Section 4 Transportation

4.1 Introduction

This section outlines the methodology and findings of traffic and transport studies undertaken for the GLNG Project. This section considers the traffic impacts associated with the construction and operation of the proposed Coal Seam Gas (CSG) fields expansion, a proposed LNG facility on Curtis Island approximately 5 km northwest of Gladstone, and a proposed gas transmission pipeline linking the CSG fields to the LNG facility. A detailed report of the background, methodology, impact assessment and mitigation measures for the project is presented in Appendix J.

4.2 Scope of Study

The study provides a determination of vehicle trips added to the road network and the traffic impacts of the following GLNG Project components:

- Construction and operation of the CSG field development;
- Construction of a gas transmission pipeline;
- Construction and operations of the LNG facility on Curtis Island; and
- Construction of a potential access road and bridge to Curtis Island for access to the LNG facility.

The assessment of these project components has been considered to be a "base case" scenario, to which alternatives may be proposed based on project planning or in order to mitigate traffic impacts. Two alternative transport options have also been assessed, including:

- "No Bridge" option: This assumes the potential access road and bridge to Curtis Island will not be constructed. All personnel, materials and equipment for the construction and operation of the LNG facility will be transported to Curtis Island by barge or ferry for the life of the GLNG Project; and
- "Material by Rail" option: The "base case" is the transport of all materials and personnel by road the Material by Rail option assumes that pipe and other materials and personnel will be transported by rail to the fullest extent possible in order to reduce vehicle trips on the regional road network, especially within Gladstone. For this option, pipe and associated materials are assumed to be transported by rail from Gladstone Port as far as Moura. Personnel travelling to accommodation facilities will be transported by rail as far as Moura.

Further details of the transport options assessed and their impacts are presented in Appendix J.

4.3 Project Description

The LNG facility will be developed on Curtis Island in close proximity to the industrial deepwater port of Gladstone. The facility will comprise three trains, and source feed gas from the CSG fields. Gas will be transported to the LNG facility via a subsurface 435 km gas transmission pipeline.

A detailed description of the various project components is provided in Section 3 and an explanation of specific factors influencing the traffic and transport study are provided below.

4.3.1 Staging

The delivery of the overall GLNG Project will occur in stages according to each project component. The proposed staging of the project is illustrated in Section 3.5. The construction and operational phases of the CSG fields is proposed to commence upon project approval and will continue throughout the life of the project. Pipe delivery for the proposed gas transmission pipeline is anticipated to begin in the fourth quarter of 2010 and last for six months. The construction of the gas transmission pipeline is anticipated to begin in the second quarter of 2011 and last for 18 - 24 months, after which it will be available for operations.

The LNG facility proposed for Curtis Island is expected to be constructed in three stages (production trains). Train 1 construction is anticipated to commence in 2010 and last approximately four years, with operation of Train 1 commencing in 2014. The timing of Trains 2 and 3 will be subject to gas availability and market conditions, and as such no definitive schedule is available. For purposes of this assessment, the construction and operation of Trains 2 and 3 have been assumed to follow in immediate succession to Train 1 as shown in Section 3.5. This provides a robust scenario wherein multiple aspects of the GLNG project generate traffic on the external road network simultaneously. If built, the proposed access road and potential bridge linking Curtis Island to the mainland is expected to commence construction in the third quarter of 2011 and take approximately two years to complete, finishing only a few months ahead of completion of Train 1 construction of the LNG facility. Thus, access to Curtis Island during Train 1 construction of the LNG facility is expected to be via barge and ferry.

If the bridge is not constructed, access to Curtis Island during the construction of all production trains and the operational life of the LNG facility will be via barge and ferry as presented in the “No Bridge” option in Appendix J, and summarised in this section.

4.3.2 Development Sites

For the purposes of the traffic and transport base case and impact assessment the project has been divided into three components; namely the CSG fields, gas transmission pipeline and the LNG facility (with associated bridge to Curtis Island). The exact locations of workers’ accommodation facilities will be determined during the early construction phase planning and will be subject to separate approvals (e.g. development applications and any other relevant approvals and permits). This section provides an overview of the location of the project components and the anticipated accommodation and access requirements. Section 4.4 provides information on the anticipated staffing, deliveries and traffic movements associated with the project components.

4.3.2.1 CSG Fields

Site Locations

CSG field development locations are described in Section 3. The CSG field development will include further development of the existing CSG fields at Roma (part), Fairview, Arcadia Valley and part of Comet Ridge (these fields are referred to as “reasonably foreseeable development area (RFD area)”).

Gas in quantities beyond 5,300 PJ required for the second and third trains is likely to be supplied by a combination of the following:

a) From the development of the CSG fields referred to above;

b) From the development of the future development area (FD area) including tenements in Mahalo, Denison, Scotia, Comet Ridge and Roma Other regions listed in Table 3.4.1 as shown in Figure 3.4.2;

c) By utilising Santos’ share of gas from tenements in which Santos has an interest but is not operator. These tenements are listed in Table 3.4.1 and shown in Figure 3.4.2; and/or

d) From third parties.

Worker Accommodation

Due to the mainly rural nature of the region and the limited townships within the CSG field study area, accommodation is not readily available and dedicated workers’ accommodation facilities will be required. It is expected that the Fairview, Roma and Arcadia Valley field workforce will be accommodated in CSG field worker accommodation facilities, and personnel working in the Roma Centre will live in the town of Roma.

It is anticipated that the main worker accommodation facilities will be located in central locations within the CSG field development areas. Worker accommodation may be co-located with construction depots.

In addition, smaller crews are likely to be accommodated at the immediate gas well leases during the exploration/appraisal phase of well development. It is likely that one or more worker accommodation facilities will be established for each of the Roma, Fairview and Arcadia Valley CSG fields.

Site Access

Primary access to the CSG fields will be via the existing state-controlled road (SCR) network and existing commercial flight services from Brisbane to Roma. Primary access to the Roma CSG fields will be from the Carnarvon Highway and the Warrego Highway. Access to the Fairview CSG fields will be from the Carnarvon Highway at Fairview Road and Injune-Taroom Road, and primary access to the Arcadia Valley CSG fields will be from the Carnarvon Highway at Mulcahys Road and Arcadia Valley Road.

Refer to Figures 3.4.1 and 3.4.2 for CSG field regional road details.

4.3.2.2 Gas Transmission Pipeline Corridor

Site Locations

The proposed route of the gas transmission pipeline corridor is presented in Figure 3.4.3 and described in Section 3. The location of construction depots associated with the gas transmission pipeline will be selected by the contractor prior to the commencement of construction activities. The sites may be co-located with construction workers accommodation facilities and will be relocated as construction of the pipeline progresses. Due to the length of the gas transmission pipeline (435 km), it is likely that several sites will be required, based on the normal practice of locating accommodation facilities and depots within an hour's drive from the active construction site, with the facilities moved when driving time increases beyond this time.

