Australia Pacific LNG Project

Volume 4: LNG Facility

Chapter 25: Cumulative Impacts

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25. Cumulative impacts

25.1 Background

The objective of the cumulative impact assessment is to take into account not only the potential impacts of the liquefied natural gas (LNG) facility component of the Australia Pacific LNG Project (the Project), but its effects in combination with the impacts of other proposed projects that may have a significant affect on important environmental, social and economic values in a similar area.

This chapter summarises the potential cumulative impacts associated with the construction and operation of the LNG facility along with relevant other projects. The assessment of impacts was undertaken on the basis of the methodology described in Volume 1 Chapter 5.

There are currently a number of existing, approved or proposed projects within the vicinity of the LNG facility which have the potential to contribute to cumulative impacts. Project suitability for inclusion in the cumulative impact assessment was based on criteria that are explained in Volume 1 Chapter 5.

Volume 1 Chapter 5 also:

- Includes summary details for the assessed projects
- Explains the relationship of the assessed projects and the project selection criteria to the terms of reference requirements for cumulative impact assessment.

The assessed projects are listed in Table 25.1. For more information on these projects, including location figures refer to Volume 1 Chapter 5.

Table 25.1 List of assessed projects

• Australia Pacific LNG Project	• Linc Energy Underground Coal Gasification
• Arrow Energy Gas Field Development	• Moura Link (government project)
• Australian Inland Rail Expressway - Toowoomba to Gladstone Railway	• Nathan Dam and Associated Pipelines (government project)
• Boyne Smelters	• Queensland Curtis LNG Project (QCLNG)
• Cameby Downs (Coal) Expansion Project	• Queensland Gas Pipeline Expansion
• Central Queensland Gas Pipeline	• Shell Australia LNG Project
• Darling Downs Power Station	• Surat Basin Railway
• Dawson Expansion Project	• Surat to Gladstone Pipeline
• East End No. 5 Mine	• Walloon Coal Seam Gas Field
• Fisherman's Landing Port Expansion	• Wallumbilla-Darling Downs Power Station Gas Pipeline
• Gladstone LNG (GLNG)	• Wandoan Coal Project
• Gladstone LNG Project—Fisherman's Landing	• Western Basin Dredging

- Gladstone Pacific Nickel Refinery
- Gladstone Steel Making Facility
- Gladstone-Fitzroy Pipeline
- Wiggins Island Coal Terminal
- Woori Coal Project
- Yarwun Alumina Refinery

These 30 projects were finalised for incorporation in the cumulative impact assessments in October 2009 in consultation with the Department of Infrastructure and Planning. Of the 30 projects, 15 were considered to be relevant when assessing the cumulative impacts associated with the LNG facility due to location, schedule or otherwise. These are defined in Volume 1 Chapter 5 and Table 25.2.

The methodology assumes that all 15 projects are implemented.

The outcomes of the cumulative impact assessments are discussed in Section 25.2.

25.2 Outcomes of cumulative impact assessment

25.2.1 Overview

Table 25.2 below indicates the physical/biological, social, cultural, economic and built environment values that may be affected by cumulative impacts arising from the identified projects. The shaded cells in the table indicate which values are relevant to each of the projects. The analysis was based on information from referenced sources. Australia Pacific LNG has designed its mitigation strategies to address cumulative impacts as far as practicable, particularly those values that are expected to be at most risk of experiencing significant cumulative impacts.

Analysis underpinning the summary tables is provided in sections 25.2.2 through to 25.2.17.

For many of the values (i.e. land, surface water, air quality, noise, heritage and hazard and risk), the impacts arising from the various projects are localised and mitigation strategies are required at the local level, following well established practices and complying with regulatory requirements. As a result, it is considered that the level of risk is not significantly compounded by cumulative effects from other projects and a low summary rating has been identified for these impact categories.

There are a limited number of values (i.e. marine ecology, coastal environment, social, economic and greenhouse gas impacts) for which one or more of the following factors has led to a high rating in terms of impact significance and/or risk:

- There is a relatively high degree of complexity in relation to the characteristics of the values in question
- There is a relatively high degree of complexity in relation to the project related cumulative impact mechanisms
- The available mitigation approaches are not well established and/or regulated and may require the ongoing cooperation of multiple parties.

The remaining values (i.e. landscape and visual, terrestrial ecology, waste and transport) have been given a moderate rating because the pre-mitigation impacts may collectively be considered to represent regional-scale or basin-wide impacts rather than representing clear localised impacts. Despite the broader scale of the impact, these impacts can be mitigated by well established and/or regulated approaches.

Table 25.2 Cumulative impacts matrix

Existing, approved or proposed projects		Affected environmental, social and economic values															
		Soils / land	Landscape and visual amenity	Terrestrial ecology	Marine ecology	Aquatic ecology	Surface water (land only)	Coastal environment	Air quality (NOx only)	Greenhouse gas emissions	Noise and vibration	Waste	Traffic and transport	Heritage	Social	Economic	Hazard and risk
Boyne Smelters Expansion	CON									✓		✓	✓		✓	✓	
	OPS								✓	✓		✓	✓		✓	✓	
Central Queensland Gas Pipeline	CON	✓		✓	✓							✓	✓		✓	✓	
	OPS			✓	✓							✓	✓		✓	✓	
East End Mine Expansion	CON									✓		✓	✓		✓	✓	
	OPS									✓		✓	✓		✓	✓	
Fisherman's Landing Northern Expansion	CON	✓			✓			✓		✓		✓	✓		✓	✓	
	OPS				✓			✓		✓		✓	✓		✓	✓	
Gladstone - Fitzroy Water Pipeline	CON	✓		✓	✓							✓	✓		✓	✓	
	OPS			✓	✓							✓	✓		✓	✓	
Gladstone LNG	CON	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	
	OPS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Gladstone LNG (Fisherman's Landing)	CON	✓		✓	✓			✓		✓	✓	✓	✓		✓	✓	
	OPS			✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	
Gladstone Pacific Nickel	CON	✓		✓	✓					✓		✓	✓		✓	✓	
	OPS			✓	✓				✓	✓		✓	✓		✓	✓	
Gladstone Steel	CON									✓		✓	✓		✓	✓	
	OPS								✓	✓		✓	✓		✓	✓	
Moura Link Railway	CON											✓	✓		✓	✓	
	OPS											✓	✓		✓	✓	
Queensland Curtis LNG	CON	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
	OPS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Shell Australia LNG	CON			✓		✓	✓	✓		✓		✓	✓	✓	✓	✓	
	OPS			✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Western Basin Dredging and Disposal	CON				✓			✓				✓	✓	✓	✓	✓	
	OPS				✓			✓				✓	✓	✓	✓	✓	
Wiggins Island Coal Terminal	CON							✓		✓	✓	✓	✓		✓	✓	
	OPS							✓		✓	✓	✓	✓		✓	✓	
Yarwun Alumina Refinery - Stage 2	CON				✓					✓		✓	✓		✓	✓	
	OPS				✓				✓	✓		✓	✓		✓	✓	
Overall assessment of impact significance/level of risk		Low	Low	Moderate	High	Low	Low	High	Low	High	Low	Low	Moderate	Low	High	High	Low

CON=Construction OPS=Operations

25.2.2 Land

Soils, topography, geomorphology and geology

Potential cumulative impacts resulting from land disturbance on Curtis Island mostly occur during the construction phase. These impacts may include:

- Demand on local extractive resources (extractive resources for construction), with follow-on effects may include increased noise, dust and vibration levels
- Landform modification (stormwater diversion, vegetation clearing and earthworks) resulting from construction and operation of the LNG facility
- Destabilisation of soils (erosion) and sedimentation of Port Curtis during construction
- Loss of topsoil quality and quantity during construction, commissioning, operation and decommissioning resulting from incorrect stripping, prolonged soil exposure, soil inversion, poor rehabilitation
- Soil acidification and decline in downstream water quality (Port Curtis)
- Dust generation during construction

The majority of the identified impacts would occur if appropriate mitigation measures and approved environmental management plans (EM Plans) are not implemented by projects on Curtis Island. It is expected that the residual risk of cumulative impacts would be low if all projects follow regulatory requirements and implement management measures.

Contaminated land and groundwater

Impacts to land and groundwater from potential contamination from facilities on Curtis Island could be caused by releases, spills and leaks of fuels, chemicals and wastes during the construction and operation of these projects. If these occur these impacts will be localised. Anticipating all fuel and chemical storage and handling is in accordance with the Queensland *Dangerous Goods Safety Management Regulation 2001* and appropriate Australian standards the risk of off-site contamination is low. Therefore any contamination that did occur would generally be contained within the facility area and be remediated in accordance with regulatory requirements.

25.2.3 Landscape character and visual amenity

The cumulative effect of the Project, QCLNG and GLNG projects on Curtis Island is considered low, predominantly due to the distance from sensitive receptors.

The establishment of industrial development in the Curtis Island Industry Precinct will replace the existing natural landscape defining the western banks of the Gladstone harbour, with industrial elements reflecting the eastern banks. The views from vistas around Gladstone, such as Auckland Point, Round Hill and Mount Larcom, will be slightly affected by the introduction of industrial development to Curtis Island. However, it is important to note that the industrialisation of the landscape is consistent with the zoning amendments made to the Gladstone State Development Area with the designation of the Curtis Island Industry Precinct.

One of the most significant visual effects relating to the cumulative consideration of the facilities is the effect of night lighting. Other projects propose the use of stack flares which will create a highly visible

effect when the stack flares are in use. Australia Pacific LNG will not contribute significantly to this impact as it proposing ground flares.

The photomontages below illustrate the cumulative impact of the three proposed LNG facilities on the western banks of Curtis Island. Both the QCLNG and GLNG facilities were modelled from information publicly available within their respective environmental impact statements (EISs).

Views from the western and southern sectors will be the most affected from the development of the three LNG facilities proposed for Curtis Island. The eastern sector is visually screened from the LNG facilities by a ridgeline which adjacent to the eastern boundaries of the facilities. Populated areas within the eastern sector, in particular South End, may be affected by a reflective glow effect on surrounding ridge and night sky landscapes, however due to the distance from the facilities and the intermittent use of the flares, these impacts are negligible. The northern sector does not contain many sensitive receptors and views will be limited to acute angles.

