from Curtis Island for the GLNG Project. At its peak construction, the GLNG Project will require 557 car trips and 57 bus trips daily trips to Port Central Wharf with 137 car trips and 13 bus trips occurring in each peak hour. This is assuming the split of workers living on Curtis Island and those living on the mainland being 52 % and 48 % respectively. Impacts on both road traffic and vessels using Port Curtis should be minor.	• Road vehicle management and congestion: a temporary car park will be developed and buses/shuttles will be used to transport the majority of workers to and from the ferry terminal daily. Both scheduled bus routes and shuttle buses from the car park to be located nearby. • Ferry services will need to be scheduled to avoid congestion in the port and marina area. It should be noted however, that Santos will continue to work closely with GPC as a key stakeholder in the Gladstone region as the transport and logistics strategy is finalised.

4

Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

A desktop assessment has been conducted to review the existing environmental values associated with the locations designed for the movement of bulk materials (Fisherman's Landing, Calliope River and potentially RG Tanna sites). This assessment has provided data to assess potential environmental impacts and develop proposed mitigation measures where required.

Summary tables are provided in this section, with supporting documentation (where required) provided in the appendices, including:

- Assessment of Potential Marine Ecological Impacts (refer Appendix A);
- Noise and Vibration (Terrestrial) report (refer Appendix B); and
- Marine Transport Strategy (refer Appendix C).

4.1 Raw Materials and Bulk Material Deliveries – Fisherman's Landing (initial six months)

Table 4-1 Summary of environmental values, potential impacts and mitigation measures

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Marine Ecology	Seagrass meadows are located adjacent to Fisherman's Landing and the species composition and biomass has fluctuated significantly since the inception of a seagrass monitoring program in 2002. The presence of apparently healthy seagrass in close proximity to port facilities indicates that the port marine environment is relatively healthy. Changes to species composition and biomass may be attributed to regional and local climate conditions. Drought conditions and major flushing events are considered to be the likely causal factors for the changes to seagrass biomass, area and species composition. Monitoring in 2005 indicated declines in seagrass meadows adjacent to Wiggins Island and north of Fisherman's Landing, in contrast to the general trend for the port area. Seagrass is eaten by both dugong and some turtle species.	Impacts from operation of the Fisherman's Landing facility are considered to be minimal. Potential maintenance dredging or silt build-up removal of the barge berth pocket for the barge ramp at Fisherman's Landing will be short-term and the footprint will be kept to a minimum. This is an existing port and only requires routine maintenance dredging. It is noted that a northern expansion of Fisherman's Landing is planned (outside this project) in the future, requiring placement of dredge material in the same location as the temporary barge ramp. Mangroves adjacent to Fisherman's Landing are unlikely to be impacted by small scale maintenance dredging.	Because this is an existing activity for the existing port area, it does not require specific mitigation measures, as they are already covered under existing approvals.
Surface Water	Fishermans Landing, as a reclaimed area, has no existing surface water environmental values. No surface water bodies are located in the areas proposed for activities. Fishermans Landing is a valuable	Site activities: • Sediment mobilisation and associated stormwater discharges from proposed laydown and truck marshalling area, and onshore activities, during and after initial site preparation;	There will be no redesign of the existing stormwater system at this existing port However, the existing stormwater systems should ensure that adequate stormwater control is present in the laydown and truck marshalling areas, infrastructure, and loading

4 Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	commercial port area. Unauthorised discharges into this water could impact on water quality. Regionally, the reclamation area adjoins Port Curtis which is a designated wetland, and the cumulative impacts on local marine water quality from discharges into the area could impact on the marine ecosystem, which is part of the Great Barrier Reef World Heritage Area.	• Emissions from ablutions facilities; and • Oil and chemical spills. Vessel operations: • Exhaust emissions from increased vessel (tug) movements; • Bank wash from vessel movements; • Smothering of habitat; • Prop-wash mobilisation of sediment; and • Increased turbidity.	ramp areas to minimise contaminant and sediment discharges to natural water. Operational plan for vessel movements: to include mitigation measures to minimise potential environmental impacts of vessels through effective vessel maintenance to ensure minimal emissions, and suitable management of routes and speed. There are no existing ablution connections at Fisherman's Landing. Ablutions with storage tanks will be located on a hardstand area near Cement Australia. Tanks will be pumped out and serviced by a licensed subcontractor who will dispose of waste in nearby community waste systems.
Air Quality	The reclaimed land area has been established for industrial use. Port Curtis is located to the east with the industrial plant site of QCL the closest sensitive receptor to the west. The reclamation area of Fisherman's Landing provides a substantial surface area for wind generated dust if disturbed. Other air pollution sources locally are QCL and the QER mining lease. Generally, air quality is expected to be high in this area, with a prevailing onshore wind.	There will be limited facilities and construction works associated with the short term activities on this site. However, there will be approximately 1.3 ha of laydown and truck marshalling area and a further 1.8 ha of hardstanding area, with associated stockpiles (gravel sand etc); all of which could pose a source of windblown dust during certain conditions. Vehicle movements over unsealed roads and yard areas could also be a source of wheel generated dust. Although the site is a substantial distance from any residential areas, there is potential for wind blown dust to impact on local sensitive receptors, such as QCL.	The design and construction of any improvements to the site facilities and infrastructure should include measures to minimise dust generation through the use of suitable controls: • Stockpiles managed to maximise shielding of finer grained stockpile material; • Watering of stockpiles and manoeuvring areas as required; • Speed limits, and watering (as required) to minimise dust from roads and tracking area; • Operational procedures to be developed to minimise dust generated from material handling activities. This could include watering prior to handling and

4 Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
			scheduling of handling during periods of lower wind speeds; and • Monitoring of wind conditions, with limits on activities, when wind speed is excessive and wind direction is towards sensitive receptors.
Noise and Vibration	Fisherman's Landing is a reclaimed area that has existing port activities and other existing commercial operations, with some substantial construction developments proposed. Environmental values are related to existing users of the facilities utilising the reclamation area on site and in close proximity. Some temporary facilities are proposed and some minor construction work is likely for the facility's proposed six months of use. This area around Fisherman's Landing is used for commercial activities, including wharfs. A major processing plant (QCL) is located in close proximity. There are some sensitive receptors between 250 and 1000 m away. Regionally, Fishermans Landing is located a substantial distance from the main port area of Gladstone, and the City of Gladstone, which are to the south.	Potential noise impacts are limited to: • Increased road traffic noise; and • Construction noise. An increase of up to 4.3 dBA is anticipated as a result of construction activities. However, these noise levels will be short lived. Traffic associated with the facility is likely to increase noise levels by approximately 2 dBA.	The following mitigation measures are proposed to limit adverse impacts on nearby sensitive receivers: • Heavy vehicle movements should be limited when possible to 6.30 am to 6.30 pm, Monday to Saturday; • Diesel powered equipment to be fitted with residential class mufflers; • Minimise the usage of truck exhaust brakes; and • Residents are to be made aware of the times and duration that they will be affected.
Land Use / Planning	The site for the proposed logistics facility (materials transfer) is reclaimed land that is designated as Strategic Port Land within the Fisherman's Landing area of the Gladstone Ports Corporations Land	Impacts will be limited to the transfer and stockpile of raw materials such as road base, rock armour, rip rap, sand and concrete aggregates on a hardstand area located at the rear entrance of the Cement	The proposed activities are identified as being in accordance with the intended use of the Fisherman's Landing port facility and there are no planning or land use impacts that require mitigation or management.

4 Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	Use Plan. This area is intended to provide additional land for the construction of wharves and provide an area for the development of transport, storage, loading and unloading facilities. The proposed activities are defined as assessable development within the Gladstone Ports Corporation's Land Use Plan (currently under review); the port corporation being the assessment manager for all proposals within the strategic land designation, There is currently a statement of proposals prepared for the review of the Land Use Plan that provide strategic direction and guidance on the preparation of the plan and the future development of the ports (i.e. Gladstone and Port Alma). The statement of proposals provides that this area "*is the main growth area of the Port particularly because of its proximity to the GSDA. A materials transportation services corridor has been identified to provide a transport link between the industrial area at the GSDA and the Port facilities".* The proposed activities involve the transfer of materials which is an acceptable use within this port area. The activities proposed are not considered to have any adverse impacts to the existing activities within the area. Consultation with the Port Corporation will be undertaken to ensure issues of	Australia facility. Material will then be reclaimed from stockpiles and transferred to barges for transfer to the Curtis Island. The following temporary facilities will be provided for this purpose: • Ablution facilities; • Traffic and logistics office; • Light vehicle car park; • Crib rooms; and • Truck marshalling area. There will be only shallow excavations constructed on site, which will minimise the potential to expose acid sulphate soils.	

4 Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	concern are tracked and monitored during the timeframe this site is required for the GLNG Project. There are several constraints to the site that include: • Susceptibility to flood and storm surge; • Within obstacle limit surface of Gladstone airport; • Site disturbance may expose acid sulphate soils; and • The site is prone to erosion if disturbed.		
Visual Amenity	Fisherman's Landing earthworks have created extensive areas of exposed coloured soil that visually contrast with adjoining mangroves and waterways. Vegetation cover is generally grassland with few scattered trees and shrubs. Once completed the site will consist of a hardstand area for storage of materials (both the GLNG Project and other LNG projects), a proposed laydown area and truck marshalling area, Fisherman's Landing barge load out facility, proposed haul route, and an alternative haul route.	The facility is within the reclamation area of Fisherman's Landing, and in close proximity to industrial sites. In this setting the small scale temporary facilities are unlikely to pose a visual impact. However, aspects of the activities do have the potential for impacting the visual amenity of the area including. Construction activities: • Sediment mobilisation during limited earthworks resulting in turbid stormwater discharges and visual impacts on port water. Site activities: • Increased vessel movements on the local waters; and • Oil and chemical spills.	The design of the facilities is unlikely to cause visual impact, so no mitigation is proposed. The limited nature of these potential operational impacts does not require additional mitigation or controls. However, controls proposed for surface water and air quality (above) will minimise potential turbidity and dust issues.
Stakeholder Liaison			In recognition of the logistical challenges identified to transport the materials and workforce required for the project, Santos has

4 Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
			been working with GPC and other LNG proponents to identify alternative facility locations to mitigate the impacts of transferring people and materials from the mainland to the LNG facility site on Curtis Island.
Traffic and Transport	Vehicles can access Fisherman's Landing from the Bruce Highway without travelling through Gladstone and for this reason is the Department of Transport and Main Roads preferred location for goods transport to Curtis Island. Fisherman's Landing is the Queensland Department of Main Roads' preferred option because of the avoidance of heavy vehicle traffic through Gladstone. The primary truck route to Fisherman's Landing will be the Bruce Highway, Calliope River Road, Gladstone-Mount Larcom Road and Landing Road. This route is approximately 30 km from Bruce Highway at Dawson Highway, and has been identified by Queensland Transport as a high mass limit roadway. As Fisherman's Landing lies outside of Gladstone, most trucks delivering goods to the site are likely to be on rural highways the entire route to the wharf. The owner of the wharf facilities at Fisherman's Landing is Gladstone Port Corporation. Fisherman's Landing is operated as a multi-user facility. Security access is gained from Landing Road.	During the initial six months of construction, it is assumed that there will be a maximum of 65 barge trips a month occurring. Based on a six day working week, this equates to approximately three return barge trips per day. With each barge being able to carry ten heavy vehicles, this equates to a maximum of 30 loaded and 30 unloaded heavy vehicle trips occurring per day due to the GLNG Project occurring during the initial six month period. The location of Fisherman's Landing, to the northern end of Port Curtis, allows the barge route to miss most of the larger vessel traffic. Road vehicle traffic for the facility, can also avoid travelling through the busier roads of Gladstone.	No mitigation or management is proposed to manage transport at the Fisherman's Landing facility, due to its location. It should be noted however, that Santos will continue to work closely with GPC as a key stakeholder in the Gladstone region as the transport and logistics strategy is finalised.

4.2 Raw Materials and Bulk Material Deliveries – Calliope River, Alternative 1 (after month six)

Table 4-2 Summary of environmental values potential impacts and mitigation measures

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Marine Ecology	Seagrass meadows are presence adjacent to Wiggins Island. The presence of apparently healthy seagrass in close proximity to port facilities indicates that the port marine environment is relatively healthy. Monitoring in 2005 indicated declines in seagrass meadows adjacent to Wiggins Island in contrast to the general trend for the port area. Seagrass is eaten by both dugong and some turtle species.	Construction of the Calliope River Inner Harbour will involve construction work to develop the barge ramps. Potential impacts to seagrass meadows adjacent to Wiggins Island are likely to be insignificant. Potential impacts to any mangroves that may be present at the Calliope River Inner Harbour site are considered to be minimal. Loss of fisheries and shorebird rocky habitat will potentially impact shorebird behaviour and impede fisheries values to the area.	No mitigation measures are proposed as impacts will be minor.
Surface Water	The Calliope River site lies adjacent to the Calliope River, in close proximity to the river mouth. The site is adjacent to, and west of the RG Tanna coal terminal, with stockpiling activities, two barge ramps and various facilities proposed to be constructed. Mangroves and intertidal areas adjoin the site to the west. No obvious surface water bodies are located in the areas proposed for activities, other than the Calliope River. Locally there are intertidal areas and seagrass beds at Wiggins Island, a valuable ecological area. The commercial port of Gladstone is located to the east. The discharge of contaminants into this water could impact on	During Construction: • Sediment mobilisation during earthworks for site structures and the barge ramps, resulting in turbid discharges and impacting port water quality; • Removal of intertidal area due to barge ramp construction; and • Flow restrictions/changes from barge ramp structures. During Operations: • Sediment mobilisation and associated stormwater discharges from proposed stockpiles, hardstand area, truck parking area, and onshore activities	The design of stormwater capture and treatment systems should be undertaken to ensure that adequate treatment is incorporated into the stockpile areas, hardstand area, car parks, infrastructure and barge loading ramps to minimise contaminant and sediment discharges to natural water. Potential impacts on water flows in the Calliope River of the barge ramps should be investigated to ensure that impacts are minimised. Sediment and erosion control plan: to include mitigation measures for the construction and operation of car parks and surface facilities to minimise the loss of sediment in any discharge to the river and

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	water quality. Regionally, the Calliope River discharges into Port Curtis, which is a designated wetland. The cumulative impacts on local marine water quality from discharges into the area could impact on the marine ecosystem, which is part of the Great Barrier Reef World Heritage Area.	after initial site preparation works; • Emissions from ablutions facilities; and • Oil and chemical spills. Vessel operations: • Exhaust emissions from increased vessel (tug) movements; • Bank wash from vessel movements; • Smothering of habitat; • Prop-wash mobilisation of sediment; and • Increased turbidity.	marine environments. Stormwater Management Plan: to provide management, mitigation and measurement measures Operational plan for vessel movements: to include mitigation measures to minimise potential environmental impacts of vessels through effective vessel maintenance to ensure minimal emissions, and suitable management of routes and speed. Ablutions facilities to be connected to exiting sewerage system to ensure that there are no unauthorised discharges into surface water or the marine environment.
Air Quality	The operational area is located on an industrial land area, to the west of the RG Tanna coal terminal. With stockpiles proposed for 26 ha of the site, for materials for construction (road base, sand, gravel etc) and for materials removed from Curtis Island (topsoil and mulch etc). Calliope River is located to the north of the site with Port Curtis to the east. Within the general area, there is stockpiled coal and other industrial activities, including rail lines and port activities. Based on the nature of the existing activities, there does not appear to be any sensitive receptors in close proximity. The stockpiled coal provides a substantial surface area for wind generated dust. Generally, air quality (at the nearest sensitive receptor) would be expected to be high in this area, with a prevailing onshore wind.	Construction works associated with the development of twin barge ramps and the various facilities at the site, have the potential to generate dust from vehicle activity and unsealed surfaces. Dust emissions from stockpiles, exposed areas and wheel generated dust from vehicle movements during operation is also possible from the 26 ha of stockpiles proposed. Vehicle activity could be a source of wheel generated dust. Although the site is a substantial distance from any residential areas, there is potential for wind blown dust to impact on local sensitive receptors. There is potential for the generation of odours from mulch (green waste) transported to the site from Curtis Island. Odours could impact local sensitive	The design and construction of any improvements to the site facilities and infrastructure should include measures to minimise dust generation through the use of suitable controls: • Stockpiles managed to maximise shielding of finer grained stockpile material; • Watering of stockpiles and manoeuvring areas as required; • Speed limits, and watering (as required) to minimise dust from roads and tracking area; • Operational procedures to be developed to minimise dust generated from material handling. This could include watering prior to handling and scheduling of handling during periods of lower wind speeds;

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
		receptors. The existing dusty environment from coal terminal and relatively remote location of the site will limit impacts on sensitive receptors.	• Monitoring of wind conditions, with limits on activities, when wind speed is excessive and wind direction is towards sensitive receptors; and • Management of materials leaving Curtis Island (in particular green wastes) which could result in odorous emissions if stockpiled for excessive periods and allowed to compost at the site.
Noise and Vibration	The proposed Calliope River site has some existing stockpiling activities located on it, and it is adjacent to the RG Tanna coal terminal, and so exposed to the noise levels associated with these activities. The sensitivity of the area to changes in the noise levels will be relatively minor, with most activity occurring in the daytime. Construction activities are planned for this facility, including construction of parking and hardstand areas, two barge ramps and various facility buildings. Regionally, the Port area of Gladstone adjoins the City of Gladstone which is located to the southeast of the site, over Auckland Inlet. The nearest parts of Gladstone to the site include the commercial/industrial areas along Hanson Road, with Palm Drive and Cray Street (West Gladstone) the nearest residential area.	There will be a number of potential noise impacts from the construction and operation of the Calliope River facility including: • Construction activities, which are predicted to be well below the 50 dBA construction noise limit; and • Traffic noise. The construction noise associated with the mainland marine facility at Calliope River is predicted to comply with the 50 dBA LAmax noise criteria at all assessment locations, and sensitive receptors at Palm Drive and Cray Street (West Gladstone). The expected increase in road traffic noise levels associated with construction activities for Calliope River is predicted to be greater than 2 dBA. The nearest sensitive receptors to Water Works (Calliope River) are at a distance of greater than 2 km. Therefore, it is anticipated that this increase of 2.6 dBA will not adversely impact these sensitive receptors.	The predicted increase in road traffic noise associated with construction activities for the Calliope River facility is expected to be 50 dBA. The nearest sensitive receptors are at a great enough offset distance that no adverse noise impact is expected. No noise mitigation measures are required.
Land Use / Planning	The site for the proposed logistics facility	Impacts will be limited to the stockpiling and	The proposed activities are identified as

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	(materials transfer) is currently located on land within the Clinton Precinct of the GSDA (according to the existing correspondence from the Port Authority and the DIP and is directly adjacent the RG Tanna Strategic Port Land. The site is used to stockpile coal and other industrial activities, including rail lines and port activities. New barge ramp facilities are to be constructed to facilitate activities such as that proposed. The proposed activities are defined as assessable development within the Development Scheme for the GSDA; the office of the Co-ordinator General being the assessment manager for all proposals within the GSDA land designation, The scheme provides for uses that are considered highly likely to meet the purpose of the land use designation; these include: • Bulk stores; • Heavy industry; • High impact industry; • Infrastructure facility; • Liquid fuel depot; • Local infrastructure; • Materials transport; • Infrastructure; • Medium industry; • Recycling industry; • Special use; and • Waste management. The proposed activities involve the transfer of	transfer of raw and bulk materials to Curtis Island as well as material transported from Curtis Island and stockpiled at this facility such as merchantable timber, unsuitable soil, mulch and topsoil. The following facilities will be provided for this purpose: • Ablutions; • Traffic and logistics office; • Light vehicle car park; • Crib rooms; • Site control/security office; and • Truck marshalling area. There will be only shallow excavations constructed on site, which will minimise the potential to expose acid sulphate soils.	being in accordance with the intended use of the barge facilities once constructed. Hard stand areas are currently used for similar purposes as that proposed. There are no planning or land use impacts that require mitigation or management.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	materials and will not create adverse impacts to the existing activities within the area, in particular with the activities within the RG Tanna Coal Facility and Marina area. Consultation with the Port Corporation will be undertaken to ensure issues of concern are tracked and monitored during the timeframe this site is required for the GLNG Project. There are several constraints to the site including: • Susceptibility to flood and storm surge; • Within obstacle limit surface of Gladstone airport; • Site disturbance may expose acid sulphate soils; and • The site is prone to erosion if disturbed.		
Visual Amenity	Calliope River earthworks have created extensive areas of exposed coloured soil that visually contrast with adjoining mangroves and surface waters. Vegetation cover is generally grassland with few scattered trees and shrubs. The RG Tanna coal stockpiles are on the adjacent property. Once completed the site will consist of: topsoil stockpile/s, mulch stockpile/s, unsuitable soil stockpile/s, temporary facilities (fenced compound, office, crib rooms, ablutions block, car park, truck parking area, and hardstand area), aggregate/sand/rock armour stockpiles, road-base stockpiles, and barge ramps.	The inclusion of a significant area of low level stockpiles of various materials will create a limited visual impact on this currently modified environment. However, aspects of the activities do have the potential for impacting the visual amenity of the area, including. Construction activities: • Sediment mobilisation during limited earthworks resulting in turbid stormwater discharges and visual impacts on port water; and • Dust generation from site earthworks. Site activities: • Increased vessel movements on the	The design of the facilities is unlikely to cause visual impact, other than potential for lighting spillage, so no mitigation is proposed, other than to minimise the potential for lighting in the design. The limited nature of these potential operational impacts does not require additional mitigation or controls. However, controls proposed for surface water and air quality impacts (above) will minimise potential visual impacts from turbidity and dust generation.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
		local waters; • Oil and chemical spills; and • Lighting spillage.	
Stakeholder Liaison			In recognition of the logistical challenges identified to transport the materials and workforce required for the project, Santos has been working with GPC and other LNG proponents to identify alternative facility locations to mitigate the impacts of transferring people and materials from the mainland to the LNG facility site on Curtis Island.
Traffic and Transport	The Calliope River facility is approximately 20km from the Bruce Highway along the Dawson Highway. The most likely route for trucks to Calliope River will be via Bruce Highway, Dawson Highway, Blain Drive, Alf O'Rourke Drive and Bryan Jordan Drive. A dedicated Port Access road through Gladstone has been constructed diverting heavy vehicles away from the CBD area and adjacent to the railway. This removes heavy vehicles from mixing with general traffic within Gladstone. The proposed Calliope River barge ramp location and associated required hardstand is owned and managed by the DIP. Access for goods delivery through Calliope River will occur both by ship through the Port of Gladstone and by truck via the highway system.	An aggregate loading facility will be constructed at Calliope River. This facility will be a new wharf for the movement of aggregate material only to and from Curtis Island. There are 3 planned trips per peak hour planned for aggregate material with 34 trips planned per day during peak construction. The location of the Calliope River facility, to the northern end of Port Curtis, allows the barge route to miss most of the larger vessel traffic. Road vehicle traffic for the facility, can also avoid travelling through the busier roads of Gladstone.	No mitigation or management is proposed to manage transport at Calliope River It should be noted however, that Santos will continue to work closely with GPC as a key stakeholder in the Gladstone region as the transport and logistics strategy is finalised.

