Australia Pacific LNG Project

Volume 4: LNG Facility

Chapter 3: Project Description

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3. Project description

3.1 Overview

Australia Pacific LNG proposes to develop a world class coal seam gas (CSG) to liquefied natural gas (LNG) project in Queensland. This includes the development of the Walloons gas fields, the construction of a high pressure gas transmission pipeline from the gas fields to Curtis Island near Gladstone and a LNG facility on Curtis Island. The Project being assessed by this environmental impact statement (EIS) will be spread over 30 years and has been addressed under the following three main components:

- Gas fields
- Gas pipeline
- LNG facility.

This chapter describes the construction, operational and decommissioning phases involved in developing the LNG facility element of the Australia Pacific LNG Project (the Project).

LNG is CSG which has been liquefied through cooling it to -161°C. When cooled to liquid form, the volume of gas is 1/600 of its original size. Liquefaction allows gas to be shipped and stored safely and economically. LNG is odourless, colourless, non-corrosive and non-toxic and does not need to be stored under pressure.

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

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

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

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

Australia Pacific LNG has also allowed for the potential of LPG 'spiking' within the design of the facility, wherein liquefied petroleum gases (LPG) such as propane, are added to the LNG product as it is loaded on the LNG vessels. This is because CSG is primarily methane and does not contain quantities of LPG that result in a slightly higher home heating value (HHV) required for conventional gas uses. In order to meet some customers' and export market specifications, addition of LPG increases the HHV of the LNG product where called for. LPG spiking is not anticipated for all LNG markets but Australia Pacific LNG is prepared to meet market requirements with their LNG facility configuration.

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

Capital dredging required for shipping access to the LNG facility will be provided for by Gladstone Ports Corporation (GPC), as part of the Western Basin Dredging and Disposal Project to enable access for multiple port uses, including the LNG facilities and loading facilities. GPC is currently undertaking an EIS process for this project. Two options for ship access to the proposed project marine infrastructure (referred to as Option 1b and Option 2a) are included in the Western Basin Dredging and Disposal Project EIS. Australia Pacific LNG has a preference for the Option 2a configuration due to ease of manoeuvring, less impact on recreational and commercial vessels and consistency with the near-to-shore marine facilities of the other LNG proponents in the Curtis Island Industry Precinct.

The scope of the Western Basin Dredging and Disposal Project includes capital and maintenance dredging and dredge material disposal requirements for shipping channels, berth pockets and the approach channel to the MOF.

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

The LNG facility described in this chapter receives its feed of CSG from the gasfields via the gas pipeline described in Volume 3. The interface between the gas pipeline and the LNG facility occurs at a pipeline isolation valve that is installed at the end delivery station of the pipeline, where the gas enters the LNG facility at the site on Curtis Island. Specifically, the point of interface is at the flange on the downstream side of the isolation valve. The isolation valve is actuated and acts as an emergency shutdown (ESD) valve if required.

Other infrastructure services (such as power, water, telecommunications, and sewage treatment) will also be established at the LNG facility.

The Project is underpinned by sustainability principles and a risk management approach that apply to all stages of the project life. Australia Pacific LNG will continue to openly engage with the community to ensure that their interests are identified and incorporated into the project planning, design, construction, operations, decommissioning and rehabilitation stages to the greatest degree possible.

3.2 Location

3.2.1 LNG facility location selection

Australia Pacific LNG undertook a site selection study to identify potential site options for the LNG facility. This study was reliant on input from several sources including the Connell Wagner study completed for the Queensland Department of Infrastructure and Planning. The study initially examined potential port sites located on the east Australian coast between Townsville and Brisbane. Early investigations also included sites in New South Wales.

The Australia Pacific LNG study of potential port sites commenced in 2008 and initially reviewed the following locations (refer Figure 3.1):

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

Figure 3.1 Potential LNG facility site locations

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

- Maritime
  - Under keel clearance (available depth adjacent to port area)
  - Metocean conditions
  - Navigability
  - Capital and maintenance dredging requirements and dredged material disposal options
  - Port capacity (where applicable)
- Land access
  - Land availability
  - Native Title impacts
- Environment
  - Marine ecological values
  - Terrestrial ecological values
  - Air quality protection
  - Noise amenity protection
- Land use planning
  - Land use compatibility and buffer land availability
  - Great Barrier Reef Marine Park zoning / issues
  - Community support
- Site suitability
  - Proximity to wharf
  - Geotechnical conditions
  - Civil and structural engineering issues

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

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

A site selection screening study was performed on each of the sites to assess the location suitability for an LNG facility and the associated constructability. Prior consultant reports were initially reviewed

to identify potential site selection criteria. Site specific conceptual layouts were developed to establish site cost criteria to be used in a comparison ranking matrix of the key cost drivers together with site related subjective advantages and disadvantages for an LNG facility. This ranking comparison identified the following as the key cost driver criteria for comparing the potential site locations:

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

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

- Relative proximity to the Australia Pacific LNG gas fields
- An existing natural deep water harbour
- Proximity to the existing heavy industrial base in Gladstone
- The perceived availability of suitable land in the Gladstone State Development Area
- Department of Infrastructure and Planning support for LNG development on Curtis Island.

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

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

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

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

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

3.2.2 Location description

Regional context

The coastal city of Gladstone is located approximately 525km north of Brisbane in Central Queensland. It is situated in a sub-tropical region comprising a flat coastal plain bordered by a range of mountains of up to 630m elevation. The city includes Port Curtis which is a deep-water port with major rail and road connections, and which is supported by the Gladstone State Development Area. The Gladstone Regional Council area had an estimated population of 58,000 persons (June 2008).

Gladstone is an important industrial centre which contains several major industries and industrial activities. These include:

- Cement Australia's cement and lime facility
- Rio Tinto Alcan's alumina refinery
- Orica Australia's chemical plant
- Boyne Smelters Limited's aluminium refinery
- QAL's alumina refinery
- Gladstone Power Station
- GPCs' coal export facilities – RG Tanna terminal, Barney Point terminal and Wiggins Island coal terminal (under construction).

The LNG facility site is located within Port Curtis, approximately 13km north-west of Gladstone City on Curtis Island (refer Figure 3.2).

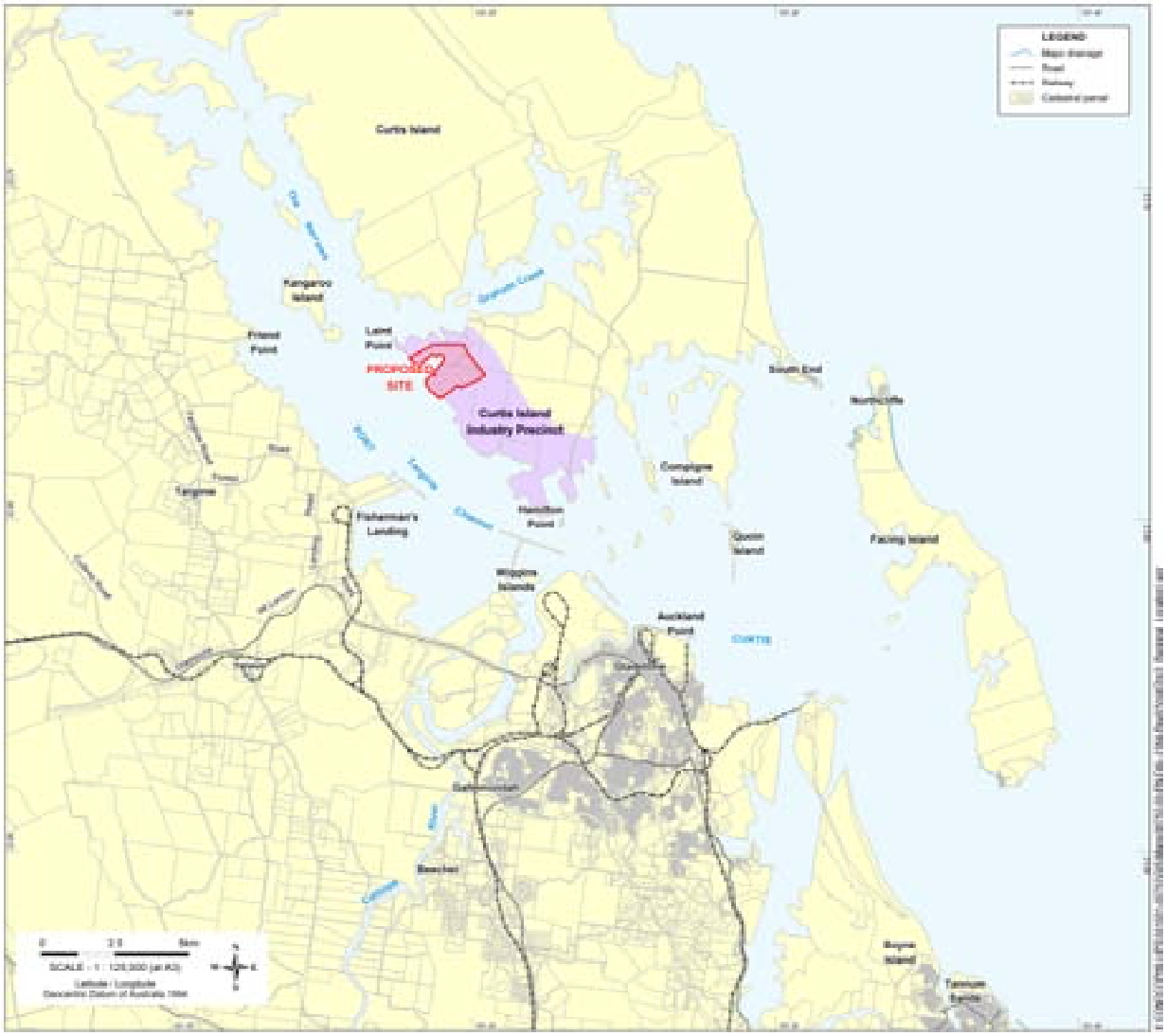

Figure 3.2 LNG facility site regional location

Local context

The LNG facility site will be located near Laird Point within the Curtis Island Industry Precinct of the GSDA and in the adjacent area of Port Curtis, as shown on Figure 3.2. Mainland facilities to support the LNG facility will be located in the Gladstone port area.

The actual extent of land and marine area required for the development will be confirmed by FEED studies. The real property description of the terrestrial LNG facility site is Lot 3 SP225924, in the Gladstone Regional Council Local Authority area. The Department of Infrastructure and Planning has freehold tenure over this land being part of the Curtis Island Industry Precinct of the GSDA. Other proposed developments in this precinct include:

- Santos and Petronas' Gladstone LNG project (GLNG)
- BG Group's Queensland Curtis LNG project (QCLNG)
- Shell's Shell Australia LNG project.

The LNG facility site will have an area of approximately 230.5 hectares (ha) above the highest astronomical tide (HAT) mark. Closure of the esplanade road and interior roads on the property will

add approximately 13.1ha giving a total of 243.6ha. The proposed reclaim areas will add up to 39.4ha to the size of this site. The proposed Australia Pacific LNG seabed lease area to cover the location of the marine facilities has an area of 325.3ha.

The context of the site in relation to features of state environmental significance, existing infrastructure, and location of key vegetation communities are depicted in Figure 3.3.

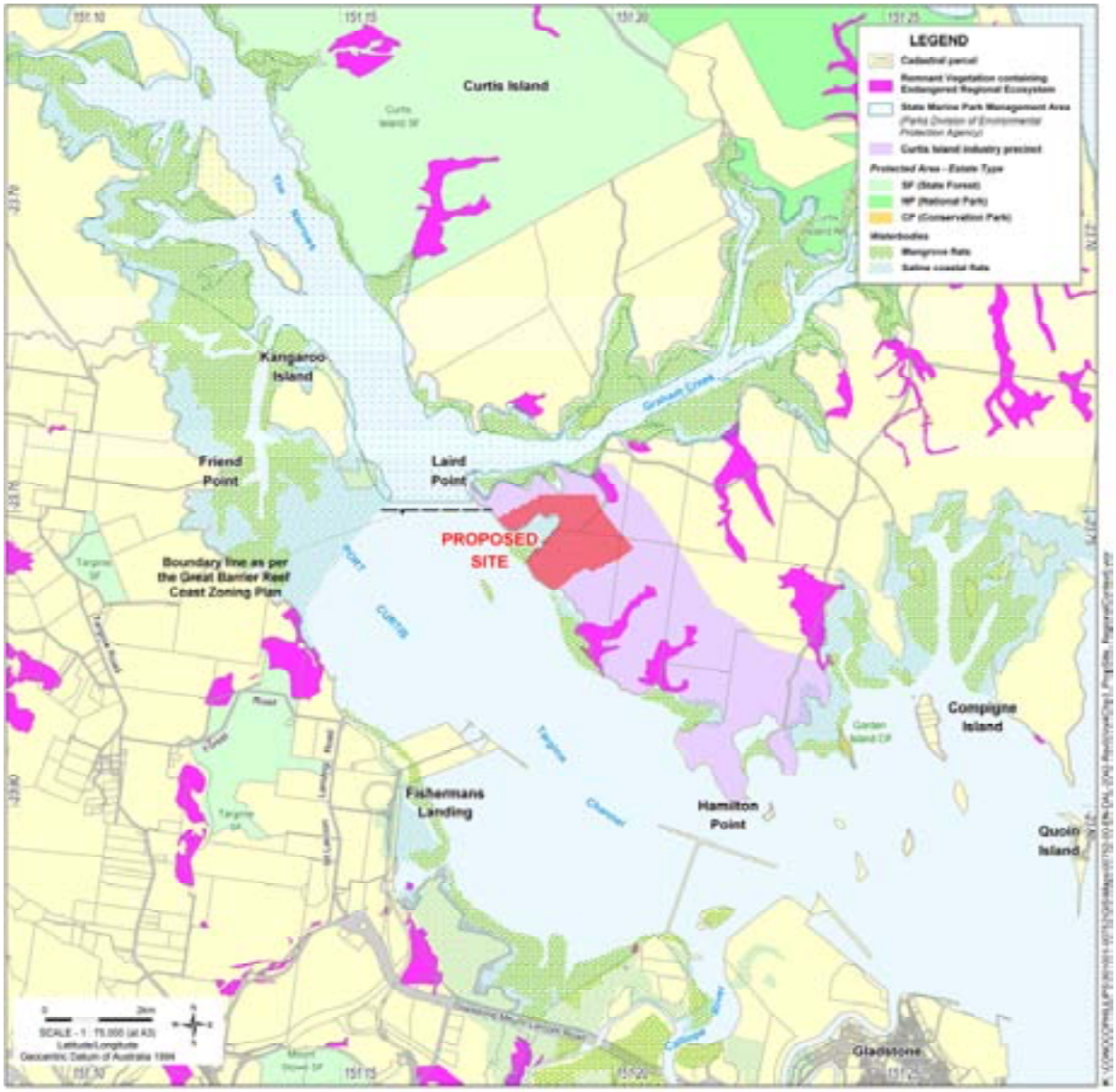

Figure 3.3 LNG facility site environmental setting

3.3 LNG facility key components

It is anticipated that the LNG facility will consist of the following key components:

- Processing facilities (4 x 4.5Mtpa LNG trains for a nominal production of approximately 18Mtpa LNG):
  - Inlet facility (including pig receiving, inlet separator, and metering)

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

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

3.3.1 LNG facility layout and alternatives

The site for the LNG facility will cover approximately 270ha, which includes a reclamation area of approximately 39ha needed for LNG facility infrastructure as shown in Figure 3.4. This figure also shows the seabed lease of approximately 325ha also proposed. The LNG facility footprint covers approximately 156ha of the project site on Curtis Island. The LNG facility layout for the two berth options still under consideration (Option 1b and Option 2a) is depicted on Figure 3.5 and the proposed layout of the facility on Figure 3.6.

An artist impression of one concept of the LNG facility layout with berth Option 2a is depicted in Figure 3.7 and Figure 3.8.

The design of the LNG facility layout has been influenced by the site characteristics, environmental and safety considerations, construction methodologies and operational requirements. A complex number of factors are considered when designing the layout of an LNG facility. Optimisation of the facility design, including layout, will continue during the FEED phase of the Project. Alternatives for optimising the facility layout being considered include:

- Revised location of the LNG storage tanks within the LNG facility footprint
- Modification to the ground flare configuration, including the use of the wet/dry ground flare enclosure for the marine flare, thereby eliminating the separate elevated stack marine flare
- Design changes to the MOF which decrease the size of the reclamation area required
- Revised location of the stormwater retention ponds and construction laydown areas within the LNG facility footprint.

Figure 3.9 and Figure 3.10 show artist's impressions of the LNG facility with these alternatives included in the design. Figure 3.11 shows an alternative reclamation area which is still being considered.

The above alternatives have come about as a result of continued design development and efforts toward optimisation of the facility layout and reducing impacts. Each alternative will result in improvement(s) to the Project, and in most cases will result in a reduction of impacts to those assessed in this EIS. Optimisation and improvements will continue through the FEED phase of the Project.

Revising the LNG product storage tank locations will result in less generation of boil-off gas during the loading operations and reduced construction effort due to the shorter loading line to the loading berths from the storage tanks. The modifications to the ground flare configuration will result in reduced visual amenity impacts as the marine flare will be located within the shielded area of the other ground flares and not be visible from offsite.

Australia Pacific LNG will also revise the location of the stormwater retention ponds and the construction phase laydown areas to optimise the construction effort and result in reduced effort, thus

lowering emissions. Lastly, the revised MOF location will enhance marine accessibility as it will be orientated in a manner more in line with the direction of the marine currents as well as improving safety and navigation of marine access. The alternate configuration of the MOF will result in a smaller footprint and size, resulting in less reclaimed seabed.