Views from the western sector, as described in Volume 4 Chapter 7, will be most affected by the introduction of industrial development within the Curtis Island Industry Precinct. The LNG facilities would appear adjacent to each other and are generally well integrated by the background hills. The visual effect could be high impacts up to a distance of 3km with moderate impacts potentially occurring up to 5km. Figure 25.1 and Figure 25.2 illustrate a view of the three plants from the Gladstone Harbour within the western sector at day and night.

Figure 25.1 Potential view from the water adjacent to QCLNG LNG facility site at day

Figure 25.2 Potential view from the water adjacent to QCLNG LNG facility site at night

The cumulative effect to the south is limited by distance and the acute angles of view to all of the LNG facilities. Similar visual effect would be achieved with high effects experienced out to 3km and moderate effects out to 5km. These effects are therefore restricted to the waters of Gladstone Harbour with low visual effects at sensitive areas of Gladstone. The effect of night lighting on the Gladstone area will potentially be higher than the day time effects. This is the result of the stronger contrast created by direct lighting effects. However, due to distance, the impacts generally remain low. This contrast is weakened by the night lights within existing port facilities between Curtis Island and Gladstone. The potential view of the three facilities from Auckland Point at day and night is presented in Figure 25.3 and Figure 25.4, respectively.

Figure 25.3 Potential view of facilities from Auckland Point at day

Figure 25.4 Potential view of facilities from Auckland Point at night

Further cumulative assessment, including photomontages from various sensitive receptors, can be found in Volume 5 Attachment 13.

25.2.4 Terrestrial ecology

An assessment of terrestrial ecological cumulative impacts must take into account not only the potential impacts of the subject Project, but its effects in combination with the impacts of other proposed projects. The combined projects have the potential to affect regional terrestrial biodiversity values in the absence of effective coordination and cooperation among project proponent and regulatory authorities.

Flora

The Project is one of many proposed or under construction in the greater Gladstone area and the cumulative impacts of these projects is expected to increase the severity and frequency of potential impacts to flora values on site. These projects were selected based on their proximity to the proposed site, availability of information and regional ecosystem (RE) type. Cumulative impacts of surrounding industry encompass the following projects:

- Gladstone LNG Project
- Queensland Curtis LNG Project
- Gladstone-Fitzroy Water Pipeline Project
- Gladstone Pacific Nickel Refinery
- Central Queensland Gas Pipeline.

Vegetation clearing associated with the Project and surrounding industry has the potential to reduce the overall extent in Queensland of those REs present on site. Of the proposed cumulative total cleared, the LNG facility would contribute to almost two-thirds of saltpan vegetation and about one-third of blue gum-ironbark forests and paperbark woodlands to be cleared in the greater Gladstone area. And whilst, the Project would account for about one-quarter of all mangrove shrublands and less than 15% of spotted gum-ironbark forests of the cumulative total proposed to be cleared in the greater area, the combined impact of the projects outlined above would not result in any of these REs falling into a higher conservation status (refer to Table 25.3).

The majority of Curtis Island is well vegetated with similar vegetation communities to those present on site and holds significant corridor and connectivity values as surrounding industry in the greater Gladstone area has led to a significant loss of broad, contiguous tracts of vegetation. The proposed Project would contribute to the loss and fragmentation of vegetation communities in the south-western corner of Curtis Island resulting in an increase in vegetation degradation through edge effects and changes to the floristic structure and composition and hydrological regimes. Increased road and personnel traffic may also promote the introduction and/or spread of weed species. Further information on loss and fragmentation can be found in Volume 5 Attachment 16.

Industry development in the greater Gladstone area particularly on Curtis Island has the potential to significantly impact upon coastal wetlands. The development of Curtis Island would result in an increase in mangrove fragmentation and a decrease in wetland vegetation in this region.

As no endangered, rare or vulnerable (EVR) or regionally significant flora species were recorded on site during field surveys, the Project is unlikely to significantly contribute to the loss or harm of these in the greater Gladstone area and is unlikely to compound the potential impacts on these species from surrounding industry. The LNG facility and surrounding industry do however, have the potential to impact upon suitable habitat for these species through direct clearing of preferred habitat areas or degradation through changes in hydrological and fire regimes and weed invasion.

The LNG facility would contribute to the overall loss of vegetation considered of cultural, recreational and economic value on Curtis Island. However, with its active involvement in the management of the Curtis Island environmental management precinct, Australia Pacific LNG seeks to preserve and enhance the habitat quality on Curtis Island.

Table 25.3 Cumulative impact of vegetation clearing in the greater area on conservation status of REs present on site

RE code	Clearing areas (ha)		Clearing extent represented in Qld (%)		Pre-clearing extent of RE (ha)	Current extent of RE (ha)	Extent of RE post-project/s (ha)		Current remaining pre-clearing extent of RE (%)	Remaining pre-clearing extent of RE post-project/s (%)	
	LNG	All	LNG	All			LNG	All		LNG	All
Of concern REs											
12.3.11	23.9	64.1	0.1	0.1	193,141	47,883	47,859	47,819	24.79	24.78	24.76
12.11.14	26.4	71.6	0.1	0.2	120,693	30,130	30,104	30,058	24.96	24.94	24.91
Least concern REs											
12.1.2	29.5	46.7	0.1	0.2	32,173	28,533	28,503	28,486	87.22	87.13	87.08
12.1.3 Option 2a	1.6	7.0	<0.01	0.01	53,499	50,483	50,481	50,476	94.363	94.360	94.350
12.1.3 Option 1b	2.3	7.7	0.01	0.02	53,499	50,483	50,481	50,475	94.363	94.358	94.348
12.3.7	1.3	3.9	<0.01	<0.01	103,884	53,259	53,258	53,255	51.268	51.267	51.264
12.11.6	73.1	562.1	0.03	0.2	378,000	241,682	241,609	241,120	63.94	63.92	63.78

LNG = Australia Pacific LNG Project – Curtis Island LNG facility component only. All = all projects outlined in section 1.2.4 and all components of the Australia Pacific LNG Project.

Clearing areas are based on data obtained for the Project site during the terrestrial ecology survey and information available in EIS documentation for specific projects (Enertrade 2006; Gladstone Area Water Board 2008; Gladstone Pacific 2007; QGC 2009; Santos 2009a; URS 2007).

RE extents are based on ground-truthed RE data for the proposed Project site and information derived from Accad et al. (2008) for the catchment, subregion and Queensland which is based on RE data up to 2005 and does not include any Department of Environment and Resource Management (DERM) amendments between 2005 and October 2009.

Fauna

The clearing of habitat required for the development of the facility will contribute to the cumulative loss of habitat within the Gladstone area. There is currently no significant development on Curtis Island as such the range of disturbance factors affecting this area is limited. Historic use for cattle grazing and the current disturbance of the area by feral cattle and horses, has affected habitat within the study area. However, habitat within the project area is suitable for a range of EVR and common fauna species. The establishment of the Curtis Island Industry Precinct, within which this facility is located, will result in the direct loss of habitat (including features such as tree hollows, mangroves and tidal mudflats) and indirect habitat loss through increased fragmentation, artificial lighting, noise, traffic, human activity, potential sedimentation and pollutants. The cumulative impacts potentially reduce the dispersal opportunities for a range of small birds, mammals and reptiles.

The effect of artificial lighting on faunal behaviour and community ecology is well documented. The disorientation of marine turtles and nocturnally migrating birds, due to artificial lighting is reasonably well known. However, research and anecdotal evidence indicate the potential for artificial lighting to influence the behaviour of other nocturnal and diurnal species (Longcore and Rich 2004). Frogs have been observed to stop mating when exposed to artificial lighting; their calls resuming once the area was shielded from the light (Longcore and Rich 2004). Small mammals have been observed to alter foraging behaviour in response to artificial light. The behavioural changes associated with illumination are likely to be an anti-predator response because the perceived risk of predation increases with increasing light (Bird et al. 2004). Insectivorous bat species have been observed to congregate around artificial lights to feed on insects. It is, however, only the faster flying bats exploiting this niche while other slower flying insectivorous bat species tend to avoid artificially lit areas (Longcore and Rich 2004). The potential impacts of artificial lighting on any particular species and their severity will vary depending on the ecology of the species, their predator-prey relations, the distance of the core population from the source of light and the reaction of that species to light disturbance. A potentially significant cumulative impact of the developments within the wider study area is the increase of artificial lighting. The implications of this for terrestrial fauna in the area are unknown. To mitigate the effect of night lighting Australia Pacific LNG is committed to use a sensitive lighting approach to reduce light spill.

Wetlands within Port Curtis are utilised by a range of migrating shorebirds for foraging and roosting habitat. Migratory shorebirds are sensitive to disturbance that causes them to stop foraging or waste energy, which is otherwise stored for migration (Geering et al. 2007). The project area has not been identified as a major feeding or roosting ground for migratory shorebirds. However, the cumulative impact of development within the intertidal zone around Port Curtis is likely to increase disturbance to this fauna group. Sensitivity to disturbance varies between species, with some species such as the bar-tailed godwit being particularly sensitive (Davidson and Rothwell 1993). Buffer zones of 150 – 200m around identified important habitat have been determined as a requirement to minimise disturbance to more nervous shorebird species (Paton et al. 2000). If buffers are provided excluding boating activity around the identified important feeding and roosting sites, it can be reasonability determined there will be minimal disturbance to the identified major roosting and feeding areas as a result of the activities of these projects.

The powerful owl has been observed in eucalypt woodland adjacent to the southern boundary of the proposed facility (Sandpiper 2008). This species is a nocturnal hunter, which preys on arboreal mammals (such as possums and gliders). Powerful owls occupy large home ranges. They require large tree hollows for their own nesting requirements and for their prey species (Webster et. al. 2004). The powerful owl is listed as vulnerable under the *Nature Conservation Act 1992*. Based on the

current understanding of this species on Curtis Island, the cumulative impact of the proposed developments within the Curtis Island Industry Precinct could result in the displacement of a potential breeding pair. Powerful Owls are known to occur at Mount Larcom, west of Gladstone, however their distribution on Curtis Island is unknown.