4.3 Raw Materials and Bulk Material Deliveries – RG Tanna, Alternative 2 (after month six)

Table 4-3 Summary of environmental values, potential impacts and mitigation measures

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Surface Water	The RG Tanna site lies adjacent to Port Curtis, and adjacent to the RG Tanna coal terminal. The site is proposed to have limited stockpiling activities, truck marshalling yard, car park, development of various facilities and the use of an existing barge ramp. Locally there are seagrass beds near Wiggins Island, a valuable ecological area. The site is located within the commercial port of Gladstone. Regionally, the site discharges into Port Curtis, which is a designated wetland. The cumulative impacts on local marine water quality from discharges into the area could impact on the marine ecosystem, which is part of the Great Barrier Reef Marine Park (a World Heritage Area).	Construction Activities: • Sediment mobilisation during earthworks for site structures, resulting in turbid discharges and impacting port water quality. Operational Activities: • Sediment mobilisation and associated stormwater discharges from proposed stockpiles, truck marshalling area, car park, and onshore activities; • Emissions from ablutions facilities; and • Oil and chemical spills. Vessel operations: • Exhaust emissions from increased vessel (tug) movements; and • Increased turbidity.	The design of stormwater capture and treatment systems should be undertaken to ensure that adequate treatment is incorporated into the stockpile areas, hardstand area, car parks and associated infrastructure to minimise contaminant and sediment discharges to adjacent water bodies. Sediment and erosion control plan: to include mitigation measures for the construction and operation of car parks and surface facilities to minimise the loss of sediment in any discharges to the marine environments. Stormwater Management Plan: to provide management, mitigation and measurement measures. Operational plan for vessel movements: to include mitigation measures to minimise potential environmental impacts of vessels through good vessel maintenance to ensure minimal emissions, and suitable management of routes and speed. There are no existing ablution connections at RG Tanna. Ablutions with storage tanks will be located on a hardstand area near Cement Australia. Tanks will be pumped out and serviced by a licensed subcontractor who will dispose of waste in nearby community waste systems.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
Air Quality	The operational area is located on a designated industrial area to the east of the RG Tanna coal terminal. Stockpiles are proposed for areas of the site for construction materials (road base, sand, gravel etc). Port Curtis lies to the east of the site. Within the general area, there is stockpiled coal and other industrial activities, including rail lines and port activities. Based on the nature of the existing activities, there do not appear to be any sensitive receptors in close proximity, although commercial activities are located or planned to be located around the site. The stockpiled coal at RG Tanna provides a substantial surface area for wind generated dust. Generally, air quality would be expected to be high in this area, with a prevailing onshore wind.	Construction works associated with the development of the various facilities at the site have the potential to generate dust from vehicle activity and unsealed surfaces. Dust emission from stockpiles, exposed areas and wheel generated dust from vehicle movements during operations is also possible. Although the site is a substantial distance from any residential areas, there is potential for wind blown dust to impact on local sensitive receptors, although these impacts are considered to be minimal.	The design and construction of any improvements to the site facilities and infrastructure should include measures to minimise dust generation through the use of suitable controls including: • Stockpiles managed to maximise shielding of finer grained stockpile material; • Watering of stockpiles and manoeuvring areas as required; • Speed limits, and watering (as required) to minimise dust from roads and tracking area; • Operational procedures to be developed to minimise dust generated from material handling. This could include watering prior to handling and scheduling of handling during periods of lower wind speeds; and • Monitoring of wind conditions, with limits on activities, when wind speed is excessive and wind direction is towards sensitive receptors.
Noise and Vibration	The proposed site is located within the commercial and industrial Gladstone Port, and is adjacent to the RG Tanna coal terminal. As a result it is exposed to the noise levels associated with these port activities. The sensitivity of the area to changes in noise levels will be relatively minor, with most activity occurring in the daytime. Construction activities are planned for this	There will be a number of potential noise impacts from the construction and operation of the RG Tana facility including: • Construction activities, which are predicted to be below the 50 dBA construction noise limit; and • Traffic noise. Construction noise levels are predicted to comply with the 50 dBA LAmax noise criteria	No noise mitigation measures are required as the predicted increase in road traffic and construction noise is minor.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	facility, including construction of parking and hardstand areas, and various facility buildings. Regionally, the Port area of Gladstone adjoins the City of Gladstone which is located to the southeast of the site, over Auckland Inlet. The nearest parts of Gladstone to the site include the commercial/industrial areas along Hanson Road, with Palm Drive and Cray Street (West Gladstone) the nearest residential area.	at all sensitive receivers at Palm Drive and Cray Street (West Gladstone). No adverse noise impacts were predicted for road traffic noise associated with construction activities for the RG Tanna site.	
Land Use / Planning	The site for the proposed logistics facility (materials transfer) is located on land designated as Strategic Port Land within the RG Tanna Coal Facility and Marina area of the Gladstone Ports Corporations Land Use Plan. The proposed activities are defined as assessable development within the Gladstone Ports Corporation's Land Use Plan (currently under review); the port corporation being the assessment manager for all proposals within the strategic land designation, There is currently a statement of proposals prepared for the review of the Land Use Plan that provide strategic direction and guidance on the preparation of the plan and the future development of the ports (i.e. Gladstone and Port Alma). The statement of proposals provides that the area will continue to be developed to provide further commercial development	Impacts will be limited to the transfer of raw and bulk materials to Curtis Island with the following facilities provided for this purpose: • Ablutions facilities; • Traffic and logistics office; • Light vehicle car park; • Crib rooms; • Site control/security office; and • Truck marshalling area. There will be only shallow excavations constructed on site, which will minimise the potential to expose acid sulphate soils.	As the site is designated for Port purposes and the proposed use is in accordance with the designated purpose of the land there are no planning or land use impacts that require mitigation or management.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	opportunities, areas for light industrial activities (as proposed) as well as catering for expansion of the existing coal terminal. The proposed activities involve the transfer of materials, and are considered to be in accordance with the strategic intent of the Port's Land Use Plan. There are no adverse impacts envisaged from the proposed activities. Consultation with the Port Corporation will be undertaken to ensure issues of concern are tracked and monitored during the timeframe this site is required for the GLNG Project. There are several physical constraints to the site that include: • Susceptibility to flood and storm surge; • Within obstacle limit surface of Gladstone airport; • Site disturbance may expose acid sulphate soils ; and • The site is prone to erosion if disturbed.		
Visual Amenity	The regional landscape setting of Gladstone is strongly defined by mountain ranges that form the skyline to views to the west from the city and by the tree-covered central ridge of Curtis Island to the north. These visually prominent natural landforms are often seen in the context of the water surface of Gladstone Harbour and Port Curtis, which	The inclusion of an area of low level stockpiles of various materials will create a limited visual impact on this already modified environment. However, aspects of the activities do have the potential for impacting the visual amenity of the area including. Construction activities:	The design of the facilities is unlikely to cause visual impact, so no mitigation is proposed. The limited nature of these potential operational impacts does not require additional mitigation or controls. However, controls proposed for surface water (above) will minimise potential turbidity issues.

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Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	contributes to the visual quality of many views. The RG Tanna area development has created extensive areas of exposed coloured soil that visually contrasts with adjoining mangroves and surface waters. Vegetation cover is generally grassland with few scattered trees and shrubs. Once completed the site will consist of truck marshalling area, facilities area (office, crib rooms, ablutions block and car park), hardstand area, GPC required area for new tug terminal construction contractor, new tug terminal, the GLNG Project and other LNG project barge ramps, proposed haul routes.	• Sediment mobilisation during limited earthworks resulting in turbid stormwater discharges and visual impacts on port water; and • Dust generation from site earthworks. Site activities: • Increased vessel movements on the local waters; and • Oil and chemical spills.	
Social and Community	The social and community assessment is covered in the CAF SIA report in Attachment F6.		
Stakeholder Liaison			In recognition of the logistical challenges identified to transport the materials and workforce required for the project, Santos has been working with GPC and other LNG proponents to identify alternative facility locations to mitigate the impacts of transferring people and materials from the mainland to the LNG facility site on Curtis Island.
Traffic and Transport	The owner and operator of the wharf facilities at RG Tanna Coal Terminal is the Gladstone Ports Corporation. Facilities include a multi-user berth for exporting coal from the Central Queensland Basin.	A material loading facility will be constructed at RG Tanna. This will be used to transport material to Curtis Island and will also be the location where pipe and material for the gas transmission pipeline and the northern CSG	No mitigation or management is proposed to manage transport at the RG Tanna site. It should be noted however, that Santos will continue to work closely with GPC as a key stakeholder in the Gladstone region as the

4 Assessment of Environmental Values and Potential Impacts - Bulk Material Transport

Environmental Aspect	Summary of Existing Environmental Values	Description of Potential Impacts	Management Plan
	The wharf is located to the west of the city, adjacent to the Clinton Industrial Estate and is accessed by road and rail (all coal is received by rail). Access for goods delivery through RG Tanna will occur both by ship through the Port of Gladstone and by truck via the highway system. Similar to Calliope River, RG Tanna is approximately 20 km from the Bruce Highway along the Dawson Highway. The most likely route for trucks to the RG Tanna facility will be via Bruce Highway, Dawson Highway, Blain Drive and Alf O'Rourke Drive. A dedicated Port Access road through Gladstone has been constructed diverting heavy vehicles away from the CBD area and adjacent to the railway. This removes heavy vehicles from mixing with general traffic within Gladstone.	field will occur. It was determined that in a peak hour, there would be up to 24 heavy vehicle trips occurring to or from the RG Tanna due to the GLNG Project. On a daily basis this there would be approximately 68 heavy vehicle trips occurring to or from the RG Tanna material loading facility.	transport and logistics strategy is finalised.

5

Conclusions

5.1 Gladstone Marina and Port Central (Transport of Personnel)

5.1.1 Gladstone Marina (Temporary Facility)

The proposed short term use of this existing ferry terminal for the transportation of personnel to Curtis Island will not significantly impact the local port area. There will be a slight increase in road traffic and associated noise levels, but the use of a short term car park (the location is yet to be defined) and associated shuttles and scheduled buses will minimise the impacts on the roads in close proximity to the marina.

Potential impacts associated with the proposed car park, which include stormwater and dust discharges will be managed and mitigated through the design and construction phases. Speed restrictions will be imposed during the operation of the car park to minimise dust impacts.

5.1.2 Port Central (Permanent Facility)

The proposed Port Central ferry facility terminal for the transportation of personnel to Curtis Island will utilise an area where port activities have historically occurred and is already industrialised. Significant development of this area will be undertaken. There will be a requirement to construct facilities and develop a wharf, barge ramp, bus marshalling area and short term and long term car parking.

Impacts associated with the construction of Port Central will include increased noise and potential for stormwater runoff and dust generation. The location of the facility, being relatively remote, will assist in isolating these potential impacts, but the design and construction activities will be managed and mitigation is proposed to limit the potential for impacts on water and air quality during the construction phase.

During operation there will be an increase in road traffic and associated noise levels, and this will tend to be during morning and evening periods. The use of a short term car park (sealed), buses and shuttles will minimise the impacts on the roads in close proximity to the facility.

Stormwater discharges during the operation of the facility, especially from car parks and roads will be managed to capture and treat the water to remove sediment and hydrocarbons (e.g. oils and fuel).

5.2 Fisherman's Landing, Calliope River and RG Tanna (Transport of Materials)

5.2.1 Fisherman's Landing

The proposed short term use of the existing barge ramp at Fisherman's Landing, and development of various facilities for the transport of materials to Curtis Island will not result in any significant impacts on the local area.

Dredging for maintenance will be required for better access to the existing barge ramp, and this will have some impacts on the ecological communities in the immediate area, although it is an existing maintenance requirement for this existing facility. However, these impacts will be restricted, short lived, and re-colonisation should occur with time. Associated vessel activity (barges and tugs) is likely to have a limited local impact on the local environment from the small number of movements per day.

Other construction work and development of facilities in this reclaimed area will have minimal impacts. There is potential for dust and stormwater runoff to impact local air and marine water quality during both construction and operation. However, design and operation of the various yards, stockpiles and activities will minimise the potential for these impacts.

There will be an increase in road traffic and associated noise levels, but these will be minor due to the existing industrial activities and the isolated location of the facility.

5.2.2 Calliope River

The Calliope River facility will require the construction of twin barge ramps in the Calliope River, with the development of substantial stockpiling, truck marshalling and vehicle parking areas. These facilities will be used to hold and transport bulk and raw materials to and from Curtis Island. The proposed site adjoins and existing coal terminal (RG Tanna) and has been used for stockpiling soil material historically. A number of potential impacts on the environment are associated with the proposed construction and operation of the facility, but none are considered to be significant.

The construction of the barge ramps will result in the removal of an intertidal area of the river bank. However, these impacts will be restricted, short lived, and re-colonisation should occur with time. Associated vessel activity (barges and tugs) is likely to have a limited local impact on the local environment from the small number of movements per day.

Other construction work and development of facilities in this commercial and industrial area will have minimal impacts. There is potential for dust and stormwater runoff to impact local air and marine water quality during both construction and operation. However, design and operation of the various yards, stockpiles and activities will minimise the potential for these impacts through the adoption of both engineering and administrative controls.

There will be an increase in road traffic and associated noise levels, but these will be insignificant due to the existing industrial activities and the isolated location of the facility.

5.2.3 RG Tanna Site

An alternate site is proposed adjoining the RG Tanna coal terminal. This small facility will be used only in the event that the Calliope River facility is not available in time and as a result will not provide the same level of service (no raw material storage etc). A new barge ramp will be required with some associated ramp construction activities. Some facilities will be required on the site including truck marshalling and vehicle parking. These facilities will be used to hold and transport bulk materials to and from Curtis Island. The proposed site adjoins an existing coal terminal (RG Tanna). A number of potential impacts on the environment are associated with the proposed construction and operation of the facility, but because this is an existing operating port area, they are considered to be minor.

Construction work and development of facilities in this commercial and industrial area will have minimal impacts. There is potential for dust and stormwater runoff to impact local air and marine water quality during both construction and operation. However, design and operation of the various yards, stockpiles and activities will minimise the potential for these impacts through the adoption of both engineering and administrative controls.

There will be an increase in road traffic and associated noise levels, but these will be minor due to the existing industrial activities and the isolated location of the facility.

6

Glossary

Abbreviation	Description
ASS	Acid Sulphate Soils
CAF SIA	Construction Accommodation Facility Social Impact Assessment
CSG	Coal Seam Gas
DEEDI	Department of Employment, Economic Development and Innovation
DIP	Department of Infrastructure and Planning
EMPs	Environmental Management Plans
EIS	Environmental Impact Statement
GLNG	Gladstone Liquefied Natural Gas
GPC	Gladstone Ports Corporation
GSDA	Gladstone State Development Area
IPA	Integrated Planning Act
LNG	Liquefied Natural Gas
MOF	Materials offloading facility
QCL	Queensland Cement Limited
QER	Queensland Energy Resources

7

References

Bechtel (2009), GLNG Project Mainland Marine Facilities (Unpublished Draft for Discussion).

Gladstone Ports Corporation (2006), Land Use Plan Review for the Port of Gladstone and Port Alma (Statement of Proposals).

The Office of the Co-ordinator General, Queensland Government (2008), Development Scheme for the Gladstone State Development Area.

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A

Appendix A Assessment of Potential Marine Ecological Impacts

Report

Mainland Marine Facilities

Assessment of Potential Marine Ecological Impacts

NOVEMBER 2009

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Abbreviations

Abbreviation	Description
CR BRF	Calliope River Barge Ramp Facility
CRC	Cooperative Research Centre
DPA	Dugong Protection Area
DPI&F	Department of Primary Industries and Fisheries
FL BLF	Fisherman's Landing Barge Loadout Facility
GBRMP	Great Barrier Reef Marine Park
GLNG	Gladstone Liquefied Natural Gas
GPC	Gladstone Ports Corporation
IMCRA	Interim Marine and Coastal Regionalisation for Australia
LAT	Lowest Astronomical Tide
LNG	Liquefied Natural Gas
MMF	Mainland Marine Facilities
MOF	Materials Offload Facility
NTP	Notice to Proceed
PCIMP	Port Curtis Integrated Monitoring Program
PLF	Product Loading Facility
TSS	Total Suspended Solids
VMA	Vegetation Management Act
WHA	World Heritage Area

1 Introduction

1.1 Project Description

This report was prepared by URS Australia Pty Ltd at the request of GLNG. It provides an assessment of potential impacts to the marine environment from the mainland marine facility (MMF) construction utilization strategies, currently proposed. The report uses information developed as part of the FEED Study, which is still under development (GLNG Project, Mainland Marine Facilities, Bechtel, Sept 2009).

For the construction of the proposed GLNG facility, a series of mainland marine facilities (MMF) will be required to allow for the transportation of personnel and materials back and forth to Curtis Island. For bulk materials it is proposed to utilise the existing barge load out facility at Fisherman's Landing for an initial 6 month period whilst a facility is developed at a site adjoining the Calliope River, where twin barge ramp will be constructed. An alternate to the Calliope River site is proposed, located alongside the RG Tanna coal terminal, where a barge ramp would need to be developed in this existing reclaimed area of the port. This is proposed in the event the Calliope River site cannot be developed rapidly enough. For personnel transportation the existing Gladstone Marine ferry terminal would be utilised for the first 6 months whist Port Central ferry terminal is developed (near Auckland Point). The locations of these proposed MMF are presented in Figure 1-1.

This assessment focuses on the potential impacts on the marine environment of the Calliope River and Fisherman's Landing facilities as the vessel activities at these locations would be more significant and they will potentially require construction in the marine environment. It should be noted that the existing barge ramp at Fisherman's Landing requires maintenance dredging, as part of the barge ramp activities, to facilitate access for vessels at all states of the tide. Potential impacts from the maintenance dredging in Fisherman's Landing facility is not covered in the scope of this report as it is a requirement for the Port Corporation and not Santos.

Furthermore, potential impacts from the RG Tanner alternative, and Port Central development are only generally covered in the scope of this report, as there are minor construction activities proposed which encroach into the marine environment. Barge ramps are proposed from both the Port Central and RG Tanna (alternative) facilities, but these are both within reclaimed areas of Gladstone Port. This assessment notes these potential structures within this reclaimed environment, but due to their location and the limited information on the nature of barge ramp developments, this assessment only briefly assesses their potential impacts.

1.1.1 Fisherman's Landing Barge Load-out Facility

The existing Fisherman's Landing barge load-out facility would require maintenance dredging of the barge pocket to allow more tidal range operation flexibility and to possibly minimize the need for night shift barge movements. Gladstone Port Corporation (GPC) has advised GLNG that other LNG Projects may also be given approval to utilize the existing Fisherman's Landing barge load out facility.

Dumb barges (towed by tugs) will be used to transfer bulk materials, such as temporary construction utilities, waste water treatment plant, water tanks, construction water plant, poly pipe and fittings, pumps, rolls of geotextile, rolls of geogrid, reinforced concrete pipes, box culverts, precast concrete headwalls, steel reinforcement bar etc and construction machinery to the Curtis Island GLNG site via road transport trucks. The barges will also be used to transfer materials from the Curtis Island site back to Fisherman's Landing. Raw materials such as merchantable timber, unsuitable soil, mulch and

topsoil will be sourced removed as required from the Curtis Island site using trucks. The dumb barges will moor at Fisherman's Landing barge load out facility and loaded trucks will be loaded on or off.

Truck loading and hauling, barge movement and truck unloading activity may operate on a 24 hour, six day per week basis.

1.1.2 Calliope River Barge Ramp Facility

Two adjacent barge ramps will be provided to suit Standard Ocean going 28m wide x 90m long dumb barges. Standard dumb barges will be equipped with front and rear ramps. Raw material bulk cargo dumb barges will be equipped with side doors and end doors. Each standard dumb barge will be able to transport an average of 10 standard highway trucks at a time (truck & trailer). Mooring points and fender piles will be installed along the perimeter of the combined barge ramp for assistance in stabilizing the barges during loading and unloading operations and for mooring during periods of idle time. Each barge will have a dedicated tug during barge movements with a certified tug skipper.

Raw materials such as road base, rock armour, rip rap, sand and concrete batch plant aggregates will be sourced from local quarries and stockpiled at a hardstand area located adjacent to the new Calliope River barge ramp facility. Articulated dumb trucks will then be used to reclaim from stockpile and haul to raw material, bulk cargo dumb barge. Loaded articulated dump trucks will deposit the material onto the barge and loaders/excavators will shape the stockpile on the raw material, bulk cargo barge. Once fully loaded, the raw material, bulk cargo barge will be transported to the Curtis Island site for unloading to stockpile in a similar manner.

Bulk materials such as steel reinforcement bar, mechanical equipment, pipe spools, cable drums, pre fabricated switchrooms, electrical equipment, raceway, structural steel, cement, vessels, small pre fabricated tanks would be transported to the Curtis Island site via road transport trucks and dumb barges. Road transport trucks will be marshalled at a hardstand area located adjacent to the new Calliope River barge ramp facility.

Truck loading and hauling, barge movement and truck unloading activity on the Jobsite may operate on a 24 hour, six day per week basis. Empty road transport trucks will be returned from the Jobsite to the new Calliope River barge ramp facility via dumb barge.

An alternative location for transporting bulk materials has been identified and highlighted in this report, however even with the tidal restrictions it is recommended all raw materials are transferred through the proposed Calliope River barge ramp facility once constructed (assumed to be by end of Month 6). According to the GPC the proposed Calliope River barge ramp location and associated required hardstand of approximate 12 to 15 Hectares in footprint area is owned/managed by the Department of Infrastructure & Planning. Accordingly, GLNG would have to secure the lease/license to utilize this land.

1.2 The Study Area

Port Curtis is located on the central Queensland coast just south of the Tropic of Capricorn, eastern Australia and adjacent to Gladstone City. Biogeographically, Port Curtis falls within the Shoalwater Coast bioregion as defined in the *Interim Marine and Coastal Regionalisation for Australia* (IMCRA Technical Group 1998). Port Curtis is a natural deepwater embayment that is protected from the open ocean by the Curtis and Facing Islands. Coastal geomorphology in the main study area is characterised by a partially enclosed embayment and shallow estuaries, including small, continental

rocky islands, intertidal flats and estuarine islands. Port Curtis estuary is a composite estuarine system that includes the Calliope and Boyne Rivers, The Narrows, Auckland Creek and several smaller creeks and inlets that merge with deeper waters to form a naturally deep harbour protected by southern Curtis Island and Facing Island. Elevated natural turbidity occurs within the shallow marine and estuarine waters with significant input of freshwater and alluvial sediments from the Boyne and Calliope Rivers.

The land adjacent to Port Curtis features over 1,000 km^2 of coastal hinterland, wetlands and estuarine waters with marine and coastal zone wetlands covering an area over 300 km^2 (McKinnon *et. al.* 1995*)*. Mangrove, seagrass, salt marsh, rocky and sandy shoreline, open water and subtidal benthic habitats support varied biological communities. Danaher et al (2005) mapped a total of 30 intertidal habitats with the Narrows and Port Curtis indicating the dominant habitat types were exposed mud banks and sandbanks (24%), closed *Rhizophora* forest (20%) and saltpans (18%) (Danaher *et al.*, 2005). Strong zonation of intertidal habitat types and the presence of extensive saltflats typify Port Curtis (Currie and Small, 2005). Much of the estuarine near-shore is lined by dense stands of mangrove, mainly *Avicennia marina* and *Rhizophora stylosa* while bare soft sediments cover most of the remaining bedforms.

The City of Gladstone has become one of the major industrial centres of Queensland due to its close proximity to the coal fields and deep water access port facilities (McKinnon *et al*. 1994). The area is heavily industrialised along the western shoreline and otherwise surrounded by large tracts of natural intertidal wetlands (Connolly *et al*. 2006). The stakeholder landscape consists mainly of industrial groups and recently, academic and government research institutions have become active in the area resulting in the delivery of current knowledge, however limited, of the values of Port Curtis intertidal wetlands (Melzer & Tanner 2005; Connolly *et al.* 2006; Rasheed *et al.* 2008).

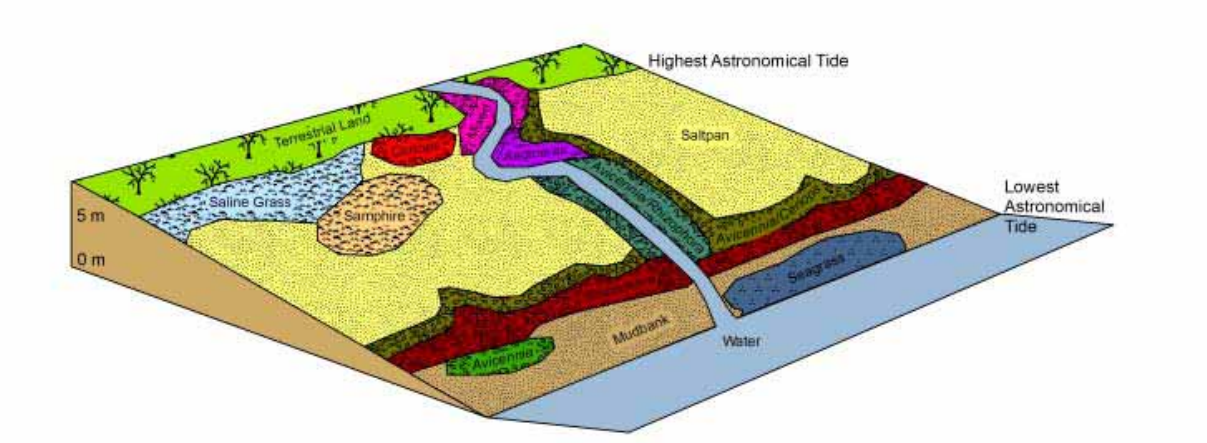
The MMF are located within the Port of Gladstone which is the southern-most port adjacent to the Great Barrier Reef Marine Coastal Park and within the Great Barrier Reef Marine Park (GBRMP) World Heritage Area. (WHA). To help evaluate the ecological significance of the area and assess the potential impacts from the project on marine habitats, a desktop study of intertidal and subtidal habitats was undertaken. This section provides a description of the marine ecological communities and benthic habitat within the proposed Gladstone Santos Mainland Marine Facilities (MMF) at Fisherman's Landing, the Calliope River and covers the surrounding area. The seagrass distribution, mangroves, saltmarsh and mudflat intertidal communities are discussed, along with the sub-tidal communities and benthic habitats present, for which more limited published information is available. It is hypothesised that subtidal communities will have been impacted during construction of Fisherman's Landing and any benthic communities present will have re-colonised since then.

The predominant subtidal habitats inside Port Curtis comprise:

- Winding channels of the tidal creek systems which drain the mud flats and hinterland in Port Curtis and The Narrows, plus the deeper channels of the lower Calliope River and its mangrove-lined Anabranch;
- The relatively turbid and tidally dominated water column that overlies the soft silty sediments of Port Curtis (0-10 m LAT depth range, extending to 15-18 m LAT near Hamilton Point);
- Restricted areas of rocky outcrop and drop-offs below headlands and beside channels;
- The dredged shipping channel leading to the swing area and berths at Fishermans Landing (7-15 m LAT), with mixed, variable and often coarse substrate dominated by cobbles, silty sandy gravel and shelly, silty sand; and

- Shelly, gravelly sand and silt substrates of the nearshore shallow subtidal zone, bare or colonised by macroalgae and *Halophila* seagrasses in depths <1 m below LAT.