Pipe and associated materials for the gas transmission pipeline will be transported to the Port of Gladstone via sea from offshore mills, and trucked by road to strategically placed laydown areas along the proposed corridor. It is presently anticipated that 6 - 10 pipe laydown areas will be spaced along the proposed pipeline corridor. Seven locations were assumed in the traffic assessment. The base case assessed in this section is that pipe will be shipped to Gladstone at Auckland Point Wharves and trucked to seven laydown locations.

An alternative option has also been assessed to transport pipe by rail from Gladstone to the laydown areas. This option is discussed in detail in Appendix J and summarised in Section 4.5.2.

Worker Accommodation

Due to the mainly rural nature of the region and the limited number of townships along the proposed gas transmission pipeline route, existing accommodation is not readily available. Hence dedicated workers' accommodation facilities will be required.

The workforce will be accommodated in a series of main and satellite accommodation facilities. It is currently anticipated that there could be three main accommodation facilities located roughly equidistant along the pipeline but the final number will be confirmed during FEED. Facilities 1 and 2 will operate for half of the time and then facilities 2 and 3 will operate for the other half. There will be up to 500 workers accommodated in the two main accommodation facilities. In addition, at least two smaller satellite accommodation facilities will be located between the main facilities. They will operate one at a time and will accommodate up to 100 workers (note: the accommodation facilities will rarely be at full capacity, which allows workers to move between accommodation facilities as required during the project).

An additional 100-person accommodation facility will be provided near Friend Point for the pipeline crossing from Friend Point to Laird Point.

The exact locations of the accommodation facilities will be determined during the detailed construction planning phase. However, approximate locations of pipe laydown areas and worker accommodation facilities along the pipeline corridor are detailed in Table 4.3.1. These locations are subject to further refinement and consultation with contractors and relevant stakeholders, but have been assumed in the assessment of the gas transmission pipeline traffic impacts.

Site Access

Equipment and personnel require regular access to the gas transmission pipeline corridor and work sites during construction. Access will generally be via existing roads and tracks as well as along the corridor. Existing access roads and tracks will be used wherever practicable.

Primary access to the gas transmission pipeline corridor will be gained from the major roads in close proximity to the pipeline for the majority of its length, including the Carnarvon Highway, the Dawson Highway, Leichhardt Highway, Burnett Highway and the Bruce Highway. The existing local road network will be accessed from these roads to provide immediate access to the pipeline corridor.

Table 4.3.1 Gas Transmission Pipeline Facility Locations

Facility Type	Site Number	Chainage from Gladstone along pipeline corridor	Location Description
Pipe Laydown Area	0	25 km	Along Gladstone-Mt Larcom Road near pipeline corridor crossing
	1	60 km	Along the Dawson Highway at Maxwelton Creek
	2	120 km	North of Biloela along Burnett Highway
	3	180 km	Along Dawson Highway at Moura
	4	250 km	Near intersection of Dawson Highway and Fitzroy Development Road (north)
	5	320 km	South of intersection of Arcadia Valley Road and Dawson Highway
	6	390 km	South of intersection of Arcadia Valley Road and Mulcahys Road
Main Accommodation Facility	1	75 km	Near intersection of Dawson Highway and Inverness Road
	2	225 km	Near Intersection of Dawson Highway and Oombabeer Road
	3	375 km	Near intersection of Arcadia Valley Road and Mulcahys Road
Satellite Accommodation Facility	1	30 km	Near intersection of Bruce Highway and Mount Alma Road
	2	150 km	Near intersection of Leichhardt Highway and Proposed Pipeline
	3	300 km	Near intersection of Dawson Highway and Arcadia Valley Road
	4	410 km	Along Fairview Road, west of Carnarvon Highway

4.3.2.3 LNG Facility

Site Location

The LNG facility will be located on Curtis Island within the Gladstone State Development Area (GSDA) in a dedicated “industrial precinct.” Section 3 provides a detailed description and location details.

Worker Accommodation

This option has been adopted for assessment of the traffic impacts of the LNG facility. The workers accommodation on Curtis Island will be self-sufficient and will likely be located within walking distance of the construction site (refer Section 2.3.7 for further details).

Site Access

During the construction of Train 1 of the LNG facility the transfer of construction workers to their accommodation on Curtis Island will be by barge/ferry operations from the mainland at Auckland Point. Access to the site following the construction of Train 1 may be then provided by an access road and bridge potentially to be constructed to Curtis Island as described in Sections 2 and 3.

If the Curtis Island access road and bridge are not constructed, barge/ferry services will continue to transport personnel to Curtis Island during ongoing construction and operations of the LNG facility.

The provision of the bridge to Curtis Island has been assessed in the traffic study as the “base case” scenario and the alternative of no bridge has been assessed as the “No Bridge” option.

For this assessment it has assumed that equipment and materials destined for Curtis Island for the construction of Train 1 will be trucked or shipped to Gladstone and offloaded at Auckland Point wharves for transfer to Curtis Island via barge. Some oversize or pre-assembled construction items are expected to arrive by ship and will be transported directly to the materials off-loading facility (MOF) adjacent to the LNG facility on Curtis Island.