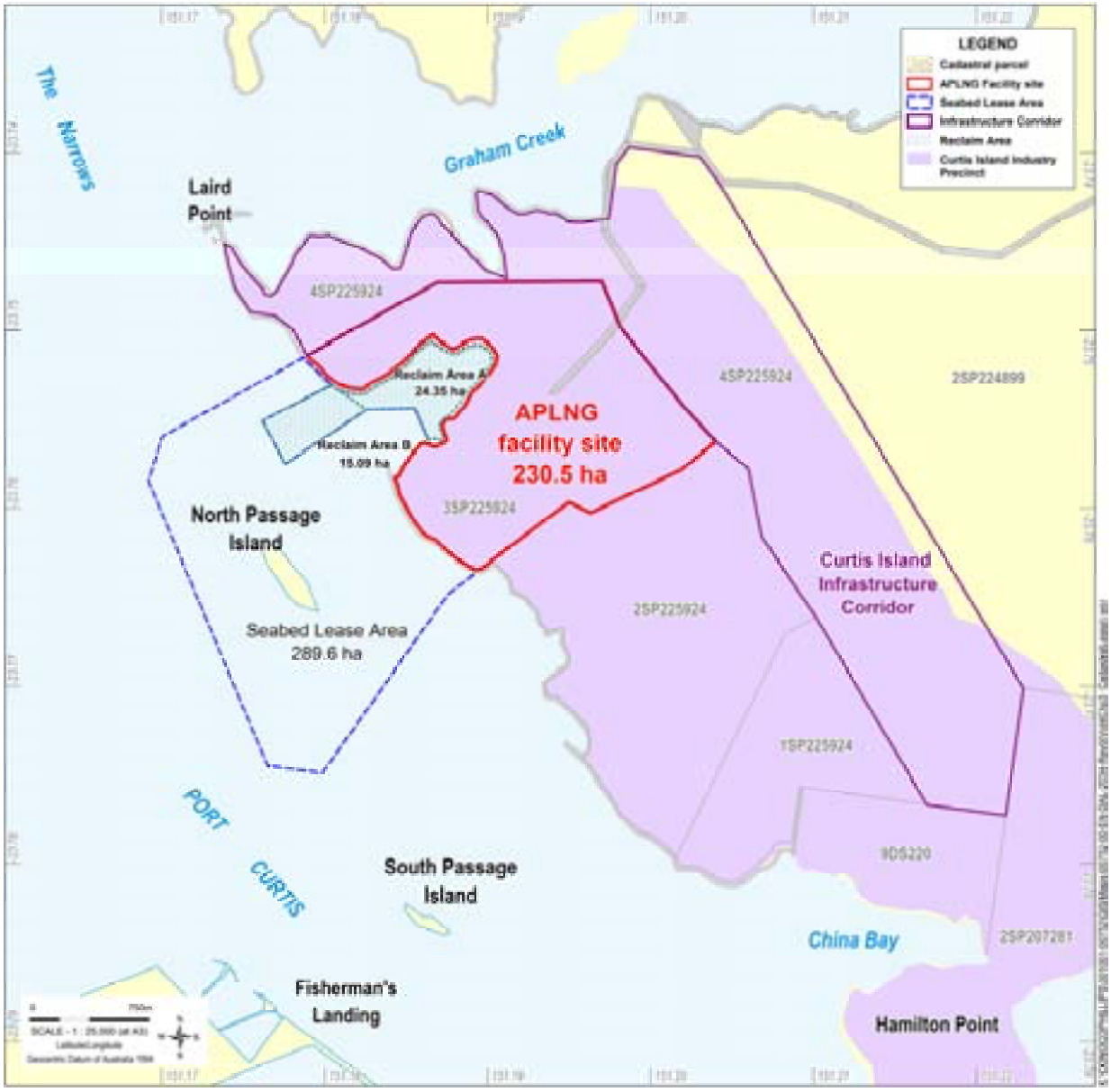

Figure 3.4 Cadastral boundaries and proposed lease areas

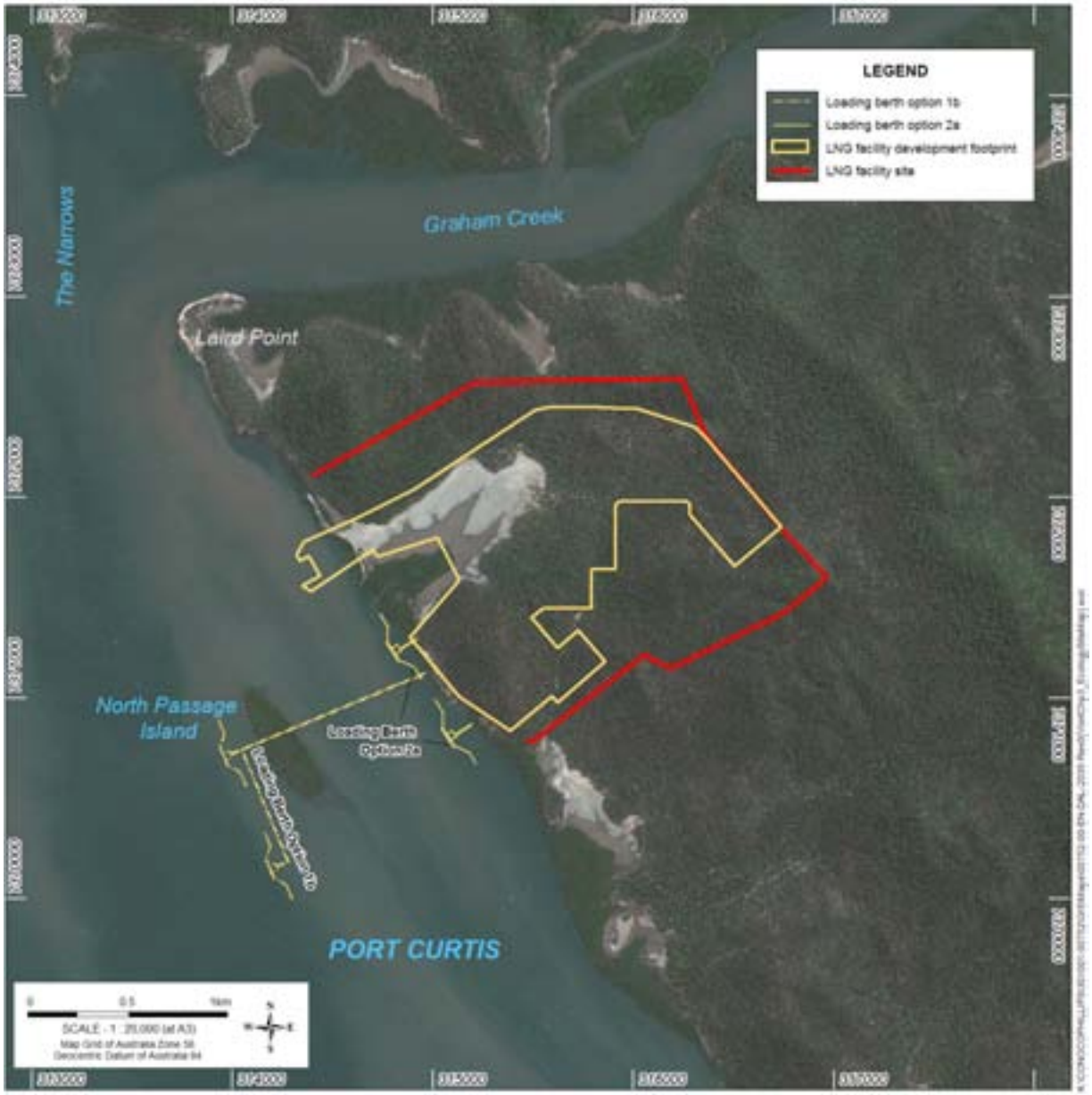

Figure 3.5 LNG facility footprint – berth Options 1b and Option 2a

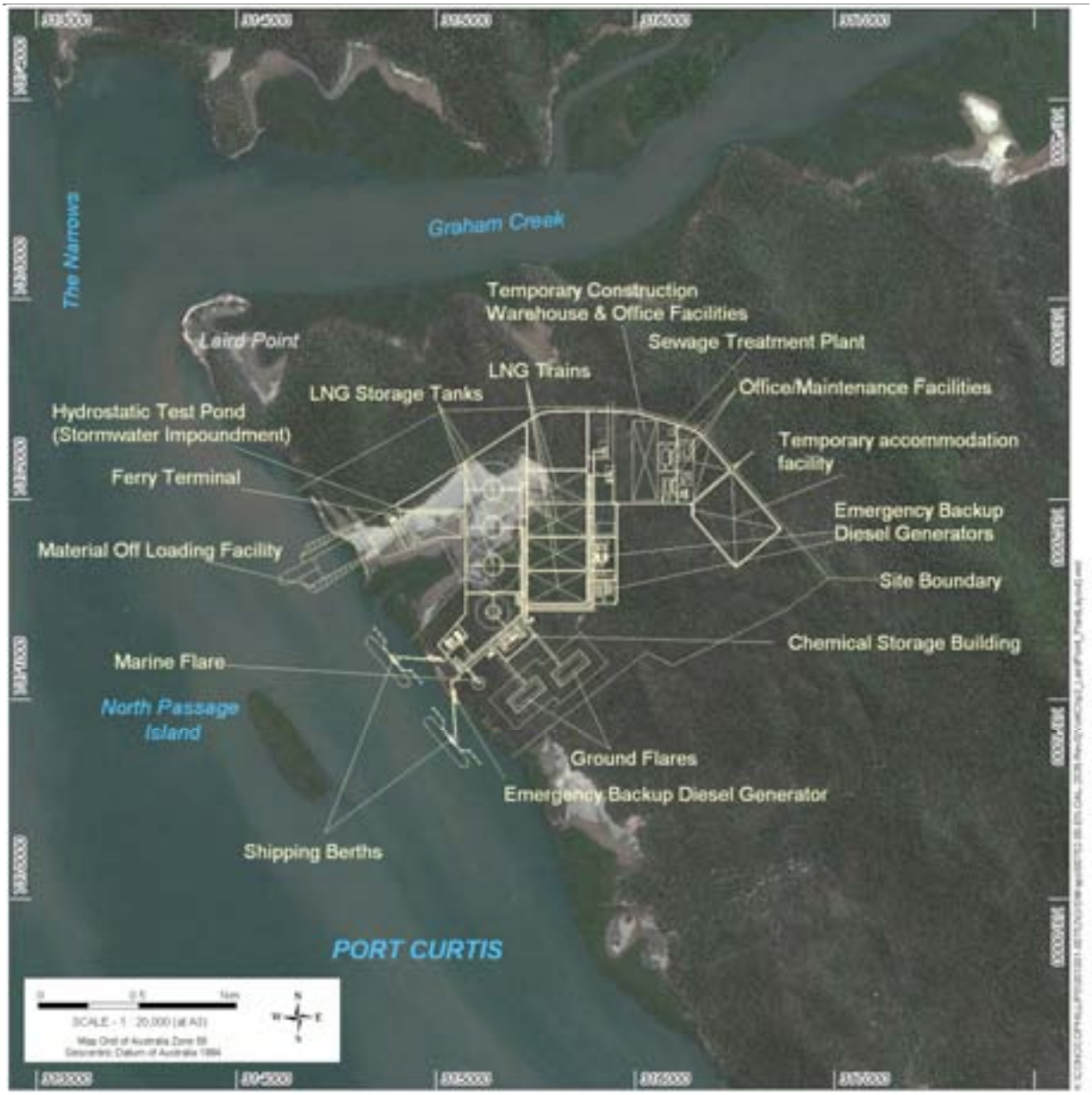

Figure 3.6 LNG facility footprint and indicative layout – berth Option 2a

Figure 3.7 Artist impression of LNG facility – indicative view from south

Figure 3.8 Artist impression of LNG facility – indicative view from east

Figure 3.9 Artist impression of LNG facility alternative – indicative view from south

Figure 3.10 Artist impression of LNG facility alternative – indicative view from east

Figure 3.11 Alternative reclamation area

3.3.2 Marine infrastructure and alternatives

To allow for loading of LNG onto ships and offloading of LPG from ships, the proposed facility includes loading jetty and wharfs. It is expected that a single jetty and wharf will be required for the operation of the first two LNG trains and an additional jetty and wharf will be required subsequently for the operation of the second two LNG trains.

To facilitate the transport of materials, equipment and personnel to the site for construction and operations purposes, a MOF is required. In addition, for construction purposes, a temporary 'rock dock' is required to facilitate early transfer of bulk aggregate and waste.

LNG loading jetty

Alternatives for the general location of the jetty and ship berths have been considered by Australia Pacific LNG. Two options have been considered in detail: Option 1b to the south-west of North Passage Island and adjacent to the proposed GPC Fisherman's Landing Northern Expansion project with shipping access via the Targinie channel, and Option 2a adjacent to the Australia Pacific LNG

Project site between Curtis Island and North Passage Island with shipping access along Curtis Island past other proposed LNG facilities. For each of these options, Australia Pacific LNG has considered a number of options to optimise wharf and jetty location and design based on dredging requirements, trestle loading and length, access for construction, harbour access for commercial and recreational purposes, shipping manoeuvrability and shipping safety.

Two of the options (Option 1b and Option 2a illustrated in Figure 3.12) for the location of the ship berths and associated marine facilities for the LNG facility have been considered in detail. These have been assessed to ensure an optimal solution is implemented through consideration of potential environmental and social impacts, in addition to technical and economic constraints. Included in this assessment are the location of exclusion zones and the cost of infrastructure.

Dredging required for shipping channels, berth pockets and the approach to the MOF for both Option 1b and Option 2a is described in the EIS for the Western Basin Dredging and Disposal Project (GPC 2009). Australia Pacific LNG has a clear preference for the Option 2a configuration due to ease of manoeuvring, less impact on recreational and commercial vessels and consistency with the near to shore marine facilities of the other LNG proponents in the Curtis Island Industry Precinct.

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

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

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

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

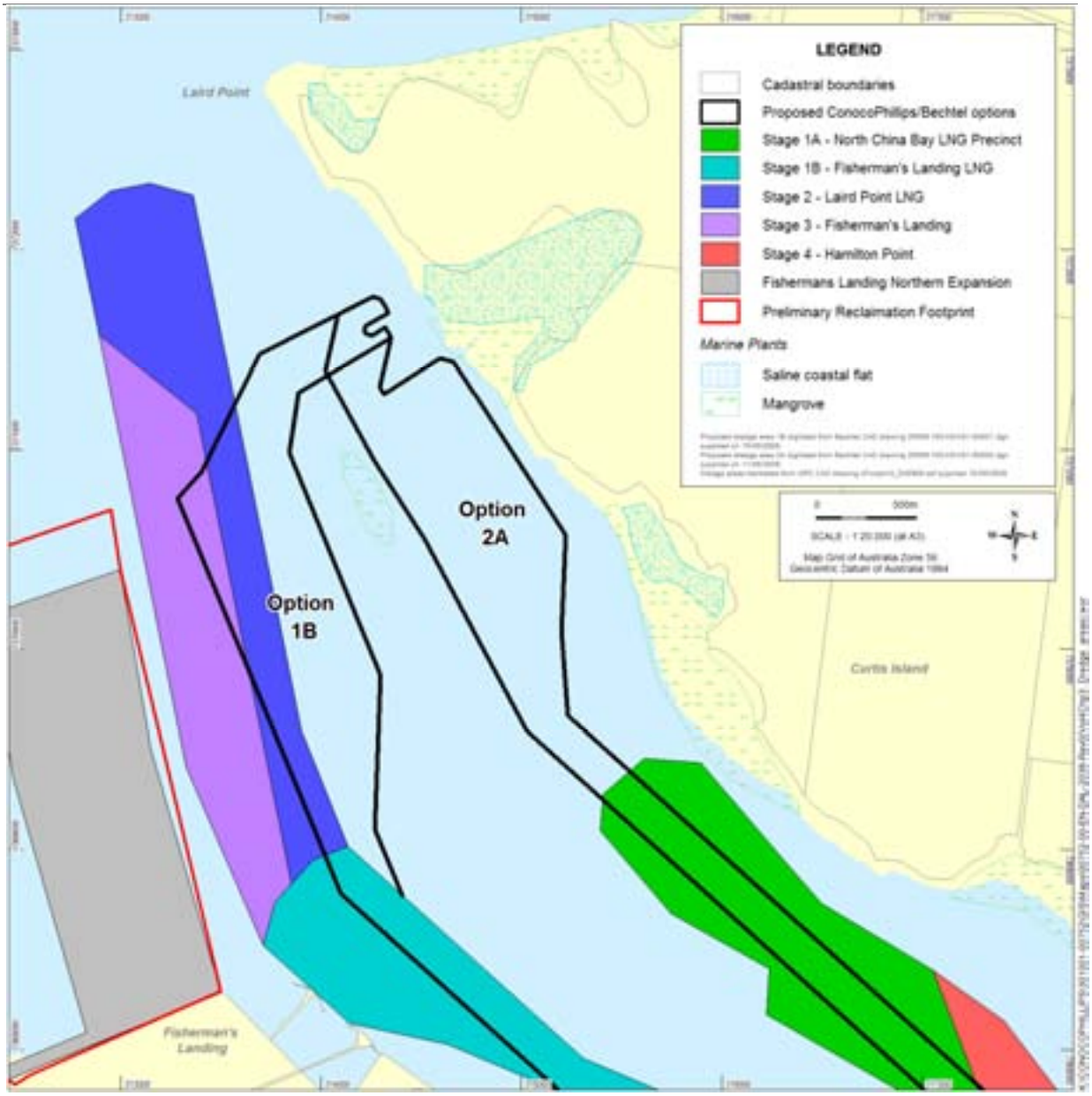

Figure 3.12 Indicative dredge options (GPC, 2009)

Material offloading facility

The MOF will provide for the following functions:

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

The preliminary layout of the MOF is included in Figure 3.13. A temporary 'rock dock' will first be constructed at the MOF location to allow offload of equipment and materials for the construction of the main facility. The MOF will be capable of handling approximately 2,500 tonne loads and crane access. Roll-on/roll-off ramps to unload heavy equipment, modules and materials will be provided for construction of all LNG trains.

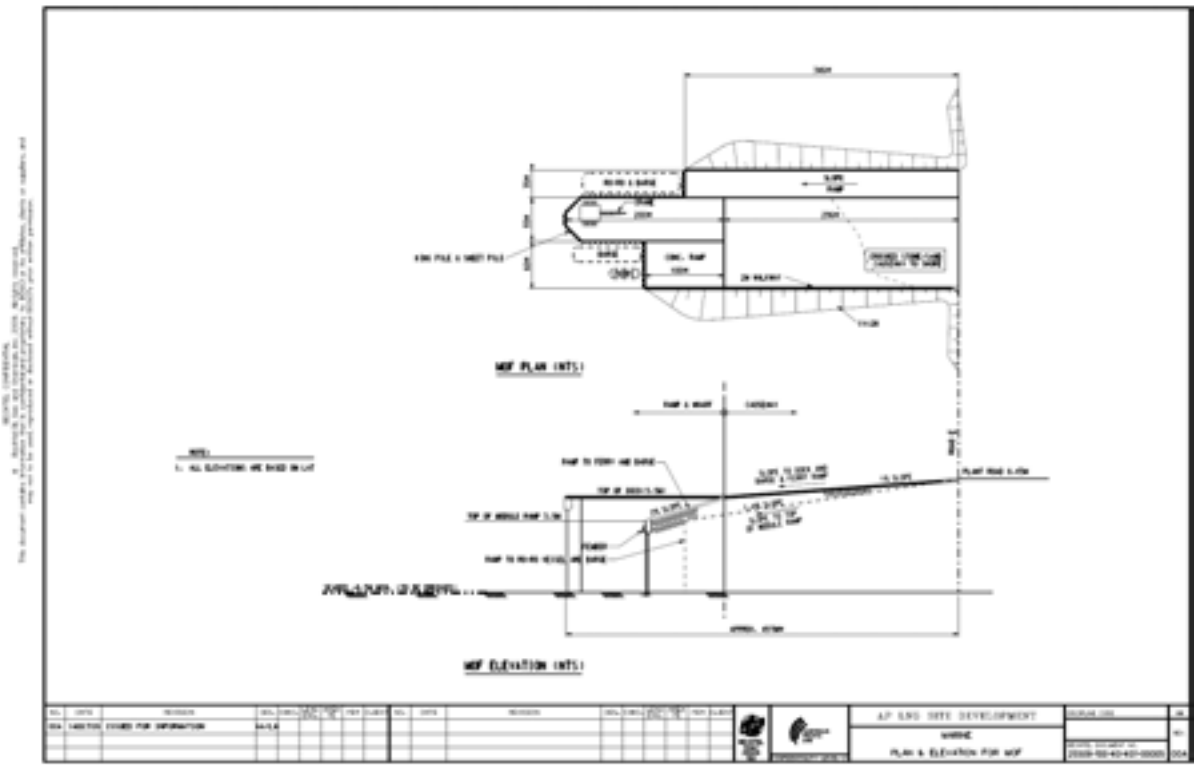

Figure 3.13 Indicative material offloading facility layout

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

This enhances safety and manoeuvrability on modelled approach scenarios. This alternative reduces the required reclamation area for the MOF and results in a smaller footprint for the installation. Figure 3.14 gives an indication of the alternate MOF configuration for use with the Option 2a berthing configuration.