The beach stone-curlew has been sited within the project area, north of the project area at Laird Point and at various locations within the Curtis Island Industry Precinct. The beach stone-curlew is listed as vulnerable under the *Nature Conservation Act 1992*. This species inhabits isolated beaches and is sensitive to disturbance of this habitat. The cumulative impacts of the proposed developments within the Curtis Island Industry Precinct are likely to result in the observed individuals moving away from this section of coastline.

25.2.5 Marine ecology

Conceptually, cumulative impacts in the marine environment range from existing impacts from recreational and industrial uses i.e. prior impacts of similar types, to complex interactions of environmental stresses due to multiple (and differing) impacts. The latter is the norm and is relevant for considering cumulative impacts generated from the proposed LNG facilities on Curtis Island.

A number of potential direct impacts on marine assemblages have been identified and need to be considered in a cumulative sense:

- Dredging and reclamation (discussed further below)
- Discharges to the marine environment from seawater desalination, sewage treatment and stormwater treatment
- Transport of personnel and materials to project areas
- Noise from construction activities in or near marine areas
- Projects' lighting.

Dredging and reclamation works for the Western Basin

Gladstone Ports Corporation (GPC) is currently assessing the cumulative impacts associated with the dredging of the Western Basin in the Western Basin Dredging and Disposal Project EIS. The volume of dredging for the Western Basin is in the order of 50 million m^3 (GPC 2009a) from the development of the Western Basin to provide for port facilities for multiple proposed developments. This volume of dredging makes it one of the largest dredging campaigns ever proposed for Queensland, and Australia. The cumulative impact of this dredging and reclamation is expected to result in:

- A longer period (four to six years) over which turbidity will be generated and suspended sediment transported
- A considerable increase in the spatial scale of the marine habitat disturbed as a result of dredging activities
- Significant increase in the area of intertidal and shallow sub-tidal habitat reclaimed. An estimate of the total area to be impacted is in the order of approximately 700 hectares and this includes areas of high value habitat including seagrass, mangrove and saltmarsh/saltpan
- Hydrodynamic impacts including flow obstruction due to the reclamation footprint
- Increased duration of decant water release from the reclamation areas.

To mitigate the impacts of ongoing dredging, GPC propose to monitor the actual deposition rates and devise a maintenance dredging plan which does not interrupt ship movements. Additionally, the rate of siltation of fine silts could be accommodated by an over-dredging allowance to extend the time between maintenance dredging campaigns.

The material dredged as part of the Western Basin Dredging and Disposal Project is proposed to be placed into bunded reclamation areas, namely the Fisherman's Landing northern expansion and the Western Basin reclamation area. The approximate footprints for the Fisherman's Landing northern expansion and the Western Basin reclamation area are 173.5ha and 235ha respectively. This equates to a total area of 408.5ha which has the capacity to accommodate approximately 55 million m^3 of dredge material (GPC 2009). The capacities of the reclamation areas are designed to cater for dredging material to enable the development of industries in the Port of Gladstone (GPC 2009). By comparison, Australia Pacific LNG's local dredging requirements for the construction of the material offloading facility (MOF) and marine facilities are minor and approximately 100,000m^3 and the material is to be located within the reclamation areas.

In addition to the Western Basin Dredging and Disposal Project, there is dredging proposed by LNG facility proponents for pipeline crossings from the mainland to Curtis Island and local dredging for the marine facilities.

Australia Pacific LNG will continue to address potential impacts from the dredging and reclamation associated with the construction of the MOF and includes marine ecology impact mitigation in the design and construction philosophies. It is anticipated that proposed projects within Port Curtis will adopt mitigation measures to reduce impacts on the marine environment.

Discharges to the marine environment

A number of point source discharges related to seawater desalination, sewage and stormwater are proposed for the projects under consideration in Port Curtis. The discharges of brine from desalination plants from three proposed LNG facilities on the western side of Curtis Island have been modelled and predictions are shown in Figure 25.5. While the predicted impact to the marine environment was minimal there remain significant uncertainties regarding the exact nature and location of these discharges, and these factors are outside the control of Australia Pacific LNG (refer to Section 25.2.8).

When considered in concert, it is plausible that all proposed discharges to Port Curtis may result in long term impacts that are greater than those estimated for individual projects. A diversity of constituents is contained in these discharges and it is currently uncertain how they would accumulate and interact in Port Curtis over time.

Transport of personnel and materials to project areas

When vessel based activities overlap with habitats utilised by dugong and marine turtles they are at particular risk from boat strike which can cause significant injury or mortality. Marine turtles and dugong are vulnerable to boat strike when they are at the surface breathing and resting between dives. It is commonly accepted that vessel speed and water depth are the main factors affecting the risk of boat strikes with faster vessels in shallower water posing a greater risk. Annually, boat strike is one of the most significant known causes of human-induced dugong mortality (Greenland and Limpus 2008).

There is current scientific evidence suggesting that death and injury caused by boat strike has a significant impact on dugong populations in Queensland (Grech and Marsh 2008). A recent study has found the reaction time of dugongs does not change in accordance with the speed of an approaching

vessel and therefore faster moving vessels have a greater probability of causing dugong mortality (Hodgson 2004).

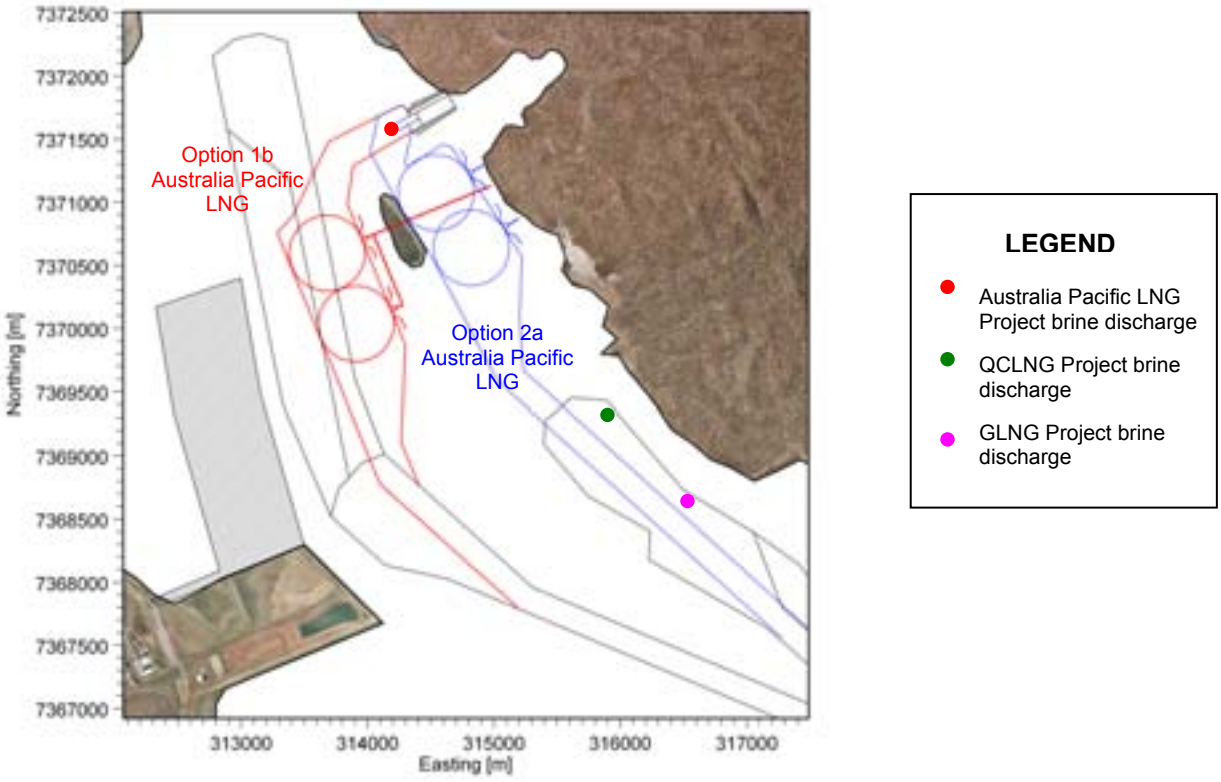

Figure 25.5 Desalination concentrate discharge locations for cumulative water quality impact assessment

Slow moving vessels such as tugs, barges, and LNG ships are considered to pose an inherently low risk of boat strike to dugong and marine turtles in Port Curtis. However, the number of projects proposed within Port Curtis relying on shipping increases the potential of boat strike.

Australia Pacific LNG are committed to working with the GPC and other port users to develop an industry wide approach to minimise boat strikes to marine mammals and turtles

Noise from construction activities

Activities associated with construction in the marine environment and operations, in particular vessel movements, have the potential to displace dugong and cetaceans from critical habitat and interrupt critical behaviours through the creation of underwater noise. Cetaceans have been found to avoid some human sound sources for ranges of several kilometres, abandoning valuable habitat in the process (Tyack 2008). There are a number of underwater noise sources that may impact on cetaceans and dugong. These include pile driving and vessel traffic.

Percussive piling for the construction of the MOF jetty is most likely to be of a frequency and volume that will cause disturbance to dolphins. While information is limited, Jefferson et al. (2009) identified that Indo-Pacific dolphins avoid areas during pile driving but return once construction ceases. Overall, it is considered that disturbance to dolphins will occur during the construction phase as a result of pile driving, however, dolphins will again utilise the area once construction activities cease. The overlap of dolphin populations with areas of high vessel activity suggests at least, in part, they habituate to boating activities.

Noise generated by vessel activity can also change the behaviour of dugong and result in alienation from important habitat. Potential energetic costs of boat disturbance to dugongs include: a reduction in energy intake, the energy expended while moving, and the possible cost of moving to a different patch on the seagrass beds. Disturbed dugongs may be forced to spend time searching for alternative feed patches and may be forced to feed on less desirable patches with lower nutritional value. Hodgson (2004) found that dugongs were less likely to remain feeding if a boat passed within 50m than if it passed at a greater distance. These movements occurred in response to boats passing at all speeds, and at distances of less than 50m to over 500m. Such disruptions to feeding can affect the health of a population if they occur at significant levels. However, if animals can move to suitable nearby habitat then this may largely mitigate impacts from disturbance (Gill et al. 2001). In the case of Port Curtis, existing high value dugong (seagrass) habitat occurs in areas unaffected by the proposed developments.