4.4 Existing Environmental Values

4.4.1 Existing Road Network

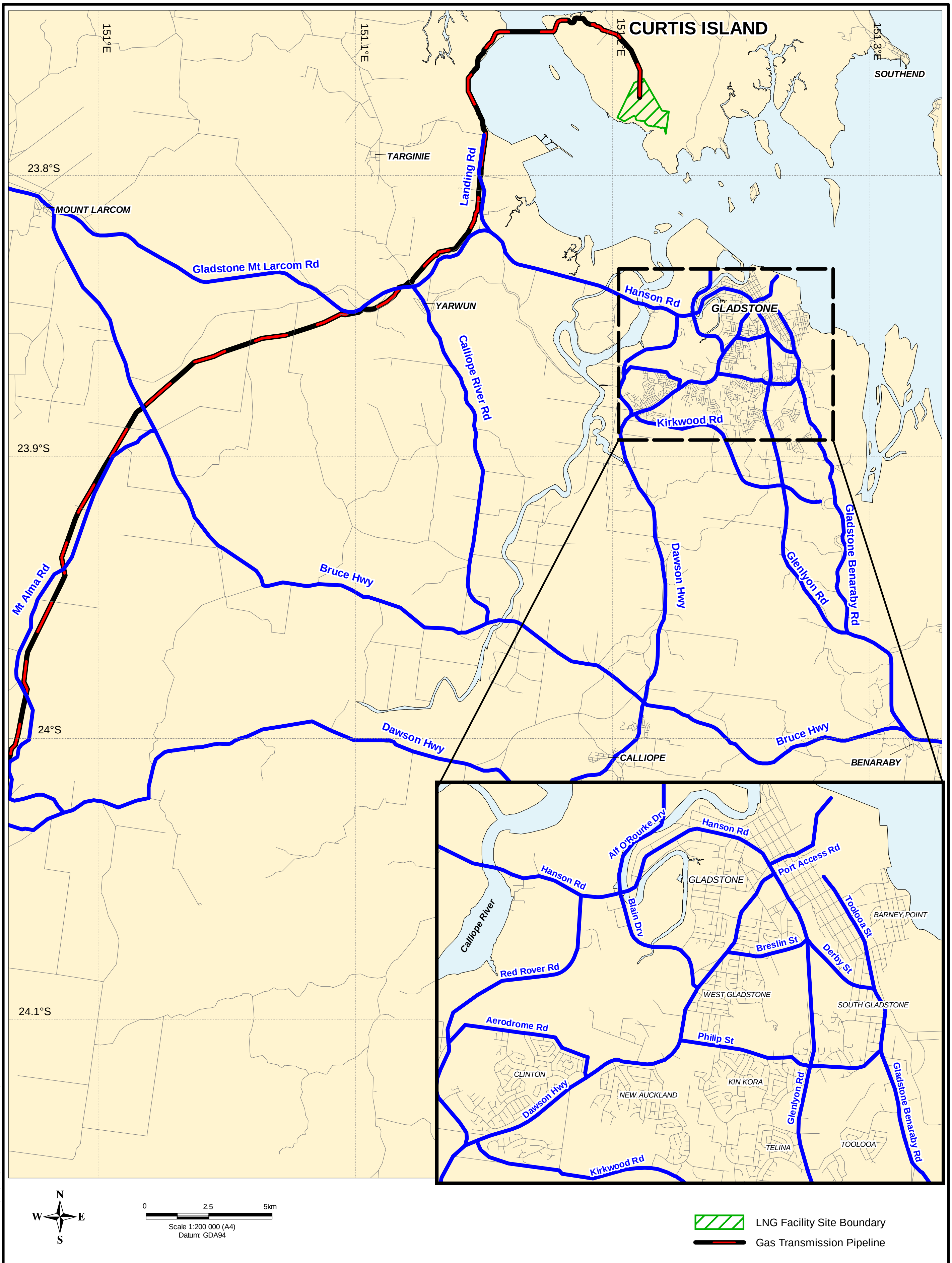
As part of the traffic and transport study a survey was undertaken of the existing roads within Gladstone and surrounds that are expected to be primarily utilised for the construction and operations of the GLNG project. These roads are illustrated in Figure 4.4.1 and Figure 4.4.2. Information relating to these roads detailing the general condition, speed limits and carrying capacities are described in Appendix J.

4.4.1.1 Traffic Volumes

Baseline traffic count data was predominantly sourced from the Department of Main Roads (DMR), and supplemented with data from previous traffic surveys undertaken by Austraffic in 2006. Traffic volumes were also obtained from the Gladstone, Banana, Roma and Central Highlands regional councils.

Existing daily traffic volumes are illustrated in Figure 4.4.3. Existing peak hour turning movement counts and daily roadway link volumes are presented in Appendix J.

Background traffic growth rates were discussed with DMR on 17 July 2008 and it was subsequently agreed that a linear growth rate of 6 % per annum will be applied to the majority of the traffic network except in higher volume urban areas where a background growth rate of 4 % per annum was adopted. These growth rates are consistent or more conservative than other major development assessments in the area. In addition to growth rates, actual traffic volumes associated with approved industrial developments (see Section 4.4.4) in the Gladstone area were included as background growth, where information was available.



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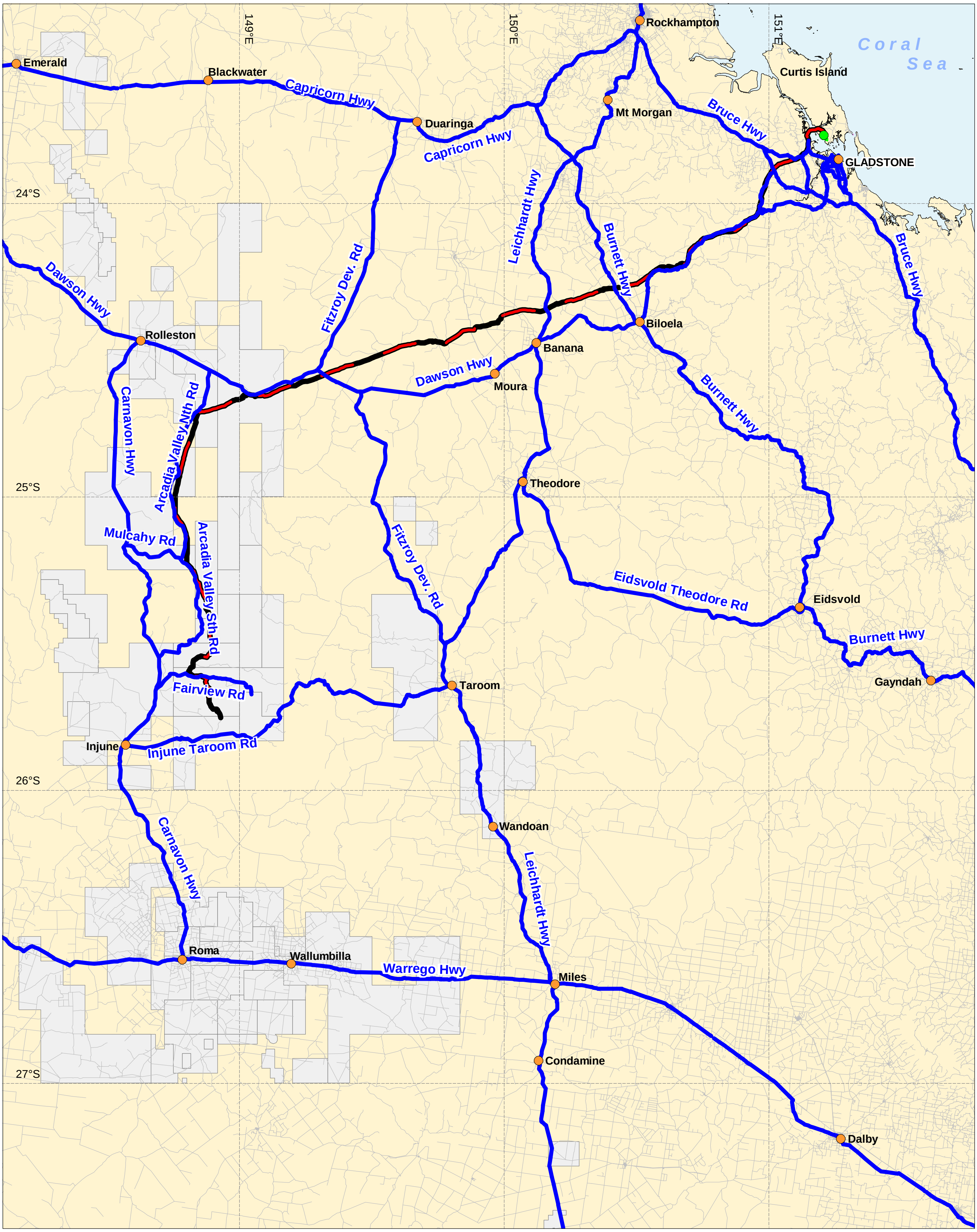
Client	Project	Title
LNG	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**STUDY AREA ROADWAYS GLADSTONE AND SURROUNDS**
URS	Drawn: CA · Approved: JB · Date: 22-04-2009 Job No: **4262 6220** · File No: 42626220-g-1039.wor	Figure: **4.4.1** · Rev:B · A4