Figure 1-2 General View of Tidal Profile within Port Curtis

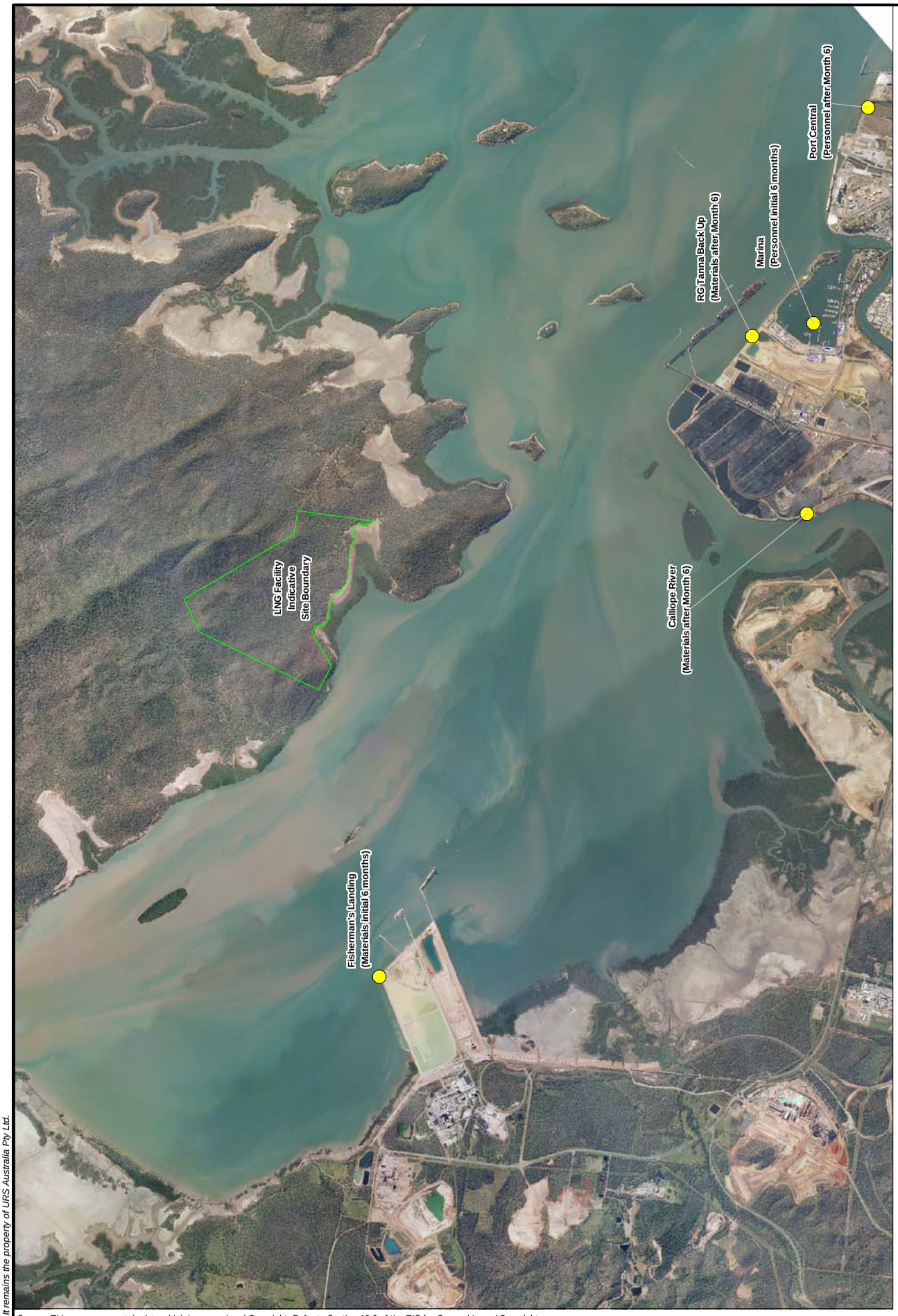


Source: Connolly RM, Currie DR, Danaher KF, Dunning M, Melzer A, Platten JR, Shearer D, Stratford PJ, Teasdale PR & Vandergragt M (2006) *Intertidal wetlands of Port Curtis: ecological patterns and processes, and their implications*. Technical Report No. 43, CRC for Coastal Zone, Estuary and Waterway Management, Brisbane.

The marine components of the mainland MMF include potential impacts from construction to adjacent seagrass meadows north and south of Fisherman's Landing and adjacent to the Calliope River location behind Wiggins Island. The objective of this assessment is to describe the marine habitats that may be impacted by the MMF component of the Santos LNG proposal, how they are represented within Port Curtis and broader regional areas and mitigation of potential impacts to the marine environment.

Previous assessments of intertidal and sub-tidal areas within Port Curtis were conducted as part of the EIS for the GLNG Project. Information obtained from field surveys and desktop studies have been used, in conjunction with available site-specific information to assess potential impacts. An overview of the field surveys conducted, the methods used to describe the existing marine environmental values of the area are provided in EIS Appendix R. The outcomes of this assessment will be applied to:

- describe the potential adverse and beneficial impacts of the proposed mainland MMF on the identified marine environmental values;
- develop environmental protection objectives for the marine environment, along with the standards and measurable indicators to be achieved; and
- examine viable alternative strategies for managing marine impacts.



Client

Project
GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
MAINLAND MARINE FACILITIES ASSESSMENT

Title
PROPOSED GLADSTONE MAINLAND MARINE FACILITIES

Drawn: RG	Approved: JB	Date: 19-11-2009
Job No: **4262 6440** /6220	File No: 42626440-g-2190.wor	

Figure: **1-1**

Rev:B

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1.3 Survey Methodology

A comprehensive desktop study was undertaken to review all available literature on the intertidal and subtidal marine environment in Port Curtis, in particular Fisherman's Landing and the Calliope River. Results from the desktop study have been used to support the information gained from field surveys conducted previously by URS for the GLNG EIS.

A helicopter survey of intertidal seagrass distribution at Port Curtis was undertaken on 4 May 2008 at spring low tide. During the survey fixed GPS coordinates using a differential geographic positioning system were taken every 50 m along the intertidal and subtidal boundaries of the mainland and Curtis Island. Video footage taken from the helicopter provided information on the zonation of intertidal saltmarsh, mud flats and mangrove communities to assist in the development of the intertidal and subtidal surveys. During this survey seagrass meadows adjacent to Fisherman's Landing were noted. The methodologies employed to assess the marine habitat were aligned where possible with existing monitoring programs in the areas, such as the Port Curtis Intertidal Monitoring conducted by the Cooperative Research Centre (CRC) for Coastal Zone Estuary and Waterway Management (CRC Coastal) and the Department of Primary Industries and Fisheries (DPI&F) and continued monitoring by the PCIMP.

A sub-tidal survey of benthic communities was conducted as part of the GLNG EIS (refer EIS Appendix R).

Environmental Values

2.1 Intertidal Habitat

2.1.1 Seagrass in Port Curtis

Seagrass meadows in Queensland are known to provide a valuable nursery habitat for juvenile prawns and commercial fish (Watson *et al.,* 1993) as well as providing an important food resource for dugong and green sea turtles with both these species observed within Port Curtis (Rasheed *et al*. 2003). Large areas of seagrass were first identified in the Port Curtis region during part of a broad scale state-wide seagrass survey conducted in 1988 (Coles *et al.*, 1989). The value of these meadows to dugong instigated the declaration of the Rodds Bay Dugong Protection Area (DPA). This program has been continued and expanded by the Port Curtis Integrated Monitoring Program (PCIMP) in 2007 to include the collection of a number of additional physicochemical parameters, including temperature, light and turbidity after the recognition of the importance of the monitoring to port users, and the potential to value add to the program (PCIMP, 2008).

Seagrasses are affected by temperature and any factor which causes a change in the amount of light reaching the meadow, including an increase in suspended sediments or an increase in epiphytic growth (algae) which can shade the seagrass (PCIMP, 2008). The Queensland DPI Monitoring Group conducted a baseline monitoring program of seagrass meadows in 2002 (Rasheed *et al.*, 2003). Results from this study indicate there are significant seagrass meadows within Port Curtis often adjacent to port infrastructure. Significant seagrass beds are found at many locations throughout the Curtis Coast region, with intertidal and subtidal communities exhibiting generally different species compositions and canopy coverage (Currie *et al*. 2003). According to Rasheed *et al*. (2003) there are six species of seagrasses found in the Curtis Coast region:

- *Halodule uninervis (Forsk.) Aschers*
- *Halophila decipiens Ostenfeld*
- *Halophila minor (Zoll.) den Hartog*
- *Halophila ovalis (R. Br) Hook. F.*
- *Halophila spinulosa (R. Br.) Aschers.*
- *Zostera capricorni Aschers.*

Seagrass meadows that are of interest to this study include intertidal and subtidal areas to the north and south of Fisherman's Landing, Wiggins Island and the Calliope River. In the Port Curtis estuary, seagrass meadow area and biomass vary seasonally and between years with peaks in late spring/summer and troughs in winter (McKenzie, 1994; McKenzie *et al.* 1998; Rasheed 1999). The drivers of seagrass change in Port Curtis appear to be associated with local and regional climate conditions and factors such as tidal exposure, rainfall, river flows, solar iradiance and temperature (Rasheed *et. al.*, 2008). Despite seagrass meadows being less conspicuous in Port Curtis than in other large estuarine embayments along the Australian east coast, they are considered to contribute significantly to the food webs that sustain fisheries species living over mudflats such as whiting.

Figure 2-1 indicates the seagrass beds that are scattered throughout Port Curtis on both mud and sand banks sourced through regular monitoring by the Department of Primary Industries and Fisheries (DPI&F). Thirteen seagrass meadows from the 2002 baseline survey were selected for the long term monitoring program to represent the range of seagrass communities that were identified to be in areas likely to be vulnerable to impacts from port operations and developments (Rasheed *et al.*, 2003).

Extensive areas of seagrass were found, mainly on the shallow coastal mud and sand banks, but rarely penetrating into subtidal areas off the edge of the banks (Rasheed *et al*. 2003). The intertidal seagrass communities on muddy sediments within Port Curtis were dominated by *Zostera capricorni* and were the most widely distributed communities within Port Curtis (Rasheed *et al*. 2003). The intertidal seagrass communities on sandy sediments were found between Quoin and Facing Islands and dominated by *Halodule uninervis* (Rasheed *et al*. 2003).

The 2008 long term monitoring survey reported that seagrass meadows in Port Curtis were in the healthiest condition recorded since the inception of the monitoring program in 2002 (Rasheed *et al*. 2008). Within Port Curtis, high seasonal variability of seagrass meadows presence and density was also reported in the Port Curtis area demonstrated by patchy meadows north of Fisherman's Landing (Rasheed *et al.*, 2008). This survey was conducted in late spring (October 2007) when seagrass was likely to be at maximum density and distribution in the region. During the Connolly *et al.*, 2006, seagrass were estimated to cover 20% of the Port Curtis area, but were considered to be overestimated because of the high seasonal variation. Both reports suggest that seagrass exist close to port infrastructure and dredged channels rendering them highly vulnerable to direct impacts of port developments.

Results from monitoring conducted in 2008 indicate that seagrass density and meadow area were similar to levels measured in past monitoring surveys in the Port of Gladstone (Rasheed *et al.*, 2008). However, 10 of the 13 meadows showed significant decline in biomass from the previous year and only one meadow, the Pelican Banks *Zostera* meadow, showing a significant increase in biomass from 2007 (Figure 2-1).

Fisherman's Landing

Results from the monitoring program in 2008 indicate that the intertidal and subtidal seagrass meadows north and south of Fisherman's Landing had declined significantly in biomass from the peak levels recorded in 2007 to 2004/2005 levels (Rasheed *et al.*, 2008). Species composition in these meadows has also shifted slightly with an increase in the proportion of biomass made up by the meadows' dominant species (Rasheed *et al.*, 2008). Subtidal meadow area had increased significantly from 2007 while the intertidal meadows remained essentially unchanged in size (Rasheed *et al.*, 2008). These results confer previous results whereby the subtidal meadows appear highly dynamic compared to the neighbouring intertidal meadows. *Zostera capricorni* and *Halophila ovalis* communities dominated the intertidal sand and mud banks between Mud Island and Fishermans Landing wharves with *Halophila decipiens* dominating in subtidal areas (Rasheed *et al.*, 2008).

Results from the 2002 monitoring survey indicate light and patchy intertidal seagrass meadows located adjacent to Fisherman's Landing Wharves were dominated by *Zostera capricorni* with *Halophila decipiens* and *Halophila spinulosa* dominating the deeper subtidal meadows (shallow subtidal and offshore more than 5 m below mean sea level) (Rasheed *et al*. 2003). In contrast, the 2005 monitoring program reports a change to species composition where sparse meadows of *Halophila ovalis* dominated between Fishermans Landing and Friend Point with isolated patches of *Halophila decipiens* in deeper waters (Rasheed *et al.*, 2006) (Figure 2-1).

In 2005 the southern Fisherman's Landing meadow was dominated by *Zostera capricorni* and showed an increase in biomass from 2002 (Rasheed et al., 2006). The intertidal meadow to the north of Fisherman's Landing had returned to being dominated by *Zostera* although biomass was significantly less than baseline survey (Rasheed *et al*., 2006). This meadow had fragmented into small isolated

patches dominated by unvegetated substrate covered by large quantities of green macro-alga *Pseudocodium floridanum* and filamentous algae (Rasheed *et al*., 2006). The monitoring conducted in 2005 reports an overall reduction from baseline levels of seagrass biomass and area adjacent to Fisherman's Landing and an increase in biomass of the subtidal seagrass meadows during the same period (Rasheed *et al.* (2006).

Seagrass meadows are considered ephemeral during the winter months (Danaher *et al*, 2005), which would explain the sparse cover found during the May 2008 survey. Within the aggregated patches of seagrass on the mainland mud flats*, Zostera capricorni* and *Halophila ovalis* were found towards the high water mark closer to the mainland and *Halophila decipens* closer to the low water mark. This is consistent with results from the seagrass baseline survey conducted in 2007 (Rasheed *et al*, 2008).

The observations recorded during the helicopter survey conducted in May 2008 for the EIS, support the findings of the 2007 monitoring program, where ephemeral intertidal seagrass meadows north of Fisherman's Landing were observed with sparse seagrass cover (<5%) evident on the mud flats between Fishermans Landing and Friend Point.

Calliope River Inner Harbour

The Calliope River Mouth contains a variety of habitats from the deep main channel to shallow intertidal mud banks around the anabranch and Beecher Creek. Rocky outcrops and gravel beds become exposed at low tide with tidal heights around 4.5 m at new and full moon tidal periods (McKinnon *et al.* 1995). The tidal characteristics of the lower reaches of the Calliope River are through the main channel to the north of the RG Tanner project (Connell-Hatch, 2006). At higher tide levels water flows through the main channel between Mud Island and Wiggins Island and between Wiggins Island and Golding Point (Connell-Hatch, 2006). Shoals at the mouth of the river adjacent to Mud Island have been reported to constrain the tidal propagation into the Calliope River, resulting in the low tide levels in the river being higher than the low tide level within Port Curtis (Connell-Hatch, 2006).

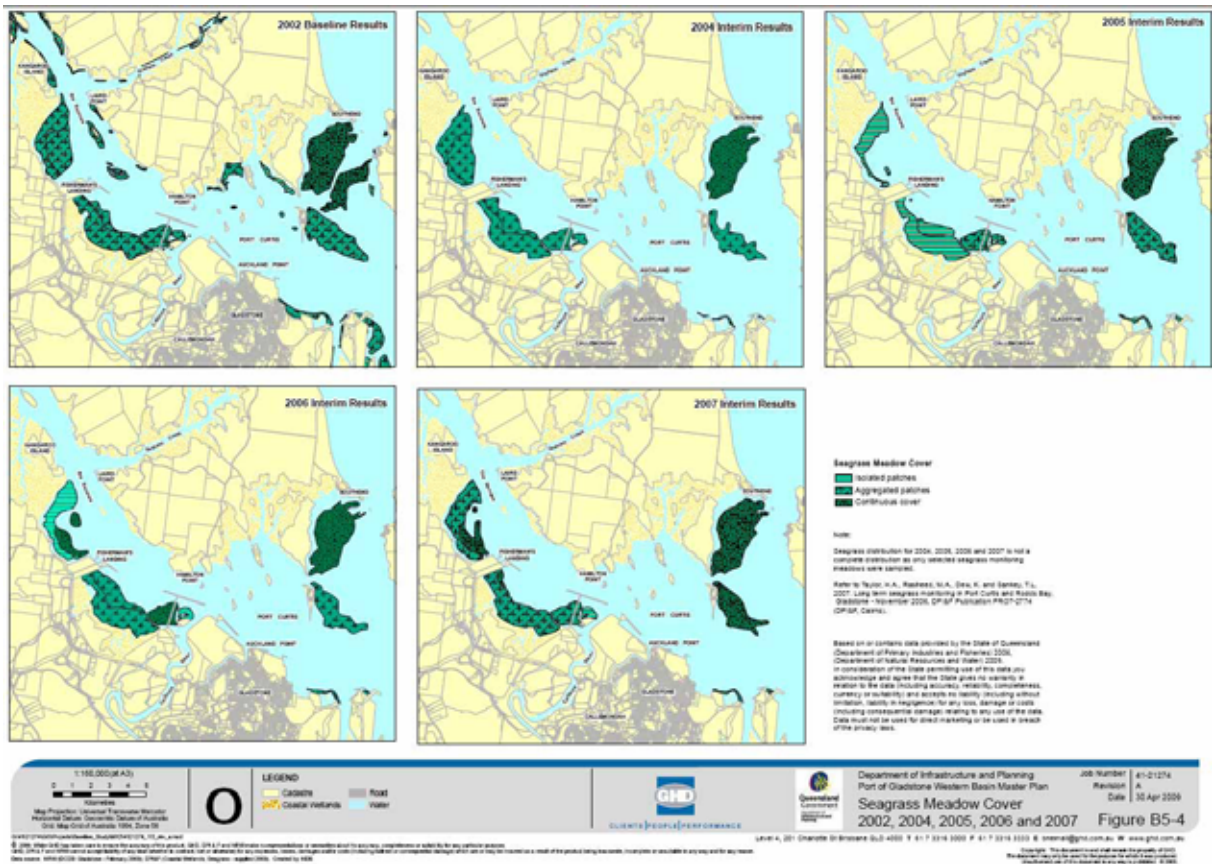
Seagrass biomass, area and cover on the two intertidal meadows closest to the mouth of the Calliope River were not significantly different from 2007 values, with a slight shift to a monospecific stand of *Zostera capricorni* (Rasheed *et al.*, 2008). Filamentous green algae were again common on the banks adjacent to Wiggins Island which has been observed during surveys since 2004 (Rasheed *et al*. 2005, 2007, 2008).

Aggregated light patches of *Halophila ovalis* with *Zostera capricorni* were recorded around Wiggins Island with light aggregated patches of *Halophila ovalis* extending out from the mouth of the Calliope River (Rasheed *et al.*, 2006). Comparison from the 2002 survey indicates the two areas adjacent to Wiggins Island continued to be dominated by *Halophila ovalis* with the western meadow increasing in biomass and the meadow immediately adjacent to Wiggins Island showing the lowest biomass recorded for the monitoring program to date (Rasheed *et al.*, 2006). *Zostera capricorni* communities occurred between South Trees Inlet and Barney Point (Rasheed *et al.*, 2008).

In comparison with previous monitoring surveys conducted by DPI&F the intertidal seagrass meadows that were monitored at Wiggins island had continued to increase in biomass in 2007 from the low levels recorded in 2005 (Rasheed *et al.* 2008). The *Zostera capricorni* dominated meadow at Pelican Banks has provided that most stable example with both biomass and area remaining relatively consistent between surveys. Biomass for this meadow had not changed significantly between years.

Surveys conducted by URS (2007) on subtidal seagrass to the north side of Wiggins Island indicate that only sparse, isolated patches of *Halophila ovalis* were found in this area.

Figure 2-1 Seagrass Meadows in Port Curtis 2002 – 2007



Source: Taylor, HA; Rasheed, MA; Dew, K; Sankey, TL (2007), Long Term seagrass monitoring in Port Curtis and Rodds Bay, Gladstone – November 2006, DPI&F Publication PR07-2774 (DPI&F Cairns).

Port Central and RG Tanna

The intertidal area adjacent to the locations of the proposed Port Central and RG Tanna developments has not been surveyed as part of the GLNG field studies. The long-term monitoring program also does not include monitoring of seagrass meadows at these location. The implication of this and the proximity of the sites to the port are that if seagrass exists, it is likely to be highly patchy and ephemeral.

2.1.2 Mangroves, Saltmarsh/Saltflats and Mudflats

At a regional scale, the distribution of mangrove species is determined by a number of factors including temperature, rainfall, catchment and tidal inundation. Mangrove species are limited in their latitudinal distribution by their tolerance to low temperatures (Duke e*t al*. 1998) and the majority of mangrove species are limited to tropical environments. Consequently, mangrove species diversity decreases with increasing latitude. In Queensland this phenomenon can be seen clearly along the

east coast, with Cape York recording 39 species, the Central Coast region recording 23 species, and the South East region (Curtis Island to Gold Coast) recording 14 species (Duke 2006). Three species (*Acanthus ilicifolius*, *Bruguiera exaristata* and *Xylocarpus moluccensis*) are at their southern limits in the Curtis coast region and the most southern occurrence of *Xylocarpus moluccensis* on the eastern Australian coast occurs near at Auckland Creek (Connolly *et al*. 2006).

Of the 14 mangrove species previously recorded from the Port Curtis area, 11 were recorded during the June 2008 survey. The mangrove species recorded from the survey were consistent with those species noted from other intertidal surveys in the Gladstone area and no new species for the Port Curtis area were found in the June 2008 survey. Species such as *Acanthus ilicifolius* (Spiny Holly Mangrove) and *Acrostichum speciosum* (Mangrove Fern) have previously been recorded from the Gladstone area but were not encountered during the June 2008 survey as suitable habitat for these species (i.e. upper reaches of large creek or river systems) do not occur in the immediate study area. While not considered to be a mangrove, the mistletoe *(Amyema* sp.) was also noted in mangrove canopies at a few sites.

Saltmarsh are found in intertidal habitat dominated by salt-tolerant herbs and low shrubs, such as samphires and saltmarsh grass. In Port Curtis, saltmarsh occurs at the seaward edge of extensive saltflats, usually just landward of mangroves (Rasheed *et al.* 2003). The vegetation consists of sparse ground cover of species such as *Suaeda* spp., *Sarcocornia quinqueflora* and *Sporobolus virginicus*. In contrast to mangrove species, saltmarsh species diversity and community complexity in Queensland increases with increasing latitude (Zeller 1998). Saenger (1996) recorded 40 saltmarsh species (shrubs, grasses, herbs and algae) for the Curtis Coast region.

Saltflats are hypersaline, unvegetated areas high in the intertidal zone, inundated only at high spring tides (Saenger 1996). They are characterised by poorly drained clay soils, high evaporation rates and a low, strongly seasonal rainfall (Saenger 1996).

Intertidal mudflats lacking conspicuous vegetation form the most extensive habitat in Port Curtis (Connolly *et al.*, 2006). Erftemeijer and Lewis (1999) recognised that intertidal mudflats constitute an important habitat that support a high biodiversity and biomass of benthic invertebrates, sustain productive fisheries and provide important feeding grounds for migratory shorebirds (Connolly *et al*., 2006).

Fisherman's Landing

There are no mangroves located at the barge ramp location of the Fisherman's Landing location. All land currently situated at the location of the temporary barge ramp is reclaimed land.

Mangroves found adjacent to the Fisherman's Landing site were estimated during the Northern Expansion of Fisherman's Landing EIS (GHD, 2009). Approximately 1.897 ha of intertidal vegetation occurs in the proposed Fisherman's Landing Northern Expansion (GHD, 2009). The majority of this vegetation (1.447 ha) is closed mangrove forest to 5 m tall, dominated by *Rhizophora stylosa* (red mangrove) (GHD, 2009). The species composition, land form and substrate correspond with the description of RE 12.1.3 (VMA Status: Not of Concern). Behind the mangrove community is a small area (0.45 ha) of sparse saltpan vegetation on marine clay. This community consists primarily of patches of *Sporobolus virginicus* (saltwater couch), samphire species and bare mud. The species composition, land form and substrate correspond with the description of RE 12.1.2 (VMA Status: Not of Concern). The mangrove communities in the vicinity of the proposed Fisherman's Landing

Northern Expansion are adapted to the turbid near shore environments. The turbid plume from the Targinie Channel and Fisherman's Landing swing basin dredging and decant from the reclamation is not expected to substantially increase turbidity along the shoreline where there are mangroves.

Calliope River Inner Harbour

The Calliope River is a tide dominated delta where the estuary has low sediment trapping efficiency, naturally high turbidity, well-mixed circulation. There is a low risk to habitat loss due to sedimentation. Natural turbidity levels have bee calculated as Turbidity 12 (34) NTU; Sechi disc depth 0.7 (0.5m) at the mouth of the river (Arnold, 1996). According to Arnold (1996) the Calliope River (total area 16.2 sq. km) was mapped in 2000 with the resulting intertidal habitat areas:

- 1.9 sq. km intertidal flats;
- 7.1 sq. km mangroves;
- 6.5 sq. km saltmarsh/saltflat; and
- 0.7 sq. km tidal sand banks.

McKinnon *et. al.* (1995) found that seven species of mangroves occur in the estuarine reaches of the river with no one species dominating. It was suggested that due to the low lying topography of the tidal influence was consistent with regular inundation. *Rhyzophora stylosa* was the dominant species found on the mangrove island adjacent to the location of the inner harbour.

Port Central and RG Tanna

There are no stands of mangroves present at the locations of the proposed barge ramps for Port Central and RG Tanna. The land and foreshore of these areas is reclaimed land.

2.2 Subtidal Habitat

Benthic communities within Port Curtis consist of sponges, sea whips, bryzoans, hydrozoans and soft corals. During the field survey in 2008 these communities were found on rocky substrate at Hamilton Point, Curtis Island. Benthic communities present at silted bays on Curtis Island were also recorded and found to be sparse when compared to rock/silt substrates. Species found in silted bays and at Friend Point include soft coral, sea whips and sea pens. It is considered that the subtidal area of Fisherman's Landing consist of light coverage of seagrass meadows and Calliope River Inner Harbour most likely consists of sparse cover benthic organisms similar to those found elsewhere within the port.