The cumulative impacts of projects affecting Port Curtis will increase the number of noise sources and duration of noise created within Port Curtis. This in turn has the potential to displace marine population from habitat areas for longer periods of time.

Australia Pacific LNG seeks to work collaboratively with other Western Basin projects to establish a process for visual observations and recording of dugongs and cetaceans and to offset the loss of sensitive marine habitats.

Project lighting

Although the nearest nesting beach is in the vicinity of South End on Curtis Island, it is plausible lighting glow from the operational LNG facilities, compounded by the heavily lit Gladstone coastline and other proposed projects, could impact sea finding behaviour of hatchlings and the selection of nesting areas by adult flatback turtles.

No single solution, but rather a combination of solutions is necessary to mitigate light impacts on marine turtle nesting while allowing for safe and efficient construction and operation of coastal infrastructure. Solutions include:

- Physically shielding the lights and directing the lights onto work areas
- Lowering the height of lights
- Reducing the amount of reflective surfaces through the use of matt paints on surfaces where practical
- Use of motion detecting sensors and light timers.

Using long wavelength red, orange or yellow lights and avoiding short wave length white lights is considered effective at mitigating lighting impacts on nesting loggerhead turtles, but is not proven to be effective at mitigating impacts on flatback turtles and as such will not specifically be employed to mitigate the risk to this species.

Australia Pacific LNG will use a sensitive lighting approach to reduce light spillage impact on marine fauna.

25.2.6 Aquatic ecology

The aquatic habitat value of the ephemeral drainage lines and wetlands on the Australia Pacific LNG site is considered to be low. It is expected that other wetlands throughout Curtis Island would provide higher habitat prospects than those within the development footprint. Notwithstanding this, the

potential cumulative effect of the proposed LNG facilities along the western coastline of Curtis Island, south of Laird Point, may impact on the overall quality of aquatic habitat available if extensive filling or redirection of drainage lines or watercourses occurs at each site.

It is anticipated that with the implementation of effective environmental management plans, potential impacts to freshwater aquatic flora and fauna will remain low.

25.2.7 Surface water and watercourses

The analysis within Volume 4 Chapter 11 indicates the potential impacts on surface water resources on Curtis Island are primarily related to:

- Changes in drainage behaviour from the area due to diversion of runoff
- Increased volumes of runoff and peak flows discharged from the area due to creation of impervious areas and improved drainage characteristics
- Changes in storm runoff water quality due to conversion from rural/forest to industrial catchment conditions.

Increased flows and volumes of runoff discharged from an individual facility are likely to have a negligible impact on water levels in Port Curtis due to the relatively insignificant volumes of runoff compared to the volume of Port Curtis.

It is considered that the cumulative impacts on water quality are likely to be relatively minor in magnitude but may be distributed over an extensive area due to tidal action.

Hydrodynamic modelling results presented in Volume 4 Chapter 12 indicate that the flushing time for Port Curtis between The Narrows and Gatcombe Head is approximately 60 days. Thus, storm runoff discharged to Port Curtis may persist for significant durations following runoff events until finally flushed out of the system.

Should well established practices and/or regulatory requirements be implemented by proposed projects, this low risk conclusion is unlikely to be affected by the development of all proposed projects in the vicinity.

25.2.8 Coastal environment

Far-field cumulative water quality impacts associated with the combined Australia Pacific LNG Project, QCLNG Project, and GLNG Project desalination plant brine discharges have been assessed using the MIKE21-FM hydrodynamics model coupled with an advection-dispersion module. Brine discharge locations for the three LNG proponents are presented in Figure 25.5.

At each discharge location a conservative tracer (the desalination concentrate) was entered to the model domain at a constant rate corresponding to approximately:

- 2400m^3/day (27.8L/s) for Australia Pacific LNG
- 1440 m^3/day (16.7L/s) for QCLNG, and
- 1300 m^3/day (15.0L/s) for GLNG.

The location and discharge rate for GLNG and QCLNG were obtained from BMT WBM (2009a) and BMT WBM (2009b) respectively. The combined desalination concentrate discharges were simulated for a six month period.

The predicted cumulative mean salinity increase at the entrance to Graham Creek and along the Curtis Island shoreline from Laird Point to China Bay for Australia Pacific LNG ship berthing Option 1b is approximately 0.06ppt and for Option 2a is approximately 0.05ppt.

For both Options 1b and 2a the maximum salinity close to Laird Point is predicted to exceed 36.11ppt and within The Narrows and Graham Creek the maximum salinity ranges between 36.06ppt and 36.09ppt. Figure 25.6 shows the extent of the maximum salinity concentrations resulting from the cumulative brine discharges.

The predicted mean and maximum increases in salinity due to the cumulative discharges of desalination brine are well within the natural ambient salinity variations and would not be detrimental to the marine environment. While the predicted impact to the marine environment was minimal there remain significant uncertainties regarding the exact nature and location of these discharges, and these factors are outside the control of Australia Pacific LNG. Salinity tolerances for a range of marine fauna are summarised in Volume 4 Chapter 10.

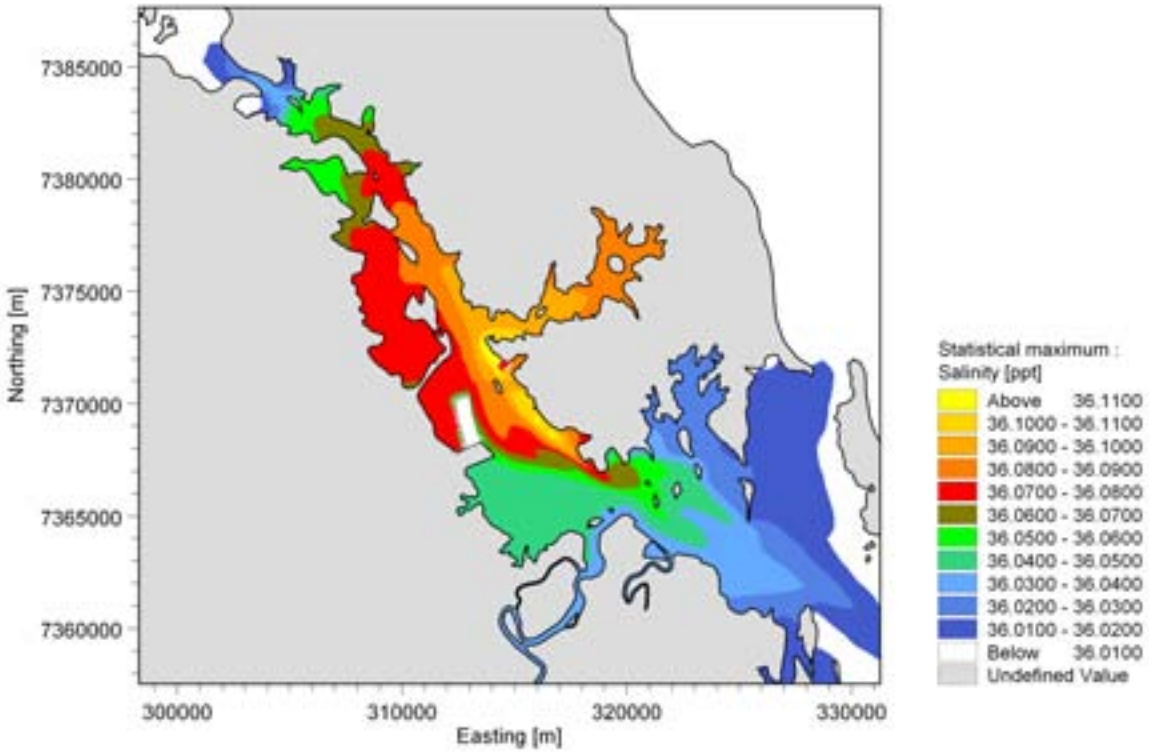

Figure 25.6 Option 2a – Cumulative desalination brine predicted statistical maximum salinity resulting from Australia Pacific LNG, GLNG, and QCLNG discharges

25.2.9 Air quality and aviation safety

Air quality

Of the potential emissions emitted from the LNG facility, the key pollutant in relation to cumulative impacts is nitrogen dioxide. A detailed modelling assessment of nitrogen dioxide taking into account all current, approved and proposed industries in the Gladstone region has been undertaken.

A two-level approach was adopted to predict the cumulative effect of emissions from the LNG facility and existing, approved and other potential industrial developments in the Gladstone region. This

assessment utilised the Gladstone Airshed Modelling System version 3 (GAMSv3), a regional airshed dispersion modelling tool developed for the Department of Infrastructure and Planning for use in planning studies. GAMSv3 was used to predict background levels of NO_X. A fine resolution micro-scale dispersion model was used to predict ground-level concentrations due to the LNG facility.

The industrial plants included in GAMSv3 are:

- Gladstone Power Station
- Queensland Alumina refinery
- Boyne Smelters
- Rio Tinto Yarwun refinery Stage 1
- Rio Tinto Yarwun refinery Stage 2 (not built)
- Cement Australia Yarwun plant
- Orica Yarwun facility
- Queensland Energy Resources (not built)
- Queensland Pacific Nickel (not built).

Other LNG facilities included in the assessment are:

- Queensland Curtis LNG (QCLNG) at Curtis Island
- Gladstone LNG (GLNG) at Curtis Island
- LNG Limited (LNG Ltd) at Fisherman's Landing
- SUN LNG at Fisherman's Landing

Based on this cumulative impact assessment, ground-level concentrations of all air pollutants associated with the LNG facility with existing and approved industries (using GAMSv3) and all proposed LNG facilities are predicted to be below the air quality objectives at all sensitive receptors (Figure 25.7) Refer to Volume 4 Chapter 13 for further details.

Aviation safety

The aviation assessment of the operation of the Project included modelling of vertical plume velocities, associated with stack and flare emission sources during both normal and non-routine operating conditions (refer to Volume 4 Chapter 13). This assessment identified that certain operating conditions have the potential to generate plumes that do not meet the civil aviation safety authority (CASA) guideline for vertical velocities above the PANS-OPS.