Figure 3.14 Indicative alternative materials offloading facility alternate layout

3.3.3 Construction workforce accommodation and alternatives

Australia Pacific LNG is proposing to accommodate up to 80% of the construction workforce in temporary accommodation facilities (TAFs) with the remainder of the workforce housed within the existing housing market in the Gladstone area. In the first 12 months whilst the TAF is being constructed, it is proposed that the workforce be housed in existing housing and accommodation in the Gladstone area.

To significantly reduce the potential impact from an influx of Australia Pacific LNG construction workers into Gladstone, a temporary accommodation facility is proposed to be located on the project site on Curtis Island. Alternative locations for the temporary accommodation facility have been considered, including locating the facility at a mainland location in or close to Gladstone, and locating the facility at another location on Curtis Island.

Evaluation Criteria

The Curtis Island location has been selected through an evaluation of the two site alternatives (mainland and Curtis Island) based on a set of assessment criteria. These criteria are detailed in Table 3.1.

Table 3.1 Site evaluation criteria

Criteria	Issues to take into consideration
Economic benefits to the local community	Opportunities for local business to provide goods and services to the Project and workforce
Traffic impacts (land based)	Transporting workforce and goods to and from Fisherman's Landing

Criteria	Issues to take into consideration
Harbour traffic impacts	Transporting workforce and goods to and from Curtis Island
Local Government / community perception	Perceptions of the benefits and constraints associated with the location of the TAF
Potential land use conflicts	Compatibility with LNG development and associated infrastructure on Curtis Island and other relevant land users on the mainland
Cost to Project	Costs associated with transport of workforce, and materials and supplies to and from Fisherman's Landing
Project delivery risk	Impacts on schedule and construction efficiencies
Environmental impact	Impacts on flora, fauna, air quality, treatment of sewerage etc
Social and cultural impact	Impact of location on workforce living in the facility and the wider community
Opportunities for shared infrastructure	Opportunities and challenges associated with shared infrastructure such as accommodation and transport infrastructure
Community legacies	Infrastructure and facilities which will remain after construction for the use of the community
Health and safety issues	Risk to human health associated with living in close proximity to a hazardous industry and other risks

Assessment of alternatives

Economic benefit to the local community

Australia Pacific LNG is committed to enhancing the positive contribution of the Project to the local economy. The Project will implement a local content strategy including participation in, or establishment of programs which assist qualified local and regional businesses to tender for provision of goods and services for the Project. Details of the strategy are provided in Volume 4, Chapter 20. Australia Pacific LNG does not anticipate any additional revenues being afforded the local economy if the TAF were to be located on the mainland.

One of the key factors which is expected to reduce the ability of mainland based construction workers to interact with the local economy is working hours. The increased travel time associated with the location of the facility on the mainland would mean that the workforce's day would start between 3am and 4am and finish between 6pm and 7pm. This leaves little time or energy for individuals to access local business and services. Australia Pacific LNG does not believe that perceived benefits to the local economy resulting from the location of the facility on the mainland would be realised. Regardless of location of the TAF, a significant portion of the services required for an Australia Pacific LNG TAF are anticipated to be drawn from the Gladstone economy.

Interaction with the local economy is anticipated to be most prevalent on employees' days off. Workers will be able to access the local economy during this period regardless of whether the TAF is located on the mainland or Curtis Island. Australia Pacific LNG anticipates that a scheduled ferry service would be provided for Curtis Island TAF residents to access the mainland in the evenings, on occasion, and on their days off.

Traffic impacts (land based)

It is anticipated that if the TAF is located on Curtis Island, there will be approximately 16 bus movements per day from the proposed car park facility at Ash Pond 7 to the embarkation site at Fisherman's Landing to cater for local staff. If all workers were to be accommodated on the mainland, it would necessitate an estimated four times more bus movements per day (up to 65 movements) between the mainland TAF and Fisherman's Landing.

Harbour traffic impacts

Australia Pacific LNG acknowledges the important role that recreational and commercial boating and fishing plays for the Gladstone community. In response to this, Australia Pacific LNG and its contractors will develop shipping operations protocols in consultation with regulatory agencies and seek to minimise shipping movements where possible.

For the TAF on Curtis Island, it is estimated that there will be a requirement for approximately 4 ferry movements per day at peak construction periods. If the construction workforce were to be accommodation entirely on the mainland, harbour traffic associated with the Project is expected to increase four to fives times to approximately 20-25 movements per day at peak. This would require extra ferries and additional anchorage infrastructure including a larger area for boarding on the mainland and a larger area for disembarking on Curtis Island.

Although there would be increased transport movement to transfer people, the benefit of a mainland TAF would be that there would not be a need to ferry consumables and waste, required for an Curtis Island TAF. This would reduce barge movements by approximately 20% per day.

Local Government and community concerns

Throughout stakeholder and community consultation undertaken as part of the Australia Pacific LNG's EIS process, a variety of views and concerns were raised by Gladstone Regional Council, state agencies, service providers and residents regarding the location of the TAF. Key concerns raised with respect to locating the TAF on Curtis Island included an expectation of reduced benefit to the local economy and less opportunities for social interaction for the workforce. Alternatively, community and stakeholder concerns have been raised during consultation regarding accommodating the workforce on the mainland included impacts on housing affordability, community safety and local infrastructure.

Potential land use conflicts

Australia Pacific LNG is aware that the State Government presently has a policy which discourages (although does not prohibit) any development within the Gladstone State Development Area (GSDA) and Curtis Island Industry Precinct (CIIP) which has the potential to compromise the purpose of the CIIP land use designation, the GSDA objectives and/or the integrity of the GSDA. Whilst Australia Pacific LNG agrees with the principle of not undertaking development which could potentially sterilise parts of the site for industry development, it is strongly believed that temporary accommodation can be incorporated within the boundary of the Project site or elsewhere on Curtis Island without compromising the integrity of the Australia Pacific LNG Project site or other projects on Curtis Island currently planned or in the future.

To help ensure that the Curtis Island community of South End is not detrimentally affected by project activities, none of the Project LNG facility workforce will be housed either permanently or temporarily at the South End settlement. The existing farm tracks that connect the site to South End will not be utilised by the Project.

Cost to Project

In order to facilitate the development of the CSG-LNG industry, costs need to be managed so that Australian projects can be competitive on the world stage, and in particular within the Asia-Pacific market.

Analysis of the costs associated with the development of a TAF has been undertaken by Australia Pacific LNG in consultation with the preferred construction contractor. This analysis indicates that with a TAF located on the mainland, the Project would cost an estimated A$180 million more in capital costs. Whilst the cost of the construction and operation of the mainland TAF itself would be somewhat lower, significant additional costs are expected to arise from the additional infrastructure associated with transporting up to 1,800 additional workers from the mainland to Curtis Island daily (ferries, buses, wharves etc). In addition to these increased capital costs, it is expected that additional costs will be incurred through a predicted and assured loss of productivity associated with an increased return travel time from 20 minutes (with an island-based TAF) to up to 3 hours per day with a mainland-based TAF. This travel time impact has the potential to significantly impact Project costs, project delivery, the attraction of workers and workforce health and safety.

Project delivery risk

The ability to complete the first trains within the designated schedule and supply markets (customers) with whom the Project has sales agreements is one of the key drivers for the Project schedule.

Risks to Project schedule, and therefore delivery, relate to workforce recruitment, schedule of availability of the TAF and economic cost. Previous experience has shown that to attract and retain non-local construction workers, projects need to provide a fully self-contained and catered accommodation facility close to the project work site. Therefore the feasibility of constructing a project without a TAF in close proximity to the site is greatly reduced on this basis as it will be very difficult to “market” a project to non-local employees that requires extensive daily travel. Given that the remuneration on the Australia Pacific LNG Project does not differ markedly from other major projects where a 10-15 minute bus/car ride is the full extent of the daily travel requirements, the lure for employees to work on the Project will be diminished if a mainland TAF is proposed which may require up to three hours of travel time daily in addition to the workforce’s shift hours.

The use of a mainland TAF will make employment conditions less attractive in the context of a nationally competitive environment for skilled workers. The significant increase in travel time and resulting impacts due to fatigue has health and safety implications. The reduction in recreation and recuperation time associated with a mainland TAF would harm the Project’s attraction and retention strategy, thereby impacting directly on delivery risk. Given the anticipated extremely tight local labour market within Gladstone, construction of the Australia Pacific LNG Project will largely be dependent on the attraction of a FIFO/DIDO non-local workforce. To ensure the Project is able to go ahead, all measures available to attract workers with the skills and experience necessary will need to be put in place.

Productivity impacts associated with the length of shifts and morale of workers is a potential risk to Project delivery. For a TAF located on Curtis Island, the workforce will be housed within a 10 minute bus trip to the work site, thus ensuring sufficient time for rest and recreation. The mainland TAF alternative however, would require up to 170 minutes of travel time, in addition to a 10 hour working day which could significantly impact productivity levels due to increased fatigue. Productivity on the Project would also be impacted as a result of insufficient rest and it is highly likely that absenteeism levels would increase and general morale would be negatively impacted.

Environmental Impact

Australia Pacific LNG is committed to minimising adverse environmental impacts, enhancing benefits associated with our activities, products or services; maintaining, and enhancing where the opportunity exists, biodiversity values. As a suitable mainland site has yet to be identified, detailed environment studies have not been undertaken to determine the potential environmental impact. It is possible however to identify the key environment issues that may differentiate between TAFs on the mainland compared with Curtis Island.

- **Air Quality:** the location of the TAF on the mainland is expected to lead to significantly more bus and ferry movements. Whilst the impact of this on air quality hasn't been quantified, it is expected that it could be considerable over the construction period.
- **Vegetation loss:** The removal of vegetation on Curtis Island has been assessed as part of the Australia Pacific LNG Project EIS. The proposed construction TAF will be contained wholly within the LNG Project site and will require the clearing of 12 ha least concern and 3 ha of concern regional ecosystem. The total area of the TAF is estimated to be approximately 15ha.

  Although some land has been proposed by Gladstone Regional Council and other proponents for the development of TAFs, the sensitivity of these land areas and other areas which may be required to accommodate the workforce on the mainland is unknown.
- **Marine impacts:** Potential impacts on marine ecology associated with the Curtis Island location including boat strike is discussed in Volume 4 Chapter 10. If the TAF is located on the mainland, there is anticipated to be a considerably greater number of boat movements (increasing from 4-20) which may result in a greater probability of boat strike.
- **Water Resources:** The estimated total volume of sewage generated during the construction period is 412,700kL, with a maximum daily volume of 550kL. An outline of the proposed management of water resources and sewerage is provided in Section 3.6.3 and Section 3.6.5 of this chapter. A mainland TAF with on-site treatment will discharge water of a similar quality as with an island-based TAF. Alternatively, wastes from a mainland TAF may be directed to the existing Gladstone Regional Council sewage system, which may have an impact on this infrastructure.

Social and Cultural Impact

It is Australia Pacific LNG's intention to become an integral and valued community member by upholding, and adding value to, existing community values and lifestyle conditions. A central component of Australia Pacific LNG's social impact management plan and policies is the management of social impacts associated with the expected large non-local workforce. These impacts range from behavioural impacts to sustainable demand on community services and facilities.

Stakeholder engagement for the EIS has found that there is a concern that segments of the construction workforce may display anti-social behaviour which could impact on community values and lifestyle. To mitigate against this potential impact, Australia Pacific LNG will manage its employees and contractors through the Australia Pacific LNG Project Rules and specific Project Code of Behaviour to ensure high standards of behaviour that extend beyond the TAF and into the general community.

The location of the TAF on Curtis Island enables better management of social impacts associated with the non-local workforce through mechanisms including:

- the access to and consumption of alcohol will be controlled through the wet mess within the TAF confines

- controlled access to the facility - access of unwanted guests will also be easier to monitor and "casual" drive in type visitors will be unable to access the TAF.

These mechanisms are anticipated to reduce impacts on the local community through decreased incidence of anti-social behaviour.

Opportunities for shared infrastructure

The possibility of combining or co-locating TAFs for all the LNG projects on Curtis Island is possible from Australia Pacific LNG's perspective. Opportunities to consolidate the TAFs in one location enhance the management of the workforce and potentially allow for economies of scale in regard to waste management, operating cost and the cumulative size of the TAF.

The sharing or collocation of TAFs has a number of challenges and opportunities. Key factors regarding the sharing or collocation of facilities which need to be taken into consideration include:

- **Industrial risks:** shared infrastructure, whether on the mainland or on Curtis Island, would introduce industrial risks between the different project workforces and would require agreement between the different project proponents with regard to impact on differing project schedules, revised location and transport networks; as well as on the design, construction and management of a shared TAF and services. However, a combined TAF removes the risks associated with differing TAF conditions between the projects.
- **Workforce health:** the location of all project workforces poses challenges in relation to the containment of any sickness which might impact the facility. If all workforces are co-located, this has the potential to impact multiple projects, rather than individual projects.
- **Efficiencies:** there are opportunities to achieve efficiencies with respect to sharing pre-employment processing facilities between the three major LNG projects as well as management, cost and transport efficiencies associated with a common site or facility.

Community Legacies

Australia Pacific LNG is aiming to ensure that it leaves a positive legacy for the Gladstone community through a range of strategies. These strategies are proposed to be implemented regardless of the location of the TAF. Further details of proposed strategies are outlined in the Social Impact Assessment in Volume 4, Chapter 20.

Locating the TAF on Curtis Island is also anticipated to reduce the likelihood of negative community legacies as air quality and traffic impacts associated with significantly increased road and marine movements required to transport the workforce from Gladstone to Curtis Island.

Health and Safety

Workforce health and safety is Australia Pacific LNG's first priority. The potential health and safety issues are as follows:

- **Hazard risk to a construction workforce in accommodation in the broad vicinity of a commissioning or operational LNG plant**

  Australia Pacific LNG has undertaken preliminary quantitative risk assessments of the LNG Plant and its operations. The conclusions of the hazard and risk assessment (Volume 4, Chapter 22) include the finding that the TAF will be located outside the risk contours applicable for residential land use as well as outside the more stringent hospitals and other sensitive developments land use contours. The noise and vibration assessments (Volume 4 Chapter 15)

indicate that potential impacts of the facility to the TAF residents are expected to be of low significance.

The TAF would be occupied while the plant is operational as the construction of further trains will occur after the initial trains are commissioned. The TAF has been located a sufficient distance from the plant such that it is outside any harmful heat radiation or overpressure zones. The LNG industry has demonstrated in many locations throughout the world that siting of TAFs adjacent to work sites can be successfully implemented while preserving a safe work environment and a low cost residential structure.

- **Transportation of large workforces daily from the mainland to Curtis Island**

  Australia Pacific LNG and its preferred construction contractor's concern for the safety of such a large workforce travelling daily from mainland to Curtis Island is a major contributing factor in support of the construction of a Curtis Island TAF. The cumulative effect of moving thousands of workers on a daily basis significantly raises the risk profile of the Project.

  Furthermore, risks inherent in the constant movement of employees by ferry associated with the location of a TAF on the mainland mean an increased prospect of injuries from accidents to both workers and users of the harbour. These risks arise from the general movement of vessels in the Harbour and from embarkation and disembarkation and berthing (particularly if there are multiple projects).

  In addition, the additional fatigue and physical stress caused by the combination of working hours and bus and ferry travel presents the Project with an unacceptably high safety risk. Employees on the Project will work in physically demanding occupations performing safety-critical work. If they are fatigued, they will have an increased potential to cause injury to themselves and others.

- **Community Safety**

  The good behaviour of Australia Pacific LNG employees and contractors who reside at the TAF at Curtis Island (during the construction phase) or in Gladstone will be a key component of mitigating potential impacts to community health and safety. The two components of this are workforce culture and workforce health promotion programs.

  Creating a culture of good behaviour, responsibility for actions and integration with the existing community to ensure harmony and minimal disturbance will be partly achieved by the design and construction of a high quality temporary accommodation facility. The TAF will be regarded as within the top quartile of facilities within Australia and will have a diverse array of recreation activities. As well as a high quality temporary accommodation facility, Australia Pacific LNG will enforce Project Rules and a TAF Code of Behaviour to ensure high standards of behaviour that extend beyond the TAF and into the general community. The Australia Pacific Project Rules and TAF Code of Behaviour would be discussed during Project inductions and would extend to contractors.

Summary

The key drivers for locating a TAF on Curtis Island include:

- Health and safety of the workforce through reduced travel time and reduced risk of transport related accidents

- Reduced risk to Project delivery associated with Project costs and attraction and retention of non-local workers
- Greater ability to manage social behaviour
- Reduced impacts on local infrastructure and facilities.

3.3.4 Mainland facilities and alternatives

The facilities on the mainland will be established to provide for barge and ferry transport of materials and personnel as well as mainland material staging and stockpiling, labour sourcing, training and mainland buildings including offices and warehousing. The mainland facilities approvals may be sought outside of the scope of this Project by Australian Pacific LNG or by others.

The mainland ferry terminal will accommodate personnel and roll-on/roll-off barges as well as facilities for loading barges with civil materials such as sand, gravel, and rock. Mainland facilities will also afford space for car parking and overnight bus and truck parking. Different facilities may be used initially for construction than what is ultimately used during operations.

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

- Storage and barge loading of gravel, rock, sand and other aggregates from the existing Fisherman's Landing between the existing Rio Tinto Alcan and Cement Australia conveyors (Figure 3.15)
- Transport of construction personnel and other materials from the proposed Fisherman's Landing North Expansion (GPC Fisherman's Landing Northern Expansion Project currently being assessed through an EIS process) to Curtis Island
- Vacant land off Blain Drive in West Gladstone (commonly referred to as Ash Pond 7) for car parking facilities during construction, with personnel being transported by bus to the ferry location on Fisherman's Landing Northern Expansion. Buses and trucks would be staged overnight on the Ash Pond 7 areas
- A permanent operations phase ferry terminal with car parking located on the proposed Fisherman's Landing North Expansion.

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

Alternative mainland locations also under consideration include:

- Port Central, adjacent to Auckland Point and Barney Point, for all storage and transport facilities
- A location on the Calliope River adjacent to the RJ Tanna Coal terminal (Figure 3.16).

Figure 3.15 and Figure 3.16 show early estimate sizes and locations for mainland facilities. Australia Pacific LNG will continue to evaluate the alternative locations in consideration of potential environmental and social impacts. The primary risks with the Calliope River alternative are associated with dredging that would be required in the Calliope River mouth.