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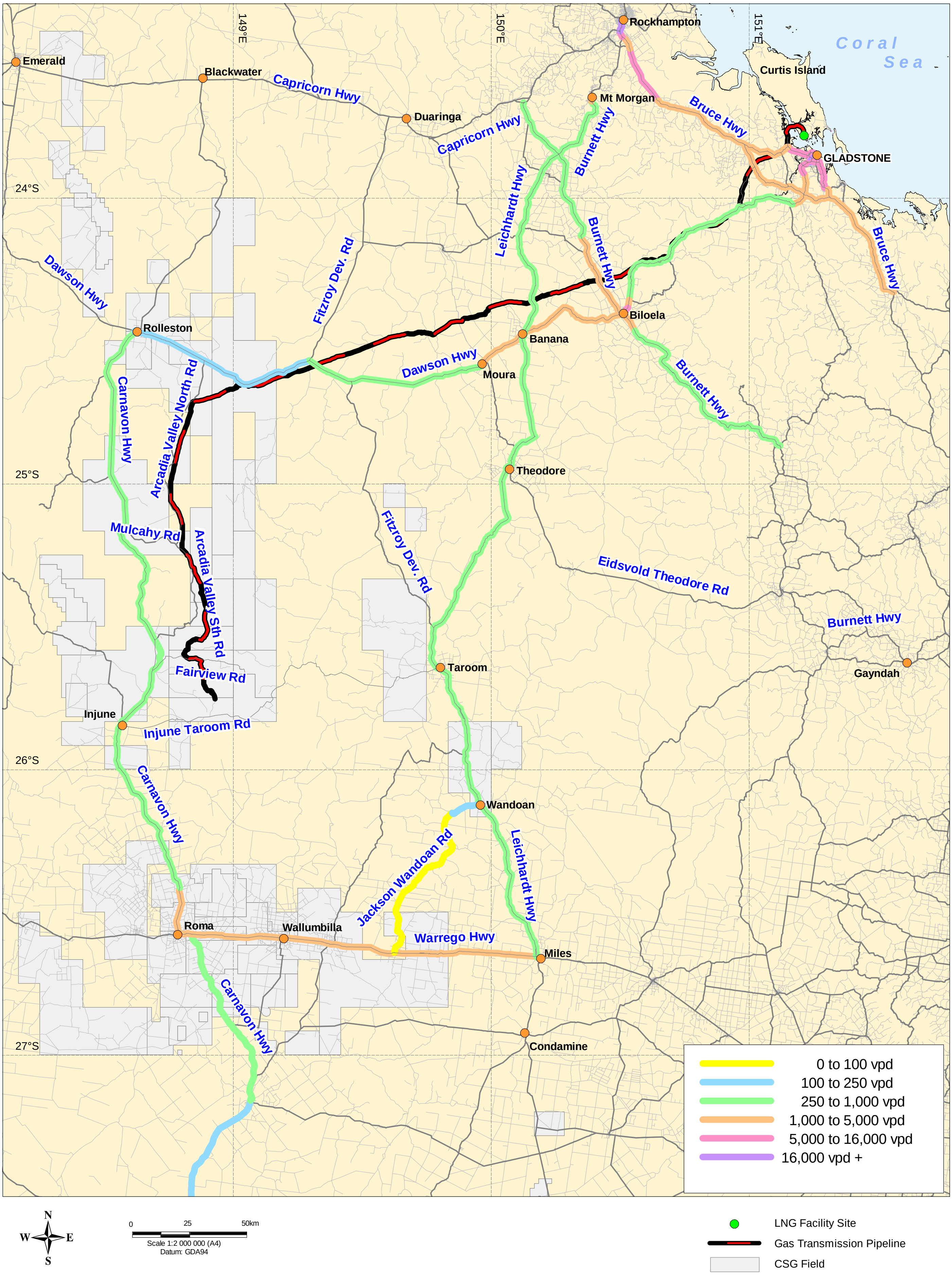
Datum: GDA94

- LNG Facility Site
- Gas Transmission Pipeline
- CSG Field

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright. Cardno Eppell Olsen 17-03-2009.

Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**STUDY AREA ROADS** **OVERALL GLNG PROJECT AREA**

Drawn: CA	Approved: JB	Date: 22-04-2009	Figure: **4.4.2**	Rev:B
Job No: **4262 6220**	File No: 42626220-g-1040.wor			A4



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Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	**EXISTING DAILY TRAFFIC VOLUMES**
	Drawn: CA · Approved: JB · Date: 21-04-2009	Figure: **4.4.3** · Rev:B
	Job No: **4262 6220** · File No: 42626220-g-1041.wor	A4

4.4.1.2 Crash History

The latest five years of crash history data was obtained from Queensland Transport in the form of a map showing the crash locations. No information about type of crash or severity has been provided. Vehicle crash rates have been calculated for each SCR section and are illustrated in ranges on Figure 4.4.4. Vehicle crash rates on road sections are reported in crashes per million vehicle-kilometres travelled per year.

Based on the limited crash data provided, there are some sections of rural road west of the Bruce Highway that appear to have a higher crash risk than others. These include:

- Carnarvon Highway south of Rolleston;
- Dawson Highway east of Rolleston;
- Dawson Highway west of Moura;
- Leichardt Highway south of Banana; and
- Dawson Highway between Biloela and Calliope (Calliope Range).

The information provided by Queensland Transport does not contain sufficient detail such that crash types and possible crash causes can be determined.

For the purposes of this traffic impact assessment, all trips generated by the GLNG Project are conservatively assumed to be new trips. However this does not necessarily mean the likelihood of crashes on the road network will increase in direct proportion, because in practice many of the development trips may divert from other parts of the road network.