Assessment of aviation safety undertaken by other proposed LNG developments has also identified operating scenarios that do not meet the CASA guideline for vertical velocities above the PANS-OPS. A quantitative cumulative assessment of aviation safety of the Australia Pacific LNG and other existing or proposed industrial developments is not necessary as the plumes from these facilities will not merge during normal operating conditions.

The CASA advisory circular does not include a method for dealing with a cumulative assessment. As such, a cumulative assessment of the risk due to increased frequency of events if all other potential LNG facilities proceed has not been undertaken. Should an assessment of plume vertical velocities

for a particular development indicate an exceedence of the CASA guideline above the PAN-OPS, CASA refers to Air Services Australia to amend the flight charts.

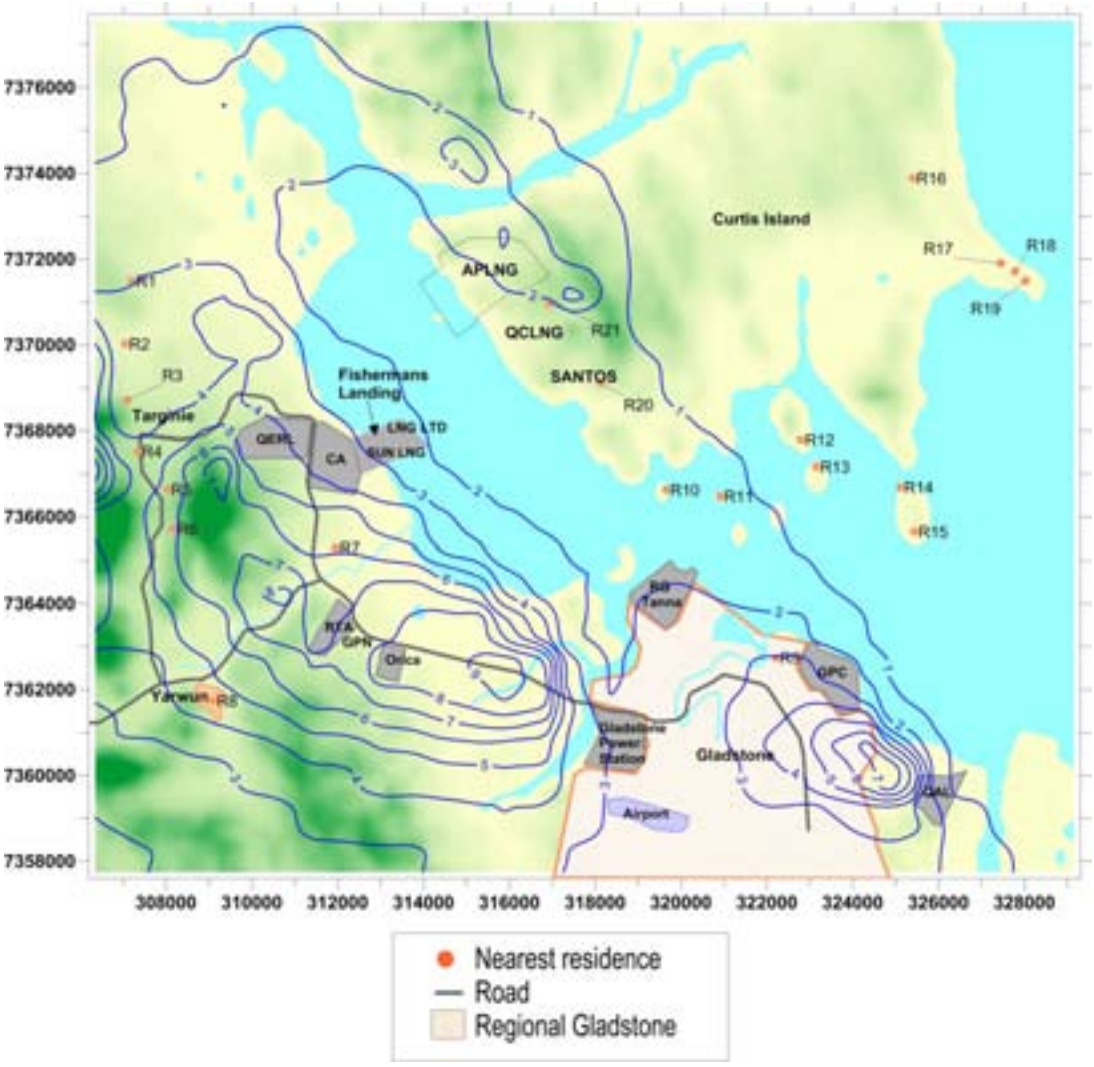

Figure 25.7 Predicted annual average ground-level concentrations of nitrogen dioxide for the LNG facility during normal operations, with GAMSv3 background plus all other LNG plants (units = µg/m^3)

25.2.10 Greenhouse gas emissions

For this cumulative impact assessment, the impact of all major projects in the region on state and national greenhouse gas (GHG) emission inventories was assessed in comparison to the year 2007. The impact on Australia's projected GHG emissions for 2030 was also considered. Table 25.4 shows the scope 1 (and where relevant, scope 2) GHG emissions of the Project and other major projects in the region, specifically those projects currently undergoing expansion and new projects (including CSG developments) not yet operating. For the Project, GHG emissions from activities associated with the gas fields and gas pipeline, the other gas fields and the LNG facility were considered.

Table 25.4 Summary of GHG emissions for major projects in the Gladstone region

Project	Emissions data Mt CO_2-e/yr	
Australia Pacific LNG – gas fields and pipeline	3.3	Estimated annual scope 1 GHG emissions for the Project gas fields and the gas pipeline during peak LNG production i.e. for operation of the 4 train LNG facility.
Australia Pacific LNG – other gas fields not assessed in this EIS	2.4	Additional estimated annual scope 1 GHG emissions from other gas fields during peak LNG production
Australia Pacific LNG – LNG facility	5.5	Additional estimated annual scope 1 GHG emissions for the Australia Pacific LNG facility with four-train operations producing approximately 18Mtpa of LNG
Boulder Steel	n/a	Gladstone Steel Plant project. EIS due to be lodged; GHG data not publicly available (refer Boulder Steel 2009)
Boyne Smelters Reduction Line Expansion	3.1	Total scope 1 and 2 GHG emissions for the expansion of plant's 3 reduction lines (refer Boyne Smelters 2002)
East End Mine Expansion	n/a	GHG data is not publicly available
GLNG facility (LNG facility)	3.7 3.5	Average annual scope 1 GHG emissions for the 10Mtpa case using the upper limit GHG emissions; covers operations and land-clearing (refer Santos 2009b) Average annual scope 1 emissions (10Mtpa) assuming ConocoPhillips' Optimized Cascade® process is adopted
Gladstone LNG, Fisherman's Landing (LNG facility	0.6 0.6	Estimated scope 1 GHG emissions for gas field and pipeline operations carried out by Arrow Energy/AGL (refer Gladstone LNG 2008) Estimated maximum annual scope 1 and 2 GHG emissions for 2 Trains (3Mtpa)
Gladstone Pacific Nickel	0.2 0.6	Stage 1 emissions: scope 1 and 2 GHG emissions per annum (refer URS Australia 2009, Appendix M) Stage 2 emissions: scope 1 and 2 GHG emissions per annum
Moura Link Railway	0.5	Scope 1 and 2 GHG emissions per annum (refer Queensland Rail 2008, section 10)

Project	Emissions data Mt CO_2-e/yr	
QCLNG	2.5	Maximum annual scope 1 GHG emissions for gas field and pipeline emissions scaled by 1.5 for three train operations (refer QGC Limited 2009)
	3.0	Maximum annual scope 1 GHG emissions for 11Mtpa operations (includes commissioning phase)
Shell LNG (with Arrow Energy)	4.8	Estimated scope 1 GHG emissions. Only initial advice statements available at this time (Shell CSG (Australia) Pty Ltd 2009)
	4.8	Estimated scope 1 GHG emissions for a 16Mtpa LNG facility with 4 LNG trains
GPC Western Basin Dredging	0.3	Data provided in EIS, assumed to be scope 1 GHG emissions (refer Gladstone Ports Corporation 2009a, Appendix T)
GPC Fisherman's Landing Northern Expansion	0.03	Data provided in EIS, assumed to be scope 1 GHG emissions (refer Gladstone Ports Corporation 2009b, Appendix F)
Wiggins Island Coal Terminal	n/a	EIS released; GHG emissions data not reported (refer Central Queensland Ports Authority 2007)
Yarwun Alumina Refinery	0.002	Stage 2 of the expansion will increase output to 3.4Mtpa. Reported GHG emissions data may not be reliable and are therefore not used in this analysis

For the other major projects, GHG data were sourced from EISs where these were publicly available.

Data for the Gladstone Steel Plant, the East End Mine Expansion, the Wiggins Island Coal Terminal and the Yarwun Alumina Refinery were either not available or not reliable for use in this analysis.

Data on the estimated GHG emissions for the proposed Shell LNG project were not publicly available at this time. Scope 1 GHG emissions data for the Shell LNG project were therefore estimated based on the average GHG emissions intensity for the Australia Pacific LNG, GLNG, QCLNG and Gladstone LNG projects which is 0.3Mt CO_2-e/Mtpa. The estimated LNG production capacity of the Shell LNG plant is 16Mtpa LNG; therefore, the estimated GHG emissions are 4.8Mt CO_2-e/yr. The gas field GHG emissions were estimated for the Shell LNG and Gladstone LNG (Fisherman's Landing) projects on the basis that the ratio of gas fields/LNG plant GHG emissions is about 1:1 on average.

Note that some GHG emissions estimates are for peak annual GHG emissions (for example, Australia Pacific LNG, Gladstone LNG and QCLNG). GLNG GHG emissions data is an annual average and the Shell LNG data are coarse estimates. Complexities due to differing CSG production ramp-up periods for each project were not considered in this analysis.

It should be emphasised that the data presented in Table 25.4 for Shell LNG and Gladstone LNG projects are estimates. A comparison of the GHG intensity data for the proposed Australia Pacific LNG, Gladstone LNG, GLNG and QCLNG LNG facilities is presented in more detail in Volume 5 Attachment 31.