Figure 3.15 Mainland terminal alternative at Fisherman's Landing

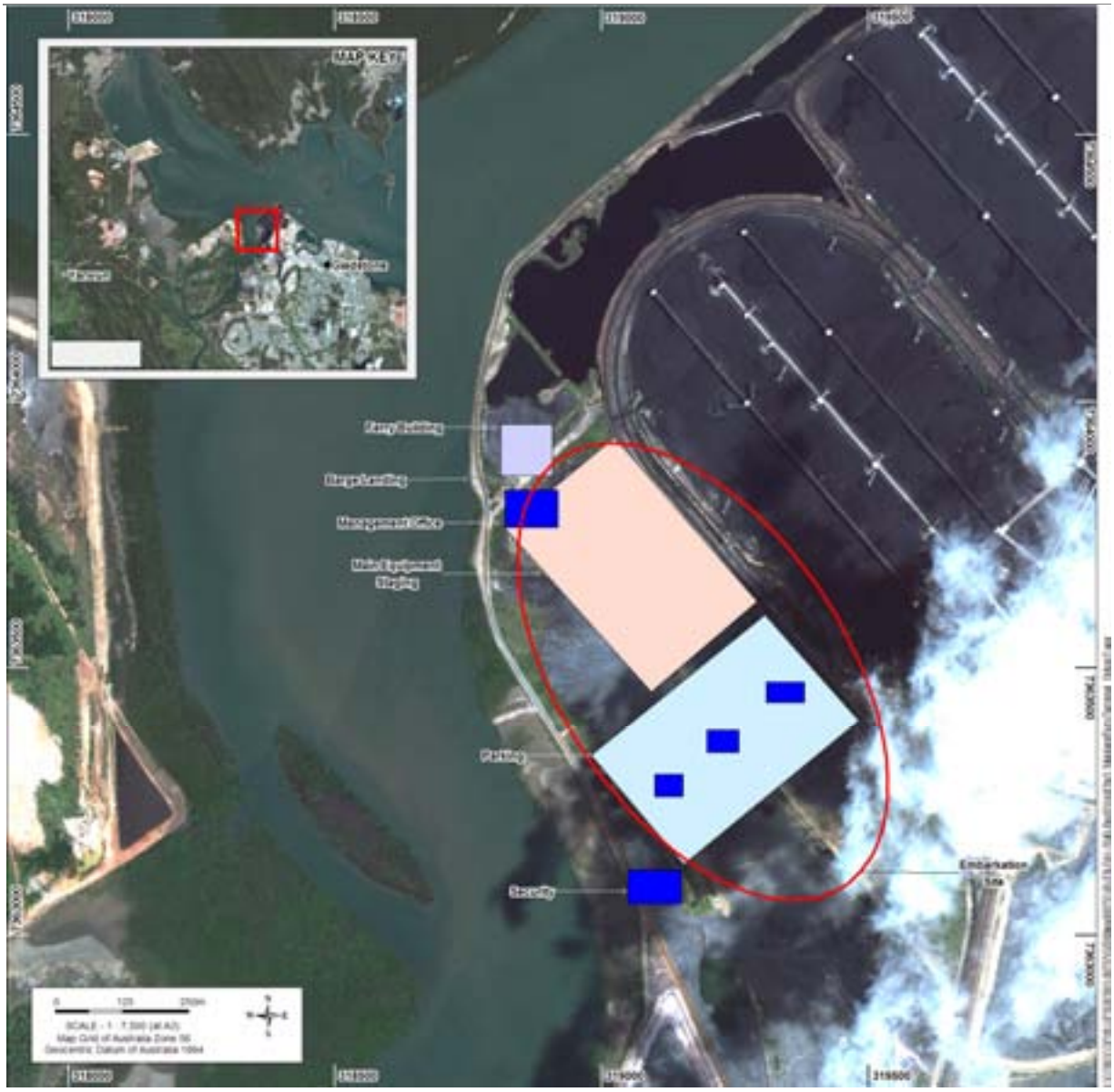

Figure 3.16 Mainland terminal alternative on the Calliope River

3.3.5 Government infrastructure

Australia Pacific LNG will work closely with government agencies and service providers to facilitate the provision of infrastructure and services described in this section that are not within the scope of the Project, but are crucial to its delivery.

Mainland facilities

Construction and operation of the mainland facilities on Fisherman's Landing will be dependent on the GPC-proposed Fisherman's Landing Northern Expansion Project which is currently in the process of gaining the necessary environmental approvals to undertake these works (GPC, 2009a[1]). The GPC project proposes reclamation of an additional 153ha adjacent to the existing port facility. The

[1] www.dip.qld.gov.au/projects/transport/harbours-and-ports/fishermans-landing-port-expansion.html

reclamation will provide additional land to support the future construction of six wharves and for the development of associated transport, storage, loading and unloading facilities. The reclamation will also provide for the containment of dredge material from various future maintenance and capital dredging programs in the port, including the Western Basin Dredging and Disposal Project described below.

The mainland facilities will also need connection to power and water supplies and telecommunications from existing suppliers.

Ship access

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

The Western Basin Dredging and Disposal Project comprises dredging associated with the deepening and widening of existing channels and swing basins and the creation of new channels, swing basins, berth pockets and approaches for MOFs. It is proposed that dredged material be placed into reclamation areas for the Fisherman's Landing Northern Expansion.

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

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

Shipping safety

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

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

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

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

It is expected that the Vessel Transit Plan will cover the following topics:

- Permission to enter the harbour procedures. These procedures will relate to berth availability, metocean and shipping traffic constraints and other MSQ and GPC pre-specified requirements
- Pilot boarding and disembarkation procedures. These procedures will require compliance with current Safety of Life at Sea (SOLAS) regulations with regard to equipment, and GPC's shipping and pilotage regulations
- Acceptable wind and sea state conditions for arrivals and departures
- Ship ballast draft conditions prior to entering the Harbour
- Tug configuration requirements will be determined in conjunction with MSQ and GPC. It is expected one tug will escort the LNG vessel through the outer harbour, with a second tug escort in the inner channel, and a third and fourth tug awaiting at the in the vicinity of Buoy G4 for final transit and berthing
- Transiting instructions and speed limits. It is intended that LNG shipping will have 24 hour access to the Port
- Required improvements to the existing navigational aid system in the Port
- Arrival and departure conditions for vessels and minimum vessel requirements
- Generalised vessel movement scheduling and traffic separation requirements
- Tug failure guidelines
- Heavy weather and cyclone evacuation protocols.

3.4 Construction

3.4.1 Construction management

The engineering, procurement and construction contractor will be responsible for the construction of the LNG facility and ancillary infrastructure. The contractor's site manager will report directly to the Australia Pacific LNG project manager. The contractor's site construction manager will have overall responsibility for the construction of the entire facility. The core construction execution team will comprise the managers for health, safety and environment, project controls, government relations, security, field engineering, field supervision, contract administration, commercial services, human relations and industrial relations.

Construction activities will be undertaken in accordance with Australian standards, as required.

First aid and medical facilities will be available on the site. A health, safety and environment (HSE) management plan and an emergency response plan will be implemented, including provision of training for all personnel. Mitigation measures to avoid and/or minimise environmental impacts as described within this EIS will be incorporated into this construction HSE management plan.

3.4.2 Construction schedule

The LNG facility is to be developed in stages. Construction of train 1 of the LNG plant and associated marine facilities is proposed to commence in 2011. Construction of train 2 will commence approximately nine months after the commencement of train 1 to take advantage of the workforce and construction equipment already mobilised on the Project. Each train takes about four years to

construct hence the first two trains are expected to be operating after approximately four years and nine months.

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

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

Dredging required for MOF construction will commence in 2011 with major capital dredging works (included in Western Basin Dredging and Disposal Project) closely followed. MOF construction will commence soon after completion of the dredging (anticipated during 2011) and will be completed in approximately six months. Construction of the ship berths will take approximately 18 months.

3.4.3 Onshore construction

Onshore construction will include the following main activities:

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

It is estimated approximately 93,000m^3 of concrete will be required for major foundations for the onshore LNG facility. Estimated total pipework for four LNG trains is 225,000 linear metres. Other materials and equipment required for construction of the facility include processing equipment including modularised equipment, heat exchangers, gas turbines, gas compressors, power generators, steel for onsite construction of the LNG storage tanks, LPG storage tank (if required), flares, pipe racks, insulation, building materials (including for the TAF) and package utility plants such as the water treatment plant.

Water is required for site preparation, including dust control, concrete works and for hydrotesting storage tanks, other equipment and piping. A supply of potable water to service the construction workers onsite and the TAF is also required. Stormwater that falls within the development footprint will be captured in impounding ponds and be used for dust control, firewater and for hydrotest purposes. This water source will be supplemented by a seawater desalination plant.

Concrete is likely to be sourced from within Australia. Equipment will be sourced from Australia and overseas. Large equipment will be transported to the site by barge or charter ship. The LNG loading facility requires piles, access trestles, pipework, loading platforms and loading arms. These materials and equipment are likely to be sourced from Australia and overseas.

Bulk products such as coarse aggregate as required, sand, cement and diesel will be transported to the site on barges from the mainland facilities.

During construction, a temporary package treatment plant will be used to treat sewage effluent to appropriate standards. Treated sewage effluent will be used for onsite irrigation and/or discharged to Port Curtis.

3.4.4 Coastal/marine construction

Offshore construction will include the construction of the following components:

- Temporary 'rock dock'
- MOF construction, including ferry terminal (minor dredging works in preparation for construction)
- Jetty and trestle construction (including loading platforms, mooring dolphins and catwalks)
- Access channel, swing basin and berth pocket dredging (undertaken by GPC).

Material offloading facility construction

The preliminary layout of the MOF is included in Figure 3.13. As the LNG facility site has no external road access, crews will initially install sea access to site to enable site preparation to commence. A rock dock will first be constructed at the MOF location to allow offload of equipment and materials for the construction of the main facility. One permanent dock capable of approximately 2,500 tonne loads and crane access with roll-on/roll-off ramps to unload heavy equipment, modules and materials will be provided for all LNG trains. The MOF will be designed and constructed with appropriate controls for Australian Quarantine and Inspection Service (AQIS) and customs. The following outlines a typical construction methodology for the MOF.

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

The upper surface of the causeway may be finished with concrete stabilised crushed rock, to provide a cambered paving surface for the movement of heavy cargo. Concrete pours will all be made from land approaches as the causeway will be completed prior to the commencement of concrete pours.

Temporary concrete batching facilities may be required if the site batching facility is not commissioned and operating during MOF construction. Estimated quantities of materials for the MOF assuming a length of 150m from the mainland are provided in Table 3.2.

Table 3.2 Estimated quantities for materials offloading facility

Item	Description	Quantity
1	Rock fill materials (assuming provided from site excavation)	250,000m^3
2	Causeway shore protection	3,500m^2
3	Cement stabilised road base (300mm thick) 15% cement	21,000m^2
4	Steel sheet piles (barge driven)	12,000
5	Steel sheet pile whaler beams and tie-backs	150t
6	Concrete – for paving, sheet piling capping beam, misc paving	1,500m^3
7	Bollard	18 each
8	Bollard foundations – concrete	144m^3
9	Rubber fenders	2

Note: MOF expansion not required for train 3 and 4 construction or operation.

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

Jetty and trestle construction

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

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

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

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

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

3.4.5 Construction sequence

Once suitable access to the LNG site has been established through construction of the temporary rock dock and MOF, site preparation will commence.

Vegetation will be cleared in the footprint area of the LNG facility, laydown areas and TAF. The extent of vegetation clearing is mapped in Figure 3.17, which shows regional ecosystems which have been established through on site ground-truthing. Impacts and mitigation of vegetation clearing are addressed in Volume 4 Chapter 8. Plant matter from clearing will be utilised onsite for erosion control or landscaping and the remainder will be compacted and removed from Curtis Island for disposal.

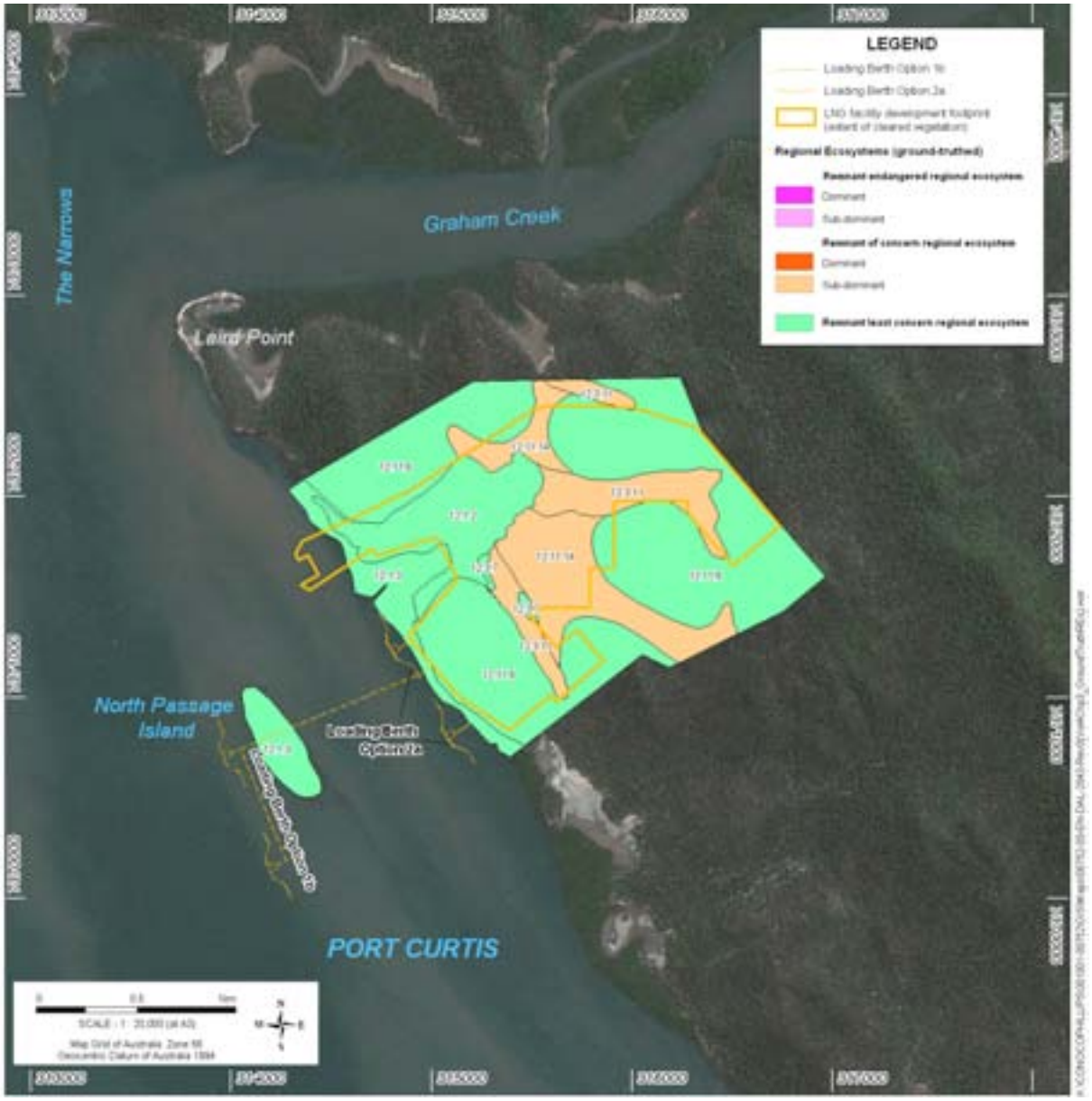

Figure 3.17 Ground-truthed regional ecosystems

The TAF, internal access and laydown areas will then be established. This will be followed by the excavation of elevated areas on the site to provide fill for lower elevation areas and so establishing a level site for civil construction (i.e. cut and fill activities). The approximate quantity of fill material to be excavated is four million m^3. The excavated material is expected to be variable in quality. It will be reused as fill for construction purposes and erosion control, subject to suitability. While preliminary

design information suggests that the quantity of excavated material is approximately the same as the quantity of fill material required for site development, any unsuitable or excess excavated material will be disposed of either on site, or at an approved off-site disposal area. Should there be a deficiency of material, then suitable materials will be transported to the site from the mainland.

Permanent plant equipment foundations and building slabs will then be installed. Concrete for all foundations and other structures will be supplied from a concrete batching plant and transit mixer trucks located onsite.

After the commencement of the concrete foundations, piping and electrical work, mechanical erection of the gas turbine, process equipment and ancillary facilities will begin. The construction of the LNG facility will include, but not be limited to, earthworks, piling, concrete construction, welding, installation of various equipment, and erection of buildings. The construction timeframe for the LNG and LPG storage tanks requires that construction commences as soon as possible after site preparation. The duration of construction for these tanks is approximately three years.

It is probable that portions of the LNG facility will be constructed using modules which are prefabricated at other locations, transported to site and then interconnected. Foundations and piling will be completed before the process modules are delivered to the site. Fabrication yards for these modules will most likely be located either elsewhere in Australia and/or offshore at an alternate site in south-east Asia. The remaining work to be done on site will include connecting the modules together and any other work that is built without modules or in a 'stick-built' fashion. The facility construction will require the use of cranes, excavators, trucks and other heavy machinery on site. These are likely to be transported to the site by barge or charter ship.

Access around the construction site will utilise typical engineered roads constructed in accordance with standard engineering specifications. Vegetated areas that are not cleared during construction will be retained and managed. Cleared areas required around the facility and equipment will be stabilised and maintained. Where practicable, areas cleared during construction that are not needed for operation will be vegetated.

3.4.6 Construction hours

Normal construction schedule will likely be five days per week, 10 hours per day for local residents and five days per week, 10 hours per day plus eight hours on Saturday for those that reside in the TAF. At peak construction, work will likely be undertaken on a 12-hour shift basis, up to 24 hours a day, seven days a week.

3.4.7 Construction workforce

Workforce size

The Project will be faced with challenges in sourcing the significant quantities of labour required to construct the LNG facility and marine facilities on Curtis Island. Additionally, the logistical challenges of personnel movement and accommodation for the labour force, whether the labour force is housed on the mainland or in TAFs on Curtis Island, will be significant. Executing direct work hours in a location outside of the Gladstone area will reduce the need for as many labour resources on the Curtis Island site. One way of doing this is to complete portions of the facility in blocks or modules, transport these modules to the site on barges, and then put the modules in place (refer to Section 3.4.5). This strategy is referred to as modularisation and results in lower onsite construction workforce on the LNG facility site compared to building the Project in a 'stick-built' fashion. It is the preferred method of construction for the LNG facility due to the constraints of labour availability in the Gladstone area. If

the LNG facility were constructed using a stick-built methodology only, it is estimated the peak construction workforce would be in the range of 3,000 to 4,000 people.

The modularisation approach detailed above is anticipated to reduce the peak workforce requirements to approximately 2,100 based on approximately 45% of the construction being executed using modularisation as is typically the case for this type of facility. The actual extent of modularisation and stick-built applications will be determined during the FEED phase of the Project.

The construction workforce will comprise both people who reside locally and non-locals. It is estimated that up to 80% of the construction workforce will be non-locals during the peak construction period. These personnel will work four weeks on and one week off. It is anticipated the peak construction workforce accommodated at the TAF on Curtis Island (refer to Section 3.6.1) would be 1,800. An allowance for future expansion in TAF capacity is included in this figure.

During the initial construction period prior to completion of the construction of the TAF, it is estimated 200 to 400 non-local workers will need accommodation on the mainland for a period of approximately 12 months.

Figure 3.18 is a chart of the approximate workforce numbers profile during the construction period.