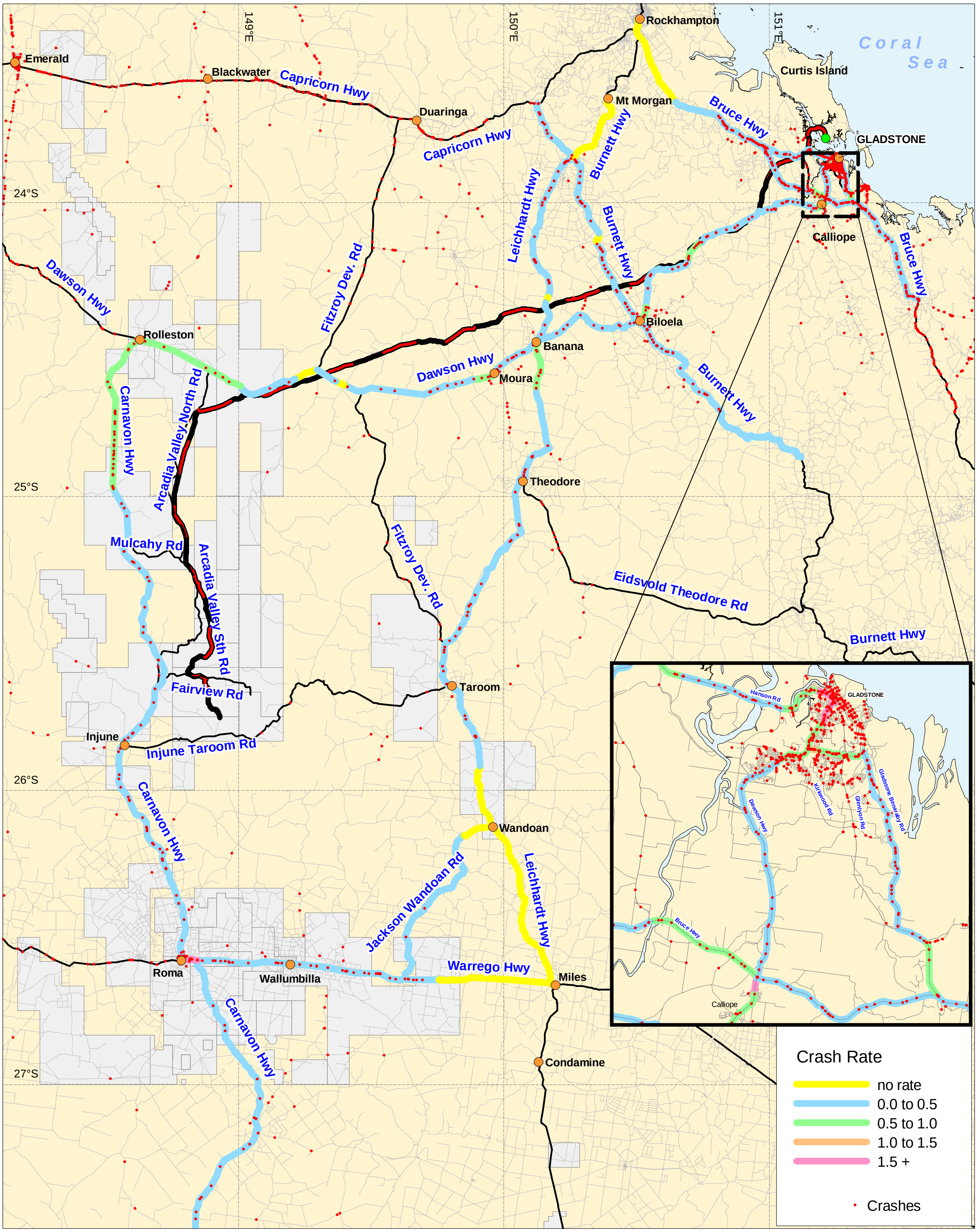
4.4.1.3 Future Traffic Network Planning

In order to determine future traffic (road and rail) related projects for the Gladstone area the following documents were reviewed and incorporated into the project assessments:

- "Roads Implementation Program 2008-09 to 2012-13" produced by the DMR;
- "Gladstone Integrated Regional Transport Plan: 2001 – 2030" produced by Queensland Transport; and
- DMR Statements of Intent for Link Development.

4.4.1.4 Roads Implementation Program 2007 – 08 to 2011 – 12

The Roads Implementation Program 2008-09 to 2012-13 details projects that have had funds allocated to them and the expected timing of these works. There are a number of projects detailed in the Roads Implementation Program that fall within the study road network, as detailed in Table 4.4.1.



Number Of Crashes Per 1,000,000 Vehicle Kilometres Travelled Per Year

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Scale 1:2 000 000 (A4)

Datum: GDA94

LNG Facility Site

Gas Transmission Pipeline

CSG Field

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Client	Project	Title
LNG	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	STUDY AREA CRASH RATES
URS	Drawn: CA / Approved: JB / Date: 22-04-2009	Figure: **4.4.4** / Rev:B
	Job No: **4262 6220** / File No: 42626220-g-1042.wor	A4

Section 4 Transportation

Table 4.4.1 Roads Implementation Program – Planned Works

Roadway	From	To	Planned Roadworks	Funding $'000	Year(s)
Dawson Highway (Banana-Rolleston)	Maloneys Gully	Roundstone Creek	Rehabilitation and overlay work	12,800	2010/11 – 2012/13 & beyond
	Basalt Creek	Sunlight Road	Widened and sealed	7,209	2012/13
Dawson Highway (Gladstone - Biloela)	Calliope Range		Construction deviation	70,000	2008/09 – 2012/13
			Accelerated Road Rehabilitation Project	78,912	2007/08 – 2008/09
Gladstone - Mt Larcom Road			Delineation and line markings	1,300	2008/09 – 2009/10
	Glenlyon Street/Dawson Highway/Bramston Street		Intersection Improvements	100	2009/10
	Calliope River Road	Reid Road	Overtaking lanes constructed	2,324	2010/11 – 2012/13
	Wiggins Island Intersection	Reid Road	Rehabilitate pavement	1,227	2009/10 – 2010/11 to 2012/13
	Gibson Street	Blain Drive	Seal shoulders	600	2008/09
Glenlyon Road	Ferris Street	Derby Street	Asphalt resurfacing	240	2008/09
Don Young Drive	Dawson Highway north		Asphalt resurfacing	300	2009/10
Mulcahys Road	6.0 km	10.7 km	Pave and seal	407	2008/09
Carnarvon Highway (Injune-Rolleston)	At deep channel		Culvert installed	1,080	2008/09
	Bullaroo Creek section		Roadway formed and improved drainage	100	2008/09
	68.50 km	77.10 km	Reconstruct pavement	5,596	2008/09 – 2012/13
	60.20 km	68.50 km	Widen pavement	5,461	2010/11 – 2012/13 & beyond
	0.60 km	21.10 km	Widen pavement	9,493	2007/08 -2008/09
	21.10 km	42.20 km	Widen and seal	11,068	2008/09 – 2012/13
Carnarvon Highway (Roma -Injune)	0.00 km	90.35 km	Roadside signing	50	2008/09
	0.00 km	90.35 km	Hazards close to road	1,600	2008/09 - 2009/10
	Quentin Street/Bowen Street		Intersection improvements	150	2007/08 – 2008/09
	McDowall Street		Install traffic signals	300	2007/08 – 2008/09
Arcadia Valley Road			Rehabilitation	220	2010/11
Roma-Taroom Road	0.00 km	64.90 km	Pave and seal	12,163	2008/09 – 2009/10
Roma-Taroom Road	42.37 km	64.75 km	Pave and seal	562	2008/09
Injune-Taroom Road	5 km	15 km	Rehabilitate Pavement	430	2012/13

4.4.1.5 Gladstone Integrated Regional Transport Plan (GIRTP): 2001 – 2030

The Gladstone Integrated Regional Transport Plan (GIRTP) Road Study was undertaken in 2001/02 to assist DMR, Gladstone City and Calliope Shire Councils to respond to future growth and the resulting impact upon the road network. A planning model was used to identify areas in the road network where future development could adversely impact upon traffic operations and to also identify where new links may be required. Road infrastructure requirements for increases in population as a result of development were also assessed and identified. A list of the major findings and recommendation for capital expenditures of the GIRTP Road Study is presented in Appendix J. It should be noted that the timing of these works and allocation of funding to these works is not in all cases assured and is in some cases dependent on future industrial development in the area and available funding.