The total GHG emissions for these major projects in the Gladstone region are approximately 39Mt CO_2-e/yr. These projects would represent 6.5% of Australian GHG emissions in 2007 (597 Mt CO_2-e). In terms of Queensland state GHG emissions in 2007 (182 Mt CO_2-e), these projects represent 21.4% of state GHG emissions.

A second scenario considers if all projects were operational in 2030. From the Garnaut Report (Garnaut 2008), Australia's GHG emissions under a business as usual scenario without a carbon pollution reduction scheme could reach approximately 800Mt CO_2-e. If it is assumed that all facilities would continue their GHG emissions at their current or presently projected levels then total GHG emissions from the major projects in the Gladstone region represent 4.9% of Australia's net GHG emissions. Of this 4.9%, 3.2% is related to LNG projects, which could avoid global emissions of 190Mt CO_2-e/yr based on 42Mtpa of export LNG substituting for coal in power generation. This avoidance is equivalent to 24% of Australia's emissions in 2030.

25.2.11 Noise and vibration

The cumulative impact of industrial noise at the nearest receptors from other proposed industrial facilities on Curtis Island or the nearby mainland has been modelled. The cumulative modelling was based on predicted noise contours for the LNG facility added to the noise contours presented in the EIS reports of the following proposed projects:

- Queensland Curtis LNG, Curtis Island (adjoining proposed site)
- Gladstone LNG, Curtis Island
- Gladstone LNG, Fisherman's Landing
- Wiggins Island Coal Terminal[1].

[1] Noise mapping for this project was presented as a continuously graduated colour key

The noise impact of existing facilities in the region are not included in the cumulative noise mapping as the contributions of these projects are implicitly included in the assessment by virtue of the baseline noise monitoring and DERM guideline methodology for determining planning noise levels (PNLs).

The noise contribution from the LNG facility may be a significant component of the cumulative noise level at residential receptors in the Targinie area and at South End. However at both of these locations the predicted cumulative noise complies with the LNG facility design PNLs.

The cumulative impact of industrial noise is presented in Table 25.5 and noise contours are presented in Figure 25.8.

Table 25.5 Assessment of cumulative industrial noise levels (L_{Aeq} dBA)

Receiver	APLNG design PNLs	APLNG predicted noise contribution	Other future nearby plant noise contributions	Sum of all noise contributions
Targinie area	36	35	30	36
Passage area (Tide Island)	38	33	55	55
Gladstone City	30	25	35	35
Fisherman's Rd	39	35	41	42
South End	30	25	23	27

For further information about the predicted noise levels and contours, refer to the technical report at Volume 5 Attachment 34.

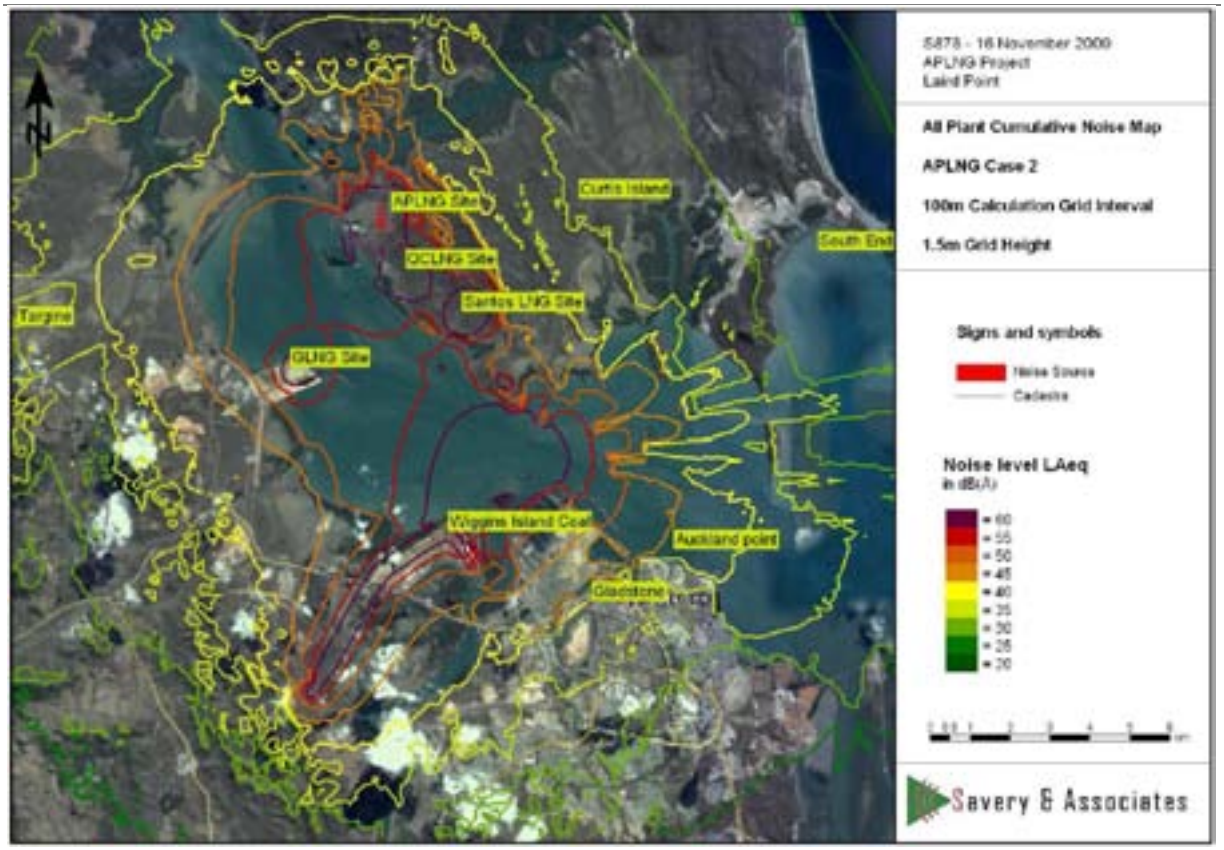

Figure 25.8 Cumulative noise map from LNG facility and other industrial sources

25.2.12 Waste

A qualitative cumulative impact assessment was undertaken of the waste management infrastructure and waste management contractors available to manage waste for the LNG facility, as well as proposed and operating industrial facilities in the Gladstone area. This assessment was based on available waste generation information for particularly general, regulated, and recyclable wastes. These waste streams were selected because it was considered that they pose a potential impact in relation to available waste management infrastructure to recycle, treat or dispose. Projects where waste generation data was available included:

- Central Queensland Gas Pipeline
- Fisherman's Landing Port Expansion
- Gladstone LNG (Fisherman's Landing)
- Gladstone Pacific Nickel
- Gladstone Steel
- Gladstone LNG
- Queensland Curtis LNG
- Western Basin Dredging and Disposal
- Wiggins Island Coal Terminal.

Overall, the estimated waste quantities for the above projects and Australia Pacific LNG's contribution to these quantities are outlined in Table 25.6.

Table 25.6 Cumulative waste management quantities

Waste stream	Estimated waste quantity other projects and Australia Pacific LNG (tonnes/year)	Australia Pacific LNG's contribution to the cumulative waste quantities
General waste	35,100	0.5%
Recyclable waste	9,050	24%
Regulated waste	2,300	7.6%

It is expected that the general waste from these projects would be transported to the Benaraby landfill located within the Gladstone Regional Council area. The quantity of general waste generated by all the proposed projects is approximately equivalent to the current throughput of general waste received at this landfill in a year.

Further, to mitigate the potential cumulative impacts on local waste management infrastructure, the following information is provided:

- Informal discussions with waste management contractors Transpacific Industries, JJ Richards and Sons and Cleanaway provided information that there would be sufficient waste management contractors and infrastructure to accommodate solid and liquid waste streams such as recyclable waste, general waste and regulated waste, from this LNG facility and other existing and future industrial facilities
- Discussions with Gladstone Regional Council officers indicated that Benaraby landfill has sufficient airspace available to cater for general waste from the region for approximately 150 years based on current demand of approximately 35,000 tonnes per year. Although the increased quantities of general waste from this, other existing and future industrial facilities and domestic waste will reduce the expected landfill life, it is expected that with emerging waste management efficiencies this would not impose a significant impact to Council's waste management infrastructure for the foreseeable future (Pers. comms. Scott Prior, Co-ordinator Waste Services, December 2009).

25.2.13 Traffic and transport

Road network

The traffic and transport analysis outlined in Volume 4 Chapter 17 highlights that the key cumulative impact associated with the Project and other proposed regionally significant projects will come from substantial increases in road traffic over time.

The technical analysis summarised in that chapter indicates that upgrade works will ensure the cumulative impact of all LNG projects and other regionally significant projects are mitigated in a satisfactory manner.

As part of this technical analysis, when determining the impact of the project, four components of the road infrastructure network were analysed as follows:

- Road link capacity
- Intersection capacity
- Pavement capacity
- Bridge capacity.

Road link, intersection and pavement capacity were assessed using a spreadsheet-based sketch traffic model. This combined background traffic and growth rates with project generated traffic. The impact of the Project on bridges was assessed qualitatively, as only limited bridge condition data was made available for this assessment.

The projected cumulative traffic increases will require the following works to upgrade the road network in the relevant parts of the Gladstone region:

- Upgrades to federal, state and local government road links within the region
- Pavement rehabilitation works brought forward on federal, state and local government road segments, due to heavy vehicle traffic generated by the proposed projects.

The cumulative impact of the other regionally significant projects, particularly other LNG projects, is expected to bring forward the need to alter the following road links within the study area:

- Gladstone-Mt Larcom Road chainage 3.258 to 12.292 (Blain Drive to Reid Road). Alterations are to be brought forward from 2020 to 2018 for Blain Drive to Red Rover Road and from 2029 to 2028 for Red Rover Road to Reid Road.
- Dawson Highway chainage 2.24 to 3.13 (Blain Drive to Philip Street). Alterations are to be brought forward from 2028 to 2027.

Table 25.7 summaries the impacts of the cumulative impacts at the intersections within the study area. The intersection impacts, as assessed in the technical report contained in Volume 5 Attachment 35 have considered the development traffic from all components of the Project, including the traffic associated with the gas pipeline and the gas fields.