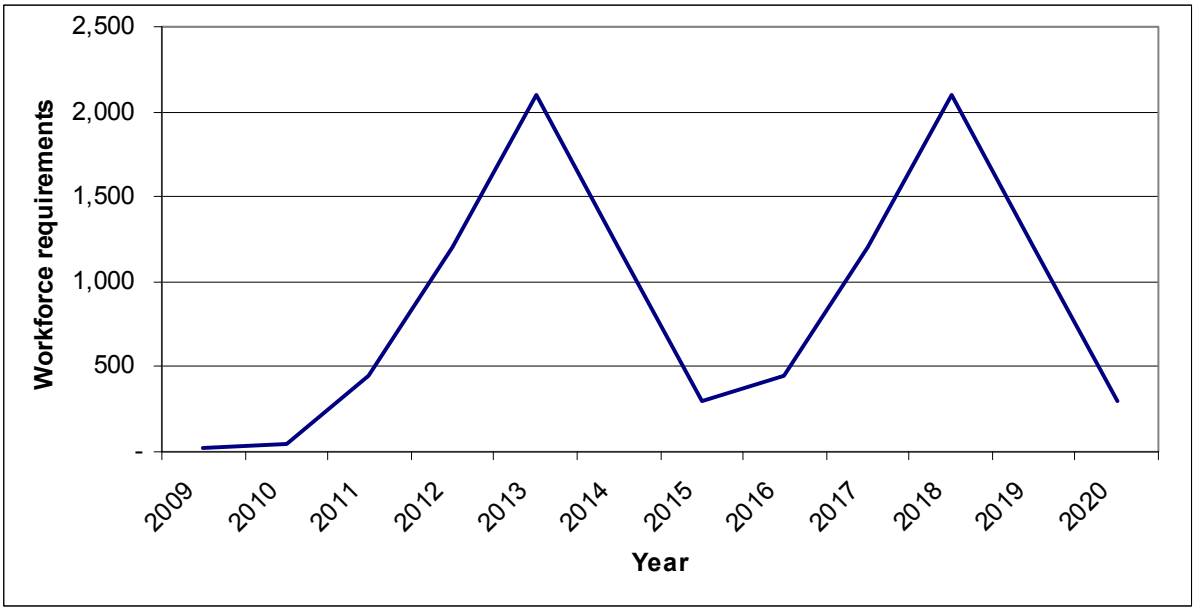

Figure 3.18 Approximate construction workforce number

Workforce recruitment

The onsite construction workforce is expected to be a composite of people residing in the local area (defined as living/residing within a 60km radius of the Gladstone Post Office) and workers recruited from other Australian geographical labour markets and overseas if required.

The scope of work is estimated to be executed on a direct-hire and specialty subcontract basis and is intended to maximise the use of Australian labour and contractors. Local labour will be utilised to the greatest extent possible particularly for staff roles and the non-manual component of the workforce. In addition, local contractors and suppliers will be encouraged to provide day-to-day services and supplies for the Project.

The Australia Pacific LNG Gladstone Community Centre, located in the centre of Gladstone, will provide a single location or 'hub' for all enquiries relating to the Project. The primary purpose of the centre is to establish a presence for Australia Pacific LNG and provide a location where community members and other stakeholders can directly liaise with project representatives with questions relating to employment and project specifics. It will also provide an educational resource for information relating to ConocoPhillips and Origin Energy and the Project through a series of visual and interactive displays. Through the Gladstone Community Centre, stakeholders will be able to register their interest for work and supply opportunities.

Skills base and training needs

The Project will train local personnel as necessary to support the short term, intensive construction work and the long term, ongoing post-construction operations and maintenance work. It is the intent of Australia Pacific LNG to hire locally as much as possible for the construction and operations of the Project where appropriate skills exist. Training opportunities will be established for local residents.

Furthermore, the Project will assist with local community capacity building to supply services or supplies to the Project. This will be achieved through a proactive contracting and procurement program and the creation of supplier databases.

Australia Pacific LNG will implement these training and business support activities in consultation with government and training and education groups.

Some construction work is specialised and requires specialised skilled labour. The availability of skilled local labour to meet this need is expected to be limited. This work could be undertaken by specialist contractors from within Australia or overseas if required.

Workforce logistics

Car parking facilities for construction workers who reside in the local area will be provided in Gladstone. Buses will transport workers from the car park to the ferry embarkation location and return workers to the car park after return to the mainland from Curtis Island.

The majority of construction workers who do not reside in the local area will travel by plane into the Gladstone Regional Airport and travel to the site's TAF by ferry, after being transported by bus to the ferry embarkation point from the airport.

3.4.8 Construction emissions and waste

Atmospheric emissions

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

Various types of construction equipment will be used from the inception of the site work until start-up and commissioning of the LNG facility. While the majority of this equipment will use diesel fuel, some equipment will use petrol. Table 3.3 provides an estimate of expected emissions generated by the use of construction equipment over a construction period of four years and nine months, the anticipated time to construct two LNG trains. During this period, it is anticipated that diesel consumption will be in the order of 10ML and petrol consumption in the order of 1.6ML.

Table 3.3 Estimated site gaseous emissions, construction phase

Emission	Total emissions (t) (Trains 1 and 2)	Total emissions (t) (Trains 3 and 4)
NOX	1,030	720
CO	1,890	1,325
SOX	80	56
PM10	90	63
CO2	42,000	29,400
VOCs	150	105

Notes:

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

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

USEPA emission factors have been used to derive emission levels.

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

Wastewater discharges

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

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

It is expected the discharge of brine from the desalination system will be up to 3000 m^3/day. Initially, prior to the completion of the jetty, desalination brine will be discharged near to the end of the MOF. It is expected treated sewage effluent from the onsite sewage treatment plant will reach a maximum of 550m^3/day during the construction period. Wastewater discharges will be reused onsite or discharged to Port Curtis, in accordance with regulatory requirements (refer Volume 4 Chapter 10).

General wastes

It is anticipated that the following waste streams will be generated from general construction activities, including:

- Vegetation cleared during site preparation works
- Oils, oily wastes from equipment and machinery maintenance activities
- Waste paints and solvent
- Waste adhesives
- Aerosol cans

- Waste antifreeze/radiator coolant
- General domestic waste and recyclables from construction workers
- Office wastes
- Paper, cardboard and timber from packaging
- Scrap metals (ferrous and non-ferrous)
- Surplus concrete
- General inert construction waste
- Greywater and sewage from onsite amenities
- Waste hydrocarbons, oily rags and consumables from equipment maintenance and refuelling
- Medical and First Aid station waste.

Additional waste streams will be generated from the TAF:

- Office wastes
- General domestic waste
- Food waste
- Greywater and sewage
- Medical and first aid station.

As part of the construction HSE management plan, mitigation measures will be implemented to reduce the amount of and effectively manage waste generated during construction. These measures include segregation of waste into recyclable and non-recyclable waste streams onsite at the waste storage compound and transportation by a licensed contractor to appropriate licensed facilities for reuse, recycling or disposal. Refer to Volume 4 Chapter 16 for more details on waste management. The volume of waste expected to be generated over the total construction phase for train 1 to 4 of the development of the LNG facility is outlined in Table 3.4.

Table 3.4 Expected construction phase solid wastes

Waste	Amount (trains 1 and 2)	Amount (trains 3 and 4)
Temporary accommodation facility		
Sewage treatment plant solids (m^3)	650	650
Food waste (t)	350	350
Domestic waste (t)	510	510
Other solid wastes (t)	1,020	1,020
Construction activities		
All wastes (t)	52,000 Approximately 70t/day	30,000 Approximately 50t/day

Noise emissions

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

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

The main noise generating activities are expected to be pile driving for LNG tank foundations and jetty trestles. Marine pile driving generates both underwater and airborne noise. The key noise emitting equipment and associated sound power levels is outlined in Table 3.5.

Table 3.5 Construction equipment approximate sound power levels

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

3.5 Operations

3.5.1 LNG process inputs

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

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

Other material inputs into the LNG process have been estimated in Table 3.6.

Table 3.6 Annual usage of materials

Item	Units	1 train	2 trains	4 trains
Propane	t	300	600	1200
Ethylene	t	210	420	840
Concentrated N-methyl-diethanolamine (MDEA 90% wt)	m^3	6	12	24
Antifoam	kg	860	1,700	3,500
Activated carbon	t	20	40	80
Mercury adsorbent	t	25	50	100
Water treatment chemicals	t	45	90	180
Lube oil	m^3	18	36	72
Heating system oil	m^3	1.3	2.5	5.0

Other than the refrigerants, LPGs and the LNG product, all fuels and chemicals onsite will be stored, handled appropriately in a dangerous goods warehouse in accordance with applicable Australian standards and guidelines.

3.5.2 LNG production process

The LNG production process is shown as a basic flowchart in Figure 3.19 and as a more detailed schematic of the Optimized Cascade® process in Figure 3.20. Further description of the process is provided below.

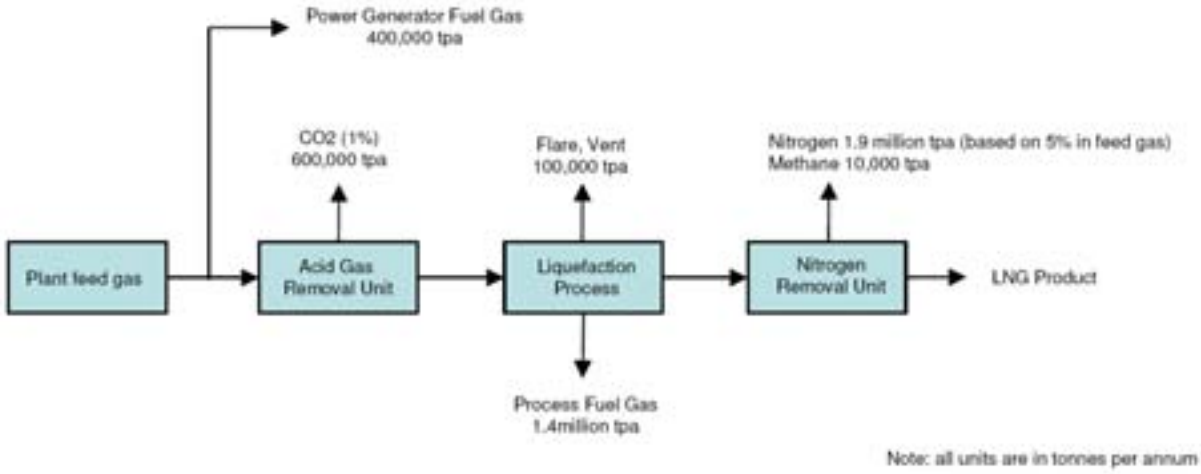

Figure 3.19 LNG production process

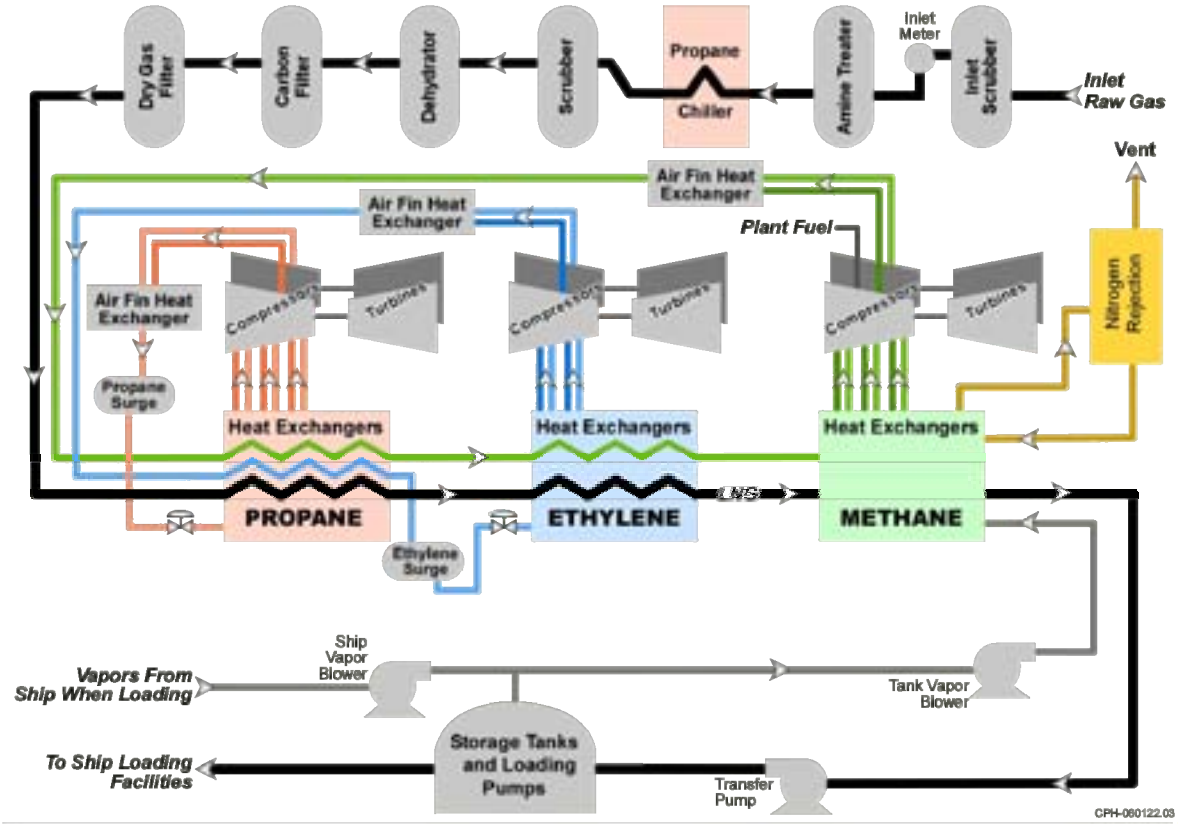

Figure 3.20 Schematic of the Optimized Cascade® process

Each LNG train will utilise six turbines arranged with two identical gas turbine driven propane compressor sets in parallel, two identical gas turbine driven ethylene compressor sets in parallel and two identical gas turbine driven methane compressor sets in parallel.

Inlet separation

After the gas is delivered by pipeline to the facility site, it is metered and enters the gas pre-treatment section of the LNG facility to remove components within the gas stream that are detrimental to the natural gas liquefaction process. These components are primarily nitrogen, carbon dioxide and water.

The expected facility feed gas composition and contaminants are outlined in Table 3.7 and Table 3.8.

Table 3.7 Expected feed gas composition

Gas composition (wet basis)	Units	Base case average gas	High CO_2 feed gas	High N_2 feed gas
Nitrogen (N_2)	Mole %	3.75	2.0	5.0
Carbon dioxide (CO_2)	Mole %	0.56	1.03	0.24
Methane (CH_4)	Mole %	95.63	96.88	94.71
Ethane (C_2H_6)	Mole %	0.06	0.09	0.05
Propane (C_3H_8)	Mole %	0.00	0.00	0.00

Table 3.8 Expected feed gas contaminants

Contaminant	Expected concentration
Water	65 mg/m^3
Mercury	20 µg/Nm^3 maximum
Hydrogen sulphide (H_2S)	< 4 ppmv maximum
Carbonyl sulphide	< 0.1 ppmv*
Total mercaptans	< 4 ppmv as methanthiol
Total sulphur content	1 ppm as H_2S
Solids	Nil
Treating chemicals	Methanol < 0.1 ppmv - Tri Ethylene Glycol : saturated
BTEX (Benzene, toluene, ethylbenzene, xylenes)	< 4 ppmv
Lube oils	Nil
Oxygen	< 0.1 ppmv

* ppmv = Parts Per Million by Volume

The feed gas is initially processed through a vapour-liquid separation system to provide a gas free of water and liquid hydrocarbons. Although no liquid hydrocarbons are expected in the feed gas, the design allows for the collection of any liquid hydrocarbons in the inlet separator for flaring.

Acid gas removal

Gas from the inlet separator is fed to the acid gas removal unit, where carbon dioxide (CO_2) is removed to eliminate potential CO_2 freezing problems and any trace amounts of hydrogen sulphide (H_2S) present is removed to meet LNG sulphur specifications.

The removal of the contaminants is accomplished in a recirculating amine system using proprietary activated amine as the solvent. The system consists of an absorber, a regenerator and associated equipment. The CSG enters the bottom of the absorber and is contacted with the amine (which flows down from the top). The CO_2 and sulphur contaminants in the gas absorbs into the amine to leave a natural gas stream exiting the top of the absorber.

The 'rich' amine solution containing the contaminants leaves the bottom of the absorber and is fed to the stripping section of the regenerator. Acid gas and water vapour are stripped out and form the regenerator overhead vapour leaving a 'lean' amine solution, which is returned to top of the absorber. The regenerator overhead vapours are partially condensed and water is returned to the regenerator and absorber. The acid gas, which is mainly CO_2 with traces of H_2S is vented. Should further testing of the quality of the CSG from the gasfields show that H_2S is present, an acid gas incinerator can be retrofitted to the Acid Gas Removal Unit.

Dehydration

The treated gas leaving the top of the absorber in the acid gas removal unit is chilled prior to entering the dryer inlet separator for separation of any condensed hydrocarbons and water. Dehydration is

accomplished with the molecular sieves dehydrators. The final traces of water vapour are removed from the feed gas and retained within these sieves.

The dryers are regenerated by back-flowing clean, dry effluent gas (which is heated by waste heat from gas turbine exhausts). The adsorbed water is stripped off the bed together with some CO_2 and heavy hydrocarbons (if present), restoring the adsorption capacity of the sieves. The hot, wet regeneration gas leaving the dehydrator is cooled and passes to a knock out drum where the condensed water is separated and sent to the oily water treatment plant. The regeneration gas is re-circulated and combined with the feed gas.

Mercury removal

The dry gas from the dehydrators is passed through the after filters prior to entering the mercury removal beds, which contain special sulphur impregnated activated carbon. This final gas treatment step removes any trace amounts of mercury to prevent potential corrosion damage on downstream heat exchangers. The activated carbon bed has the capacity to last at least three years before the beds need to be replaced with fresh carbon. Spent carbon, containing mercury, will be returned to the supplier for appropriate management.

After this stage, the gas is further filtered before flowing to the refrigeration and liquefaction units. At this point, the facility inlet gas should be very dry and free of impurities.

Liquefaction

The dry gas is fed to the refrigeration systems where it is liquefied into the LNG product through a combination of heat exchange and pressure reduction with the refrigerants. This liquefaction system consists of three refrigeration services – propane, ethylene and methane. Propane is the first stage of the liquefaction.

The propane refrigeration chills the feed, condenses ethylene refrigerant, and de-superheats the methane. Each driver/gas turbine driven refrigerant compressor combination is equipped with individual suction drums and anti-surge control system for each stage. All compressors within a train share a common condensing system.

Ethylene refrigeration further cools and liquefies the feed and methane refrigerant. The liquefaction section consists of a cold box with flash drums and heat exchangers. The LNG product is pumped to the LNG storage tanks. Boil-off gas is received from LNG storage and re-liquefied. LPG can be injected into the LNG product as a ship is loading if this is necessary to meet LNG heating value specifications.

Nitrogen is vented to the atmosphere to prevent build-up in the fuel gas and methane refrigerant streams. Nitrogen is removed from the gas stream using a dedicated cryogenic nitrogen rejection unit.

Utilities

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

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

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

3.5.3 Flare system

The flare system acts as a vapour relief system and is the primary safety feature of the LNG facility. The flare system will collect and dispose of hydrocarbon-containing streams which are typically released during start-up and shutdown, but also during upset and emergency conditions. These streams are disposed of by flaring. The design of the flares has been based on expected 'worst-case' upset conditions for each stream.

There will be three types of flare systems within each ground flare:

- Wet flare
- Dry flare
- Marine flare.