4.4.1.6 DMR Statements of Intent for Link Development

Statements of Intent (SOI) were provided for some sub-links of the SCR network within the GLNG Project area, including sections of Carnarvon Highway, Dawson Highway, Burnett Highway, Gladstone - Mount Larcom Road and Bruce Highway. These SOI's were used to inform assessment of GLNG impacts on them as well as determine acceptable solutions based on existing planning pressures and long-term DMR vision for the roadways.

4.4.2 Existing Rail Network

The following rail lines currently exist through the proposed project area:

- **Moura Line:** Single track system that runs southwest from Gladstone. The Moura Short Railway branches off north-south from this line at Jambin;
- **Blackwater System:** Bi-directional duplicated track system primarily services coal mines off the Central Line and carries the product through to Stanwell Power Station, Gladstone Power Station and the Port of Gladstone via the North Coast Line;
- **Maryborough Area System:** Single track system that runs south from Gladstone at Calliope to Maryborough via Monto; and
- **North Coast Line:** Runs north-south along the coast from Brisbane to Cairns. The track is duplicated from Gladstone to Rockhampton.

Figure 4.4.5 illustrates the rail network in the overall GLNG study area and Figure 4.4.6 illustrates the interaction of the Blackwater, Moura and North Coast Lines within Gladstone.

4.4.3 Future Rail Network Planning

The GIRTP, in addition to addressing the areas future road transport requirements, also addresses the rail network planning needs for the region. The rail network planning items identified in the GIRTP are also presented in Appendix J.

4.4.4 Cumulative Impacts of Regionally Significant Projects

There are a number of major developments that are proposed in relation to areas in which the GLNG Project will be constructed and operated, these are described in Section 1.7. There is limited information available as to the planned development of those projects or the scale and timing of their development which affects the ability to undertake an assessment of the possible cumulative transport impacts.