2.3 Marine Fauna

Evidence of dugong activity has been consistently observed at the Wiggins Island seagrass meadows since inception of the monitoring program since 2002 (Rasheed *et al.*, 2006, 2008). Dugong feeding trails were found at a majority of sites sampled in 2008 and have been recorded in all previous surveys (Rasheed et al., 2008). Further evidence of feeding activity was observed in South Trees, Quoin Island and Fisherman's Landing (Rasheed et al., 2008).

Green sea turtles have also been observed within these seagrass meadows (Rasheed *et. al.,* 2006) in particular at Pelican Banks where they were often 'stranded' at low tide (Rasheed et al., 2008). Recent research indicates that Indo-Pacific humpback dolphins are known to visit Port Curtis on occasion (Cagnazzi, unpub.).

Potential Impacts and Mitigation Measures

3.1 Potential Impacts

Potential impacts to marine fauna and flora include decrease in water quality, alteration of the hydrodynamic (wave climate from vessels' engines) boat strike from barges and increased water taxi activity, loss of habitat, changes to behaviour including avoidance behaviour due to noise and vibration form construction and operation phase of the project.

Field studies conducted by URS for the GLNG EIS indicate that migratory shorebirds roost occasionally on mud banks and sand banks within Port Curtis, however, due to the low level of benthic productivity in the sediment it was hypothesised that the importance of the area to migratory shorebirds is limited (Appendix N).

3.1.1 Fisherman's Landing

An existing barge ramp is planned to be utilised temporarily (6 month period) while the Calliope River Inner Harbour is being developed. Potential impacts from construction and operation of the Fisherman's Landing MMF will be short–term, and land based. Maintenance dredging for access to the barge ramp is not the responsibility of Santos and has not been addressed in the impact section. Note that no maintenance dredging is anticipated while the barge ramp is being utilized by Santos.

Monitoring in 2005 indicates that seagrass meadows north of Fisherman's Landing declined in contrast to the general trend for the port. Monitoring conducted on seagrasses in Port Curtis in 2006 and 2007 indicates that intertidal seagrass meadow biomass increased in 2006 and 2007, however subtidal meadows at Fisherman's Landing and Wiggins Island was unchanged. This indicates a tendency for the seagrass meadows to respond differently to pressures in this area than in other areas of the port. Rasheed *et al*. (2006) reports that potential causal factors were:

- Influence of the Calliope River – flow and discharge
- Increased abundance of algae – water quality reduction; smothering and shading
- Potential increase in water temperature – Comalco discharge at Fisherman's Landing and the power station discharge into the Calliope River;
- Low resilience of seagrass meadows;
- Cessation of sewage discharge into the Calliope River;
- Runoff from Fisherman's Landing reclamation – turbid plumes; and
- Longer-term decline – high modification of these areas.

3.1.2 Calliope River

Potential impacts from construction and operation of the Calliope River Inner Harbour will involve construction of the barge ramps through the intertidal area. This will result in the removal of existing habitat within these zones, and potential for localised impacts on water quality, through the release of turbid water.

As the inner harbour is proposed to be a long term area of operation for transportation of construction materials and machinery for the GLNG Project, minimal impacts from vehicles and vessels traffic is anticipated during the life of the project.

Potential impacts to mangroves will be mitigated through agency agreement on environmental offsets for any mangroves lost under the Environmental Offset Policy.

3.1.3 Port Central and RG Tanna

Potential impacts from construction and operation of barge ramps at both Port Central and RG Tanna are unlikely to impact seagrass in the local area (if it is found at these location). In both cases the proposed barge ramps would be constructed though the intertidal zone on reclamation area within the existing port area. As the land is reclaimed, it is unlikely that marine plants such as mangroves or saltmarsh will be impacted.

3.2 Mitigation Measures

Minimising the footprints for the facilities will be key to minimising the impacts on the existing communities present at the MMFs. Mitigation measures for potential impacts will be detailed in the DMP once developed.

Measures to avoid interactions with marine fauna will include the use of an Independent Fauna Observer during marine operations. Other mitigation measures for indirect impacts of construction activities and operations are detailed in the table provided in Appendix B of the Turtle and Dugong Management Plan (Attachment F5).

3.3 Cumulative Impacts

Causal factors impacting seagrass meadows and causing declines can be attributed to a number of environmental and anthropogenic factors. Previous evidence suggests that the health of the seagrass meadows adjacent to Wiggins Island, Calliope River and Fisherman's Landing has suffered longer term losses with less ability to recover. Experimental studies show that larger scale loss of seagrass takes longer to recover due to the poor success of recruitment from seeds (Rasheed et. al, 2006). As regeneration relies on the presence of adult plants, future declines in seagrass biomass and areas that resulted in complete loss of adult plants would significantly hinder recovery.

Cumulative impacts from the Wiggins Island Coal Terminal construction, including on-going industrial activities and the Fisherman's Landing Northern Expansion proposal may contribute to any potential impacts associated with the GLNG Project.

Conclusions

Rasheed et al. (2003) conclude that the presence of apparently healthy seagrass meadows in such close proximity to port facilities indicates that the port marine environment is relatively healthy. However, due to their location, these seagrass meadows would be vulnerable to direct impacts by future port infrastructure developments such as wharves, breakwaters and reclamation.

A potential increase in the level of estuarine contamination may be observed after construction and during operations of these facilities if many years worth of sediment linked contaminants are resuspended over a short period. To date, no causal link has been established between sediment resuspension and contamination levels within Port Curtis, but monitoring should be used to assess this potential link given increasing levels of construction and development in the area (Rasheed et al., 1993).

The proposed MMF construction would potentially have some minor impacts on seagrass and mangroves, and there is potential for increases in turbidity associated with the construction activity. With the implementation of mitigations measures to reduce TSS and light attenuation during construction activities, potential impacts to adjacent seagrass meadows are anticipated to be short-term. Recovery and shifts in biomass appear to be different between intertidal and subtidal seagrass meadows. Monitoring of seagrass meadows biomass, area and species composition in both intertidal and sub-tidal areas can occur through contribution to the PCIMP Program to conduct annual monitoring of seagrass and mangrove health.

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Appendix B Noise and Vibration (Terrestrial) Report

HEGGIES

REPORT 20-2014-R10

Revision 1

Santos Gladstone LNG
Mainland Marine Facilities
Noise and Vibration Assessment

PREPARED FOR

URS Australia Pty Ltd
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16 NOVEMBER 2009

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Santos Gladstone LNG
Mainland Marine Facilities
Noise and Vibration Assessment

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20-2014-R10	Revision 0	13 November 2009	Glyn Cowie	Dave Lindsey / Henrik Malker	Henrik Malker

PROJECT DESCRIPTION

As a result of ongoing project design refinements and in response to a number of stakeholder EIS submission comments, a number of marine facilities are proposed on the mainland for the transporting of personnel and materials from the Gladstone Region to the LNG facility work site (Curtis Island). Separate facilities are proposed for the transport of personnel and materials, with facilities proposed at the following locations (including whether the site is for transportation of personnel or material):

- Port Central (Auckland Point) – Personnel transportation after Month 6;
- Gladstone Marina – Personnel transportation for initial 6 months;
- Fisherman's Landing – Material transportation for initial 6 months;
- Calliope River – Material transportation after Month 6; and
- RG Tanna – Material transportation after Month 6 (backup option).

A new bus depot, long-term car park, short-term car park (Port Central) and temporary car park (Gladstone Marina) have also been proposed. The bus depot will act as a marshalling area for buses / shuttles which are utilised for transporting personnel from pickup points within Gladstone to the Port Central marine facility. The long-term car park will provide a secure parking location for workers who are staying at the Construction Accommodation Facility (CAF) on Curtis Island. The short-term car park at Port Central will provide secure parking location for workers who are travelling from the Port Central to Curtis Island. Similar to the Port Central car park, the temporary car park near the Gladstone Marina will provide secure parking location for workers who are travelling from the Gladstone Marina to Curtis Island. This temporary car park will only be in operation for the initial six (6) months of the GLNG Project.

The location of the bus depot, long-term car park and temporary car park (Gladstone Marina) are at this stage not yet confirmed.

A comprehensive assessment has been undertaken of the potential noise and vibration impacts associated with the construction and operational phases of the mainland marine facilities as well as associated traffic movements, bus depots, and long-term and temporary car parks.

The noise assessment methodology and noise criteria used for this assessment are as per Heggies GLNG EIS Noise and Vibration Report – 20-2014-R1R4 dated 22 May 2009.

NOISE AND VIBRATION CRITERIA

Construction

The limiting noise and vibration criteria for the construction phase of the mainland marine facilities are summarised below.

EXECUTIVE SUMMARY

Summary of Construction Noise and Vibration Criteria

	Construction Noise		Vibration		
	Monday to Saturday (6:30am to 6:30pm)	Monday to Saturday (6:30pm to 6:30am); Sundays and Public Holidays	Structural Damage (mm/s)	Human Comfort (mm/s)	
				Day	Night
Residential	No limit	50 dBA L_{Amax}	12.5	0.3 – 0.6	0.2
Industrial	No Limits	No Limits	50	1.2	1.2

Operational

The limiting noise criteria for the operational phase of the mainland marine facilities are summarised below.

Summary of the Limiting Operational Criteria

Assessment Location	Design Criteria[1]	Sleep disturbance
	$L_{Aeq(1hour)}$ (dBA)	L_{Amax} (dBA)
Plant 1	44	50
Plant 2	34	50
Plant 3	40	50
Plant 4	40	50
Plant 5	34	50
Plant 6	41	50
Plant 7 [2]	43	50

Note: Limiting operational criteria is defined as the most stringent of the day, evening and night-time project operational criteria

1: Design criterion is the most stringent of the Planning Noise Level (PNL) and Specific Noise Level (SNL) (as defined in EcoAccess Guideline: Planning for Noise Control).

2: Noise criteria are based on typical background noise levels for an "Industrial Area' as shown in the Queensland Department of Environment and Resource Management's (DERM) *Ecoaccess Guideline: Planning for Noise Control* 'Recommended Outdoor Planning Noise Levels'.

Road Traffic

Where the mainland marine facilities are adding vehicles to an existing or upgraded road, it is appropriate to consider the incremental change in noise levels due to the changes in traffic volume.

For assessment purposes, it is common to set the threshold of significance in relation to changes in the noise emission level from roads at 2 dBA.

CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

Construction Noise

Construction noise associated with Port Central, Calliope River and RG Tanna mainland marine facilities was predicted to achieve the 50 dBA L_{Amax} sleep disturbance noise criteria at assessment locations and nearby sensitive receptors for all scenarios except piling works. Piling works was predicted to exceed the 50 dBA L_{Amax} sleep disturbance noise criteria by up to 10 dBA. Mitigation measures for the piling works is discussed in the mitigation section below.

Construction Vibration

Construction vibration associated with Port Central, Calliope River and RG Tanna mainland marine facilities was predicted to achieve relevant vibration criteria at all sensitive receptors. No mitigation measures were required.

OPERATIONAL NOISE ASSESSMENT

Based on the assumption that the Port Central Car Park will have a capacity of approximately 216 cars, noise emissions from the car park were predicted to be 18 dBA at the nearest sensitive receptors (Off Street). This level achieves compliance with the operational criteria of 40 dBA $L_{Aeq(1hour)}$.

Noise levels associated with car door slams and engine starts were predicted to be 27 dBA at the nearest sensitive receptors (Off Street). This level achieves compliance with the 50 dBA L_{Amax} sleep disturbance noise criteria.

With an offset buffer distance of 180 m, operational noise associated with the Bus Depot was predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$) and 50 dBA L_{Amax} sleep disturbance noise criteria (assuming the bus depot will be sized for a peak capacity of approximately 40 buses). No mitigation measures will be required at this offset buffer distance and bus capacity.

Assuming a maximum car park capacity of 2,200 vehicles and with an offset buffer distance of 275 m, operational noise associated with the long-term car park was predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$)) and 50 dBA L_{Amax} sleep disturbance noise criteria. No mitigation measures will be required at this capacity and offset buffer distance.

Assuming a maximum car park capacity of 360 vehicles and with an offset buffer distance of 80 m, operational noise associated with the Temporary Car Park (Gladstone Marina) was predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$)) and 50 dBA L_{Amax} sleep disturbance noise criteria. No mitigation measures will be required at this capacity and offset buffer distance.

Operational noise associated with the the operational phase of the material transfer facilities at Fisherman's Landing, RG Tanna and Calliope River were predicted to comply with the design criteria ($L_{Aeq(1hour)}$) at all assessment locations. Operational noise from the material transfer facilities at Calliope River is also predicted to comply with the design criteria at the representative noise sensitive locations along Palm Drive and Cray Street (West Gladstone). No mitigation measures will be required.

ROAD TRAFFIC NOISE ASSESSMENT

No adverse noise impacts were predicted for road traffic noise associated with construction activities for the mainland marine facilities at Port Central, Gladstone Marina and RG Tanna, as well as operational activities from Port Central. Therefore no noise mitigation measures are proposed to attenuate noise from road traffic for the mainland marine facilities at Port Central, Gladstone Marina and RG Tanna.

The predicted increase in road traffic noise associated with construction activities for the mainland marine facilities at Fisherman's Landing and Calliope River was greater than 2 dBA. Therefore, mitigation measures were considered for these locations and are discussed in the mitigation section below.

MITIGATION MEASURES

Construction

It was predicted that construction activities associated with the mainland marine facilities (Port Central, Calliope River and RG Tanna) should not adversely affect nearby sensitive receptors for all scenarios except piling works.

Noise mitigation strategies beyond the implementation of "best practice" techniques (as discussed in AS 2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites"*) should be considered and implemented for construction activities preformed at the mainland marine facilities (Port Central, Calliope River and RG Tanna) during the evening and night-time periods (6.30pm to 6.30am) or on Sundays/Public holidays.

Piling works is recommended to be limited to normal working hours between 6:30am to 6:30pm, Monday to Saturday.

Operational

Based on assumed capacities and offset buffer distances for the car parks and bus depot, no mitigation measures will be required.

No mitigation measures will be required for noise emissions associated with the operational phase of the material transfer facilities at Fisherman's Landing, RG Tanna and Calliope River due to compliance with the design criteria ($L_{Aeq(1hour)}$) at all assessment locations and at representative noise sensitive locations along Palm Drive and Cray Street (West Gladstone).

Road Traffic

The expected increase in road traffic noise levels associated with construction activities for the mainland marine facilities at Calliope River was predicted to be 2.6 dBA. The nearest sensitive receptors to Water Works (Calliope River) are at a distance of greater than 2 km. It is therefore anticipated that this increase of 2.6 dBA will not adversely impact these sensitive receptors and noise mitigation measures were not required.

The expected increase in road traffic noise levels associated with construction activities for the mainland marine facilities at Fisherman's Landing was predicted to be 4.3 dBA.

The nearest sensitive receptors to Landings Road (Fisherman's Landing) are approximately 250 m to 1,000m from the road edge (four (4) properties in total).

Although the construction activities for the mainland marine facilities at Fisherman's Landing are expected to be short-term (proposed for the first 6 months of the GLNG Project) and nearest sensitive receptors are already likely to be experiencing exceedances of the 50 dBA L_{Amax} sleep disturbance noise criteria (due to existing traffic composition), the following mitigation measures were recommended to limit adverse impacts on nearby sensitive receivers to Fisherman's Landing:

- Heavy vehicle movements should be minimised outside the period of 6:30am to 6:30pm, Monday to Saturday;
- Diesel powered equipment to be fitted with residential class mufflers;
- Minimise the usage of truck exhaust brakes; and
- Residents are to be made aware of the times and duration that they will be affected.

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1 INTRODUCTION

Marine facilities are proposed on the mainland for the transporting of personnel and materials from the Gladstone Region to the LNG facility work site (Curtis Island). Mainland marine facilities are proposed at the following locations (including whether the site is for transportation of personnel or material):

- Port Central (Auckland Point) – Personnel transportation after Month 6;
- Gladstone Marina – Personnel transportation for initial 6 months;
- Fisherman's Landing – Material transportation for initial 6 months;
- Calliope River – Material transportation after Month 6; and
- RG Tanna – Material transportation after Month 6 (backup option).

The location of the above mentioned mainland marine facilities are shown on **Figure 1** below.

Figure 1 Mainland Marine Facilities

The Gladstone Marina and Fisherman's Landings sites are both existing sites and will handle personnel and material transportation of the initial six (6) months of the constructions phase of the LNG facility while the other three (3) sites are being constructed. Once the Port Central, Calliope River and RG Tanna sites have been completed, they will handle personnel and material transportation of the remaindered of the constructions phase of the LNG facility. Port Central will continue to operate as a personnel transportation facility during the operational phase of the LNG facility.

A new bus depot, long-term car park, short-term car park (Port Central) and temporary car park (Gladstone Marina) have also been proposed. The bus depot will act as a marshalling area for buses / shuttles which are utilised for transporting personnel from pickup points within Gladstone to the Port Central marine facility. The long-term car park will provide a secure parking location for workers who are staying at the Construction Accommodation Facility (CAF) on Curtis Island. The short-term car park at Port Central will provide secure parking location for workers who are travelling from the Port Central to Curtis Island. Similar to the Port Central car park, the temporary car park near the Gladstone Marina will provide secure parking location for workers who are travelling from the Gladstone Marina to Curtis Island. This temporary car park will only be in operation for the initial six (6) months of the GLNG Project.

The location of the bus depot, long-term car park and temporary car park (Gladstone Marina) are at this stage not yet confirmed. However, the locations have been planned with the following in mind:

- Bus depot: close proximity to Port Central.
- Long-term car park: between Gladstone Airport and Port Central; and
- Temporary car park (Gladstone Marina): sufficient distance from the Marina to not cause congestion issue and will use Alf O'Rourke Drive for access.

The following section assesses the potential noise and vibration impacts associated with the construction and operational phases of the mainland marine facilities, including impacts from traffic movements, bus depots, and long-term and temporary car parks.

The noise assessment methodology and noise criteria used for this assessment are as per Heggies GLNG EIS Noise and Vibration Report – 20-2014-R1R4 dated 22 May 2009.

2 NOISE AND VIBRATION CRITERIA

2.1 Construction Criteria

The limiting noise and vibration criteria for the construction phase of the mainland marine facilities are summarised in **Table 1** below.

Table 1 Summary of Construction Criteria

	Construction Noise		Vibration		
	Monday to Saturday (6:30am to 6:30pm)	Monday to Saturday (6:30pm to 6:30am); Sundays and Public Holidays	Structural Damage (mm/s)	Human Comfort (mm/s)	
				Day	Night
Residential	No limit	50 dBA LAmax	12.5	0.3 – 0.6	0.2
Industrial	No Limits	No Limits	50	1.2	1.2

2.2 Operational Criteria

The only assessable operational noise associated with the mainland marine facilities are the following:

- Operational activities at Fisherman's Landing, RG Tanna and Calliope River material transfer facilities (noise source including barges, trucks, loaders and tugs); and
- Car parks including traffic noise (ie low speed), door slams and engine starts etc.

The limiting noise criteria for the operational phase of the mainland marine facilities are summarised in **Table 2** below.

Table 2 Summary of the Limiting Operational Noise Criteria

Assessment Location	Design Criteria[1]	Sleep disturbance[2]
	LAeq(1hour) (dBA)	LAmax (dBA)
Plant 1	44	50
Plant 2	34	50
Plant 3	40	50
Plant 4	40	50
Plant 5	34	50
Plant 6	41	50
Plant 7 [3]	43	50

Note: Limiting operational criteria is defined as the most stringent of the day, evening and night-time project operational criteria.

1: Design criterion is the most stringent of the PNL and SNL as per the Queensland DERM's *Ecoaccess Guideline: Planning for Noise Control*.

2: Sleep disturbance criteria have been adjusted to represent outdoor levels.

3: Noise criteria are based on typical background noise levels for an "Industrial Area' as shown in the Queensland DERM's *Ecoaccess Guideline: Planning for Noise Control* 'Recommended Outdoor Planning Noise Levels'.

For the sensitive receptors adjacent to Port Central, and the assessment of the bus depot and car parks, the operational noise criteria noted for Assessment Location Plant 3 (P3) is most applicable. The locations of Assessment Locations Plant 1 – Plant 7 (P1 – P7) are shown on **Figure 2** (see **Section 0**).

2.3 Road Traffic Noise Criteria

Incremental Change in Road Traffic Noise Levels

Where the mainland marine facilities are adding vehicles to an existing or upgraded road it is appropriate to consider the incremental change in noise levels due to the changes in traffic volume.

A change of up to 3 dBA in the level of a dynamic noise (such as passing vehicles) is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness.

It is acknowledged that people will probably notice increased traffic based on visual clues and perception of vehicle pass-by frequency before they will objectively notice an increase in the average noise level.

For assessment purposes it is common to set the threshold of significance in relation to changes in the noise emission level from roads at 2 dBA.

3 MODELLING METHODOLOGY

3.1 SoundPLAN

In order to calculate the noise emission levels at the various noise sensitive receiver locations from construction and operational plant and equipment associated with the mainland marine facilities, the existing SoundPLAN noise model for the Gladstone Region was updated to incorporate construction and operational phases of the mainland marine facilities development.

Noise level predictions have been undertaken at approximately 50 sensitive receivers in the surrounding community of Gladstone. These have been grouped based on their location within regards to the ambient noise monitoring (each group is referred to as an assessment location). Each of these prediction locations within each group is assessed against the same construction/operational criteria based on the results of the monitoring. Only the prediction location within each group with the highest predicted noise level is reported. All receivers have been positioned 1.5 m above ground and a minimum of 4 m from the nearest building facade (ie free field).

Gladstone harbour and surrounding rivers/estuaries have been modelled as a reflective (hard) surface. All other areas of the model have been modelled as absorptive (soft) surfaces.

Additional predictions have been undertaken at the nearest noise sensitive receptors to the Port Central and Calliope River mainland marine facilities as the locations of these facilities are in areas previously unassessed in Heggies GLNG EIS Noise and Vibration Report (Ref: 20-2014-R1R4).

3.2 CONCAWE

All noise predictions for the mainland marine facilities have been carried out utilising the CONCAWE prediction methodology within SoundPLAN, with the exception of road traffic noise predictions (which have been carried out using the CoRTN prediction method).

The CONCAWE prediction method is specially designed for large facilities and incorporates the influence of wind effects and the stability of the atmosphere.

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 - 1982). Marsh concluded that CONCAWE was accurate to ±2 dBA in any one octave band between 63 Hz and 4 kHz and ± 1 dBA overall.

3.3 CoRTN Road Traffic Noise Prediction Method

The Calculation of Road Traffic Noise (CoRTN) 1988 prediction technique was utilised to calculate the change in road traffic noise levels from the project.

These calculations account for traffic volumes, composition, vehicle speed, road gradient and the road surface. CoRTN is the recommended road traffic noise prediction technique in Main Roads *Code of Practice* [2008].

The road transport noise assessment methodology has been performed by calculating how traffic changes would alter the $L_{A10(18hour)}$ traffic noise level along the roadways using the CoRTN prediction algorithms. The $L_{A10(18hour)}$ parameter is the average of the hourly L_{A10} traffic noise level between the hours of 6 am and midnight.

Road traffic noise impacts associated with the construction and operational phases of the project are discussed in **Section 5.**

3.4 Construction Noise and Vibration

The assessment methodology for determining noise and vibration impacts associated with the construction phase of the mainland marine facilities at Port Central, RG Tanna and Calliope River are discussed in the following section. This section addresses the assessment of the following construction noise and vibration sources:

- Mainland Marine Facilities
  - Clearing of site;
  - General facility construction; and
  - Pile driving and jetty construction.

3.4.1 Construction Noise

Significant construction noise sources typically include pile driving and mobile equipment (air compressors, cranes and service trucks).

A list of the proposed construction equipment to be used and their associated maximum sound power level (sourced from Heggies' database) is presented in **Table 3**.

Table 3 Mainland Marine Facility Construction Equipment Maximum Sound Power Levels (SWL)

Item	Maximum SWL (dBA)
14g Grader	110
Asphalt delivery truck	103
Asphalt Paver	114
Barge with 250t Crane	113
Compactor	110
Concrete pump and vibrator	112
Concrete truck	103
D8 Dozer	110
Excavator – 50t	117
Generator	107
Haul Truck	113
Pile Driver	130
Roller – Vibratory	110
Scraper – Cat 621G	120

While noise from diesel-powered mobile plant (ie dozers and excavators etc) will generally form a major part of the emission over the construction phase of the mainland marine facilities, the highest noise levels are expected to occur where construction requires the use of pile driving, rock drilling or rock breaking equipment.

Predicted construction noise levels will inevitably depend upon the number of plant items and equipment operating at any one time and on their precise location relative to the receiver(s). Therefore a receiver will experience a range of values representing "minimum" and "maximum" construction noise emissions depending upon:

- The location of the particular construction activity (ie if the plant item of interest were as close as possible to or further away from the receiver of interest); and
- The likelihood of the various items of equipment operating simultaneously.

General Construction, Pile Driving and Jetty Construction

Three (3) representative construction noise modelling scenarios have been assessed for general mainland marine facility construction, based upon information provided. These construction scenarios are described in **Table 4** and are considered to best reflect the proposed methodologies for construction of the proposed mainland marine facilities.

Table 4 Mainland Marine Facilities Construction Scenarios and Typical Plant Items

Stage	Description	Typical Plant Items
Clear and grade	Clearing of vegetation and topsoil; levelling ground around the site	Dozers
		Scrapers
		Excavators
		Haul trucks
		Compacters
Concrete pad, asphalt paving and foundations	Concrete batch-plant; pouring concrete and asphalt surface;	Concrete trucks and pumps
		Asphalt trucks and pavers
		Rollers
Piling and Jetty	Pile driving and building the jetty	Piling rig
		Barge and crane

3.4.2 Construction Vibration

The following potential sources of ground vibration have been identified for the construction phase of the mainland marine facility.