The wet flare system will dispose of warm hydrocarbon streams that may be saturated with water vapour and/or contain free liquid hydrocarbons and water. These streams will be mainly generated by relief valve and start-up/shutdown control discharges from the process vessels. The dry flare system will handle cryogenic hydrocarbons (both vapour and liquid) from the LNG storage tank and boil off gas systems. These two types of burner systems will be located within the same ground level flare enclosure. The flare enclosures will be located in a safe area away from the process LNG facilities and LNG storage tanks.

The marine flare will handle any flashed LNG vapours generated during loading of LNG product to the ship's storage tanks and from LNG storage tank and boil off gas systems. Boil-off gas compression is important for limiting the amount of flaring required during loading of LNG. The marine flare will be located near the LNG ship loading area. For the EIS studies, it has been assumed that the LNG facility has a stack marine flare, but design options including the use of the wet/dry ground flare enclosure for the marine flare, are being considered to mitigate the visual amenity impacts associated with a stack flare.

3.5.4 LNG and LPG storage

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

Each LNG storage tank will be equipped with loading pumps, level gauges, level transmitters, relief valves, vents, temperature elements, and other basic instrumentation.

One full-containment, refrigerated LPG storage tank with a capacity of 100,000m^3, a diameter of approximately 80m and a height of 30m, will be provided to receive shipments of LPG into the facility. This tank will be a full containment type with double-wall construction, with an inner wall being of low temperature steel and the outer wall of reinforced concrete.

In order to meet the heating value requirements of some LNG customers, it may be necessary to increase the energy content of the LNG by adding LPG. The LPG required for this action will be imported by sea, unloaded at the product loading facility and transferred to a second LPG storage tank. This additional LPG tank will also be a full-containment type with a capacity of 28,000m^3. LPG from this tank will be routed though a treatment system and then to a cryogenic chiller system to the super cooled LPG storage tank. The super cooled LPG is mixed with the LNG product. Vapour from the LPG storage tank will be compressed and re-condensed during normal operations. Only during emergency and upset conditions will these vapours be directed to the marine flare for disposal.

Both LPG storage tanks will be designed to meet requirements established in the relevant Australian and international standards. Each LPG storage tank will be equipped with transfer pumps, level gauges, level transmitters, relief valves, vents, temperature elements, and other basic instrumentation.

3.5.5 Marine facilities operation

Product loading

The ship loading facility at the Australia Pacific LNG complex will allow for the simultaneous loading of two LNG ships ranging in capacity from 125,000m^3 to 220,000m^3 each.

The LNG product will be pumped from the LNG storage tanks to the jetty via a loading line, and transferred to the ship via several loading arms. A vapour return arm will capture gas displaced from the ship's tank, flashed gas including and vaporised gas from heat gain during ship loading, and return this gas to the LNG tanks via a separate gas line.

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

LNG shipping

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

The typical LNG tankers will have a minimum draught of 11.5m and are between 285 and 314m in length with a carrying capacity of 125,000m^3 to 165,000m^3 of LNG. Figure 3.21 and Figure 3.22 provide examples of typical LNG tankers. The vessel in Figure 3.21 has an approximate length of 285 to 314m; the vessel in Figure 3.22 has an approximate length of 315m. However, it is possible that LNG tankers with a capacity of up to 220,000m^3 may also be used. These vessels have a draught of up to 12m with a length of 315m.

Figure 3.21 Typical spherical LNG carrier

Figure 3.22 Typical membrane tank LNG carrier

Ship access to the Laird Point LNG facility site will require deepening and extension of shipping channels and in the Port of Gladstone and provision of swing basins. The impact assessment of this development is included in the EIS for GPC's Western Basin Dredging and Disposal Project (refer to Figure 3.12)

Australia Pacific LNG plans to use two tugs from the Fairway Buoy inward and four tugs in the vicinity of Buoy G4 for assisting LNG (and LPG) vessels during transit and berthing in the Gladstone Port. Tugs and associated facilities will be provided and managed by GPC. After an evaluation period, the use of three 80 tonne bollard pull tugs from Buoy G4 inward will be considered.

LNG ships, as determined by the Regional Harbour Master, will use dedicated LNG anchorages adjacent to the existing port anchorages. LPG ships will use the existing port anchorages. Australia Pacific LNG has been working closely with GPC and the Regional Harbour Master on real-time

navigation simulations and workshops in relation to safety of shipping resulting from the Project. This has included determination of safe procedures, including number of tugs to be deployed and navigational aids. Bunker oil will not be stored on the Laird Point site, but barges may be used for bunkering of vessels and come under standard controls of GPC.

LPG shipping

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

3.5.6 Maintenance dredging

Maintenance dredging of shipping channels, turning basins and berths will be provided by GPC. Plans for dredging and maintenance dredging material disposal and associated impacts and mitigation are described in GPC's EIS for the Western Basin Dredging and Disposal Project (GPC, 2009b).

3.5.7 Hours of operation

The facility will be operated 24 hours per day, seven days per week, 365 days per year. The facility may incur shutdowns on one or more of the production trains but will be continuously manned over the period.

3.5.8 Operational workforce

A workforce of approximately 100 is estimated to be required to operate the first 4.5Mtpa train of the LNG facility, with a further 75 persons required for each additional train. At the nominal facility capacity of approximately 18Mtpa the LNG facility will require an estimated operational workforce of 325 people. Additional personnel will be required during major maintenance activities.

The operational workforce will likely be split between two different rosters, either an eight hour day shift, or a twelve hour rotating shift. As well as the core operational workforce, personnel will be required to perform shutdowns of the LNG trains for maintenance. Major shutdowns are generally scheduled every few years and will require an approximate workforce of 300 to 500 personnel, depending on scope. Minor shutdowns may occur more frequently and will require an additional staff of approximately 50 to 100 personnel.

Major and minor shutdown teams will work 12 hours shifts, operating 24 hours a day, seven days per week. Project and recruitment information for potential operational workers will be available at the Project's Gladstone Community Centre.

3.5.9 Safety systems

Emergency shut down, gas detectors and fire detection

Emergency shut down valves will be installed at the feed gas metering station and at critical points within the process, product lines to the LNG storage tanks, lines to/from the LPG storage tanks, and the vessel (un)loading lines.

Gas detectors and fire detection systems will be installed at key areas in the LNG facility. Signals from the detection systems will activate systems that initiate protocols to activate the appropriate emergency shut down valves and fire systems.

Firewater system

A self-sufficient, fire protection system is proposed to control or extinguish a fire within the LNG facility site. The primary element of the fire protection system is the firewater system. Sufficient capacity is available in the facility's firewater storage tank to provide water for fire fighting. This capacity provides the ability to fight two sequential four hour design fires, as required by NFPA 59a. The tank's volume and pumping capacity also allows for fighting two concurrent four hour fires on the jetty. Current design includes two diesel firewater pumps and one electrical driven pump.

Firewater is pumped from the firewater tank through a ring-main distribution system to hydrants, monitors, and hose stations at appropriate locations.

Chemical/foam system

The second element of the fire protection system is the dry chemical/foam fire truck which is equipped with a 500kg of dry chemicals, 3,800L of foam, and the 3,000L of high expansion foam.

3.5.10 Security and safety zones

The LNG facility will have a number of security systems installed as part of the installation. Security fencing around the cleared areas will be installed for the purposes of deterring unauthorised intrusion into the LNG plant areas. The property boundary will also be fenced. Closed circuit television will also be employed to allow for continuous monitoring of the perimeter fencing. Access to the facility will be controlled via the marine access at the MOF and jetties. Access to the facility from the common infrastructure corridor at the east boundary of the facility is anticipated.

The MOF will be designed and constructed with appropriate controls for AQIS and customs, including an appropriate office. Cameras to monitor the wharf front will be installed to meet customs and security requirements. Additionally, facilities will also be designed to meet the needs of the Gladstone Police and other emergency services.

An exclusion zone of 250m from the ship's manifold adjacent to the loading platform will be enforced at the LNG jetty. Vessels manoeuvring to and from an adjacent berth and associated craft will be permitted to enter the exclusion zone subject to a set of procedures determined in consultation with MSQ and GPC.

A preliminary risk assessment and a preliminary consequence assessment have been completed for the Project (refer Volume 4 Chapter 22). These initial assessments demonstrate that offsite risk meets the required criteria and also the consequence effects from worst-case scenarios should not affect the adjacent infrastructure or operations. These assessments include assessment of safety risk for LNG and LPG berthing and loading/offloading operations.

Safety and security operational requirements will be in force whilst an LNG or LPG vessel is moored at the jetty. These requirements and procedures will include:

- All loading personnel have appropriate qualifications and certification
- During loading, a responsible officer will remain in the cargo control room
- During critical periods of loading, the Loading Master will be in the vessel's cargo control room

- Communication systems will include: a portable ultra high-frequency radio link, a very high frequency link for standby tug(s), an emergency shut down transmitter, and a 'hotline' telephone link between the vessel's cargo control room and terminal cargo control room for emergency and priority use
- CCTV system installed on the loading platform
- Safety inspection checklist appropriately completed
- Adherence to fire protection control procedures, and with working order
- All fire fighting equipment to be maintained in good working order
- One tug on standby with emergency response equipment that meets fire fighting standards
- Main engine readiness is maintained
- Adherence to GPC's environmental procedures whilst moored
- Boil-off gas will not be vented to atmosphere under normal loading operations
- Pedestrian and vehicle access to the jetty is to be strictly controlled
- Non-Australia Pacific LNG vessel access will be prohibited at all times under and around the jetty.

LNG and LPG vessels will only be accepted to load if they have a valid international ship security certificate and they have satisfactorily completed the ship security certificate list and the pre-arrival questionnaire. Once the vessel is securely moored, the gangway will be positioned onto the vessel strictly in accordance with terminal procedures.

3.5.11 Operational emissions and waste

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

Atmospheric emissions

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

Normal operating conditions

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

- Gas turbines to drive refrigeration compressors
- Gas turbines for power generation
- Acid gas removal unit
- Hot oil heaters
- Nitrogen rejection unit
- Dry gas flare (pilot light operating)

- Wet gas flare (pilot light operating)
- Marine flare (pilot light operating).

An expected emissions inventory for normal facility operations is given in Table 3.9 .

Table 3.9 Point source emissions inventory

LNG production	4.5Mtpa (1 train) (t)[1]	18Mtpa (4 trains) (t)[1]
Emissions (t/per year)		
PM_{10}	56	215
SO_2	1	2
NO_X	860	3,440
CO	780	3090
CO_2	1,337,000	5,112,000
N_2O	30	100
CH_4	3,130[2]	12,540[2]
VOCs	35	180
Greenhouse gas equivalent		
t CO_2e/year	1,412,000	5,408,000

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

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

The estimates for each train are:

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

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

Non-routine operating conditions

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

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

Upset conditions could occur in the following situations:

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

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

Wastewater discharges

The LNG facility operations will generate the following wastewater disposal streams:

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

Clean stormwater

Stormwater is generally not considered a waste unless it becomes contaminated in a construction or process area. As such, stormwater will be diverted around the LNG facility's footprint to reduce the quantity of stormwater entering the site.

Clean stormwater will be collected from sections of the LNG facility that has limited potential for contaminating this runoff. This stormwater will be directed by surface drains to hydrotest pond prior to harvesting for use in the LNG facility for irrigation and dust suppression purposes and/or for ocean disposal during wet weather.

Sewage treatment plant effluent

The sewage treatment plant will be an extended aeration, biological treatment plant designed to treat the wastewater to applicable standards for use for site irrigation purposes and/or for discharged into Port Curtis. It is anticipated that during steady state LNG production (four trains), effluent disposal will be at an average rate of 3.5m^3/hour and up to a maximum rate of 15m^3/ hour. Indicative effluent characteristics from the sewage treatment plant are detailed in Table 3.10. Treated sewage effluent will be stored in a tank for dechlorination purposes prior to being used for irrigation purposes or discharged to Port Curtis. If it is discharged it is likely that treated sewage effluent will be discharged with the desalination plant brine.

Table 3.10 Indicative treated sewage effluent characteristics

Parameter	Concentration
pH	6.5 - 7.5
5 day biochemical oxygen demand (BOD5)	10 - 20 mg/L
Oil	5 - 10 mg/L

Parameter	Concentration
Total nitrogen	< 4 mg/L as N
Total Kjeldahl nitrogen	1 - 4 mg/L
Ammonia nitrogen	1 - 4 mg/L
Total phosphorus	<1 mg/L
Chlorine	1 - 2 mg/L
Total dissolved solids (TDS)	250 mg/L

Brine disposal

The brine will be piped and discharged into Port Curtis at a location sufficiently far offshore to prevent the formation of stagnant hypersaline areas in harbour waters. The distance between the discharge point and the location of the seawater intake is also an important consideration in the selection of discharge location. For the EIS studies, it has been assumed that the desalination plant brine is discharged from the MOF. Alternative locations under consideration in the FEED phase of the Project include the ends of the jetty. It is anticipated that during steady state LNG production (four trains), brine disposal will be at an average rate of 96m^3/hour and likely up to 116m^3/hour. The indicative characteristics of the brine are detailed in Table 3.11.

Table 3.11 Indicative brine characteristics, desalination plant

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

Parameter	Concentration
Silica oxide	1 – 2 mg/L
BOD_5	5 – 10 mg/L

Potentially contaminated wastewater

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

The oily wastewater will be pre-treated in a hydrocarbon sump drum where vapours and condensate will be separated. The condensate will be pumped to the oil and water separator for retrieval of free oil, and the vapours will be sent to the wet gas flare for disposal. The separator produces three waste streams – sludge, treated effluent, and waste oil. The sludge will be temporarily stored in a sludge holding tank pending periodical transport by a licensed contractor for disposal at a licensed waste management facility. Waste oil will also be stored and transported off-site for recycling.

The treated effluent from the oil and water separator will be sent to the dissolved air flotation unit and effluent filter to remove any remaining oil. It will be stored onsite in a tank with treated sewage effluent and is likely to be discharged to Port Curtis with the desalination plant brine if not used for onsite irrigation purposes. The indicative characteristics of the treated effluent are detailed in Table 3.12.

Table 3.12 Indicative treated effluent characteristics

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

*Note: quality characteristics are influenced by the water quality of the process water used

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

Solid and semi-liquid wastes

The wastes generated by the operation of the facility will be:

- Non-hazardous wastes including waste lubricating oils, sewage treatment plant sludge, molecular sieve waste, oily sludge from the corrugated plate interceptor, float from the dissolved air flotation unit, cellulose and general garbage
- Hazardous waste such as spent solvents, oily filters and rags, process filters and batteries.

Table 3.13 outlines the anticipated LNG facility solid water generation in tonnes per year.

Table 3.13 Anticipated LNG facility solid and semi-solid waste generation

Waste product	Waste source	Quantity (t/year)
Waste lubricating oils	Plant area	220
Spent oils	Plant area	4
Cellulose	Plant area	3
Biological sludge (dry basis)	Sewage treatment plant	15
Oily sludge/float	Corrugated plate interceptor/dissolved air floatation unit	28
Spent solvents	Plant area	0.4
Ceramic balls*	Dehydration	16
Molecular sieve waste*	Dehydration	350
Activated carbon (Amine filter)*	Acid gas removal	80
General wastes	Plant area	320
Waste oil from slop oil tank	Plant area	140m^3/year
Mercury adsorbent**	Mercury removal unit	100
Cartridge filters	Plant area	12

* Adsorbent bed life is expected to be the facility design life.

Waste materials generated during the construction and operational phases that can not be reused onsite will be collected in mobile garbage units or appropriately sized roll-on roll-off bins with proper waste identification, colour and labels in a designated staging area, and transported by a licensed contractor for reuse, recycling or disposal at licensed waste management facilities on the mainland. Pre-processing such as compaction onsite will be considered during detailed planning with the waste contractors.

3.5.12 Summary of key environmental design features

The following is a summary of the key environmental design features incorporated in the design of the facility to avoid or minimise potential environmental impact.

Liquid waste minimisation

The LNG facility will use a variety of technologies and practices to control and minimise liquid wastes. These measures will include the:

- Segregation of waste water streams and their treatment (contaminated stormwater, sanitary wastewater, clean stormwater)
- Reuse of treated sewage effluent and treated stormwater for potential onsite irrigation
- Use of the facility's inlet air chilling system to generate fresh water thereby reducing the need to obtain water from the desalination plant
- Use of air cooling in place of water cooling; this will lessen site water demand for demineralised water and will avoid the discharge of blowdown water

- Use of a waste heat recovery system using heat transfer oil in place of water to avoid the need to dispose of boiler blowdown and to produce demineralised water
- Use of dry gas seals rather than water cooling to avoid potential water blowdown and thermal discharges impacts
- Use of secondary containment structures for diesel tanks.

Solid waste minimisation

The LNG facility will use of a variety of technologies and practices to control, minimise, and reuse solid wastes during construction and operation. These measures will include the:

- Implementation of waste management practices through the supply chain that will minimise the generation of solid wastes and recycle as much as practicable at source
- disposal of inert wastes to an approved landfill on the mainland
- Reuse of cleared site vegetation as a mulch to aid site landscaping following site earthworks
- Air-drying of solvent-based wastes (waste paint, paint thinner, adhesives, etc.) prior to disposal.

Air emissions minimisation

The LNG facility will make use of a variety of technologies and practices to control and minimise gaseous wastes. These measures will include the:

- Use of CSG as the fuel source where practicable, in preference to liquid or solid fuels
- Use of power generators equipped with dry low NO_x technology, and aero-derivative gas turbine drivers equipped with dry low emission (DLE) technology
- Use of waste heat recovery to supply process heat
- Capture and re-liquefaction of excess gas generated during ship loading in the ING process rather than being flared. Which will reduce emissions resulting from the burning of this gas stream, whilst preserving CSG resources
- Use of closed-loop sampling systems to minimise fugitive emissions.

Noise emissions minimisation

The LNG facility will use a variety of proven technologies and practicable mitigations to control and minimise noise emissions. These mitigations may include the following pending on the overall noise design limit:

- Low noise equipment
- Acoustic enclosures for gas turbines
- Acoustic enclosures for gas turbine generators
- Exhaust silencers for gas turbine exhausts
- Acoustic insulation
- Acoustic blankets
- Noise hoods for gearboxes.

Required sound power levels, such as 99dBA for the air coolers, will be included in specifications for equipment.

3.6 Associated infrastructure

3.6.1 Workforce accommodation

Construction

Housing in the Gladstone area will be required to cater for the initial accommodation needs of the construction workforce up until the proposed TAF on Curtis Island is available for occupation. It is estimated 200 to 400 non-local workers will need accommodation on the mainland during this initial construction stage of approximately 12 months while the TAF is being constructed. For the main construction phase, the non-local workforce will be accommodated in an 1,800 bed TAF on Curtis Island. This TAF will accommodate single status male and female workers only. It is anticipated that facilities and buildings at the facility will include:

- Office, reception, and training centre
- One person accommodation units
- Commercial kitchen and dining
- Laundry
- Recreational facilities – lounge, TV rooms, games room, fitness centre, basketball/volleyball courts, tennis courts, squash courts
- Small shop
- Jogging circuit
- Medical clinic
- Warehouse and maintenance shop
- Guard house.

Figure 3.23 illustrates the proposed layout of the TAF.

Operations

The operational workforce is expected to comprise a mixture of single and married persons. Such a workforce will require a range of accommodation types to satisfy their individual needs. It is expected there will be sufficient housing stock available in the local Gladstone and district market to cater for the housing needs of this permanent workforce.