Table 25.7 Intersection impacts

Intersection	Current layout	Impact
Dawson Highway/Dawson Road/Breslin Street	Signalised	The existing intersection will operate within capacity for the full planning horizon under background traffic only The cumulative traffic from the regionally significant projects will have a minor impact on the operation of the existing intersection
Dawson Highway/Blain Drive/Herbertson Street	Two lane roundabout	The existing intersection will operate within capacity to 2021 under background traffic only The cumulative traffic from the regionally significant projects will result in the intersection reaching capacity in 2012
Dawson Highway/Philip Street/Shopping Centre	Two lane roundabout	The existing intersection currently fails during the PM peak hour. It is noted that the roundabout would be expected to operate at a higher level as three legs of the roundabout are metered during the peak hour periods

Intersection	Current layout	Impact
		Cumulative traffic from the regionally significant projects will have a worsening effect on the intersection performance, particularly during the peak construction years of 2013 and 2019
Dawson Highway/Penda Avenue	Two-lane roundabout	The existing intersection will operate within capacity to 2013 under background traffic only The cumulative traffic from the regionally significant projects will result in the intersection reaching capacity by 2011
Dawson Highway/Aerodrome Road	Signalised	The existing intersection will operate within capacity to 2014 under background traffic only The cumulative traffic from the regionally significant projects will result in the intersection reaching capacity by 2010
Dawson Highway/Chapman Road/Harvey Road	Two lane roundabout	The existing intersection will operate within capacity to 2014 under background traffic only The cumulative traffic from the regionally significant projects will result in the intersection reaching capacity by 2012
Dawson Highway/Don Young Drive	Priority controlled	The existing intersection will operate within capacity to 2018 under background traffic only The cumulative traffic from the regionally significant projects will result in the intersection reaching capacity by 2016
Dawson Highway/Kirkwood Road	Priority controlled	The existing intersection will operate within capacity for the full planning horizon under background traffic only The cumulative traffic from the regionally significant projects will have a negligible impact on the operation of the existing intersection and the intersection will operate within capacity for the full planning horizon
Dawson Highway/Bruce Highway	Priority controlled	The existing intersection will operate within capacity to 2012 under background traffic only The cumulative traffic from the regionally significant projects will have a minor impact on the operation of the existing intersection but will not result in bringing forward the need for the alteration earlier than 2012
Hanson Road/Blain Drive/Alf O'Rourke Drive	Single-lane roundabout	The existing intersection currently fails during the AM peak hour under background traffic only The cumulative traffic from the regionally-significant projects will have a worsening effect on the intersection performance, particularly during the peak construction years of 2013 and 2019
Hanson Road/Red Rover Road	Single-lane roundabout	The existing intersection will operate within capacity to 2016 under background traffic only The cumulative traffic from the regionally significant projects will result

Intersection	Current layout	Impact
		in the intersection reaching capacity by 2010
Gladstone-Mt Larcom Road/Landing Road	Priority controlled	The existing intersection will operate within capacity to 2019 under background traffic only The cumulative traffic from the regionally significant projects will result in the intersection reaching capacity by 2016
Gladstone-Mt Larcom Road/Calliope River Targinie Road	Priority controlled	The existing intersection will operate within capacity for the full planning horizon under background traffic only The cumulative traffic from the regionally significant projects will have a negligible impact on the operation of the existing intersection and the intersection will operate within capacity for the full planning horizon
Bruce Highway/Gladstone -Mt Larcom Road	Priority controlled	The existing intersection will operate within capacity for the full planning horizon under background traffic only The cumulative traffic from the regionally significant projects will have a negligible impact on the operation of the existing intersection and the intersection will operate within capacity for the full planning horizon

Australia Pacific LNG is committed to working with state and local government and industry regarding the upgrades that may be required to meet the increased demands from regionally significant projects.

Air services

It was estimated that the additional passenger movements associated with the construction of the Project's LNG facility is between 50 and 80 per day. An estimate of the additional passenger movements associated with the construction of the LNG facilities for the Queensland Curtis Island LNG and Gladstone LNG has been made. It is expected that up to an additional 120 personnel associated with these projects may pass through the airport in any one day during the same period.

In order to minimise the potential impacts, Australia Pacific LNG will work with industry to optimise roster timings and reduce daily passenger movement peaks.

Shipping network

With a probable cumulative LNG capacity of 28Mtpa in the Western Basin (numbers based on Blueprint for Queensland's LNG Industry, Department of Employment, Economic Development and Innovation, 2009) approximately 400 LNG ship visits per year are anticipated. This equates to slightly more than one LNG ship per day. The GPC's strategic plan envisages an increase in planned port capacity to 300 million tonnes per year within the next 50 years, which is nearly four times the 2008 throughput. The proposed addition of approximately 400 LNG ship visits per year equates to an increase in harbour traffic of approximately 7 percent of the predicted increase in shipping as defined in the GPC's strategic plan.

A model simulating Gladstone's shipping operations was undertaken in 2009. This assessed the traffic flow within the Gladstone harbour and included a number of LNG cumulative projects. The report concludes that using improved management logic, only a marginal decrease in average port performance (with the introduction of LNG trades), is expected.

There is expected to be an increase in small craft movement, mainly in the Fisherman's Landing northern expansion area. The impact of increased small craft traffic will depend upon the number of projects being constructed at the same time.

An initial appraisal of the marine traffic inside the Port of Gladstone suggests that congestion within the Western Basin/Clinton and Auckland channel areas is likely to be a significant issue for the cumulative case due to existing and proposed shipping as well as the proposed dredging operation (Western Basin Dredging and Disposal Project).

25.2.14 Heritage

A cumulative impact assessment on heritage values was limited to Curtis Island. Impacts on Indigenous and non-Indigenous heritage values have been investigated in Volume 4 Chapter 18 and Volume 4 Chapter 19 respectively.

Indigenous

The LNG facility site will occupy an area of modified open forest, mangroves and estuarine mud flats. The entire island has, because of its location and history of isolation, remained relatively wooded, in contrast to the heavy industrial development of Gladstone opposite. Archeological investigations undertaken by Rowland (1987) along the coastline from Bundaberg to Round Hill Creek found that sites were mostly located on rocky headlands or in sheltered estuaries and small shell scatters were found along sections of open beach.

In addition to impacts that will arise from construction of the LNG facility, additional infrastructure will occur within and near the site, in the form of a transmission pipeline, to be built to the north and east of the facility. Any potential impacts to Indigenous heritage sites and places will be managed through the mechanism of the negotiated cultural heritage management plan (CHMP).

In addition to the effects on Indigenous heritage sites associated with construction of this pipeline, are the potential effects of several other LNG facilities and pipelines planned by other proponents located on Curtis Island. These other projects could potentially place other Indigenous heritage sites at risk, however, Australia Pacific LNG understands that the respective proponents are managing Indigenous cultural heritage in a similar manner to Australia Pacific LNG, through the development and implementation of CHMPs.

Non-Indigenous

In addition to impacts that will arise from construction of the LNG facility, other associated infrastructure is planned on Curtis Island. A pipeline to supply the LNG facility with gas will be built to the north and east of the facility. A further pipeline will then be routed south to supply proposed GLNG and QCLNG facilities. This pipeline is anticipated to result in further impacts to non-Indigenous heritage sites on Curtis Island. The proposed pipeline route crosses the historical fence line (identified in Volume 4 Chapter 19), 350m to the north of the LNG facility boundary, and will result in the loss of a further 5 fence posts, however, two of these are no longer standing.

The other LNG projects will also result in impacts to sites associated with the pastoral industry on Curtis Island. Two pastoral sites will be lost through development of the GLNG LNG plant site (Archaeo 2009): the Chinaman's Bay loading site (HAS-29) and Curtis Island industrial working site (HAS-30). Disused cattle yards (Site CINICH01) will be destroyed by the construction of the QCLNG LNG plant (QGC 2009 Volume 8: 78).

Through a commitment to archival recording of these impacted sites as detailed in the GLNG project EIS and the QCLNG project EIS, recovery of information on the land use of the island will ensure that any loss of information on the pastoral use of the island is minimised.

25.2.15 Social impacts

The development of multiple projects within the LNG facility study area will impact on the local social environment and values. These impacts are broadly consistent with those associated with the Project in isolation, yet the probability and consequences (if not appropriately mitigated) are greater.

In the context of social impacts, quantitative and qualitative tools (for example, modelling and stakeholder consultation) were used to evaluate the collective information from the projects to assess the cumulative impacts to the greater Gladstone region. As with the Project level assessment cumulative social impacts have been classified according to a number of categories identified through existing knowledge of the study area and contemporary social impact assessment practices, and then refined during the Australia Pacific LNG impact assessment workshops. Results from the social cumulative impact assessment are outlined in Table 25.8.