Pile Driving

Based on the current proposed construction methodology, it is anticipated that the primary source of potential ground vibration is likely to be from pile driving associated with jetty construction. The typical levels of ground vibration from pile driving range from 1 mm/s to 3 mm/s at distances of 25 m to 50 m, depending on the ground conditions and the energy of the driving hammer. Recent measured vibration levels (conducted in September 2006) from pile driving at the RG Tanna Coal Terminal Berth 4 expansion which used a 14 tonne hammer to drive a 1200 mm diameter pile of 600 mm wall thickness showed that vibration levels at a distance of 380 m from the piling site were not measurable (only ambient vibration levels were measured, at less than 0.1 mm/s peak particle velocity).

Truck Traffic

Heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels, typically ranging from 0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m to 20 m from a roadway. Very large surface irregularities can cause levels up to 5 to 10 times higher. This highlights the importance of maintaining good quality haul roads to help reduce vibration and noise emissions from truck traffic.

3.5 Operational Noise

The methodologies for assessing noise impacts associated with the operational phase of the mainland marine facilities are discussed in the following section. This section specifically addresses the following impacts:

- Operational Noise Emission – Port Central Car Park;
- Operational Noise Emission – Bus Depot (Linked to Port Central);
- Operational Noise Emission – Long-term Car Park (to be located between Gladstone Airport and Port Central); and
- Operational Noise Emission – Temporary Car Park (Gladstone Marina).
- Operational Noise Emission – Material Transfer Facilities (Fisherman's Landing, RG Tanna and Calliope River)

Operational noise sources associated with a car park include the traffic noise (low speed), door slams and engine starts. Operational noise sources associated with the material transfer facilities (Fisherman's Landing, RG Tanna and Calliope River) include machinery movement from trucks, loaders, barges and tugs.

Operational noise emissions from traffic noise and machinery movement at the material transfer facilities have been assessed against the short term intrusive noise criteria (L_{Aeq}) as traffic noise is a more transient noise source. Operational noise emissions from door slams and engine starts have been assessment against the sleep disturbance criteria (50 dBA L_{Amax}) as these noise sources are peak events.

Road traffic noise impacts associated with the operational phase of the project are discussed in **Section 5**

3.5.1 Operational Noise – Port Central Car Park

Operational noise sources associated with the Port Central car park will include traffic noise (low speed), door slams and engine starts.

The "US Department of Transport, FHWA Traffic Noise Model (TNM) – Technical Manual (1998)" provides noise level emissions for cars at speeds of 15 to 20 km/h (ie those expected in a car park). The noise level emissions for cars are as follows:

- Car – 50 dBA at 15 metres.

Noise emission levels for car door slams and engine starts have been measured at 55 dBA at 30 metres.

Based on "CEO Assumptions for Santos GLNG Project (2009)", approximately 1,440 mainland workers (48% of the peak volume of 3,000 construction personnel) will be transported back and forth to Curtis Island every day. Of this 1,440 mainland workers, 216 workers (15%) have been assumed to drive to the ferry. Therefore, the Port Central Car Park has been assumed to have a capacity of approximately 216 cars.

3.5.2 Operational Noise – Bus Depot

For this assessment, operational noise sources associated with the bus depot have been limited to traffic speed movement of the buses and engine starts.

Noise level emissions for buses (diesel) at speeds of 30 km/h (ie those expected in a depot) have been sourced from a previous Heggies' study (Ref: 20-1663-R5R0 dated 30 May 2006). The noise level emissions for buses are as follows:

- Bus – 63 dBA at 15 metres.

It is anticipated that the bus depot will be sized for a peak capacity of approximately 40 buses.

3.5.3 Operational Noise – Long-term Car Park

As per the assessment for operational noise sources associated with the Port Central car park, the long-term car park will assess traffic noise (low speed), door slams and engine starts.

At the time of reporting, the car park location and capacity had not been confirmed. Therefore, a generic assessment has been undertaken to recommend offset buffer distances to achieve the short-term intrusive noise criteria (for P3) as stated in **Table 2**. The maximum capacity of the car park has been assumed to be 2,200 which equates to the peak workforce number during Month 30 (as stated in Section 3.1.9 of Bechtel's *GLNG Project – Mainland Marine Facilities* draft document (2009[1])).

3.5.4 Operational Noise – Temporary Car Park (Gladstone Marina)

As per the assessment for operational noise sources associated with the Port Central and long-term car parks, the temporary car park will assess traffic noise (low speed), door slams and engine starts.

At the time of reporting, the car park location and capacity had not been confirmed. Therefore, a generic assessment has been undertaken to recommend offset buffer distances to achieve the short-term intrusive noise criteria (for assessment location P3) as stated in **Table 2**. The maximum capacity of the car park has been assumed to be 360 which equates to the peak workforce number during Month 6 (as stated in Section 3.1.9 of Bechtel's *GLNG Project – Mainland Marine Facilities* draft document (2009[1])).

3.5.5 Operational Noise – Material Transfer Facilities (Fisherman's Landing, RG Tanna and Calliope River)

Operational noise sources associated with activities at the material transfer facilities (Fisherman's Landing, RG Tanna and Calliope River) will include trucks (dump and transport), loaders, barge and tug.

A list of the proposed operational equipment to be used and their associated equivalent sound power level (sourced from Heggies' database) is presented in **Table 5**.

Table 5 Summary of Typical Equivalent Sound Power Levels for Material Transfer Facilities (Fisherman's Landing, RG Tanna and Calliope River)

Item	Equivalent SWL (dBA)
Idling Truck (Dump and transport) x10 [1]	102
Loaders	102
Barge	105
Tug	111

Note 1: As stated in Section 3.2.5 of Bechtel's *GLNG Project – Mainland Marine Facilities* draft document (2009[1]), each standard dump barge will be able to transport on average 10 standard highway trucks at a time.

4 RESULTS AND ASSESSMENT

Noise level emissions associated with construction and operational phases of the mainland marine facilities have been predicted at the assessment locations in the Gladstone region as shown in **Figure 2**. Additional predictions undertaken at the nearest noise sensitive receptors to the Port Central and Calliope River mainland marine facilities are shown in **Figure 3**.

All predictions are based on methodology and noise sources as specified in **Section 3**.

Figure 2 Assessment Locations in the Gladstone Area

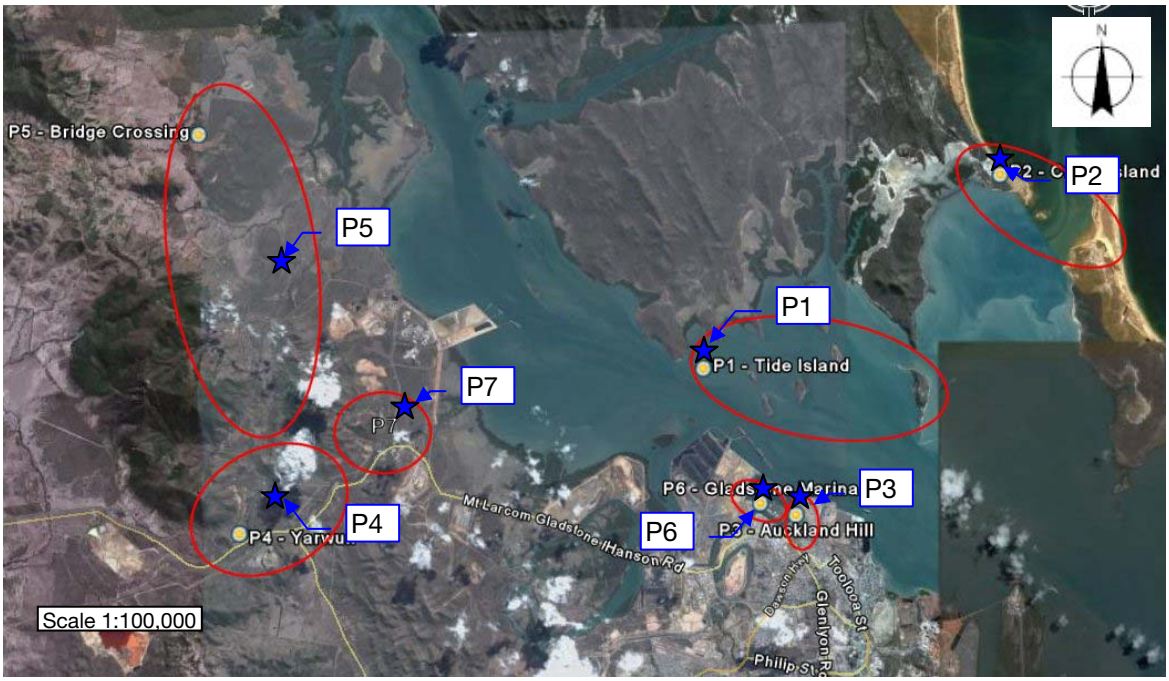
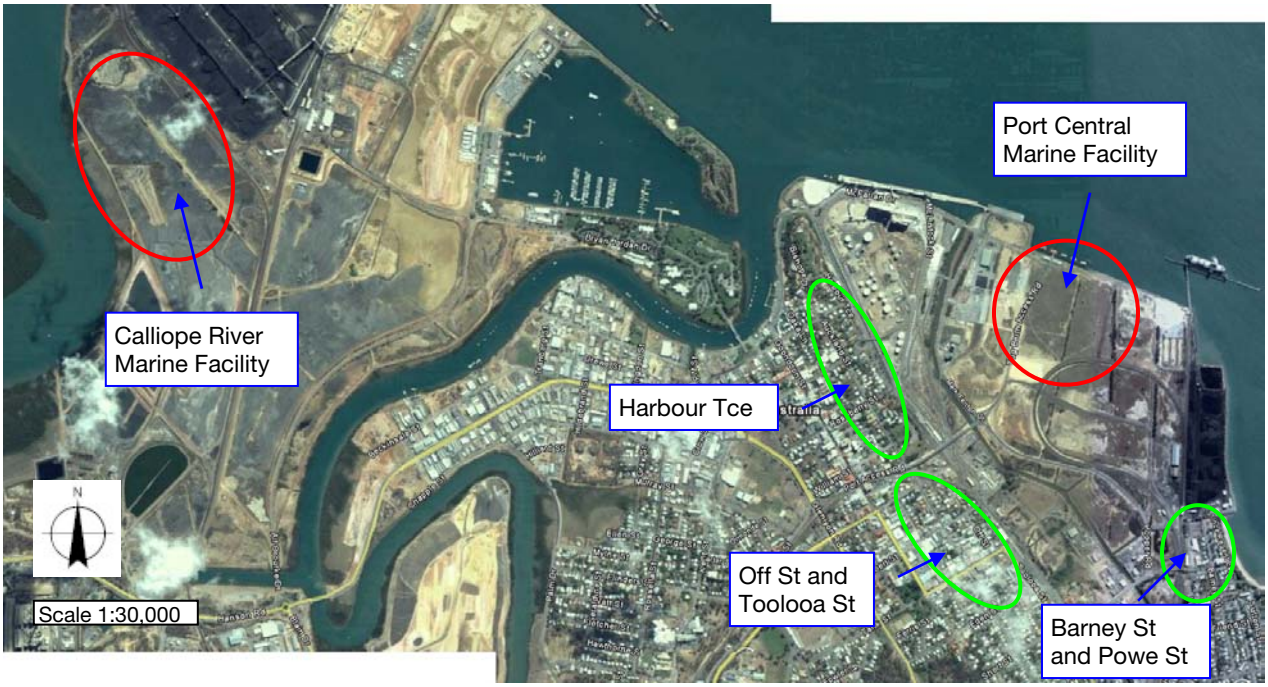


Figure 3 Additional Prediction Locations – Port Central and Calliope River Mainland Marine Facilities



4.1 Construction Noise and Vibration

The predicted construction noise and vibration emissions from the mainland marine facilities are presented in the following sections. The predicted noise and vibration levels are assessed against the relevant criteria as per **Table 1**.

4.1.1 Construction Noise

The following potential sources of construction noise emissions associated with the mainland marine facility construction works form the basis of the noise assessment.

On-Site Construction Activities

Noise level emissions associated with the construction phase of the mainland marine facilities have been predicted for the assessment locations in the Gladstone region (see **Figure 2**). Predictions have also been undertaken at representative noise sensitive locations which are closer to either Port Central or Calliope River than assessment locations P1 – P7 (see **Figure 3**). The predictions are based on methodology and noise sources specified in **Section 3** and **Table 3** respectively. The predicted noise levels for the three (3) different construction scenarios are presented in **Table 6** together with the relevant evening and night-time noise criteria (night-time sleep disturbance L_{Amax} 50 dBA).

Table 6 Predicted Sound Pressure Levels from Construction Noise – Mainland Marine Facilities

Mainland Marine Facility	Assessment Locations	Construction Noise Criteria (dBA) [1]	Predicted Sound Pressure Levels (L_{Amax}) (dBA)		
			Clear and Grade	Concrete Pad and Foundations	Piling and Jetty
Port Central	P1	50	35	34	46
	P2	50	21	21	33

Mainland Marine Facility	Assessment Locations	Construction Noise Criteria (dBA) [1]	Predicted Sound Pressure Levels (L_{Amax}) (dBA)		
			Clear and Grade	Concrete Pad and Foundations	Piling and Jetty
	P3	50	39	36	50
	P4	50	< 10	< 10	12
	P5	50	< 10	< 10	< 10
	P6	50	32	32	43
	P7	50	< 10	< 10	19
	Barney St and Powe St	50	42	38	**52**
	Toolooa St and Off St	50	44	40	**51**
	Harbour Tce	50	44	40	**54**
Calliope River	P1	50	32	30	38
	P2	50	15	14	21
	P3	50	28	26	34
	P4	50	< 10	< 10	14
	P5	50	< 10	< 10	13
	P6	50	33	30	39
	P7	50	16	14	22
	Palm Dr and Cray St (West Gladstone)	50	33	29	39
RG Tanna	P1	50	40	37	**52**
	P2	50	19	18	31
	P3	50	42	38	**52**
	P4	50	< 10	< 10	13
	P5	50	< 10	< 10	13
	P6	50	49	45	**60**
	P7	50	16	14	22

Note 1: Monday to Saturday (6:30pm to 6:30am); Sundays and Public Holidays

Bold numbers indicate an exceedance of the night-time sleep disturbance L_{Amax} 50 dBA criteria.

The construction noise associated with the mainland marine facility at Port Central is predicted to exceed the 50 dBA L_{Amax} noise criteria at sensitive receptors along Barney Street / Powe Street, Toolooa Street / Off Street, and Harbour Terrace for piling works (exceedances of up to 4 dBA). All other assessment locations are predicted to comply with the 50 dBA L_{Amax} noise criteria.

The construction noise associated with the mainland marine facility at Calliope River is predicted to comply with the 50 dBA L_{Amax} noise criteria at all assessment locations, and sensitive receivers at Palm Drive and Cray Street (West Gladstone).

The construction noise associated with the mainland marine facility at RG Tanna is predicted to exceed the 50 dBA L_{Amax} noise criteria at assessment locations P1, P3 and P6 for piling works (exceedances of up to 10 dBA). All other assessment locations are predicted to comply with the 50 dBA L_{Amax} noise criteria.

There are no construction noise criteria applicable to daytime construction works (except on Sundays and Public Holidays, though no work is proposed at these times).

4.1.2 Construction Vibration

The following potential sources of ground vibration associated with mainland marine facility construction works form the basis of the vibration assessment.

Pile Driving

Based on the current proposed construction methodology, it is anticipated that the primary source of potential ground vibration is likely to be from pile driving associated with jetty bridge construction. The typical levels of ground vibration from pile driving range from 1 mm/s to 3 mm/s at distances of 25 m to 50 m, depending on the ground conditions and the energy of the driving hammer. Recent measured vibration levels (September 2006) from pile driving at the RG Tanna Coal Terminal Berth 4 expansion for a 14 tonne hammer driving a 1200 mm diameter pile of 600 mm wall thickness showed that vibration levels at a distance of 380 m from the piling site were not measurable (only ambient vibration levels were measured, at less than 0.1 mm/s peak particle velocity).

The above data in combination with vibration criteria outlined in **Table 1** was used to develop "Safe Working Distances" for the pile driving activities. Safe working distances for pile driving equipment are listed in **Table 7** for both "cosmetic" damage and human comfort. The human comfort safe working distances correspond to a *"Low Probability of Adverse Comment"* response.

Table 7 "Safe Working Distances" for Vibration Intensive Plant Items – Residential

Item	"Safe" Working Distance	
	Cosmetic Damage (BS7385)	**Human Comfort (BS6472)**
Impact Pile Driver	20 m to 40 m	80 m to 120 m
Vibratory Pile Driver	5 m to 15 m	20 m to 50 m
Pile Boring (<800 mm)	2 m (nominal)	N/A

The safe working distances given in **Table 7** are indicative and will vary depending upon the particular item of plant and local geotechnical conditions (eg presence of elevated water table). Furthermore, it is noted that the safe working distances for "cosmetic" damage apply to damage of typical buildings and do not address heavy industrial buildings.

Based on the separation distances between the bridge and jetty structures and the nearest buildings within proximity to Port Central and Calliope River facilities, vibration emissions from pile driving would be in compliance with the relevant vibration criteria. The recommended safe working distances shown in **Table 7** should be adhered to for all pile driving activities carried out on the project.

The location of the new tug terminal associated with the RG Tanna marine facility is approximately 45m from a warehouse located at 297 Alf O'Rourke Drive. As this warehouse is classified as an industrial building, the "Safe Working Distance" will be significantly less. The "Safe Working Distance" to achieve the human comfort level of 1.2 mm/s for an industrial building equates to approximately 40m. Therefore, vibration emissions from pile driving at the RG Tanna marine facility would be in compliance with the relevant vibration criteria.

Truck Traffic

Heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels, typically ranging from 0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m to 20 m from a roadway. Very large surface irregularities can cause levels up to 5 to 10 times higher.

Based on the data above, vibration levels from truck traffic utilising the roads on site are expected to be significantly below both "building damage" and "human comfort" criteria. In fact it is expected that any vibration from truck movements would be imperceptible (ie less than 0.15 mm/s).

4.2 Operational Noise

4.2.1 Port Central Car Park

Based on the assumption that the Port Central Car Park will have a capacity of approximately 216 cars, it is predicted that the peak L_{Aeq} noise levels from vehicles travelling within the car park to be 18 dBA at the nearest sensitive receptors (Off Street). This level achieves compliance with the operational criteria of 40 dBA.

Noise levels associated with car door slams and engine starts are predicted to be 27 dBA at the nearest sensitive receptors (Off Street). This level achieves compliance with the 50 dBA L_{Amax} sleep disturbance noise criteria.

4.2.2 Bus Depot

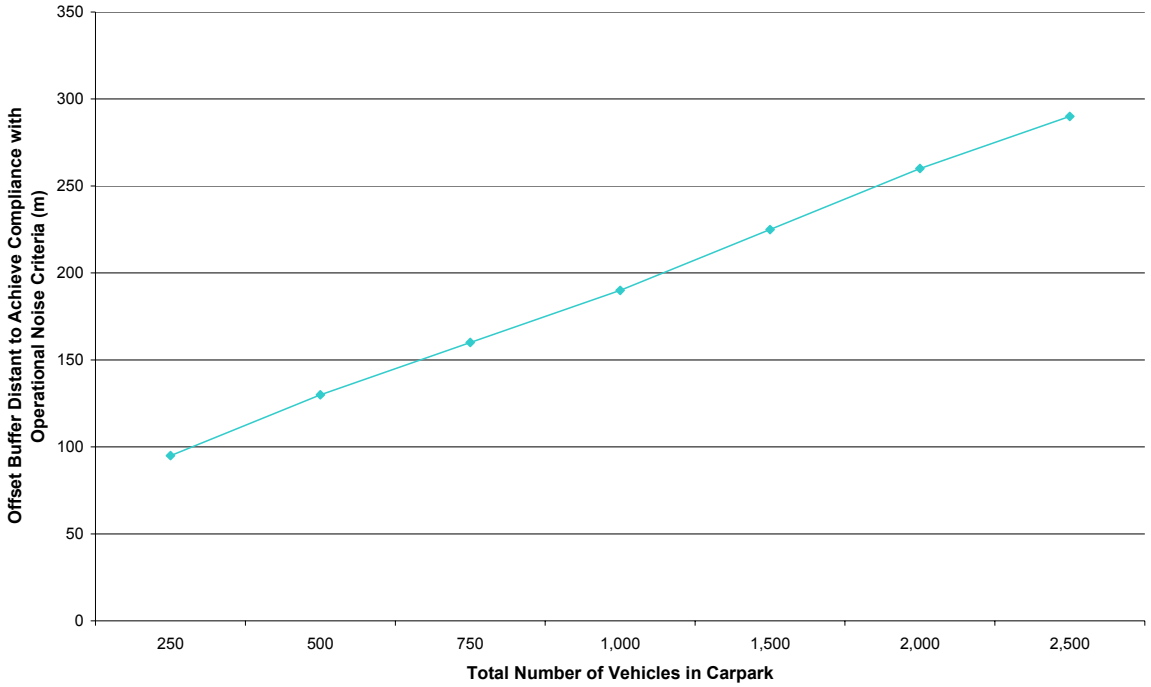
At a maximum bus depot capacity of approximately 40 vehicles, an offset buffer distance of 180 m for low speed traffic noise would be required to achieve compliance with the operational noise criteria of 40 dBA.

An offset buffer distant of 55 m for engine starts would be required to achieve compliance with the 50 dBA L_{Amax} sleep disturbance noise criteria.

4.2.3 Long-term Car Park

Figure 4 shows the relationship between the total number of vehicles in the long-term car park and the corresponding offset distance to the nearest sensitive receptors required to achieve compliance with the operational noise criteria of 40 dBA.

Figure 4 Relationship between Total Number of Vehicles in a Car Park and Offset Buffer Distance to Achieve Compliance with 40 dBA Operational Noise Criteria



At a maximum car park capacity of 2,200 vehicles, an offset buffer distance of 275 m for low speed traffic noise would be required to achieve compliance with the operational noise criteria of 40 dBA.

An offset buffer distance of 55 m for door slams and engine starts would be required to achieve compliance with the 50 dBA L_{Amax} sleep disturbance noise criteria.

4.2.4 Temporary Car Park (Gladstone Marina)

At a maximum car park capacity of 360 vehicles, an offset buffer distance of 80 m for low speed traffic noise would be required to achieve compliance with the operational noise criteria of 40 dBA.

An offset buffer distant of 55 m for engine starts would be required to achieve compliance with the 50 dBA L_{Amax} sleep disturbance noise criteria.

4.2.5 Operational Noise – Material Transfer Facilities (Fisherman's Landing, RG Tanna and Calliope River)

Based on the noise sources associated with the operational phase of the material transfer facilities as stated in **Table 5**, predictions were undertaken at the assessment locations in the Gladstone region (see **Figure 2**). Predictions have also been undertaken at representative noise sensitive locations which are closer to Calliope River than assessment locations P1 – P7 (see **Figure 3**).

Table 8 presents the predicted noise levels associated with the operational phase of the material transfer facilities at Fisherman's Landing, RG Tanna and Calliope River

Table 8 Predicted Sound Pressure Levels from Operational Activities – Material Transfer Facilities

Mainland Marine Facility	Assessment Locations	Design Criteria $L_{Aeq(1hour)}$ (dBA) [1]	Predicted Sound Pressure Levels (L_{Aeq}) (dBA)
Fisherman's Landing	P1	44	19
	P2	34	< 10
	P3	40	10
	P4	40	< 10
	P5	34	10
	P6	41	< 10
	P7	43	18
RG Tanna	P1	44	33
	P2	34	14
	P3	40	33
	P4	40	< 10
	P5	34	< 10
	P6	41	39
	P7	43	< 10
Calliope River	P1	44	22
	P2	34	< 10
	P3	40	18
	P4	40	< 10
	P5	34	< 10
	P6	41	22
	P7	43	< 10
	Palm Dr and Cray St (West Gladstone)	40	22

Noise levels associated with the operational phase of the material transfer facilities at Fisherman's Landing, RG Tanna and Calliope River are predicted to comply with the design criteria at each assessment location. Operational noise from the material transfer facilities at Calliope River is also predicted to comply with the design criteria at the representative noise sensitive locations along Palm Drive and Cray Street (West Gladstone).

5 TRANSPORTATION – ROAD TRAFFIC NOISE

5.1 Vehicle Movements

Existing and future traffic patterns (supplied by GLNG) for mainland marine facilities are summarised in **Table 9**, and have been assumed for the purpose of assessing the road traffic noise impact due to construction and operational activities for the mainland marine facilities.

Table 9 Existing and Future Traffic Patterns for Mainland Marine Facilities

Road / Section	Existing Traffic			Future Traffic		
	AADT	% HV	Speed (km/h)	AADT	% HV	Speed (km/h)
Port Access Rd – Port Central [1]	1,999	28.4%	60	2609	23.8%	60
Alf O'Rourke Dr - Marina	3,074	18.9%	40	3323	18.3%	40
Alf O'Rourke Dr – RG Tanna	3,074	18.9%	40-80	3259	23.5%	40-80
Water Works – Calliope River	50	40.0%	20	84	64.3%	40
Landing Road – Fisherman's Landing	868	30.5%	60-100	1820	42.3%	60-100

Note: AADT – Annual Average Daily Traffic

% HV – Percentage of Heavy Vehicles

1: Traffic volumes and percentage of heavy vehicles for construction and operational phase associated with Port Central have been assumed to be the same. Operational volumes and percentage of heavy vehicles are likely to be lower than the reported numbers.