In view of this expectation, no dedicated accommodation facilities for operational personnel will be provided as part of the Project either on Curtis Island or in the Gladstone area. During major shutdowns, the additional maintenance personnel required will be accommodated on the mainland.

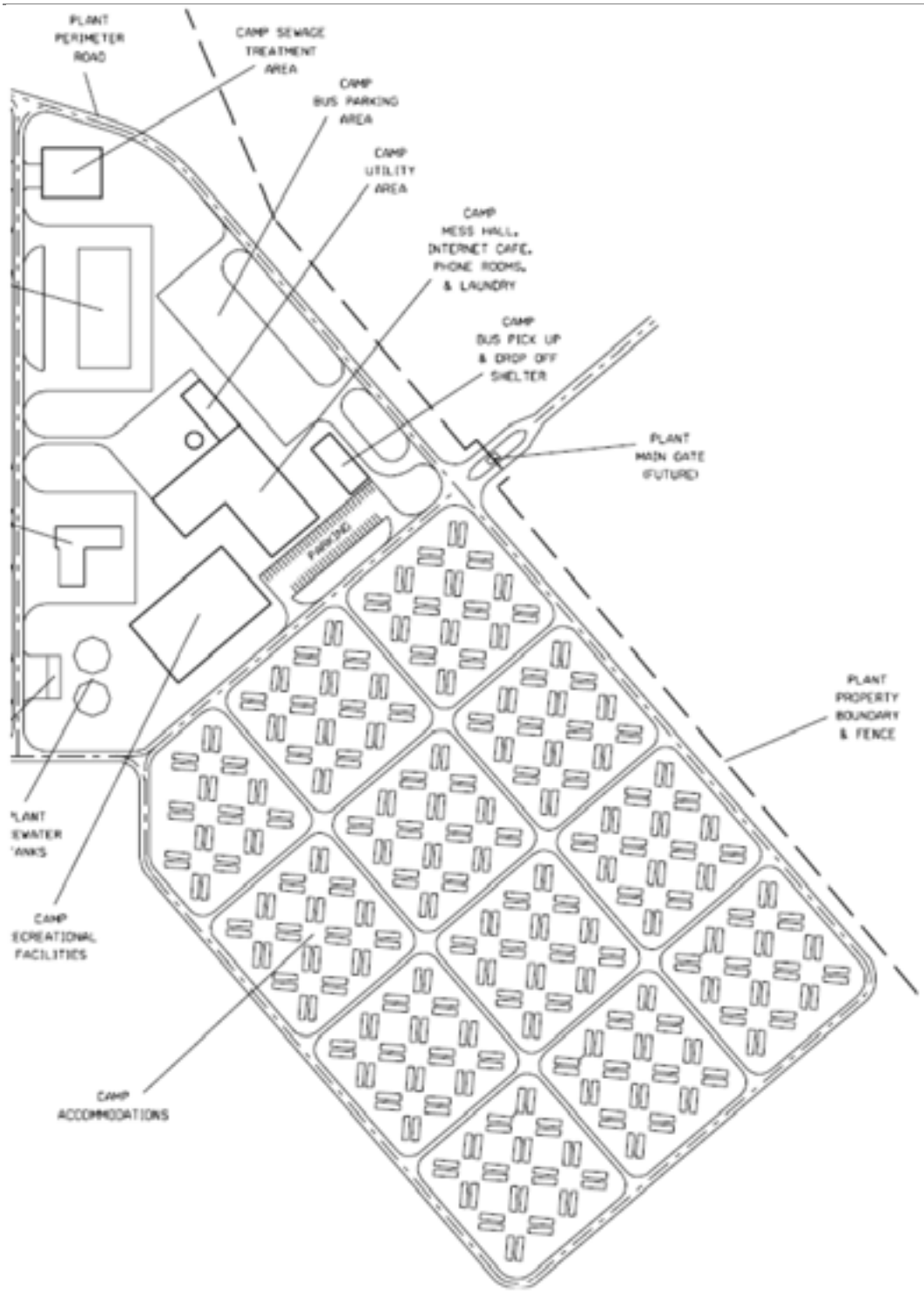

Figure 3.23 Indicative temporary accommodation facility conceptual layout

3.6.2 Transport

Construction phase

The MOF will enable all construction materials and personnel to be transported to the site by sea. A materials staging area on the mainland side of the harbour at Gladstone will be established to facilitate the loading of barges and ferries.

It is expected materials will be transported to the Gladstone area by truck and rail from in-country suppliers and subsequently delivered by barge to the project site. All offshore equipment modules, fabricated offshore Australia or elsewhere within Australia, will be shipped directly to site via the MOF where possible. It is expected that there will be approximately 60 modules for each LNG train.

It is also expected that construction of the LNG facility will involve the fabrication of a proportion of process modules overseas or elsewhere in Australia and their transportation directly to the project site by sea.

The transport of heavy loads of construction equipment and consumables to the site will be undertaken by barge. It is estimated that in the order of 15 to 20 barges per day will be required over a period of 48 months during construction of trains 1 and 2 and a similar time for construction of trains 3 and 4.

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

Transportation of the workforce from Gladstone to Curtis Island will be by ferry and occasionally by helicopter. It is estimated that there will be two ferry trips using a barge with a 400 person capacity in the morning and two ferry trips in the afternoon.

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

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

Operational phase transport

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

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

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

During major maintenance shutdowns, additional ferry and barge movements may be required for personnel and equipment. The impacts and management of transport for the construction and operation of the LNG facility element of the Project are detailed in Volume 4 Chapter 17.

3.6.3 Water supply, storage and management

Construction phase water demand and sources

Australia Pacific LNG will be as self-sufficient as practicable for all construction water requirements. For the very early part of the construction phase, clean treated water will be brought to the site from Gladstone in tanks on barges. Potable water for drinking will comprise packaged water purchased in Gladstone.

It is proposed to replace the import of treated water to the site as soon as is practicable. As a first step, it is intended to capture surface water runoff water in impounding ponds established as part of the temporary site drainage system. This water will be used for dust control, firewater and for hydrotest purposes.

As the amount of water able to be supplied from this source will be variable and due to potable water demand, it is also proposed to install a plant to desalinate seawater to provide a reliable supply of treated water.

Freshwater will be used for integrity testing (hydrotesting) of the LNG storage tanks and pipelines, and the flushing of other facility components. The large volume of water required to hydrotest the LNG storage tanks will be required during the commissioning phase at the end of the construction phase. Hydrotest water will be supplied from stormwater in impounding ponds. Desalinated water will be used to supplement as required. Table 3.14 and Figure 3.24 outline the expected demand for water during the construction phase.

Table 3.14 Estimated construction phase water demand (two trains)

Demand	Quantity
LNG facility concrete work	31,500m^3
Site preparation/dust control	6,000m^3
Potable water	433,000m^3
Hydrotest water (equivalent to 1 LNG storage tank)	160,000m^3

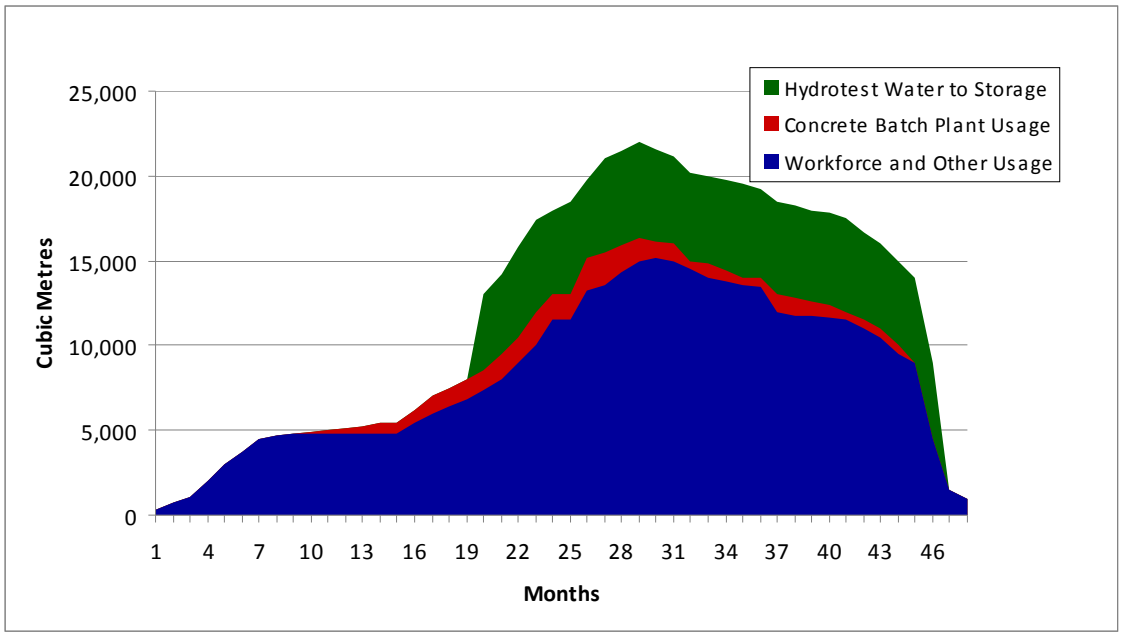

Figure 3.24 Monthly cumulative fresh water requirements

Operational phase water demand and sources

Australia Pacific LNG will be as self-sufficient as practicable for all operational water requirements. Desalination of seawater to produce process and potable water will be used to supplement captured stormwater. Stormwater collected in impounding ponds will be stored and used on the site if the quality is suitable for reuse.

The demand for water is primarily driven by the continuous demand for demineralised water required for amine makeup. Utility water and potable water demand are intermittent and generally lower volume rates.

The design demand for the LNG facility during operations is estimated to be about 1,550m^3/day (four trains) of freshwater. This is equivalent to approximately 3,870m^3/day of seawater intake. Projected water demands for the facility are presented in Table 3.15. Note that this includes an allowance of 20% for demand not currently specified in the facility design.

Table 3.15 Estimated operational water demand

Use	Four train facility (m^3/hr)
Treated water demand	1.6
Potable water demand	13.3
Laboratory usage	2.4
Clinical usage	2.0
Demineralised water	26.7
Safety showers	6.0
Firewater flush demand	1.6
Total water demand	53.6

Use	Four train facility (m^3/hr)
20% margin	10.7
Expected freshwater demand	64.5
Total seawater intake to the facility	160.8

There are no suitable surface or groundwater sources in reasonable proximity to the site which could be used as a permanent water source for the Project. The volume of water likely to be available from groundwater sources is insufficient to meet project needs and of a quality that is not suitable without treatment. Surface water runoff has the potential to provide sufficient water but only for part of the year.

In view of the above situation, a seawater desalination plant was selected as the primary water source for the Project, with supplementary water provided through the capture of site runoff. The LNG facility water system flow chart is outlined in Figure 3.25.

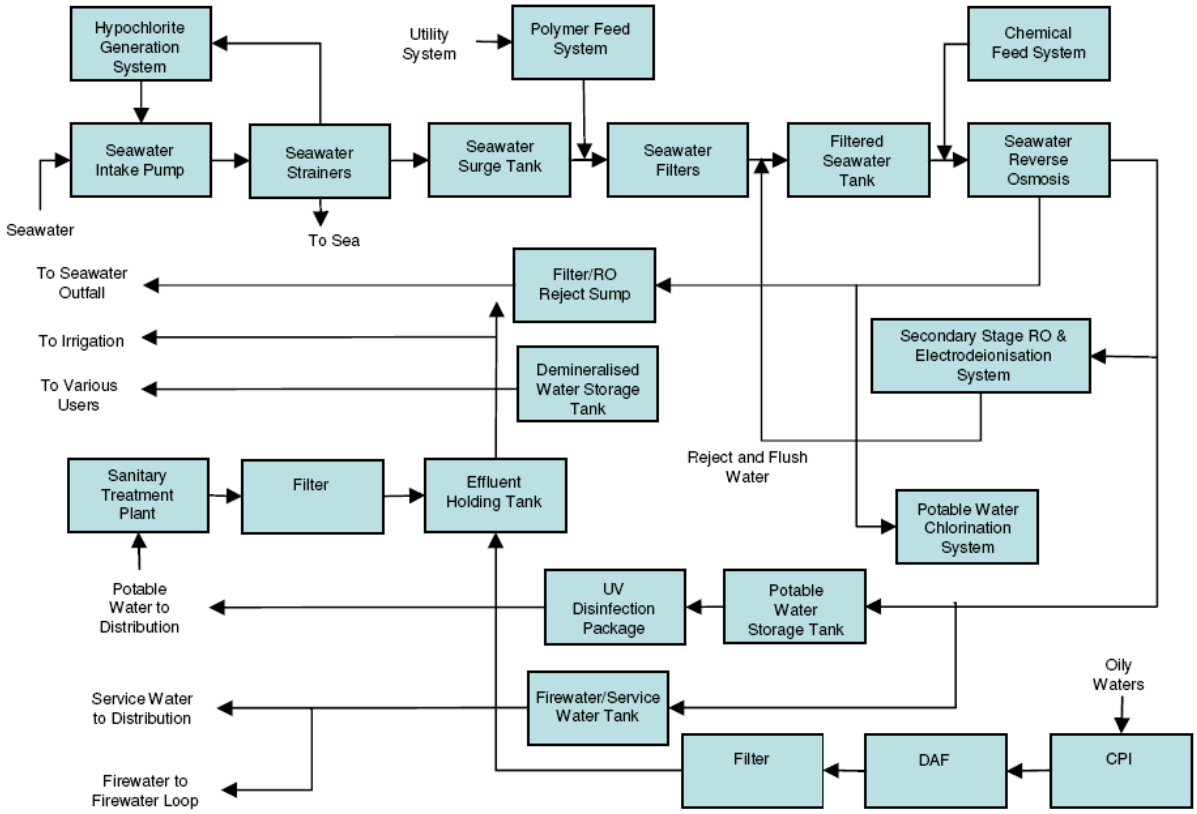

Figure 3.25 Facility water system

Seawater desalination plant

During operations, a permanent, onshore seawater desalination plant will be located within the LNG facility site to provide potable water, fire/utility water, and demineralised water. Australia Pacific LNG is also considering an alternative source of water via a pipeline from the mainland with fresh water supplied by the Gladstone Area Water Board. This alternative to seawater desalination would need collaborative support from other project proponents on Curtis Island and would need to be installed with the gas pipelines from the mainland to Curtis Island to be practicable.

The treatment process initially involves the removal of debris and other solids for the seawater. This intake water is then passed through a filter package to remove suspended solids and turbidity. Sulphuric acid, ferric chloride, polymer, sodium bisulphite and scale inhibitors are added to the water as part of this filtration process.

The desalination plant is expected to use a two-stage reverse osmosis system to desalinate the filtered water stream. The water stream will be passed through the first train of the desalination plant to produce water of a quality suitable for potable water and fire/utility water uses. In addition, part of this water stream will be passed through the second train of the desalination plant to produce demineralised water for specific applications in the LNG facility. A typical flow chart of the process is depicted in Figure 3.26.

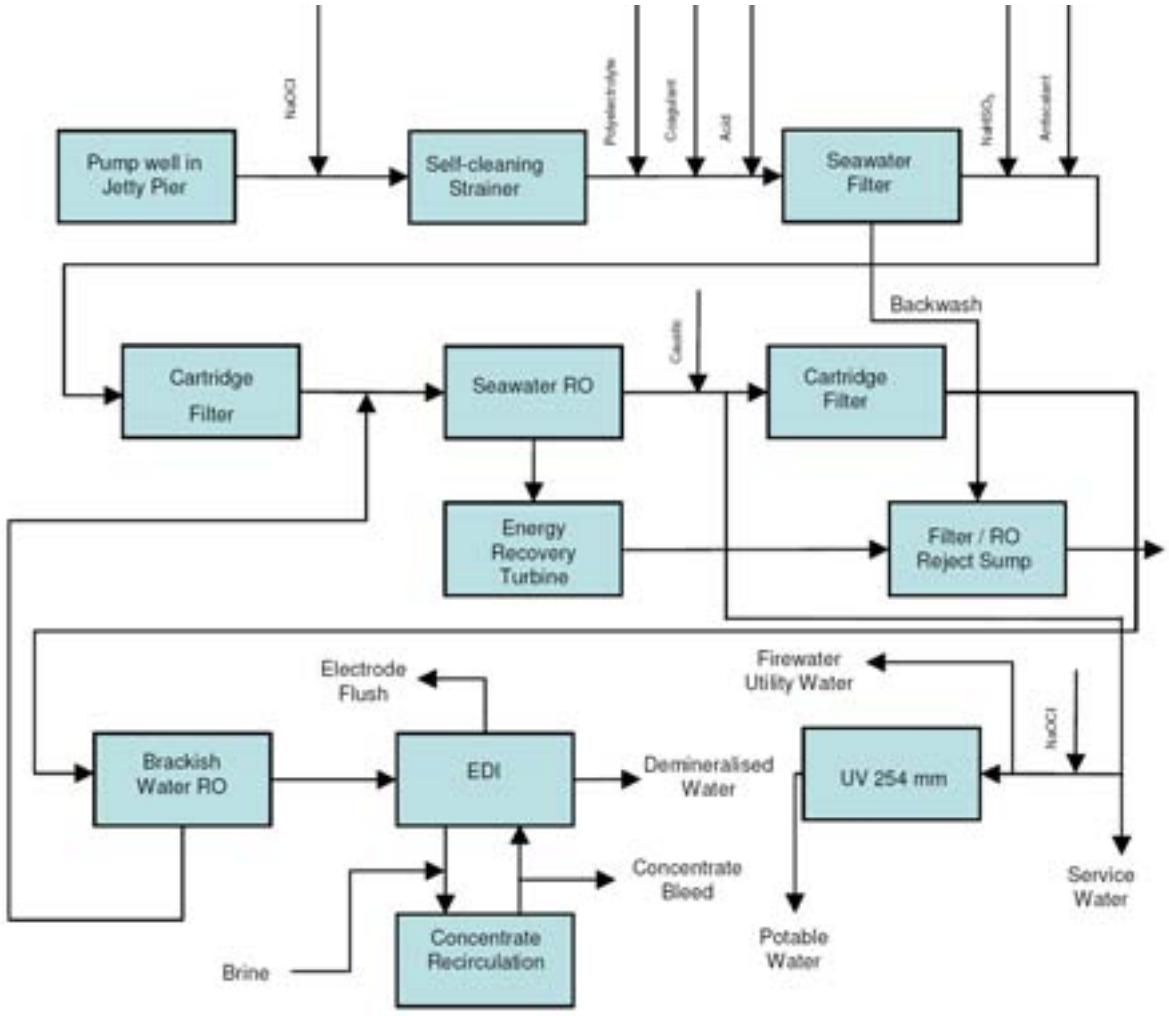

Figure 3.26 Proposed seawater desalination plant system

Service water system

The service water system will provide water for the LNG facility's demineralised water and potable water systems. The system will consist of a 5,000m^3 freshwater tank, pumps, a potable water treatment plant, and make-up water pre-treatment for the demineralised water system.

Service water will be treated to Queensland potable standards in a plant with sufficient capacity to meet operations requirements. The potable water system will consist of a storage tank, filter system,

hypochlorite injection set to provide free residual chlorine, and transfer pumps. Treated water will be dosed with salts to provide taste if necessary and stored in a buffer tank prior to distribution.