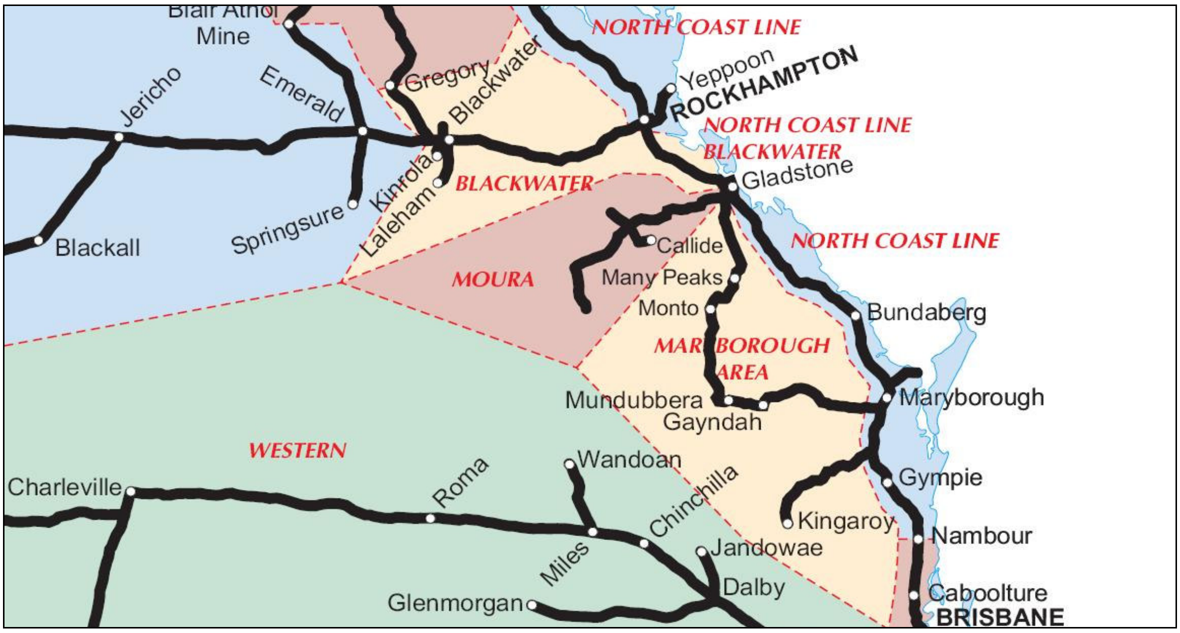

Figure 4.4.5 Existing Rail Network

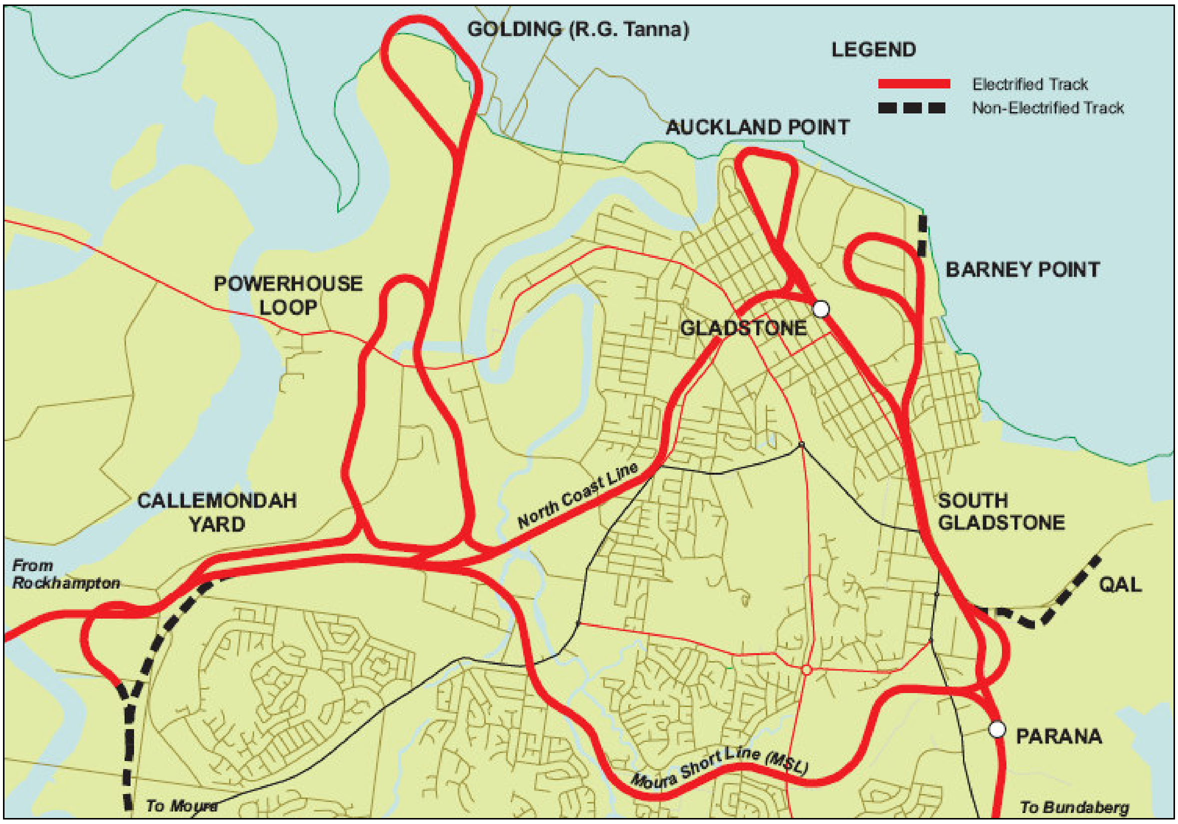

Figure 4.4.6 Gladstone Rail Network

A review of the available information and planning stage for each project as well as the useability of the information for this study was undertaken. Only the following projects had information publicly available that was in a form to be readily included in the assessment of the cumulative traffic impacts:

- Gladstone Pacific Nickel Refinery Project;
- Moura Link - Aldoga Rail Project; and
- Wiggins Island Coal Terminal Project.

A qualitative review of the recommendations for each project was undertaken to provide context and maintain consistency with the recommendations of this assessment. It was found that both the Gladstone Pacific Nickel Refinery Project and the Wiggins Island Coal Terminal Project have identified impacts at the Hanson Road/Blain Drive/Alf O'Rourke and Hanson Road/Red Rover Road intersections and recommend mitigation measures to provide two-lane roundabouts at these locations. Discussion of GLNG Project impacts to these intersections in relation to the cumulative projects is provided in Sections 4.7-4.12.

Further details of the review of these developments and key information from these projects are included at Appendix J.

4.4.5 Gladstone Port Facilities

The Port of Gladstone is a major commodities export port which had a throughout in 2007/08 of 75.5 million tonnes of cargo of which 54.1 million tonnes were coal (GPC 2008a). This generated 1,368 ship visits during the financial year.

A fairway beacon marks the approach to the harbour entrance and is situated approximately 33 km north-west of Bustard Head. An outer harbour anchorage (within port limits) has been gazetted in the vicinity of the Fairway Buoy. Table 4.4.2 shows details of the dredged channels which provide shipping access to the port.

Table 4.4.2 Port of Gladstone Channels

Channel	Length (km)	Depth (m)	Width (m)
Outer Harbour Channel	22.45	16.3	183
Auckland Channel	8.7	15.8	180
Clinton Channel	2.2	16.0	180
Clinton By-Pass Channel		10.6	160
Targinie Channel	6.1	10.6	120

Source; GPC (2008b)

Table 4.4.3 provides details of the port's 6 wharf centres which together have 15 wharves. Each wharf contains facilities to handle a number of specific cargoes as shown in the table. The port's maximum capacity (Clinton Wharf) is 220,000 DWT.

Table 4.4.3 Port of Gladstone Wharves

Wharf Centre	Wharf	Cargoes	Maximum Vessel Size (DWT)
Boyne	Boyne Wharf	Aluminium, petroleum coke, general cargo, break bulk and liquid pitch.	60,000
South Trees	South Trees East	Alumina, caustic soda and bunker oil.	80,000
	South Trees West	Bauxite and bunker oil.	80,000
Barney Point	Barney Point Wharf	Coal, magnesite, bunker coal and limonite.	90,000
Auckland Point	Auckland Point No. 1	Magnesia, calcite and break bulk.	65,000
	Auckland Point No. 2	Grain.	60,000
	Auckland Point No. 3	Petroleum products, caustic soda, LP gas and break bulk.	55,000
	Auckland Point No. 4	General cargo, containers, gypsum, magnetite, break bulk, scrap metal and ammonium nitrate.	70,000
Clinton	Clinton No. 1	Coal.	220,000
	Clinton No. 2	Coal.	220,000
	Clinton No. 3	Coal.	220,000
	Clinton No. 4	Coal.	220,000
Fisherman’s Landing	Fisherman’s Landing No. 2	Bauxite, alumina and caustic soda.	80,000
	Fisherman’s Landing No. 4	Cement clinker, cement, fly ash, caustic and limestone.	25,000
	Fisherman’s Landing No. 5	Liquid ammonia.	35,000

Source; GPC (2008b)

4.5 Proposed Development

This section outlines the anticipated level of deliveries and traffic movement patterns for both construction and operational phases of the three proposed GLNG Project components (CSG fields, gas transmission pipeline and the LNG facility). The staffing levels for the construction and operational phases of the project, which are important for determining worker transportation impacts, are presented in Sections 6.14, 7.14 and 8.14.

4.5.1 Coal Seam Gas Fields

To meet the additional demand that will be created by the GLNG Project, the existing Santos CSG field development will be expanded. It is the expanded field development that is the subject of this traffic impact assessment.

As the CSG field will develop gradually over time, the exact nature and location of all of the facilities and associated infrastructure required for the GLNG Project are not currently known. Table 4.5.1 summarises the currently expected operational activities within the Roma, Fairview and Arcadia Valley CSG fields over the life of the project. However, this is subject to change as more detailed exploration and planning is undertaken. This traffic impact assessment only takes into consideration the development of the RFD area.

Table 4.5.1 Coal Seam Gas Field Development Summary

Activity	Location	Years				
		2010-2014	2015-2019	2020-2024	2025-2029	2030-2034
Wells Drilled (number)	Roma	386	336	336	206	36
	Fairview	325	198	121	0	0
	Arcadia Valley	137	121	133	0	0
	Total	**848**	**655**	**590**	**206**	**36**

4.5.1.1 Construction Deliveries

In addition to personnel movements, traffic movements associated with the CSG field construction will include deliveries of equipment and materials associated with construction of access roads, fencing, well drilling sites, pipelines, and compressor stations, water management facilities and accommodation facilities. The total traffic movements estimated for the construction of each proposed well leases are presented in Table 4.5.2.

It is expected that almost all movements for construction deliveries and setup will be via heavy vehicles, with the exception that half the miscellaneous trips will be light vehicles.