Table 25.8 Cumulative social Impact

Impact category	Construction/ operation	Cumulative impact
Population	Construction	Modelling shows that approximately 9,500 construction workers will be required during the peak construction period in 2012 under the cumulative scenario. Of this, approximately 6,800 would be working on projects on Curtis Island
	Operation	Up to 1,600 workers required by 2013 and then ramping up to 2,600 by 2016 and beyond under the maximum scenario. The overall cumulative population increase is expected to be significant given that operational workers are more likely to relocate to the local area with their families than construction workers due to the long-term nature of the work
Income and affordability	Construction	There will be significant cumulative effects associated with increases in overall income due to the influx of construction workers, short-to-medium term increases in the cost of goods and services and decreased housing affordability. Local business may be impacted positively through increased revenue and opportunities to expand and/or diversify. Further information outlined in Volume 4 Chapter 21
	Operation	Potential impacts include an estimated cumulative increase in real post tax wages of 0.6%, accompanied by a regional increase in goods and services in the in the short to medium term, as the supply side in local areas adjust to the increase in demand. Further information outlined in Volume 4 Chapter 21
Employment, training and business	Construction	The cumulative impact of multiple projects on construction workforce requirement would place severe strains on labour force availability. Cumulative effects will further exacerbate the potential impacts to local and regional businesses including competition for labour, goods and

Impact category	Construction/ operation	Cumulative impact
		services and commercial real estate, somewhat offsetting some of the gains that are likely to flow through from increased demographic and economic growth
	Operation	The cumulative impact of multiple projects has the potential to impact areas of current skills shortages (especially with respect to electrical and instrumentation technicians and electrical engineers) and pose challenges for recruitment and retention. Potential cumulative impacts to the regional labour force are discussed in the economic impact assessment, presented in Volume 4 Chapter 21
Primary and secondary education	Construction	It is not anticipated that there will be a significant cumulative impact to primary and secondary education services because: • The construction workforce for the various projects will be predominately made up of non-local staff • Consultation with Education Queensland indicates that present capacity of schools in the region should be sufficient to absorb the increased population, particularly in the short to medium term
	Operation	Consultation with Education Queensland indicated that the primary and high schools in the LNG facility study area have excess capacity and they do not anticipate a significant impact from the operational phase of the various proposed projects. Ultimately, the impact will be dependent on the extent to which all projects communicate their anticipated workforce numbers and associated population impacts to Education Queensland in a timely manner
Housing and accommodation	Construction	Potential cumulative impacts on housing and accommodation are discussed in the economic impact assessment, Volume 4 Chapter 21. Increased demand for housing in the region, particularly in Gladstone will depend on the proportion of the construction workers housed in temporary accommodation facilities. It is expected that the majority of construction workers will be housed in temporary accommodation facilities, however given the large cumulative construction workforce requirements it is expected there will be an impact on cost and availability of housing and accommodation
	Operation	Potential cumulative impacts on housing and accommodation are discussed in the economic impact assessment, Volume 4 Chapter 21. It is estimated that due to cumulative impacts there could be a significant increase in housing prices the Gladstone region until additional stock (new construction of houses) fulfils demand
Community health and safety	Construction	An increase in the population due to cumulative construction workforce requirements, particularly an influx of young, male dominated workers will have an impact on community safety and health

Impact category	Construction/ operation	Cumulative impact
		Cumulative impacts due to construction of the LNG facility will cause a significant increase to road, air and shipping movements as a direct result of the transport of personnel, materials and equipment and potentially impact on community health and safety
	Operation	Potential cumulative impacts to community safety and health due to an influx of operational workers and their dependents are not expected to be as significant for the operational phase given the workforce numbers will be less and the demographics of the operational workforce more closely aligned to the existing population
Facilities and services	Construction	The degree to which the construction phases of the cumulative project scenario will impact on facilities and services will depend on the extent to which construction workers are housed in temporary accommodation facilities. It is expected that the majority of the projects will house a large proportion of employees in temporary accommodation facilities, thus reducing the impact on facilities and services, however overall it is expected the region will experience a significant increase in demand when flow-on effects are considered.
	Operation	The Social Infrastructure Strategic Plan (2009) background report suggests that the cumulative effects of current industrial projects are already exerting pressures on available social services related to the increase in the number of people moving into the area impacting access to existing facilities and services. It is anticipated planned projects for the area will exacerbate existing pressures to the following facilities and services: medical and health, recreation, emergency, community and support and utility
Community values and lifestyle	Construction and Operations	An influx of a construction workforce, dependents and general growth attributed to the cumulative impacts from a large number of projects, has the potential to place pressure on community values and residents lifestyle patterns. The greater the influx in population to Gladstone, the more likely there will be an increased impact on community values and lifestyles as the region would be experiencing an increased rate of change and increased pressure on facilities and services. Furthermore, community values and lifestyle may be impacted due to the relationship between increased disposable income and how people spend it

In order to address the cumulative impact of a population increase and related social impacts, Australia Pacific LNG will work with other industries, local government and service providers to plan and share information relating to potential impacts and mitigation measures. This will facilitate longer term planning and allow for increased services and social infrastructure to be provided to match the increasing population. Other key mitigations will include the following:

- Australia Pacific LNG will continue to work with government, the community and industry to plan for potential cumulative impacts and to share information about potential impacts and mitigation measures
- Australia Pacific LNG will provide housing for non-local construction staff and contractors
- Australia Pacific LNG will expect the operations workforce for the LNG facility to live within the local community in the general housing pool.

25.2.16 Economic impacts

The economic impacts associated with the Project will be further enhanced as a result of the multiple projects being undertaken in the Project region. The projects modelled in the cumulative impact scenario can generally be listed under three broad categories:

- Mining and energy projects
- Manufacturing projects
- Infrastructure and transport projects.

The CGE MM600+ model was used to assess the economy-wide cumulative impact of the 30 identified projects. For practical purposes, the economic impacts have been modelled for the Project from the gas pipeline through to the LNG facility. This has been largely been done so the impacts can be examined and mitigated in a holistic manner. Due to the specific geographical nature of the projects, economic impacts were then also examined at a state and regional level. In order to evaluate the maximum impact associated with the projects, it has been assumed that all projects will go ahead.

The cumulative impact scenario has assumed that each project impacts the economy independently, with no sharing of resources.

The following results represent the deviation from the Baseline Scenario, where no projects proceed. This captures the effects on the economy of all 30 proposed projects as detailed in Table 25.1.

Once all of the proposed projects are fully operational, the national economy will benefit from:

- Higher real gross domestic product on average by A$6.1 billion annually
- Increased real national income, driving both higher consumption and investment
- Higher consumer welfare of around A$1.1 billion annually, on average.

Because of the anticipated increase to Australian real national income, the price of non-tradeables relative to tradeables – the real exchange rate – is expected to be higher. Modelling illustrates that in the cumulative impact scenario, the Australian dollar would appreciate by 2.1 %.

The change in the real value of the Australian dollar would impact on both export and import levels in Australia. Specifically, with an appreciation of the exchange rate, Australia's international competitiveness on global markets would be marginally lower, leading to lower demand for Australian exports (although this will not be the case for LNG exports which will continue to increase). Trade exposed industries such as manufacturing and agriculture are expected to experience lower production levels following the appreciation of the Australian dollar.

At the state level, once the projects are fully operational:

- The projects are estimated to lead to higher employment in Queensland by an average of 55,000 jobs (both direct and indirect)

- Queensland's gross state product is expected to be A$6.9 billion higher on average each year (or 3.6 %).

At full operation, the 30 projects are estimated to have the following impacts on the regional economy within which the LNG facility is situated.

- In the Mackay-Fitzroy-Central West region which includes the LNG facility study area, the projects are estimated to lead to higher employment by an average of 15,400 jobs
- Mackay-Fitzroy-Central West's gross regional product is expected to be A$2.6 billion higher on average each year (or 10.0%).

The primary cumulative economic impacts of the projects will be positive, leading to increased incomes, expenditure and employment. The Gladstone area will be a key beneficiary of the impacts on the Mackay-Fitzroy-Central West region. These impacts will create substantial employment opportunities in Gladstone, specifically in the mining, manufacturing and transport industries. This is primarily due to the development of large LNG facilities, aluminium smelter and refinery, as well as steel production and major port and rail redevelopments.

As well as directly stimulating output, if all 30 proposed projects included in the cumulative impact scenario proceed, there will be a range of indirect flow on benefits. This will occur through an increase in demand from the projects' supply chains, and increased demand by the project workers. This, in turn, would boost revenue in the Mackay-Fitzroy-Central West. This higher revenue will then flow through to extra spending in the regions' consumer-oriented industries, such as retail trade, health and community services and cultural and recreational services.

25.2.17 Hazard and risk

There are several projects similar to the LNG facility proposed for Curtis Island. The risk contours applicable for industrial land use stay within the site boundary of the LNG plant as seen in Volume 4 Chapter 22. Therefore the plant will have no impact on surrounding facilities. This has been achieved by adequate selection of site layout and footprint.

The intra plant spacing is also sufficient such that there is no knock-on effect from incidents within the plant or with other facilities. The plant layout will be as per NPFA 59 to ensure correct spacing.

The site accommodation facilities are 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.

Major hazard facilities (MHFs) in the Curtis Island Industrial Precinct will be regulated by the Hazardous Industries and Chemical Branch (HICB) which is a unit within Workplace Health and Safety Queensland. HICB requires that the design of the proposed LNG facilities is such that risk criteria are met at the respective site boundaries. The risk profiles for neighbouring facilities will therefore not impact on the risk criteria compliance at the boundary of the LNG facility. Additionally, emergency management plans will be in place to help reduce the impact of any incidents on Curtis Island such that surrounding facilities and personnel are not affected.

The process technology chosen for the Australia Pacific LNG facility is proven technology, used in many LNG facilities worldwide and with an excellent track record in terms of safety. The selected process has been used for LNG production for over 40 years. According to their EIS documents, the neighbouring QCLNG and GLNG facilities will use ConocoPhillips' Optimized Cascade® process for liquefaction as Australia Pacific LNG.

Other MHFs located in the Gladstone area have similar risk criteria. Hence with the greater distance from the proposed facility, there will be no cumulative effect.

A positive effect of additional and similar neighbouring industrial facilities is that there is the potential for mutual aid groups to be formed. That is, the various industrial facilities can pool resources to provide enhanced emergency response equipment and develop standard emergency management plans. The promotion of mutual aid groups will be ongoing throughout the development of the LNG facility.

The introduction of LNG shipping to Gladstone Port will increase the cumulative risk to shipping. These additional risks have been mitigated by the use of four tugs and a pilot while in port and provide sufficient control in managing the transit through the port to minimise the likelihood and consequence of incidents.

25.3 Conclusions

Cumulative impacts have been assessed, taking into consideration those projects currently proposed for the Gladstone region that are relevant for specific environmental, social and economic values. Sixteen categories of values were assessed.

In 11 categories, it is considered that there is only a low to moderate level of risk associated with potential cumulative impacts.

There are a number of categories, (i.e. social, economic, greenhouse gas, marine ecology and coastal environment) for which one or more of the following factors have led to a high rating in terms of impact significance and/or risk:

- There is a relatively high degree of complexity in relation to the characteristics of the values in question
- There is a relatively high degree of complexity in relation to the project-related cumulative impact mechanisms
- The available mitigation approaches are not standardised and require the ongoing cooperation of multiple parties.

In these cases, it is considered that the risks can be suitably managed if the various proponents and relevant regulatory authorities cooperate effectively in relation to the implementation of impact mitigations strategies.

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