Service water will also be treated in a demineralisation plant to produce demineralised water. Demineralised water will be used to wash the blades of the gas turbines and to provide make-up water and wash water for the acid gas removal unit.

The effluents generated by the service water system components will be treated prior to release into Port Curtis in accordance with discharge criteria established in the relevant environmental permits. A discussion of the brine waste stream water volume and quality, dispersion modelling and assessment of impact of this discharge on the marine environment, is provided in Volume 4 Chapter 10 and Volume 4 Chapter 12.

Site water balance

The site water balance is shown diagrammatically in Figure 3.27. Water produced through desalination of seawater will supplement stormwater captured in impounding ponds. Water condensed from the inlet air propane chilling process will also be used to reduce the volume of desalinated water required.

Treated oily process water will be directed to a holding tank with treated sewage effluent and will be used as irrigation water to the extent possible with any excess likely to be discharged with the desalination plant brine.

Water conservation and management measures

The Project includes the use of a variety of means to minimise water consumption. Examples include:

- Using treated sewage effluent and treated stormwater for onsite irrigation to the extent possible
- Using inlet air chilling system to generate fresh water for reducing use of seawater desalination system
- Using storm water ponds for the supply of hydrotest water for the LNG tanks and pipes to minimise use of seawater desalination system
- A waste-heat-recovery system using heat transfer oil will be used instead of steam because it will avoid potential water quality impacts associated with generation of boiler blowdown and the increased demand for ultra pure fresh water to generate steam
- Air-cooling will be used rather than water cooling to avoid potential water blowdown and thermal discharge impacts.

Further optimisation of water production and use, including opportunities for water recycling and reuse, will be pursued during the detailed design phase for this facility.

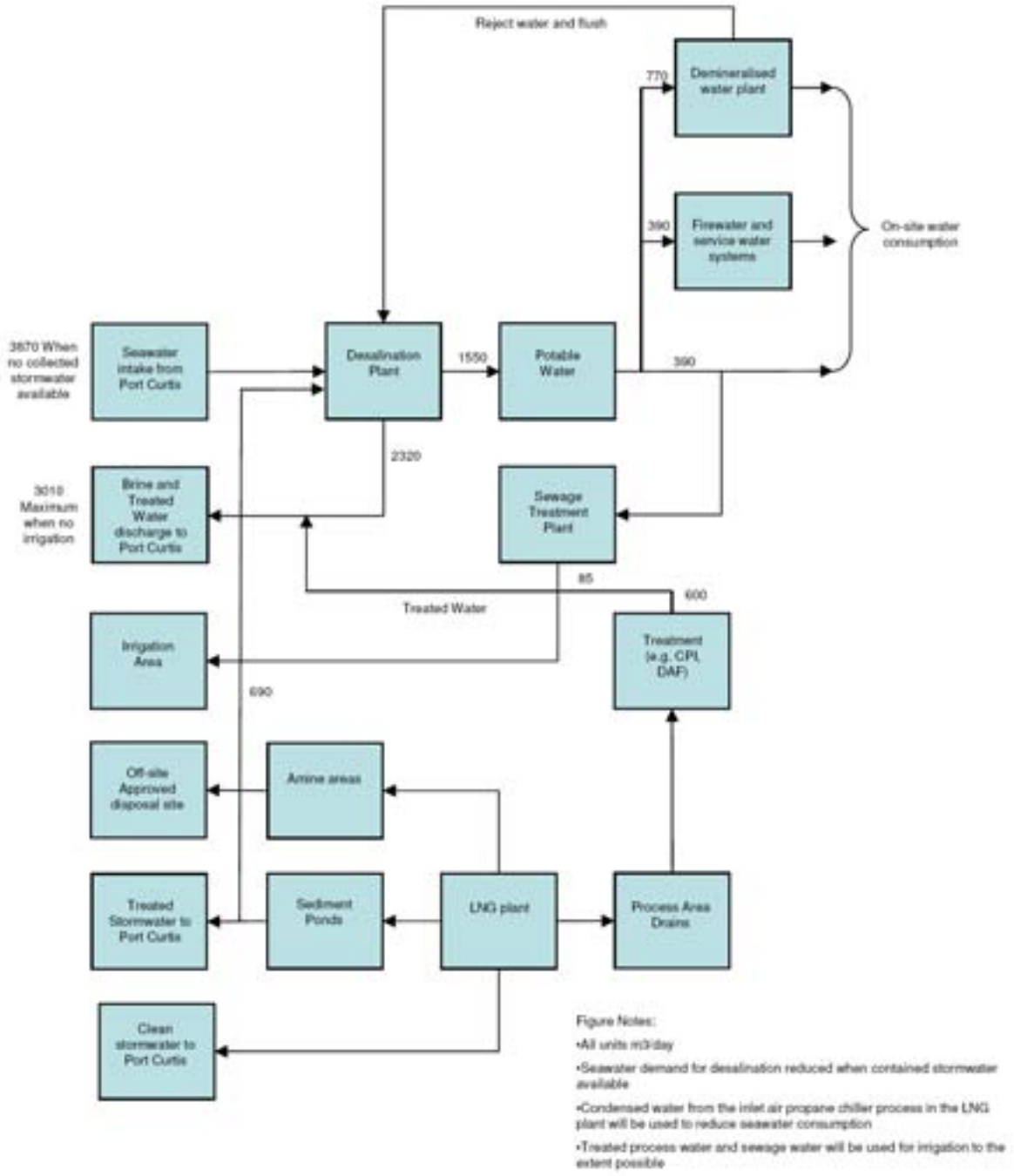

Figure 3.27 Site water balance

3.6.4 Stormwater drainage

Construction phase

As part of the initial clearing of the site, combinations of silt fences, check dams, hay bales, and other means will be installed to reduce site erosion and sedimentation. The temporary stormwater drainage system will direct all runoff to sedimentation ponds. Outfall structures will enable high flows encountered during major storm events to be managed by discharging to Port Curtis after an initial 10 minute diversion.

The sedimentation ponds will impound most stormwater. The main sedimentation pond will be used to store stormwater to enable its use for dust control, firewater and/or hydrotesting.

Operational phase

The LNG facility's operational phase drainage system will consist of two components – a clean water system and a contaminated stormwater collection system. The function of the system will be to divert clean water away from process areas and to contain and manage potentially contaminated water to minimise potential water quality impacts on the waters of Port Curtis. Potential stormwater impacts and management are discussed in Volume 4 Chapter 11.

Clean stormwater system

The clean water system will collect stormwater runoff from the parts of the project site that will not potentially give rise to contaminated stormwater. This stormwater stream will be directed by surface drains to settling ponds prior to harvesting for use in the facility where the quality is suitable for reuse.

Contaminated stormwater system

Potentially contaminated stormwater runoff from the process areas will be collected and routed via concrete lined ditches to the process area oil skimmer. The skimmed oil/water will be directed to the corrugated plate interceptor oil/water separator for treatment. The skimmer sump will be designed to contain a ten minute refrigerant leak from the process area.

Waste water from the skimmer tank will be pumped to a 'first flush' retention pond. Retained water will be tested to determine its suitability for discharge, prior to reuse for irrigation purposes and/or discharge to Port Curtis. If the stormwater flow exceeds the pump capacity, the water in the sump will underflow the oil/water separation baffle and then overflow into the effluent channel to the sea.

3.6.5 Sewage treatment

Construction phase

Prior to the TAF becoming operational, sewage streams will be handled by transporting sewage effluent back to the mainland by barge for disposal via Gladstone's existing wastewater infrastructure.

The TAF and site sewage will be treated using a temporary package treatment plant with a capacity of approximately 70m^3/hr. The sanitary treatment plant will be an extended aeration biological treatment plant designed to treat the sanitary wastewater to applicable standards suitable for reuse as irrigation water when possible and for direct discharge to ocean outfall. It will have the capacity to handle a maximum inlet flow of up to 70m^3/hr. It will be equipped with the following units:

- Aeration chamber
- Clarifier
- Aerobic sludge digester tank
- Chlorine tablet feeder
- Chlorine contact tank.

Influent to the aeration tank flows through a screen for removal of debris. The aeration tank will have capacity to provide a retention time of 24 hours for biodegradation of the organic contaminants to be achieved. Effluent from the aeration tank gravity will flow to the clarifier, where, flocculation and

settling of biological solids is achieved. The bio-solids settled at the bottom of the clarifier are recycled back to the aeration chamber at a controlled rate by means of an air lift pump. The recycled sludge in the aeration tank helps to maintain the required concentration of mixed liquor suspended solids (MLSS) in the aeration tank. In order to maintain the desired sludge age in the treatment system, it is necessary to periodically remove bio-solids in the form of sludge. A side stream from the sludge recycle line will be routed to the aerobic sludge digester.

The clarified water flows by gravity from the clarifier to a chlorine contact tank. Treated sewage effluent will be used for irrigation or otherwise discharged to Port Curtis.

The bio-sludge from the clarifier will be periodically transferred to the aerobic digester. The digester aerobically digests the sludge and reduces the amount of solids for final disposal. It is operated in a batch mode and will be used to provide sludge thickening. Supernatant liquid from the digester will be pumped back to the surge tank using an airlift pump. Aeration blowers provide the necessary air to the pump and diffusers in the digester. The digested sludge will be periodically removed using a vacuum truck and disposed of off-site. Further details can be found in Volume 4 Chapter 16.

Operational phase

Domestic sewage will be collected from a variety of locations on the project site and sent to the sewage treatment plant for treatment. The detailed design of the sewage collection system and treatment plant will be undertaken during FEED phase of the Project.

The sewage treatment plant is proposed to be an extended aeration, biological treatment plant designed to treat the wastewater to applicable standards for ocean disposal and/or use for site irrigation purposes. It will have the capacity to discharge treated effluent at an average rate of approximately 84m^3/day. It will be equipped with the following units:

- Bar screens
- Equalisation chamber
- Aeration chamber
- Clarifier
- Aerobic sludge digester tank
- Chlorine contact chamber.

The treatment process will involve the following steps. Effluent collected from around the site will firstly enter the aeration tank where the biodegradation of the organic contaminants takes place. Effluent from the aeration tank will then flow to the clarifier, where, flocculation and settling of biological solids is achieved. The bio-solids settled at the bottom of the clarifier will then be recycled back to the aeration tank to help maintain the required concentration of mixed liquor suspended solids in the aeration tank. In order to maintain the desired sludge age in the treatment system, bio-solids will be periodically removed in the form of sludge. A side stream from the sludge recycle line will be routed to the aerobic sludge digester.

The clarified water from the clarifier will be sent to the chlorine contact tank for bacteriological disinfection, prior to tank storage before reuse for site irrigation or disposal via a diffuser outfall in Port Curtis.

The bio-sludge from the clarifier will be periodically transferred to the aerobic digester. The digester aerobically digests the sludge and reduces the amount of solids for final disposal. Supernatant liquid

from the digester is pumped back to the aeration tank. The digested sludge will be transported by a licensed contractor for disposal at a licensed waste management facility off-site.

3.6.6 Liquid wastes control and minimisation

The Project includes the use of a variety of technologies to control liquid wastes emitted during the LNG production and loading processes. These technologies were selected because other alternatives were deemed not practicable and include the following:

- Wastewater streams, potentially contaminated stormwater, sanitary wastewater and clean storm water streams will be segregated (as opposed to combining all water streams and providing treatment before disposal)
- Using treated wastewater for onsite irrigation to the extent possible will reduce the quantity of discharges to the holding/evaporation ponds or discharge to the harbour
- Using inlet air chilling system to generate fresh water for reducing use of seawater desalination system
- Using storm water ponds for the supply of hydrotest water for the LNG tanks and pipes to minimise use of seawater desalination system
- Use of previously proven treatment technologies that are cost effective and should prevent significant adverse water quality or other environmental impacts
- A waste-heat-recovery system using heat transfer oil will be used instead of steam because it will avoid potential water quality impacts associated with generation of boiler blowdown and the increased demand for ultra pure fresh water to generate steam
- Air-cooling will be used rather than water cooling to avoid potential water blowdown and thermal discharge impacts
- Dry gas seals will be used rather than liquid gas seals where practicable to minimise liquid waste generated by leaks
- Secondary containments will be provided for diesel tanks and firewater pumps amine storage and the like.

All installed drainage control facilities will be sized to handle the anticipated design rainfall and runoff quantities from the disturbed catchment areas. Additionally sediment and erosion control devices will be implemented and maintained such as stone-check dams, silt fences, sedimentation basins and intercept ditches (refer Volume 4 Chapter 5).

3.6.7 Power generation

Electrical power

Construction phase

Approximately 10MW of construction power will be required. This power will be generated using diesel generators. In addition, the 10MW generation system will be supported by adequate backup power to ensure critical activities and electronic equipment continue to be powered should a blackout of the main system occur. Diesel is likely to be transported to the site by barge and will be stored onsite in accordance with the relevant Australian standards for the storage of combustible materials.

Operational phase

The LNG facility will utilise CSG for power generation in order to be self-sufficient in power requirements. Electrical power will be generated onsite to supply electricity for LNG processing and the common utility and off-facility areas.

Power for the four train facility will be provided by 13 Solar Titan 130 gas turbine generator sets for the four LNG trains. The number and manufacturer of the generators are preliminary and will be finalised during the FEED phase of the Project. However, Australia Pacific LNG is still optimising the turbine configuration including the potential use of 14 turbines. The Solar Titan 130 generators are ISO rated at 15MW each. Power generators will be equipped with dry low NO_x technology and aero-derivative turbine drivers equipped with DLE technology.

Low sulphur, diesel powered, generators with dedicated battery systems will be provided an uninterruptible power supply and emergency backup power system. Diesel will be stored onsite in accordance with the relevant Australian Standards for the storage of combustible liquids.

Energy conservation measures

The proposed Project includes the use of a variety of technologies to control gaseous emissions during the LNG production and loading processes. These technologies were selected because other alternatives were deemed not practicable. Examples of the technologies that were evaluated and selected include the following:

- CSG will be used as the primary source of fuel for most operating equipment rather than liquid or solid fuels
- Use of energy efficient gas turbines (efficiency approximately 40%)
- Waste heat recovery to supply heat to the hot oil system and the dehydration system regeneration gas is recommended on two of the refrigeration gas turbines
- Excess gas generated during ship loading will be recovered rather than flared to minimise emissions (Note: flaring may be required if a warm ships comes to the facility)
- Acid gas will be vented to atmosphere rather than being incinerated (oxidised) since the feed gas does not contain any sulfur compounds or air toxics.

3.6.8 Telecommunications

Construction phase

There is no communications infrastructure presently available at the LNG facility site. A complete high-speed microwave communications system back to the mainland will be required for both telecommunications and data transfers to service the construction activities. Synergies with other projects on Curtis Island will be investigated.

Operational phase

External telecommunications needs for the operational phase, including voice and data transmission, will be provided by private, point-to-point microwave and cellular-based systems. Additional systems will be installed for localised and internal site communications such as very high frequency ship-to-shore radios and ultra high frequency land mobile radios. The ultra high frequency service will be provided for facility operational use, and the very high frequency service will be provided for carrier, tanker, tug and supply boat communications.

A tower at the LNG facility will provide a microwave link between the LNG facility and a service provider in Gladstone. The tower will support all local RF-based services.

Alternative communication systems including installing cables in the infrastructure corridor between the mainland and Curtis Island during pipeline construction are being considered.

The telecommunications system will conform to current regulatory standards.

3.6.9 Buildings

The following buildings to be required onsite for the operation of the LNG facility:

- Operations control room
- Administration offices
- Maintenance building
- Laboratory
- Compressor control building
- Warehouses and storage buildings
- Guard house and ferry embarkation building
- Electrical substations
- Fire and medical buildings
- AQIS office and customs office.

3.6.10 Materials storage and handing

Materials required for the construction of the LNG facility will be stored handled and disposed of in accordance with relevant Australian Standards and guidelines. Materials include, diesel fuel, paints, solvents, chemicals. Refer to Volume 4, Chapter 16 for further details.

Materials required for processing of CSG to LNG will be stored, handled and disposed of in accordance with relevant Australian Standards and guidelines. Materials include: diesel fuel, propane, ethylene, concentrated N-methyl-diethanolamine (MDEA), antifoam, activated carbon, adsorbent, water treatment chemicals and oils. Refer to Volume 4, Chapter 22 and Chapter 16 for further details.

3.7 Decommissioning

It is expected that individual items of equipment and the LNG facility as a whole will be decommissioned when its operation is no longer economically viable.

Facility decommissioning activities will be carried out in accordance with a decommissioning plan and will comply with regulatory requirements that are in force at the time of decommissioning and good industry practice. The overall aim of the decommissioning plan will be to ensure that the site does not pose an ongoing risk to public safety or the quality of the environment and fulfils community expectations. The decommissioning plan will be prepared for the facility before decommissioning work starts, in consultation with regulatory authorities and relevant stakeholders.

In preparing the decommissioning plan, Australia Pacific LNG will aim to demonstrate how it will reduce as far as practicable the amount of waste requiring disposal. This will include consideration of reuse and recycling alternatives where feasible, such as:

- Removal for use by another operator
- Removal for sale to a third party
- Leaving in place facilities or infrastructure of benefit to the community.

Australia Pacific LNG will consult with relevant regulatory authorities in relation to proposals for facilities or infrastructure to be left in place. It is anticipated that this will include the causeway for the MOF and the beginning of the LNG jetty, as it is predicted that:

- The local benthic habitat and the associated flora and fauna will have adapted to its presence over the 30-year operational life of the Project
- The removal of these facilities would result in a greater environmental disturbance than leaving them in place
- The causeway will be of value to the local community.

It is anticipated that the section of the LNG jetty that continues past the causeway and is mounted on subsea piles will be dismantled, the piles cut off at the mud-line and the debris removed for disposal on land. The dredged access channel to the MOF will not be refilled as the resulting environmental impact would be greater than leaving the channel to reach a natural equilibrium. The same is true for any areas where maintenance dredging is required during operations, although this is not expected to be necessary. At the MOF, this equilibrium will most likely be reached well before decommissioning.

It is anticipated that the TAF will be decommissioned at the completion of construction of the fourth LNG train. Decommissioning of this facility will be undertaken in accordance with the decommissioning plan.

In some instances, certain infrastructure or improvements may also be purchased by the State under agreements between Australia Pacific LNG and the State.

The decommissioning plan will provide for the procedure to be followed for the removal or making safe of plant, equipment, structures and buildings. Where necessary, this will involve depressurising, purging and flushing of hydrocarbons to ensure that the removal process does not result in adverse hydrocarbon releases.

The hydrocarbon product to be processed will be predominantly gaseous; therefore, soil contamination is not expected to be an issue. However, the decommissioning plan will provide for a soil contamination survey to be conducted to determine if there has been any inadvertent contamination (e.g. diesel fuel). If any contamination is discovered, a soil remediation program will be developed and implemented consistent with regulatory requirements and good industry practice at the time of decommissioning.

Where rehabilitation is required, measures and associated monitoring such as those described below are expected to be included within the decommissioning plan:

- Revegetate land to its former vegetation community using native species recorded in that community during preconstruction field surveys
- Species to be sourced locally to promote endemic and local provenance
- Undertake active weed management and control until vegetation becomes established.

References

GPC, 2009a. Gladstone Ports Corporation Fisherman's Landing Northern Expansion Project EIS. GHD, July 2009.

GPC, 2009b. Gladstone Ports Corporation Western Basin Dredging and Disposal Project. GHD, November 2009.