5.2 Road Traffic Noise

The effect of project-related traffic on the noise emission from roadways near the mainland marine facilities has been assessed. This assessment has been performed by calculating how traffic volume changes on the surrounding road network, attributable to the mainland marine facilities, would alter the $L_{A10(18hour)}$ level of noise emission from roadways using the CoRTN prediction algorithms. The $L_{A10(18hour)}$ parameter is the average of the hourly L_{A10} traffic noise level between the hours of 6 am and midnight.

Based on the traffic volumes and compositions described in **Table 9**, **Table 10** shows the expected increase in road traffic noise levels associated with construction and operation activities for the mainland marine facilities.

Table 10 Increase in Road Traffic Noise Levels due to Construction and Operational Vehicles – Mainland Marine Facilities

Road Segment	Predicted Increase in $L_{A10(18hour)}$ Noise Level (dBA)	
	Construction Phase	Operational Phase
Port Access Rd – Auckland Point	+0.6	+0.6
Alf O'Rourke Dr - Marina	+0.2	N/A
Alf O'Rourke Dr – RG Tanna	+0.9	N/A
Water Works – Calliope River	**+2.6**	N/A
Landing Road – Fisherman's Landing	**+4.3**	N/A

Note 1: **Bold** numbers indicate an incremental change in noise level of greater than 2 dBA.

The expected increase in road traffic noise levels associated with construction activities for the mainland marine facilities at Port Central, Gladstone Marina and RG Tanna are all predicted to be less than 2 dBA, therefore no adverse impact is anticipated.

The expected increase in road traffic noise level associated with operational activities for the mainland marine facilities at Port Central is predicted to be less than 2 dBA, therefore no adverse impact is anticipated.

The expected increase in road traffic noise levels associated with construction activities for the mainland marine facilities at Fisherman's Landing and Calliope River are both predicted to be greater than 2 dBA. The nearest sensitive receptors to Water Works (Calliope River) are at a distance of greater than 2 km. It is therefore anticipated that this increase of 2.6 dBA will not adversely impact these sensitive receptors.

An adverse impact from increases to road traffic noise is anticipated for sensitive receptors along Landings Road.

6 MITIGATION MEASURES

6.1 Construction

6.1.1 Construction Noise

It is recommended that where possible, construction activities be carried out between 6:30am and 6:30pm, Monday to Saturday, when ambient noise levels are higher. Regulatory agencies have specifically try to encourage construction during these hours by not applying any specific noise criteria.

Section 4.1 shows that the 50 dBA L_{Amax} sleep disturbance noise criteria would be achieved for construction noise emissions from the 'clear and grade' and 'paving works' construction scenarios at the assessment locations and nearest sensitive receptors to the Port Central, Calliope River and RG Tanna mainland marine facilities.

The construction noise associated with piling works at the Port Central and RG Tanna mainland marine facilities are predicted to exceed the 50 dBA L_{Amax} sleep disturbance noise criteria (exceedances of up to 10 dBA). Construction noise associated with piling works at the Calliope River mainland marine facilities are predicted to achieve the 50 dBA L_{Amax} sleep disturbance noise criteria.

Noise mitigation strategies should be considered and implemented during work performed during the evening and night-time periods (6.30pm to 6.30am) or on Sundays/Public holidays. Due to the predicted exceedances of piling works associated with the Port Central and RG Tanna mainland marine facilities, piling works should be limited to 6:30am to 6:30pm, Monday to Saturday.

AS 2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. Noise control strategies that should be considered for construction activities carried out on the mainland marine facilities are listed below.

Source Noise Control Strategies

- Quietest plant and equipment that can economically undertake the work should be selected, wherever possible.
- Regular maintenance of equipment in order to keep it in good working order.

Work Practice Control Strategies

- Construction work to occur, wherever possible, within the daytime period (6:30am to 6:30pm).
- Where practicable, avoid the coincidence of plant and equipment working simultaneously close together.

- Operators of construction equipment to be made aware of the potential noise problems and of techniques to minimise noise emission through a continuous process of operator education.

Community Liaison Strategies

- Utilise existing community consultation framework to provide access to information for the community and maintain positive relations with residents.

The following details elaborate further on the strategies outlined above and should be examined and implemented in critical areas wherever practical.

Work Practice Controls

- Reversing alarms within construction areas cannot be avoided for safety reasons. Consideration should therefore be given to sourcing so-called "quiet" white-noise alarms whose annoying character diminishes quickly with distance and self-adjusting alarms which adjust emission levels relative to the local background noise level.
- Large rocks are to be placed in dump trucks not dropped.
- Horn signals should be kept at a low volume, where feasible.
- Regular maintenance of haul roads close to sensitive receptors to minimise vibration and noise emissions.

Source Noise Controls

- Mobile plant and other diesel powered equipment to be fitted with residential class mufflers.
- Minimise the usage of truck exhaust brakes.

Community Liaison Controls

- Construction site personnel are to be made aware of all community attitudes and complaints.
- Residents are to be made aware of the times and duration that they will be affected. Making residents aware of likely future occurrence of noise significantly reduces annoyance and allows people to make arrangements accordingly.
- Implement as part of the broader community involvement plan, a well-planned, focussed community awareness programme inviting representative groups of the community to a short, concentrated noise and vibration briefing prior to commencement of works near or within their community.
- Provision of a complaints phone number.
- A nominated person is to receive, log, track and respond to complaints within an appropriate timeframe and to record what actions were taken.

6.1.2 Construction Vibration

Based on the predicted vibration levels in **Section 4.1**, no mitigation measures are required to reduce vibration levels at residences in the communities surrounding the mainland marine facilities.

6.2 Operational

6.2.1 Port Central Car Park

No noise mitigation measures are required for noise emission from the Port Central car park due to the sufficient buffer distance between the car park location and the nearest sensitive receivers.

6.2.2 Bus Depot

An offset buffer distance of 180 m would be required to achieve compliance with both the operational noise criteria of 40 dBA as well as the 50 dBA L_{Amax} sleep disturbance noise criteria. At this distance, no noise mitigation measures are required.

6.2.3 Long-term Car Park

Assuming a maximum car park capacity of 2,200 vehicles, an offset buffer distance of 275 m would be required to achieve compliance with both the operational noise criteria of 40 dBA as well as the 50 dBA L_{Amax} sleep disturbance noise criteria. At this distance, no noise mitigation measures are required.

6.2.4 Temporary Car Park (Gladstone Marina)

Assuming a maximum car park capacity of 360 vehicles, an offset buffer distance of 80 m would be required to achieve compliance with both the operational noise criteria of 40 dBA as well as the 50 dBA L_{Amax} sleep disturbance noise criteria. At this distance, no noise mitigation measures are required.

6.2.5 Operational Noise – Material Transfer Facilities (Fisherman's Landing, RG Tanna and Calliope River)

No noise mitigation measures are required for noise emission from the operational phase of the material transfer facilities at Fisherman's Landing, RG Tanna and Calliope River as compliance of the design criteria ($L_{Aeq(1hour)}$) is predicted to be achieved at all assessment locations and representative noise sensitive locations along Palm Drive and Cray Street (West Gladstone).

6.3 Road Traffic Noise

Section 5.2 shows the no mitigation measures are required for increases in road traffic noise levels associated with construction activities for the mainland marine facilities at Port Central, Gladstone Marina and RG Tanna, as well as operational activities from Port Central as all predicted increases are less than 2 dBA.

The expected increase in road traffic noise levels associated with construction activities for the mainland marine facilities at Fisherman's Landing and Calliope River are both predicted to be less than 2 dBA.

The nearest sensitive receptors to Water Works (Calliope River) are at a distance of greater than 2 km. It is therefore anticipated that this increase of 2.6 dBA will not adversely impact these sensitive receptors so noise mitigation measures are not required.

The nearest sensitive receptors to Landings Road (Fisherman's Landing) are approximately 250 m to 1,000m from the road edge (four (4) properties in total).

The expected increase in road traffic noise levels associated with construction activities for the mainland marine facility at Fisherman's Landing is predicted to be 4.3 dBA, however this increase will only be short-term as this location is only proposed for the first 6 months of the project. Further, due to the current vehicle volumes and heavy vehicle percentages, it is expected that these sensitive receptors already experience exceedances of the 50 dBA L_{Amax} sleep disturbance noise criteria. However, the following mitigation measures are recommended to limit adverse impacts on nearby sensitive receivers to Fisherman's Landing:

- Heavy vehicle movements should be limited to 6:30am to 6:30pm, Monday to Saturday;
- Diesel powered equipment to be fitted with residential class mufflers;
- Minimise the usage of truck exhaust brakes; and
- Residents are to be made aware of the times and duration that they will be affected. Making residents aware of likely future occurrence of noise significantly reduces annoyance and allows people to make arrangements accordingly.

7 CONCLUSION

A comprehensive assessment has been undertaken of the potential noise and vibration impacts associated with the construction and operational phases of the mainland marine facilities as well as associated traffic movements, bus depots, and long-term and temporary car parks. The findings of this assessment are of follows:

- Construction noise associated with Port Central, Calliope River and RG Tanna mainland marine facilities is predicted to achieve the 50 dBA L_{Amax} sleep disturbance noise criteria at assessment locations and nearby sensitive receptors for all scenarios except piling works. It is recommended that piling works be carried out during 6:30am to 6:30pm, Monday to Saturday, when ambient noise levels are higher and there are no applicable noise criteria.
- Construction vibration associated with Port Central, Calliope River and RG Tanna mainland marine facilities is predicted to achieve relevant vibration criteria. No mitigation measures are required.
- Operational noise associated with the Port Central Car Park is predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$) and 50 dBA L_{Amax} sleep disturbance noise criteria. No mitigation measures are required.
- With an offset buffer distance of 180 m, operational noise associated with the Bus Depot is predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$) and 50 dBA L_{Amax} sleep disturbance noise criteria. No mitigation measures are required at this offset buffer distance.
- Assuming a maximum car park capacity of 2,200 vehicles and with an offset buffer distance of 275 m, operational noise associated with the Long-term Car Park is predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$) and 50 dBA L_{Amax} sleep disturbance noise criteria. No mitigation measures are required at this capacity and offset buffer distance.
- Assuming a maximum car park capacity of 360 vehicles and with an offset buffer distance of 80 m, operational noise associated with the Temporary Car Park (Gladstone Marina) is predicted to achieve the operational noise criteria (40 dBA $L_{Aeq(1hour)}$) and 50 dBA L_{Amax} sleep disturbance noise criteria. No mitigation measures are required at this capacity and offset buffer distance.
- Noise emissions associated with the the operational phase of the material transfer facilities at Fisherman's Landing, RG Tanna and Calliope River are predicted to comply with the design criteria ($L_{Aeq(1hour)}$) at all assessment locations. Operational noise from the material transfer facilities at Calliope River is also predicted to comply with the design criteria at the representative noise sensitive locations along Palm Drive and Cray Street (West Gladstone). No mitigation measures are required.

- No adverse noise impacts are predicted for road traffic noise associated with construction activities for the mainland marine facilities at Port Central, Gladstone Marina and RG Tanna, as well as operational activities from Port Central.
- The predicted increase in road traffic noise associated with construction activities for the mainland marine facilities at Calliope River is great than 2 dBA. The nearest sensitive receptors are at a great enough offset distance that no adverse noise impact is expected.
- The predicted increase in road traffic noise associated with construction activities for the mainland marine facilities at Fisherman's Landing is greater than 2 dBA. Construction activities for this mainland marine facility are only short-term (6 months) and nearest sensitive receptors are already likely to be experiencing exceedances of the 50 dBA L_{Amax} sleep disturbance noise criteria due to existing traffic composition. Mitigation measures are recommended to limit adverse impacts on nearby sensitive receivers to Fisherman's Landing including:
  - Limit heavy vehicle movements to 6:30am to 6:30pm, Monday to Saturday;
  - Heavy vehicle to be fitted with residential class mufflers;
  - Minimise the usage of truck exhaust brakes; and
  - Residents are to be made aware of the times and duration that they will be affected.

8 REFERENCE

Australian Standard AS 2436 (1981). *Guide to Noise Control on Construction, Maintenance and Demolition Sites.* Standards Australia.

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Heggies, (2009). *Santos Gladstone LNG Environmental Impact Statement – Noise and Vibration (Terrestrial)*. (Reference: 20-2014-R1R4, dated 22 May 2009).

US Department of Transport (1998) *FHWA Traffic Noise Model (TNM) – Technical Manual.*

C

Appendix C Marine Transport Strategy

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Cardno Eppell Olsen

GLNG Supplementary Environmental Impact Statement – Marine Transport Strategy

Prepared for GLNG

October 2009

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Document Control

GLNG Supplementary Environmental Impact Statement – Marine Transport Strategy

Version	Date	Author		Reviewer	
		Name	Initials	Name	Initials
1	16 October 2009	Michael Gilles Johannes Grobler		Stephen Harkins	
2	27 October 2009	Michael Gilles Johannes Grobler		Stephen Harkins	

1.0 INTRODUCTION

1.1 Background

Cardno Eppell Olsen (CEO) has been commissioned by URS Australia Pty Ltd (URS) as a representative of Santos Ltd (Santos) to prepare a Marine Transport Strategy for the movement of goods, equipment and personnel related to the construction of Train 1 of the proposed Liquefied Natural Gas (LNG facility) on Curtis Island for the GLNG Project.

A bridge from the mainland to Curtis Island approximately 20km northwest of Gladstone is being considered to ultimately provide a link for the LNG facility construction and operation. It is proposed that this bridge will cross Port Curtis from a location between Friend Point (on the mainland) and Laird Point (on Curtis Island). However, the need for such a bridge is still being assessed in consultation with stakeholder agencies and has been omitted from this assessment.

Current planning of the project suggests that the bridge, if built, would not be completed during construction of Train 1 of the LNG facility. Because of this, alternative arrangements are necessary for transferring construction materials, plant, equipment and personnel to Curtis Island, including the barging of goods and ferrying of people.

1.2 Previous Assessments

Previous assessments and investigations undertaken by CEO to move goods, equipment and personnel to Curtis Island for the construction of Train 1 of the LNG facility included the following:

- location and arrangements for construction worker accommodation;
- location of mainland ferry landing for worker loading/offloading and bus transfer;
- location of ship and truck cargo transfer facility.

1.3 Movement of Personnel

Options for worker accommodation locations have been outlined in the Bechtel memorandum *GLNG Project Pre-FEED Study Camp Strategy*, dated 22 August 2008 and Cardno Eppell Olsen's *GLNG Project – Marine Transport Strategy*, dated February 2009.

Two options were identified and discussed in the Bechtel memorandum, which included accommodation for all workers on Curtis Island and workers accommodation for all construction workers on the mainland at Calliope. The main issues discussed related to the two worker accommodation options were:

- safety: getting employees to/from work safely;
- community impact: including disruptions due to commute, ferry services, living accommodation, and local economy;
- employee quality of life: including standard of accommodation, food, recreation and communication and commute time; and
- employee well-being/medical.

CEO's *GLNG Project – Marine Transport Strategy* (which is included in the GLNG EIS) added two additional worker accommodation options. Worker accommodation options were further investigated to quantify and qualify the issues/benefits of each, as related to the transport of workers to/from the site and the associated traffic impacts of doing so. CEO's *GLNG Project – Marine Transport Strategy* assessed the following options for the movement of personnel:

1. 100% of worker accommodation on Curtis Island;
2. 50% of worker accommodation at Calliope Historical Village and 50% person workers accommodation on Curtis Island;
3. 100% of worker accommodation at Calliope Historical Village; and
4. 50% of worker accommodation at Calliope Historical Village and 50% of workers in Gladstone (bus pickup).

Based on the general and comparative assessment of options for worker accommodation, the following conclusions were made:

- Option 1 had a considerably lower need for bus services than the other three options;
- traffic on the Gladstone road network is expected to be significantly lower for Option 1 than the other options;
- Option 1 had a considerably lower need for ferry service than the other three options because of the lower frequency of shift changeovers and the reduced need to travel back and forth between Gladstone and Curtis Island; and
- total commute time for each worker under Option 1 is expected to be less than 10% of Options 2, 3 and 4 for a 14-day typical work cycle.

A comparison of worker accommodation options on both Curtis Island and at Gladstone or Calliope Historical Village (Options 2, 3, and 4) revealed that Option 2 will require the lowest number of bus and ferry trips with a significant saving in total travel time per 14 day cycle.

In addition to the above, four options for potential mainland ferry landing locations were identified and compared, including:

1. Gladstone Marina – Public Wharf at Brian Jordan Drive;
2. Connell Wharf – Flinders Parade;
3. Auckland Point Wharf; and

4. Fisherman's Landing Wharf.

Overall, cycle times for each ferry landing location were found to be similar with the exception of Option 4 – Fisherman's Landing Wharf, which has a shorter cycle time due to its closer proximity to Curtis Island. Other benefits of Fisherman's Landing over the others included:

- closer proximity to Curtis Island (approximately 4.5km);
- closest option to proposed Calliope worker accommodation, if that option is selected;
- potential to consolidate worker and goods transport to Curtis Island (Auckland Point Wharf also has this potential); and
- best potential location to provide worker vehicle car parking and bus pick-up to ferry, while reducing duration of bus trips.

The GLNG project infrastructure at Auckland Point is now referred to as Port Central; however, Auckland Point is used throughout this report in order to remain consistent with the terminology in the GLNG EIS.

1.4 Movement of Goods

The barge landing location options evaluated to move goods and equipment to Curtis Island included:

1. Auckland Point Wharf;
2. Fisherman's Landing; and
3. Proposed Port Curtis bridge crossing site.

A general and comparative assessment of the above options showed that Fisherman's Landing is the preferred location for goods and material transfer from trucks and ships to Curtis Island.

1.5 References

In preparing this report the following background reference materials and documents have be utilised:

- Cardno Eppell Olsen, *GLNG Project – Marine Transport Strategy, Version 4* February 2009;
- Bechtel, *GLNG Project Pre-FEED Study – Camp Strategy*, 22 August 2008;
- Foster Wheeler Energy Ltd, *Civil Design Report*, 12 August 2008;
- Curtis Ferry Services: http://www.curtisferryservices.com.au/;
- Bechtel, *Traffic and Logistics Survey*, 22 August 2008; and
- GLNG EIS Project Description, URS, 8 January 2009.

2.0 WORKER ACCOMMODATION ASSESSMENT

The following worker accommodation option has been assessed:

- 48% of worker accommodation on the mainland within Gladstone and 52% of worker accommodation on Curtis Island. These percentages come from the Supplementary EIS Report (Attachment C) which lists how they were found;
- Gladstone Marina (Public Wharf at Brian Jordan Drive) will be used for the initial six months and thereafter Auckland Point Wharf will be used to transfer workers to Curtis Island for the remainder of the construction period (refer to the Mainland Marine Facilities assessment report in the GLNG EIS Supplement for location details).

Based on information provided by URS, a workforce of approximately 3,000 workers has been assumed to be associated with the construction of Train 1 of the LNG facility. This option has been evaluated assuming that the potential bridge to Curtis Island would not be accessible until near the end of Train 1 construction (4th quarter 2013). If the proposed bridge is constructed and accessible for construction personnel to the island, the mode of travel to Curtis Island would be likely to change significantly to primarily buses/shuttles and personal vehicles (i.e. no ferries).

The following criteria have been identified for the evaluation of the worker accommodation option:

- bus services needed from the Gladstone area to ferry service;
- needs of ferry service:
  - frequency;
  - number of vessels; and
  - ferry cycle times to island;
- logistics of passenger drop-off and ferry loading;
  - need for bus drop-off areas;
  - need for parking of private vehicles; and
  - loading procedures for people onto ferries;
- total time required to transport staff from accommodation to Curtis Island worksite.

2.1 Workforce Transport Assumptions

Based on construction personnel numbers provided in the *GLNG EIS Project Description*, the peak and average workforce for each year of LNG facility Train 1 construction are provided in Table 2.1 below.

Table 2.1 LNG Facility – Train 1 Daily Construction Workforce Numbers

Year of Construction	1	2	3	4
Peak Workforce	1,482	3,080	2,940	1,120
Average Workforce	1,002	2,760	2,494	649

As shown in the table above, Year 2 is expected to have the highest construction workforce needs, with approximately 3,080 in the peak month and 2,760 averaged over the year. The workforce numbers for Year 2 of construction have formed the basis for the assessment provided herein to provide a "worst case" assessment of workforce transport strategies.

Information and the expected movements and shift patterns of the construction workforce is unknown at this time. The information and assumptions used thus far for determining the personnel movements are summarised in the following section.

2.1.1 Worker Shift Patterns

The worker accommodation option proposes that 52% (approximately 1,602) of the total construction personnel will be housed in a self-contained worker accommodation on Curtis Island and 48% (approximately 1,478) will be housed in worker accommodation on the mainland in Gladstone.

The following general assumptions have been made regarding shift patterns of the LNG facility construction workforce. Information has been sourced from the Bechtel Camp Strategy, dated 25 August 2008:

- personnel housed in the worker accommodation will spend ten days working and living in the workers accommodations, with a subsequent four-day leave period;
- based on the above shift patterns, it is assumed the total workforce will be split in thirds, with two-thirds of the total workforce always on the construction site, and one-third always on leave;
- workers based on the mainland will be transported to Curtis Island every day and are assumed to be split into three shifts, with two-thirds of the workforce working on any given day.

Based on the above assumptions for construction personnel movements, Table 2.2 below summarises the number of workers transported per shift change.

Table 2.2 ***Construction Workforce Movement Summary***

Option	Accommodation Location	Personnel transported per shift change:
Peak	Curtis Island	534
	Gladstone	986
Average	Curtis Island	478
	Gladstone	883

In a 14-day work cycle the number of times the workers will be transported to/from Curtis Island varies depending on whether the workers are being housed in Gladstone or on Curtis Island. Workers being housed on Curtis Island will be transported to/from the island three times during the 14-day period. However, workers housed in Gladstone will be transported to/from the island 14 times (i.e. daily) in the same period.

2.2 Bus and Car Services

2.2.1 Bus Services

An assessment has been undertaken to determine the bus service needs to transport workers from within Gladstone to the ferry service to Curtis Island. An average bus capacity for worker transport has been estimated at 40 passengers per bus. It was determined that 80% of all workers would catch a bus in some form to the ferry services.

A summary of bus services is provided in Table 2.3, including the number of bus trips needed to transport the construction personnel during each shift change (provided in Table 2.2) and the total number of return bus trips for a 14-day work cycle.

Table 2.3 ***Bus Service Summary***

Option	Accommodation Location	Return Bus Trips per Day of Travel	Return Bus Trips per 14-day Cycle
Peak	Curtis Island	11	32
	Gladstone	20	276
Average	Curtis Island	10	29
	Gladstone	18	247

The following general assumptions have been made for bus travel from the Gladstone area.

Curtis Island Accommodation Workforce:

- for workers travelling to Curtis Island to rotate into the ten-day shift, a commute time of 20 minutes was assumed for workers being transported from the airport to Auckland Point via the Dawson Highway, Glenlyon Road and Port Access Road;
- in addition to buses on the mainland, buses or shuttles will also be needed to transport workers from the Material Off-Loading Facility (MOF) drop-off point to the worker accommodation on Curtis Island. It has been assumed that the worker accommodation on Curtis Island is an estimated 20 minute bus/shuttle ride from the MOF on the island and that the worker accommodation is within walking distance to the LNG facility construction site.

Gladstone Accommodation Workforce:

- for local residents living in the Gladstone area there are four methods that will be adopted to travel from their residences to the ferry terminal at Auckland Point. These are:
  - 40% of the workforce will be picked up locally from the Gladstone area and will be transported to the ferry terminal at Auckland Point by bus;
  - 40% of the workforce will drive to a park and ride facility on Blain Drive from where they will be shuttled by bus to the ferry terminal at Auckland Point;
  - 15% of the workforce will drive from their residences to Auckland Point and park there; and
  - 5% of the workforce will be driven to Auckland Point from their residences and be dropped off.
- it has been assumed that all buses, being either the shuttle services or neighbourhood services, will take approximately 20 minutes on average to carry people from their respective residences to the ferry terminal. The routes used to gain access to the ferry terminal will be dependent on where personnel live in Gladstone and will follow the routes adopted in the intersection analysis of the base traffic report for the GLNG project. Shuttle services from the park and ride facility will travel south along Blain Drive before heading north along the Dawson Highway and Glenlyon Road to Port Access Road.

2.2.2 Car Parking Requirement

For workers who live on Curtis Island, 20% of them will travel by car. They will drive from either the airport or from areas external to Gladstone. All of these workers will park at Auckland Point. Consequently, 214 parking spaces will be required to accommodate the car parking demand associated with workers living on Curtis Island that drive to the ferry terminal (20% of the 52%).

For workers who live in Gladstone there are three forms of car travel that have to be catered for. These are:

- 15% of the local workforce will behave in a similar manner to the car drivers living on Curtis Island. These drivers will require 148 parking spaces at Auckland Point;
- 5% of the local workforce will be driven to Auckland Point from their homes and be dropped off there. These 49 trips will not require any parking spaces, although a drop-off area will be required; and
- 40% of the local workforce will drive to a park and ride facility on Blain Drive from where they will be shuttled by bus to Auckland Point. These drivers will require secure parking at this location to hold 394 parking spaces.

Based on the above, there will be a maximum of 805 vehicle trips a day when both the local and Curtis Island accommodation workforce travel to work. Of these 805 vehicles, parking spaces for 756 vehicles will need to be provided. 394 car parking spaces will be required at the park and ride facility at Blain Drive, with 362 spaces required at Auckland Point.

2.3 Ferry Service

An assessment has been undertaken to determine the ferry service needs to transport workers from the mainland to the LNG facility construction site on Curtis Island.

It is proposed to utilise the Gladstone Marina (public wharf at Brian Jordan Drive) for the initial six months and thereafter Auckland Point Wharf for the remainder of construction period. Both ferry landings are approximately 7.5km from Curtis Island, making the total ferry cycle time of 69 minutes irrespective of which ferry landing is utilised (assuming a ferry operating speed of ten knots). Based on information provided, a ferry capacity of 250 passengers is assumed.

Table 2.4 below provides a summary of the number of ferry trips needed to transport the construction personnel during each shift change (provided in Table 2.2) and the total number of ferry trips for a 14-day work cycle.

Table 2.4 ***Ferry Service Summary***

Option	Accommodation Location	Ferry Trips per Day of Travel	Ferry Trips per 14-day Cycle
Peak	Curtis Island	3	9
	Gladstone	4	56
Average	Curtis Island	2	6
	Gladstone	4	56

2.3.1 Ferry Landing Location Assessment (Worker Transport)

Based on information provided, it is proposed to utilise the Gladstone Marina (public wharf at Brian Jordan Drive) for the initial six months and thereafter Auckland Point Wharf for the remainder of the construction period.

The proposed ferry landing locations to transport workers to Curtis Island are described below.

2.3.2 Gladstone Marina Ferry Terminal

The Gladstone Marina services a mix of private and commercial vessels. It contains several barge/ferry ramps that may present opportunity to serve as a ferry landing for transporting construction personnel to Curtis Island. It is proposed to use the ferry/barge ramp on the east end of the marina at the Gladstone Ferry Terminal, accessed via Brian Jordan Drive. A service jetty also exists adjacent to the Ferry Terminal off Brian Jordan Drive, which could also serve ferry loading and unloading if needed. Marine facilities at Gladstone Marina are maintained by Gladstone Port Corporation.

Access

The ferry landing at Gladstone Ferry Terminal on the east end of the marina is approximately 7.5km from Curtis Island, making the total ferry cycle time of 69 minutes. It is noted that low speed limits exist within the marina, possibly increasing cycle times, though a constant speed of ten knots has been assumed.

Gladstone Marina allows easy access to the Port of Gladstone via Auckland Creek. Depending on the location of the ferry landing within the Gladstone Marina, different levels of conflicts with other vessels will occur. Adequate space is generally available for manoeuvring and docking within the marina.

Vehicle and bus access to the Gladstone Marina can be gained via Dawson Highway, Glenlyon Road and Brian Jordan Drive through Gladstone or via Hanson Road and Alf O'Rourke Drive from the west. Adequate bus manoeuvring, drop-off and turn-around space is provided at Curtis Ferry Services as well as at the Ferry Terminal.

Amenity

Amenities for passenger queuing and loading at Curtis Ferry Services and Gladstone Ferry Terminal exist. As Curtis Ferry Service is located away from the public access docks and ferry terminal, it is a more suitable location for transferring a larger numbers of construction personnel to the ferry and creates less disruption to existing activity in the area.

A private car park is available for customers at Curtis Ferry Service which may present limited opportunity for securing permanent parking for private/GLNG vehicles. Similarly, a public car park is located at the marina off Brian Jordan Drive, though would likely not be available for long term parking options for this project. The vast majority of personnel transported to the island would need to arrive via bus or be dropped off at the ferry location because of lack of parking provision and to reduce the overall traffic impacts associated with the construction workforce.

Coordination with Owner/Operator

Conflicts with existing barge/ferry traffic may present issues. Since this is a public marina, it may not be favourable to the operators to have such a large volume of workers embarking and disembarking every day.

Depending on the worker accommodation option selected, the existing Curtis Ferry Service at Gladstone Marina may present a viable option for transporting construction personnel and vehicles to Curtis Island. Because Gladstone Marina is owned and operated by Gladstone Port Corporation, agreements may need to be put in place to coordinate the increased activity in the marina.

2.3.3 Auckland Point Wharf

Auckland Point Wharf is owned and partially operated by Gladstone Port Corporation, with portions of the facility operated by private entities.

Access

Docks at Auckland Point are approximately 7.5km from the currently proposed MOF site and ferry landing on Curtis Island. Assuming the existing Curtis Ferry Service will transport workers, total cycle time for ferries from Auckland Point Wharf is approximately 69 minutes, similar to the Gladstone Marina ferry terminal. This provides direct access to Curtis Island, with adequate space for ferries to manoeuvre to reach the docks.

The existing Curtis Ferry Service would likely be able to access Auckland Point Wharf, though additional services/ferry capacity may be needed.

Vehicle access to Auckland Point from Gladstone and from the south would likely be via Dawson Road, Glenlyon Road and Port Access Road. Access from the west would be via Gladstone-Mount Larcom Road to Glenlyon Road and Port Access Road. Using these routes, most traffic would be travelling on highways or arterial roadways.

Amenity

There appears to be adequate space for bus drop-off and passenger queuing and loading. Private vehicle parking would not likely be available; therefore all workers would likely need to be transported to the site by bus.

Coordination with Owner/Operator

Since Auckland Point Wharf is a secure facility, it may not be feasible to gain access for the large number of workers proposed during the construction of the LNG facility. Because it is a secure port area, all workers will require Commonwealth security and safety induction cards to enter the area for embarkation to the island.

2.4 Worker Travel Time

Approximate worker travel times were calculated based on bus and ferry input assumptions and the Bechtel Camp Strategy memorandum.

As outlined above, the following assumptions for worker travel time have been made:

- one-way travel by bus from the workers accommodation throughout Gladstone to the ferry terminal was calculated at 20 minutes, including loading and unloading time;
- travel via ferry calculated at 44 minutes for a one-way trip including loading and disembarking (this varies from the 69 minutes previously stated for a round trip due to the one way nature of this trip); and
- bus travel from the MOF ferry drop-off point to the workers accommodation or worksite on Curtis Island assumed at 20 minutes.

Worker travel times include a mix of daily travel from the workers accommodation at Calliope on the mainland as well as fortnightly travel to the workers accommodation on Curtis Island.

Based on the ferry service speed of ten knots, a return trip from Gladstone Marina/Auckland Point Wharf to Curtis Island (7.5km each way) will take approximately 69 minutes, factoring in ten minutes each for loading and unloading.

A summary of the commute times for workers, broken into the two worker accommodation options is provided in Table 2.5.

In addition to all these times, it has been assumed that on average 20 minutes a day would be required for workers living on Curtis Island to get from their accommodation to the construction site by walking.

With the combination of all the components of worker commute times required for this project, a cumulative total travel time for all LNG facility construction workers over a 14-day work period was calculated at 45,880 hours (1,912 days).

Table 2.5 ***Employee Commute Time Summary***

Employee Travel Time Per 14-Day Period - Island Accommodation Portion			
Secure parking lot to ferry	20 min	*From Bechtel Camp Strategy*	
Ferry - Gladstone to MOF	44 min	*Calculated from assumptions*	
MOF to Workers accommodation	20 min	*From Bechtel Camp Strategy*	
Workers accommodation to MOF	20 min	*From Bechtel Camp Strategy*	
Ferry - MOF to Gladstone	44 min	*Calculated from assumptions*	
Ferry to Parking Lot	20 min	*From Bechtel Camp Strategy*	
Travel Time Per 14-Day Period (per person) by Ferry:	**168 min**	**2 hrs 48 minutes**	
Employee Travel Time Per 14-Day Period – Gladstone Accommodation Portion			
Gladstone accommodation to ferry	20 min	*From Bechtel Camp Strategy*	
Ferry - Gladstone to MOF	44 min	*Calculated from assumptions*	
Bus - MOF to Site	20 min	*From Bechtel Camp Strategy*	
Bus - Site to MOF	20 min	*From Bechtel Camp Strategy*	
Ferry - MOF to Gladstone	44 min	*Calculated from assumptions*	
Ferry to Gladstone accommodation	20 min	*From Bechtel Camp Strategy*	
Travel Time Per Day:	**168 min**	**2 hrs 48 minutes**	
Travel Time Per 14-Day Period (per person) Total:	**1,680 min**	**28 hrs**	
Total Travel Time (all employees):		**2,752,781min**	**45,880 hrs**

As a comparison, the *Marine Transport Study* prepared by CEO in February 2009 (as part of the GLNG EIS) was referred to, to assess the change that a 52%/48% island/mainland accommodation split had compared to a 100%/0% island/mainland accommodation split. The previous analysis undertaken indicated that this would require a total travel time for all employees over a 14-day period of 8,655 hours. This would mean that if all workers were to be accommodated on Curtis Island, less than 20% of this time would be spent travelling to work compared to the 52%/48% split option.

3.0 BARGE LANDING LOCATION ASSESSMENT (GOODS TRANSPORT)

The barge landing locations evaluated to move goods and equipment to Curtis Island included:

1. Fisherman's Landing;
2. Calliope River;
3. RG Tanna;
4. Auckland Point.

Refer to the Mainland Marine Facilities assessment report in the GLNG EIS Supplement for location details.

Related issues for the evaluation of the barge landing location options include:

- access/security restrictions for facility use;
- accommodation for vehicles delivering goods;
- vehicle weight/size restrictions;
- facility accommodation for storage of goods/vehicles before loading;
- origin of goods to be delivered;
- impacts of vehicles on external road networks; and
- ease of access of vehicles from origin.

Available port facilities in the area are outlined and discussed in the Bechtel *Traffic and Logistics Survey*, dated 22 August 2008. The survey describes Auckland Point Wharf and Fishermans Landing Wharf as the two best potential options.

3.1 Fisherman's Landing

The owner of the wharf facilities at Fisherman's Landing is Gladstone Port Corporation. Fisherman's Landing is operated as a multi-user facility. Security access is gained from Landing Road. The Bechtel survey nominates Fisherman's Landing as a suitable option, and it is the closest option to Curtis Island at 4km via Port of Gladstone. It is also important to note that Fisherman's Landing is the Department of Transport and Main Roads preferred location for goods transport to Curtis Island because trucks will avoid travelling through the Gladstone urban area.

3.1.1 Goods Handling Capabilities

Three wharf facilities are currently available at Fisherman's Landing. Gladstone Port Corporation has proposed plans for the future expansion of the Fisherman's Landing reclamation area and a potential for seven additional wharf facilities. Wharf Number 4 has a pivoting radial arm ship loader with capacity of 2,000tph. Wharf Number 5 has two SVT 300mm loading arms.

3.1.2 Access

Access for goods delivery through Fisherman's Landing would likely occur both by ship through the Port of Gladstone and by truck via the highway system. The origin of goods will generally be as follows:

- large items likely via ship; and
- road cargo mostly from Brisbane and other areas to the south. The main route will be via Bruce Highway to Calliope River Road.

The primary truck route to Fisherman's Landing will be the Bruce Highway, Calliope River Road, Gladstone-Mount Larcom Road and Landing Road. This route is approximately 30km from Bruce Highway at Dawson Highway, and has been identified by Queensland Transport as a high mass limit roadway. As Fisherman's Landing lies outside of Gladstone, most trucks delivering goods to the site are likely to be on rural highways the entire route to the wharf.

The potential haulage route to Fisherman's Landing crosses underneath the rail line at one point, which may present a vertical clearance issue. Visual inspections of vertical clearance signs were undertaken at the following locations:

- Gladstone-Mount Larcom Road under conveyor at Rio Tinto Aluminium (Formerly Comalco) (0.7km east of Landing Road): 7m;
- Gladstone-Mount Larcom Road under rail east of Rio Tinto Aluminium (Formerly Comalco) (1.5km east of Landing Road) : 6.75m; and
- Calliope River Road under rail south of Gladstone-Mount Larcom Road: not signed – though appears to be approximately 7m.

All potential haulage routes to Fisherman's Landing pass under the rail line at one point, of which vertical clearances and load expectations for the project should be reconciled before selecting this option.

High mass limit access on Landing Road terminates at the access road to Cement Australia. Landing Road will need to be upgraded to high mass limit standards if used as a goods transport location for the LNG facility construction.

3.2 Calliope River

Based on the Bechtel survey, the proposed Calliope River barge ramp location and associated required hardstand is owned and managed by the Department of Infrastructure and Planning.

The Bechtel survey also highlighted that the existing Calliope River mouth is tide constrained. Consequently, it may be necessary to perform some dredging of the river mouth to allow more flexibility and possibly minimise the need for night shift barge movements. The proposed Calliope River barge landing location is approximately 5 km from Curtis Island.

3.2.1 Goods Handling Capabilities

It is proposed to establish a new twin Calliope River barge ramp facility behind Wiggin's Island to transfer raw and bulk materials from the mainland to Curtis Island. The two adjacent barge ramps will be provided to suit standard, ocean going 28m x 90m long dumb barges. Mooring points and fender piles will be installed along the perimeter of the combined barge ramp for assistance in stabilising the barges during loading and unloading operations and for mooring during periods of idle time.

3.2.2 Access

Access for goods delivery through Calliope River will occur both by ship through the Port of Gladstone and by truck via the highway system. The origin of goods will generally be as follows:

- large items likely via ship; and
- road cargo mostly from Brisbane and other areas to the south. The primary route will be via Bruce Highway.

Calliope River is approximately 20km from the Bruce Highway along the Dawson Highway. The most likely route for trucks to Calliope River will be via Bruce Highway, Dawson Highway, Blain Drive, Alf Orourke Drive and Bryan Jordan Drive. A dedicated Port Access road through Gladstone has been constructed diverting heavy vehicles away from the CBD area and adjacent to the railway. This removes heavy vehicles from mixing with general traffic within Gladstone.

The route specified above leave trucks primarily on highways and arterial roads to access Calliope River, following designated high mass limit routes into Gladstone. Movement of multi-combination vehicles is restricted in Gladstone between the hours of 8:30am to 9:00am and 3:00pm to 3:30pm Monday to Friday. Combination trucks up to 23 metres and 25 metre B-double are permitted on selected routes in Gladstone.

Truck routes specified by Queensland Transport are provided at Appendix B.

3.3 RG Tanna

The owner and operator of the wharf facilities at GC Tanna Coal Terminal is the Gladstone Ports Corporation. Facilities include a multi-user berth for exporting coal from the Central Queensland Basin. The wharf is located to the west of the city, adjacent to the Clinton Industrial Estate and is accessed by road and rail (all coal is received by rail).

Based on the Bechtel survey, it is proposed to upgrade the existing RG Tanna facility. However, the Gladstone Port Corporation has advised that the proposed location has already been allocated to another LNG project and that only a relative small area (yet to be confirmed) may be utilised and allocated to the GLNG project. Consequently this arrangement will not be considered a long term or permanent facility solution in that interface with others constructing and operating adjacent barge ramps may cause delays to the GLNG project and hamper progress. The RG Tanna facility is approximately 5.5 km from Curtis Island.

3.3.1 Goods Handling Capabilities

The wharf has three mobile gantry shiploaders able to accommodate 6,000 tph each and four berths at 18.8m deep. A maximum vessel size of 220,000 DWT is allowed with larger vessel capacity subject to approval. The minimum vessel size allowed is 25,000 DWT. Ships are required to swing before berthing to face out to sea. The swing basin is located north west of the berth and has a depth of 10.4m and 600m diameter.

Most large cargo for this project is expected to arrive via ship and be offloaded to a barge to Curtis Island. RG Tanna can handle larger ships than Auckland Point and Fisherman's Landing and includes a rail loop.

3.3.2 Access

Access for goods delivery through RG Tanna will occur both by ship through the Port of Gladstone and by truck via the highway system. The origin of goods will generally be as follows:

- large items likely via ship; and
- road cargo mostly from Brisbane and other areas to the south. Primary route will be via Bruce Highway.

Similar to Calliope River, RG Tanna is approximately 20km from the Bruce Highway along the Dawson Highway. The most likely route for trucks to the RG Tanna facility will be via Bruce Highway, Dawson Highway, Blain Drive and Alf O'Rourke Drive. A dedicated Port Access road through Gladstone has been constructed diverting heavy vehicles away from the CBD area and adjacent to the railway. This removes heavy vehicles from mixing with general traffic within Gladstone.

The route specified above confines trucks primarily to highways and arterial roads to access the RG Tanna site, following designated high mass limit routes into Gladstone. Movement of multi-combination vehicles is restricted in Gladstone between the hours of 8:30am to 9:00am and 3:00pm to 3:30pm Monday to Friday. Combination trucks up to 23 metre and 25 metre B-double are permitted on selected routes in Gladstone.

Truck routes specified by Queensland Transport are provided at Appendix B.

3.4 Auckland Point Wharf

The use of Auckland Point Wharf to move material has been tested as an option for evaluation purposes only. This is technically not one of the proposed options but has been included for comparison purposes (as it was previously in the EIS).

The Auckland Point Wharf is owned and operated by the Gladstone Port Corporation. Wharves 3 and 4 are multi-user facilities. The Bechtel survey nominates Wharves 3 and 4 as suitable options. Auckland Point is approximately 7.5km from Curtis Island via the Port of Gladstone.

3.4.1 Goods Handling Capabilities

Auckland Point Wharf does not have an unloading crane. All vessels that berth here are usually self-geared. The facility has a weight limit of 90 metric tons to be craned onto a multi-wheeled trailer. This limit will only apply to this project for cargo being transported to Auckland Point by truck and offloaded onto barge. Most large cargo for this project is expected to arrive via ship and be offloaded to a barge to Curtis Island. Auckland Point can handle larger ships than Fisherman's Landing and includes undercover warehousing and lay-down areas, a rail loop and Australian Quarantine facilities if needed.

3.4.2 Access

Access for goods delivery through Auckland Point will occur both by ship through the Port of Gladstone and by truck via the highway system. The origin of goods will generally be as follows:

- large items likely via ship; and
- road cargo mostly from Brisbane and other areas to the south. Primary route will be via Bruce Highway.

Auckland Point Wharf is approximately 24km from the Bruce Highway along the Dawson Highway. The most likely route for trucks to Auckland Point Wharves will be via Bruce Highway, Dawson Highway, Glenlyon Road and Port Access Road; or Dawson Highway, Don Young Drive, Red Rover Road, Glenlyon Road and Port Access Road. A dedicated Port Access road through Gladstone has been constructed diverting heavy vehicles away from the CBD area and adjacent to the railway. This removes heavy vehicles from mixing with general traffic within Gladstone.

The routes specified above restrict trucks primarily to highways and arterial roads to access Auckland Point, following designated high mass limit routes into Gladstone. Movement of multi-combination vehicles is restricted in Gladstone between the hours of 8:30am to 9:00am and 3:00pm to 3:30pm Monday to Friday. Combination trucks up to 23 metre and 25 metre B-doubles are permitted on selected routes in Gladstone.

Truck routes specified by Queensland Transport are provided at Appendix B.

One constraint found with accessing Auckland Point Wharves is the Goondoon Street bridge over Port Access Road, which has a vertical clearance of 5.1m which controls the land-side delivery of large items. It should also be noted that Glenlyon Road has a vertical clearance of 4.7m under the rail line in this vicinity. Other routes that do not require passing under bridges or road overpasses are more circuitous routes through Gladstone, which may not be negotiated by a large truck or comply with Queensland Transport's high mass limit routes. Deliveries to the site will need to be coordinated to ensure that loads with vertical clearance constraints are delivered via ship or barge.

4.0 PORT FACILITY IMPACTS

4.1 Port Facilities

The GLNG Project adds a number of vehicles to the road network in Gladstone, especially surrounding the port facilities that will be used to transport personnel and material to the GLNG Project. The following locations were looked at in determining the amount of traffic currently existing as well as the number of additional trips the GLNG Project will contribute:

- Fisherman's Landing: for material movements in the first six months;
- Gladstone Marina Ferry Terminal: for personnel movements in the first six months;
- Auckland Point Wharf: for personnel movements for the rest of the life of the project;
- RG Tanna: for material movements for the rest of the life of the project; and
- Calliope River: for aggregate material movements for the rest of the life of the project.

4.1.1 Fishermans Landing

During the initial six months of construction, it is assumed that there will be a maximum of 65 barge trips a month occurring. Based on a six day working week, this equates to approximately three return barge trips per day. With each barge been able to carry ten heavy vehicles, this equates to a maximum of 30 loaded and 30 unloaded heavy vehicle trips occurring per day due to the GLNG Project occurring during the initial six month period.

4.1.2 Gladstone Marina Ferry Terminal

The assessment of the GLNG Project indicates that the Gladstone Marina Ferry Terminal will not be impacted to any major degree. This is due to the very low numbers of workers that will be travelling to Curtis Island during the initial six month period. Assuming the worst case where all workers are accommodated on the mainland and need to travel across to Curtis Island daily, there will be a maximum of 360 workers, with 290 workers in the day shift and 70 workers in the night shift. Based on these numbers, there will be two return ferry trips required in each peak period. Based on the movement of these 360 workers there will be an additional 72 car trips to the Marina per peak hour with 8 additional bus trips per peak hour.

4.1.3 Auckland Point Wharf

Auckland Point Wharf will be used, following the initial six months, as the location for the movement of personnel to and from Curtis Island for the GLNG Project. At its peak construction, the GLNG Project will require 557 car trips and 57 bus trips daily trips to Auckland Point Wharf with 137 car trips and 13 bus trips occurring in each peak hour. This is assuming the split of workers living on Curtis Island and those living on the mainland being 52% and 48% respectively.

4.1.4 RG Tanna

A material loading facility will be constructed at RG Tanna. This will be used to transport material to Curtis Island and will also be the location where pipe and material for the Gas Transmission Pipeline and the northern CSG Fields will occur. It was determined that in a peak hour, there would be up to 24 heavy vehicle trips occurring to or from the RG Tanna due to the GLNG Project. On a daily basis this there would be approximately 68 heavy vehicle trips occurring to or from the RG Tanna material loading facility.

4.1.5 Calliope River

An aggregate loading facility will be constructed at Calliope River. This facility will be a new wharf for the movement of aggregate material only to and from Curtis Island. There are 3 planned trips per peak hour planned for aggregate material with 34 trips planned per day during peak construction.

4.2 Port Facility Impacts

4.2.1 Road Link Impacts

Due to the development traffic shown above for the GLNG Project at the various planned material and personnel loading facilities, the existing road network was analysed to determine the impacts that this project would contribute. Table 4.1 below shows the existing peak and daily volumes on the road network surrounding these port facilities along with the proposed additional traffic. A percentage of the total volume that the GLNG Project traffic will contribute is also shown. The peak construction volumes for 2012 were used.

Table 4.1 ***GLNG Project Impacts on Link Volumes***

Road Section	Peak Hour Volumes			Daily Volumes		
	Existing	Dev	Increase	Existing	Dev	Increase
Landing Road	285	153	53.7%	868	459	52.9%
Alf O'Rourke Drive	682	4	0.6%	3,074	12	0.4%
Blain Drive - southern end	1,498	169	11.3%	7,157	507	7.1%
Port Access Road	395	144	36.5%	1,999	410	20.5%
Dawson Highway - between Hanson Road and Blain Drive	949	142	15.0%	16,676	410	2.5%
Hanson Road - between Port Access Road and Dawson Highway	1,240	147	11.9%	16,008	440	2.7%
Hanson Road - between Port Access Road and Blain Drive	1,064	23	2.2%	9,717	182	1.9%
Hanson Road - between Blain Drive and Red Rover Road	2,231	111	5.0%	13,145	1123	8.5%
Hanson Road - between Red Rover Road and Landing Road	1,965	117	6.0%	10,302	1123	10.9%

Analysis of the road links indicated that due to the GLNG Project a number of road links will require upgrades from their two lane cross sections to four lane cross sections. These road sections are located along Gladstone-Mount Larcom Road between Blain Drive and Reid Road. These are the only road sections across the entire road network which have increases in traffic volumes due to the GLNG Project that attribute to the brining forward of the road upgrades.

4.2.2 Intersection Impacts

Due to the GLNG Project traffic the following intersections required additional intersection upgrades, above those that were required due to the background traffic on the road network.

- Hanson Road/Red Rover Road intersection;
- Hanson Road/Blain Drive/Alf O'Rourke Drive intersection;
- Dawson Highway/Bramston Street/Glenlyon Road intersection;
- Dawson Highway/Don Young Road intersection;
- Dawson Highway/Blain Drive/Herbertson Road intersection;
- Hanson Road/Landing Road/Gladstone-Mt Larcom Road intersection; and
- Gladstone-Mt Larcom Road/Calliope River Road/Targinie Road intersection.

Details of the mitigation requirements are documented within the traffic analysis of the Supplementary EIS Report (Attachment C) for a range of potential scenarios.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on information provided, a workforce of approximately 3,000 personnel workers has been assumed with 48% of the workforce accommodated on the mainland within Gladstone and 52% of the workforce accommodated on Curtis Island.

Assuming a bus capacity of 40 passengers, 20 bus trips per average shift change or 40 trips per day will be required to transport local workers from within Gladstone to the Gladstone Marina or Auckland Point Wharf.

In addition, 11 bus trips will be required to transport workers from the ferry landing on Curtis Island to the plant. In total, 31 buses with a capacity of 40 passengers will be required to transport workers on Curtis Island in a peak period.

Assuming a ferry capacity of 250 passengers, a total number of six ferry trips per average shift change will be required to transport workers to and from Curtis Island.

A cumulative total travel time for all LNG facility construction workers over a 14-day work period was calculated at 45,880 hours. Estimated travel time for workers residing within Gladstone amounts to 2 hours 48 minutes per day or 1 hour 24 minutes one-way, while estimated travel time for workers residing on Curtis Island amounts to two 1 hour 4 minute one-way trips per fortnight.

Approximately 361 car park spaces are required at Auckland Point Wharf with 394 car parks spaces required at Blain Drive to accommodate workers driving to work.

Based on the general and comparative assessment of options for goods transport location to Curtis Island, the following conclusions are made:

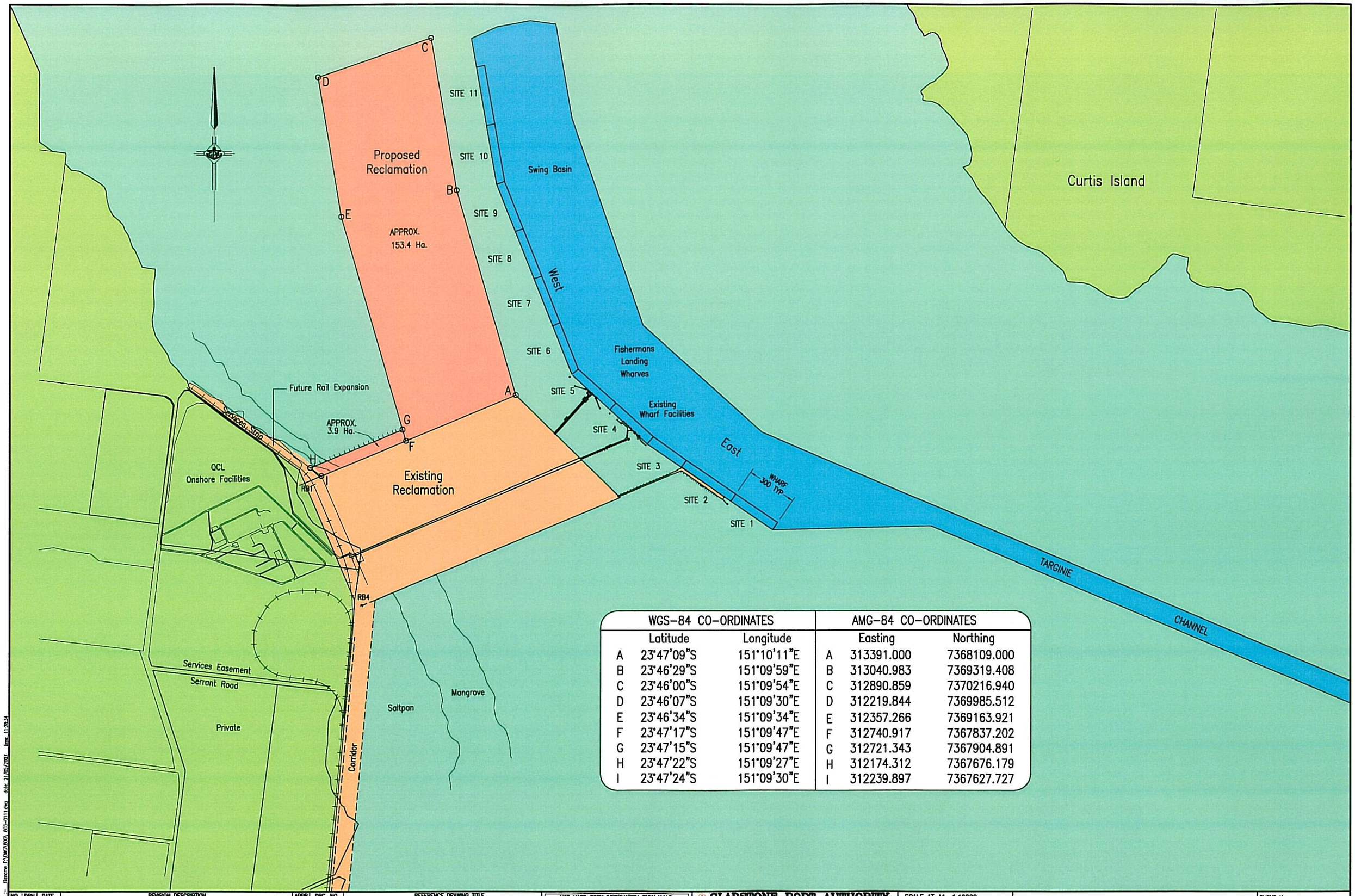
- Fisherman's Landing is the closest to Curtis Island, at approximately 4km compared to 5-7.5km for the other options;
- Fisherman's Landing and Auckland Point Wharves may be viable options for handling both truck and ship cargo, with the possibility of also providing a ferry landing point for transporting personnel to Curtis Island;
- Fisherman's Landing has the most direct access of all options – trucks will be able to access Fisherman's Landing from the Bruce Highway without travelling through Gladstone;
- potential wharf expansion: with potential plans for the expansion of Fisherman's Landing wharf facilities, opportunity may exist to coordinate the expansion to meet the material handling needs of this project;
- Fisherman's Landing is the Queensland Department of Main Roads' preferred option because of the avoidance of heavy vehicle traffic through Gladstone;

- the use of the RG Tanna site would provide facilities that include a multi-user berth for exporting coal and a train turnaround. It would enable trucks to access it without travelling through most of Gladstone;
- RG Tanna would require construction work to be undertaken to enable it to be used, which would conflict with existing operations;
- RG Tanna can handle larger ships than Auckland Point and Fisherman's Landing and includes a rail loop;
- the use of Calliope River would require a new twin Calliope River barge ramp facility behind Wiggin's Island to transfer raw and bulk materials;
- Calliope River is tidal which would limit operational time and may require dredging; and
- Calliope River would enable trucks to access it without travelling through most of Gladstone.

It is noted that other LNG and industrial facilities are currently being planned in the Fisherman's Landing area, which may create a conflict for GLNG equipment and material transfer activities to be based there. Similarly the use of RG Tanna is limited as other LNG and industrial facilities are currently being planning to use this area.

Appendix A

Fisherman's Landing Expansion Plan



WGS–84 CO-ORDINATES			AMG–84 CO-ORDINATES		
	Latitude	Longitude		Easting	Northing
A	23°47'09"S	151°10'11"E	A	313391.000	7368109.000
B	23°46'29"S	151°09'59"E	B	313040.983	7369319.408
C	23°46'00"S	151°09'54"E	C	312890.859	7370216.940
D	23°46'07"S	151°09'30"E	D	312219.844	7369985.512
E	23°46'34"S	151°09'34"E	E	312357.266	7369163.921
F	23°47'17"S	151°09'47"E	F	312740.917	7367837.202
G	23°47'15"S	151°09'47"E	G	312721.343	7367904.891
H	23°47'22"S	151°09'27"E	H	312174.312	7367676.179
I	23°47'24"S	151°09'30"E	I	312239.897	7367627.727

NO.	DRN	DATE	REVISION DESCRIPTION	APPR
E	G.K.	21.11.00	S/BUILD AREA REMOVED, NEW RECLAIM COLOUR CHANGE, CORRIDOR AREA WIDENED	
			AND NEW RECLAIM CO-ORDINATES ADDED	N.B.
F	G.K.	27.2.04	RAIL LINE & RECLAMATION REMOVED, COMALCO BERTH ADDED	O.B.
G	G.K.	11.5.04	CO-ORDINATES AMENDED & ADDED, EASTINGS NORTHINGS & REFERENCES ADDED AND	
			AREA UPGRADE	O.B.
H	G.K.	16.5.07	70M RECLAIM STRIP & CO-ORDINATES ADDED	B.C.

DRG. NO.	REFERENCE DRAWING TITLE
411–0023	FISHERMANS LANDING – PROPOSED 7 BERTH WHARF EXTENSION
431–0020	RECLAMATION NORTH OF F/LANDING LAYOUT AND LEVELS
431–0053	PROPOSED NORTHERN DEVELOPMENT AT F/LANDING
431–0054	RECLAMATION NORTH OF F/LANDING HYDROGRAPHIC DATA

USE HARD COPY INFORMATION ONLY U.N.O.
ELECTRONIC CAD FILE ACCURACY IS NOT GUARANTEED.

3RD ANGLE PROJECTION U.N.O.
ALL DIMENSIONS IN MILLIMETRES U.N.O.
DO NOT SCALE

SCALE AT A1: 1:10000

DRAWN*	S.DEMPSEY	16–06–97
CHECK*		
DESIGN*	N.BOWLEY	
APPROVE*		

FISHERMANS LANDING DEVELOPMENT

CLIENT No:
DRAWING No. 803–0111
REV. H
FILE No:
A1

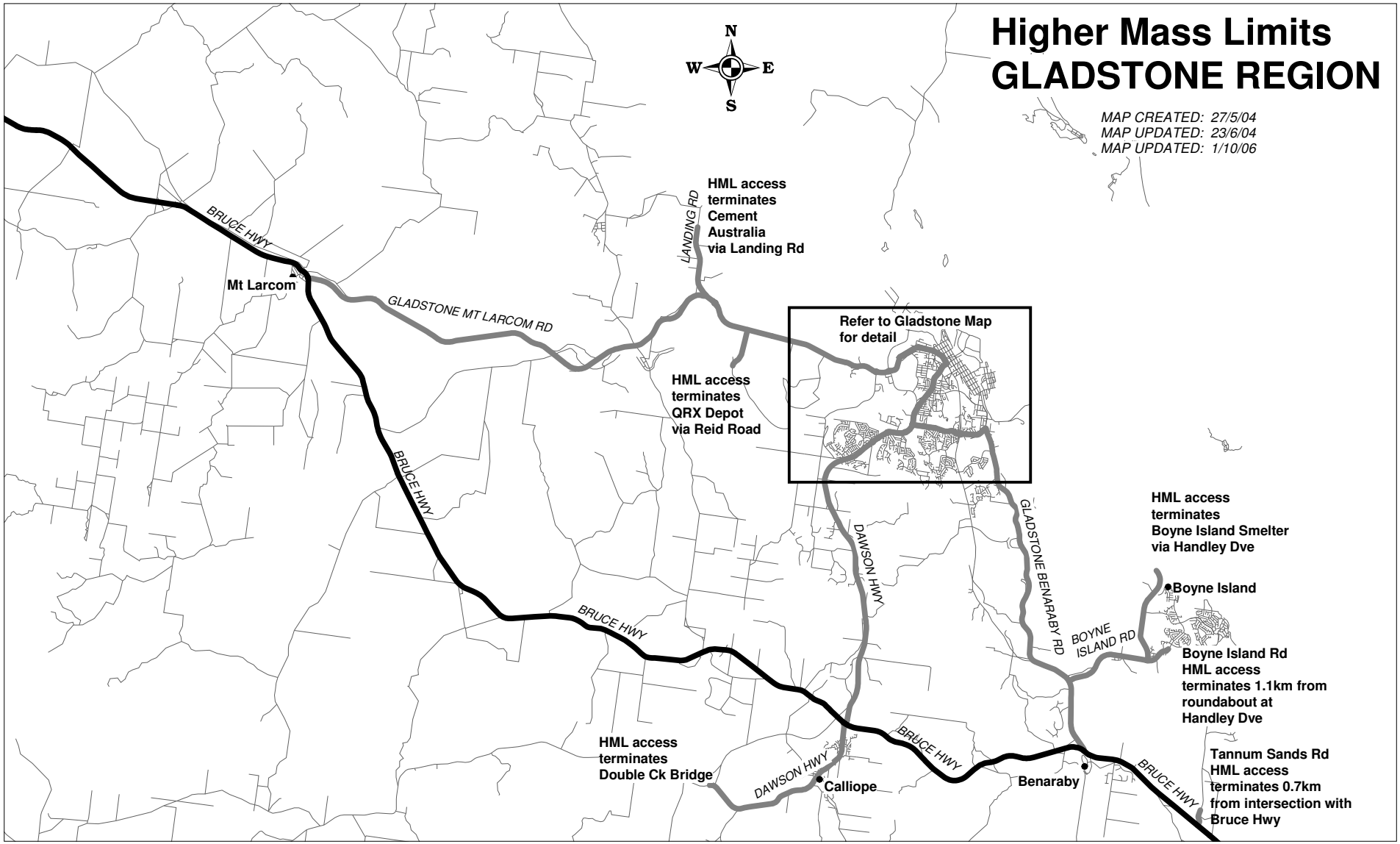
AUTOCAD PLOTTED :- filename: F:\DWGS\DGN\803-0111.dgn date: 21/05/2007 time: 11:19:34

Appendix B

Queensland Transport Approved Truck Routes

Queensland Government
Queensland Transport

APPROVED ROUTES FOR HIGHER MASS LIMITS FOR VEHICLES WITH ROAD FRIENDLY SUSPENSIONS

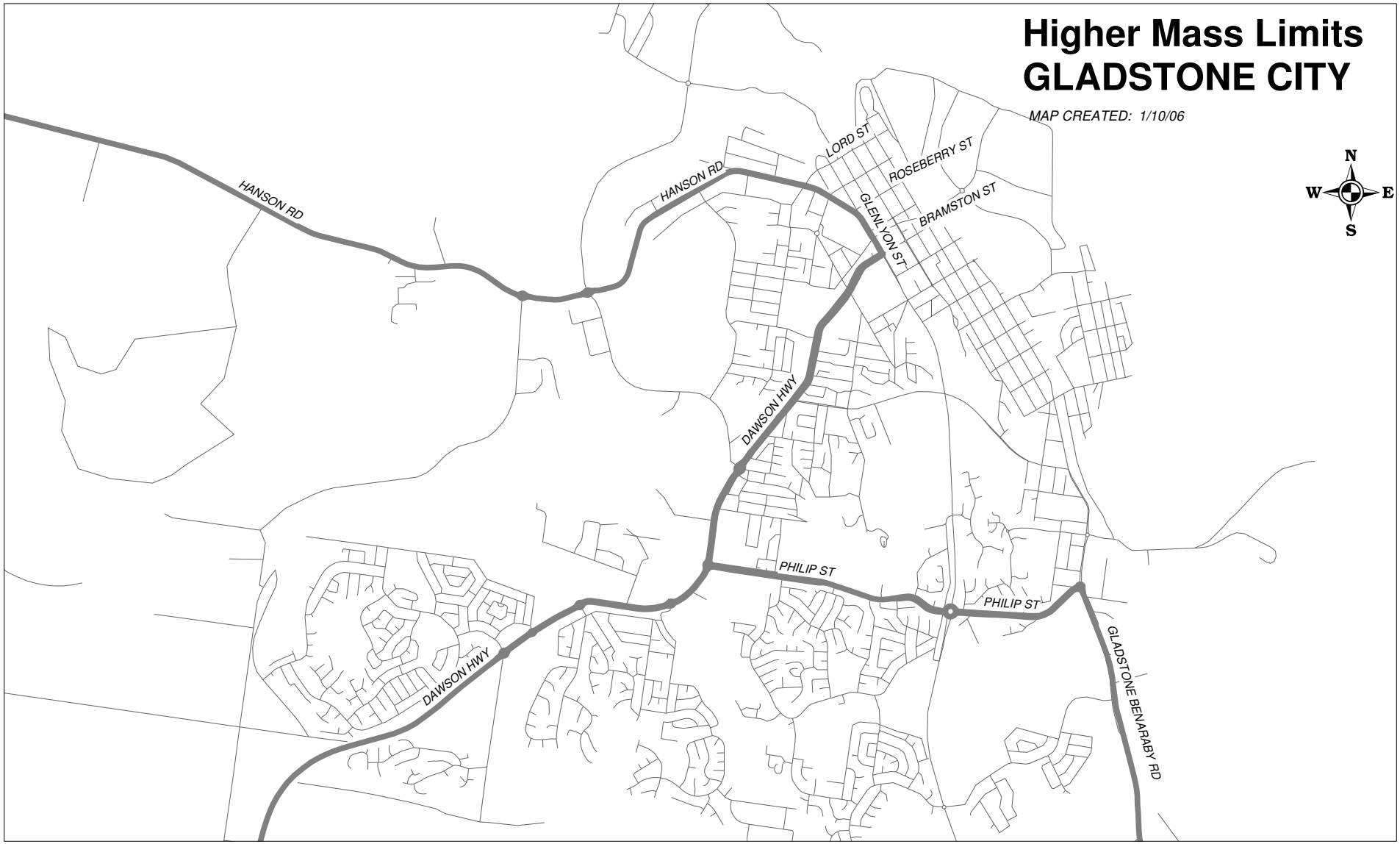


Major Highway System

Additional Roads approved for Higher Mass Limits

Queensland Government
Queensland Transport

APPROVED ROUTES FOR HIGHER MASS LIMITS FOR VEHICLES WITH ROAD FRIENDLY SUSPENSIONS



Major Highway System

Additional Roads approved for Higher Mass Limits

MULTI-COMBINATION VEHICLES IN QUEENSLAND

MARKED ROUTES

The following legend indicates which vehicles may/or may not use routes which are marked in the maps.

The vehicle description listed opposite the type of route marking indicates which vehicles are permitted or not permitted on routes depicted in that manner in the maps.

Legend

23 metre B-doubles only

23 metre & 25 metre B-doubles only

Type 1 road trains,
23 metre & 25 metre B-doubles only

Type 1 and Type 2 road trains,
23 metre & 25 metre B-doubles

No road trains or B-doubles to operate on these roads

Operations are not permitted on roads where signs prohibit use or as indicated by above legend

SHADED AREAS

There are two shaded areas indicated on the maps.
These areas indicate that specified types of multi-combination vehicles can operate on most roads within the specified shaded area as per the legend above and text below.

All multi-combination vehicles (excluding Type 2 road trains)

Light shaded area

There are some marked routes in the light shaded area that cannot be used by road train or B-double combinations. Refer to the marked routes legend to identify these routes on maps.

All multi-combination vehicles

Dark shaded area

There are some marked routes in the dark shaded area that cannot be used by road train or B-double combinations. Refer to the marked routes legend to identify these routes on maps.

There are maps provided for some towns within the shaded areas where operation of road train or B-double combinations is limited to the routes specified (see index to locate these maps which are marked with an asterisk).

Operations in other towns is not restricted unless signs prohibit use or the route is marked for no road train or B-double operations in the guideline.

Operations on local authority roads in shaded areas is not restricted unless signs prohibit use or the route is marked for no road train or B-double operations in the guideline.

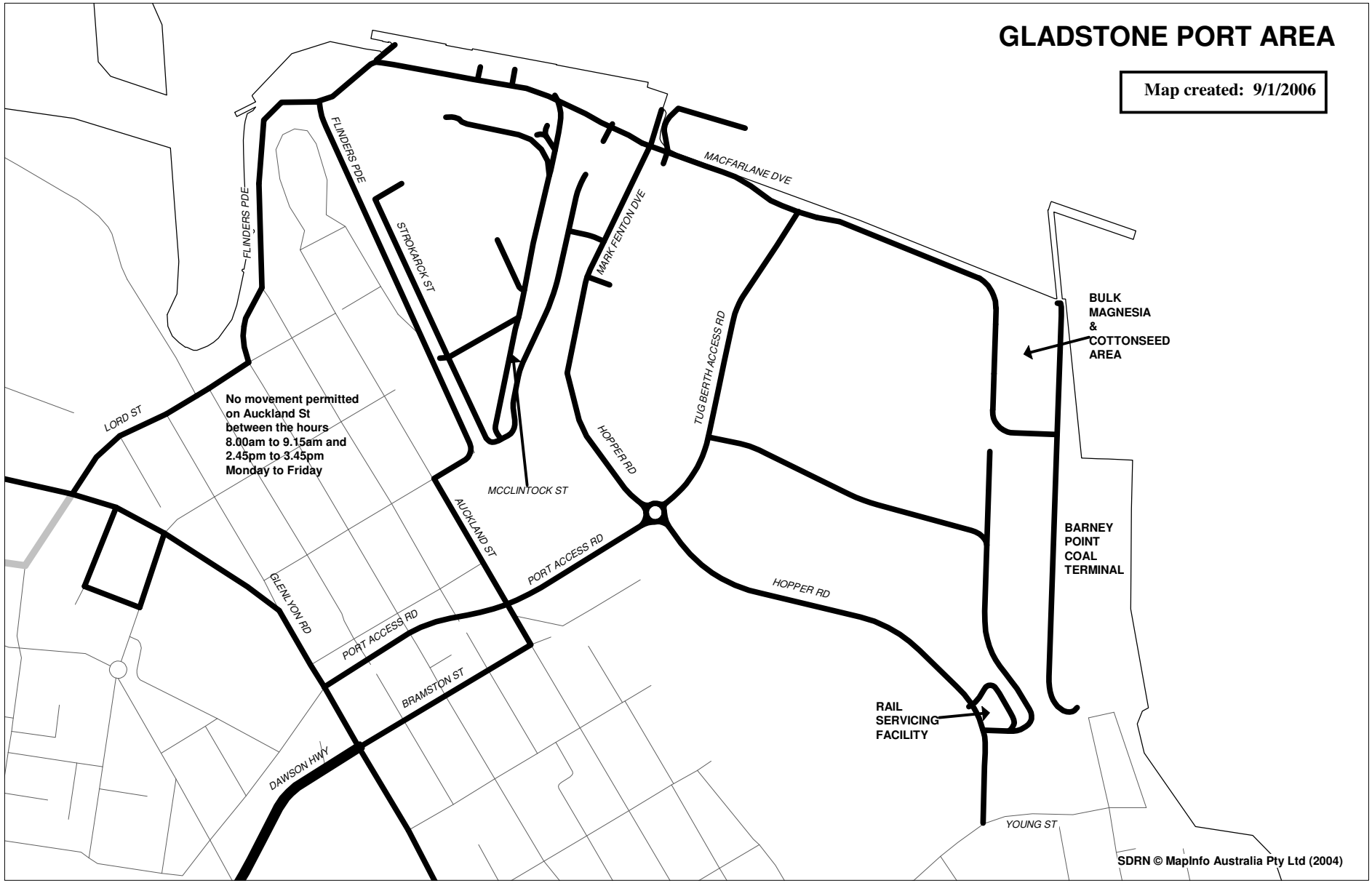
UNSHADED AREA

There is also an unshaded (all white) area where multi-combination vehicles can only operate on marked routes as per the legend above.

Multi-combination vehicles may operate only on approved routes shown.

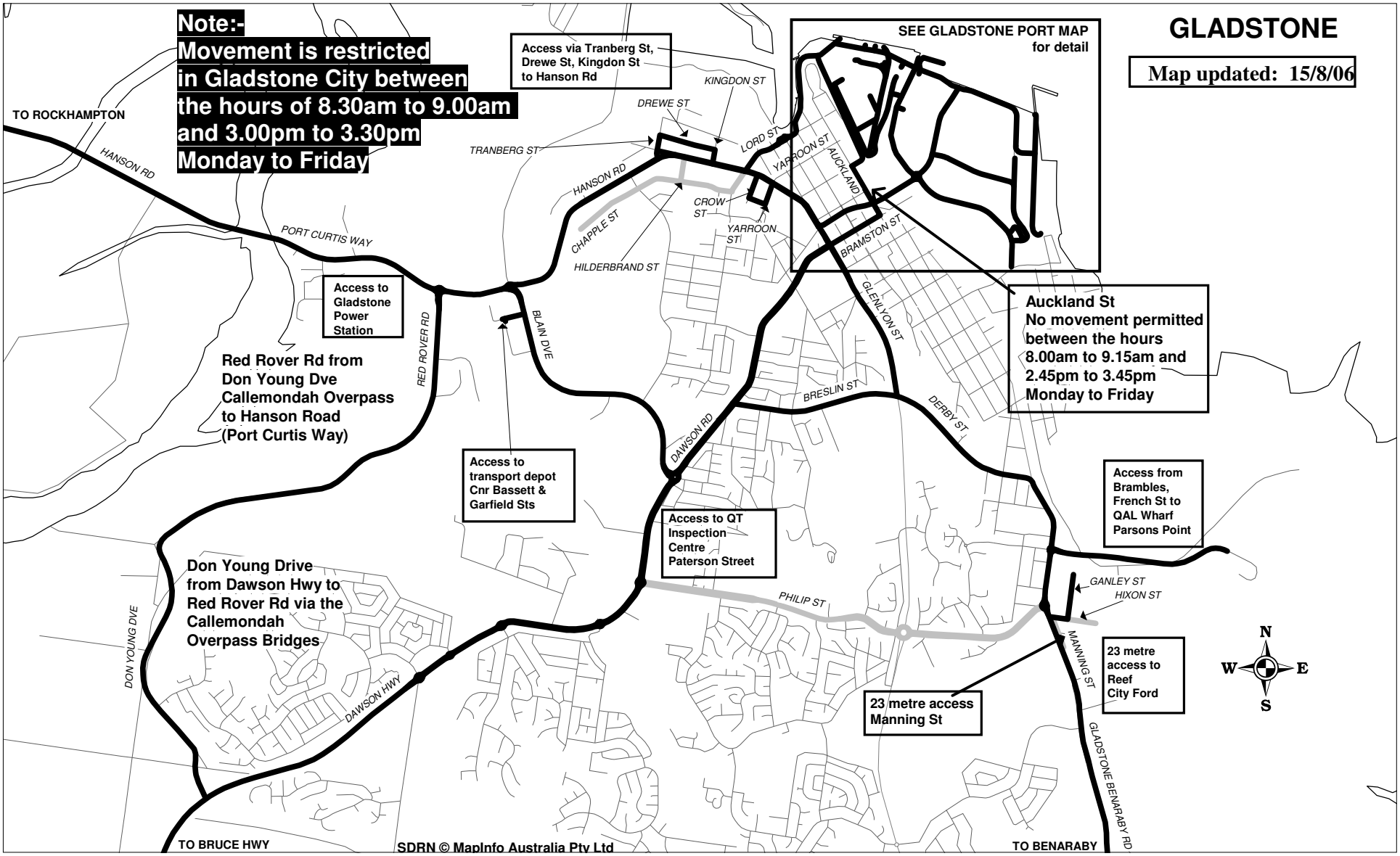
All white area

Queensland Government
Queensland Transport



Refer to Legend for identification of marked routes and shaded areas

Queensland Government
Queensland Transport



Refer to Legend for identification of marked routes and shaded areas

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