Table 4.5.2 CSG Well Construction Traffic Movements

Activity/Material	Deliveries per well
Potable Water	2
Waste	1
Fuel	2
Well Water	3
Equipment	5
Pipe	10
Miscellaneous (50 % heavy, 50 % light vehicles)	3
Total	**26**

4.5.1.2 Operation Deliveries

The CSG wells will be developed progressively over time, with most transport trips involving the delivery of materials and equipment during the exploration and construction phase of each well lease, as described above. It is not anticipated that a significant amount of goods will be transported to the CSG fields after the completion of construction of each well leases. To account for any other deliveries during operations of well leases, a nominal number of operational traffic movements per day not related to personnel transport have been included in the assessment. It is expected that approximately half of these movements will be heavy vehicle, and half light vehicles.

4.5.1.3 Traffic Movement Patterns

Personnel

The construction and operation activities associated with the CSG fields are expected to take place seven days a week for 52 weeks of the year. Imported workers CSG field construction and operations personnel are expected to work a 14-day on, 14-day off work cycle. Approximately 90 % of the construction workforce is expected to reside outside of the area, and attend site on a fly-in/fly-out basis. In order to model the most conservative scenario, all workers were assumed to leave from Roma, travel to the worker accommodations by bus (assumed 20 passengers per bus) and work in the CSG fields for 14 days, before returning to Roma for 14 days off. This assessment estimates that rolling shift changes will occur once every two weeks, with half occurring during the combined peak hours (morning and afternoon) of project traffic generation.

Once on site, field personnel will travel by four-wheel-drive (4WD) vehicle from the accommodations through the CSG fields. Most of the movements of personnel on a daily basis are expected to occur within the field access tracks and local roads. Since personnel working in the Roma Centre will also be living in Roma, it is expected that these personnel will be travelling to and from the Roma Centre once a day, Monday through Friday in private vehicles.

The traffic movement patterns described above have been adopted for personnel working in both the construction and operations of the CSG fields. These assumptions create a robust assessment scenario by assuming that personnel travel will be concentrated on specific days, with the assessment considering these days and their peak travel periods.

Deliveries

Deliveries of supplies, equipment, and materials to the CSG field construction areas have been assumed to occur twice a week. Thus, by concentrating deliveries to two days per week instead of splitting evenly across the week, a more robust assessment scenario has been assessed. Because deliveries are likely to be spread throughout the entire day, this assessment estimates that approximately 10 % of construction deliveries will occur during each of the morning and afternoon peak hours.

4.5.1.4 Traffic Generation

The overall traffic generation has been estimated for the CSG field construction and operations activities based on the information presented above. Annual, daily and peak hour trip generation has been estimated, and used in the subsequent impact assessment section (Sections 4.7, 4.8 and 4.9). Summary tables of the expected traffic generation of each project component for each year of the project are presented in Appendix J.

Construction of the CSG fields is estimated to generate an average of approximately 100 total daily vehicle movements for the first 10 years of CSG field development (2010 - 2019) and an average of approximately 50 total daily vehicle movements for the ten years after (2020 - 2029).

Operations of the CSG fields is estimated to generate an average of approximately 275 total daily vehicle movements for the first 10 years of CSG field development (2010 - 2019) and an average of approximately 325 total daily vehicle movements for the ten years after (2020 - 2029). These traffic movements will be spread throughout the three CSG field areas assessed.

The estimates for traffic generated by the CSG field component of the GLNG Project are consistent for all transport options assessed.

4.5.1.5 Traffic Distribution

The distribution and assignment of traffic generated by the CSG fields to the roadway network has been determined from the traffic movement patterns above as well as likely sources and destinations for materials and equipment. Further details of origins and destinations of CSG field development trips are provided in Appendix J.

4.5.2 Gas Transmission Pipeline Corridor

A summary of the typical pipeline construction procedures and activities is provided in Section 3. Once operational, the gas transmission pipeline will require minimal operator supervision.

4.5.2.1 Construction Deliveries

Pipe Transport

An intricate transport issue associated with the construction of the gas transmission pipeline is the transport of pipe to the construction corridor. It is presently anticipated that pipes will be transported to the Port of Gladstone via sea from offshore mills, and transported to strategically placed pipe laydown areas along the corridor.

The base case assessed in this report is for the transport of pipe by truck from Gladstone to pipe laydown areas along the pipeline corridor. The option to transport pipe from Gladstone by train to the pipeline corridor has also been investigated to reduce heavy vehicle impact on the road network, and is presented as the “Material by Rail” option in Appendix J and briefly discussed below. Initial discussions have commenced with the relevant stakeholder agencies on this option, and the outcomes are still being assessed.

Approximately 37,000 pipe sections (pipe joints) will be required for the 435 km pipeline. Trucks used for pipeline delivery will most likely be extendable semi-trailers and the pipes are likely to be transported in lengths of 12 - 15 metres. Trucks are estimated to have a load capacity of three pipes, equating to approximately 12,300 truck loads, or 25,000 truck trips added to the road network. Ships are estimated to carry approximately 6,000 pipe joints, at an estimated delivery rate of one ship per month. This equates to approximately 67 truck loads (134 truck movements) per day for pipe haulage.

SCRs will be used for the delivery of pipe from Gladstone to the laydown sites. Seven laydown sites approximately equidistant along the pipeline have been assumed. The approximate locations of proposed pipe laydown sites have been presented in Table 4.3.1 above.

Equipment Transport

Other heavy vehicle movements associated with the pipeline construction will include the transport of the construction equipment to the corridor and mobilisation and demobilisation of the workers accommodations. At the beginning of the construction period it is estimated that approximately 1,000 items of equipment, plant and vehicles will be mobilised to the accommodation facilities and construction depots from Gladstone. It is anticipated that the majority will be heavy vehicles (approximately half Class 9 and half Class 3).

Equipment and materials will be moved on a daily basis from the construction depots to the pipeline corridor for construction activities. Many of these trips may occur on local roads and access tracks and the pipeline corridor. Santos has estimated 50 truck movements per day to the pipeline corridor. Further details are provided in Appendix J.

4.5.2.2 Operation Deliveries

It is not anticipated that goods will be transported for the gas transmission pipeline after the completion of construction, unless required for more significant repair or maintenance work. Thus, no traffic due to goods transport for the pipeline has been assumed for the operations stage.

4.5.2.3 Pipeline Construction Sequence

Delivery of pipe to the gas transmission pipeline corridor will precede construction and is expected to last approximately six months from beginning of the fourth quarter of 2010 to the end of the first quarter of 2011. Pipeline construction will commence at the Gladstone end, and is anticipated to last 18 - 24 months. Construction is anticipated to commence in the second quarter of 2011 with an approximately 3-month period of mobilisation of workforce and equipment and construction ramp-up. During this time, approximately half the total peak workforce is anticipated to be on site, split between a main accommodation facility and a satellite accommodation facility.

After construction ramp-up, the majority of gas transmission pipeline construction activities are expected to last approximately 15 months, with the workforce accommodated in a series of main and satellite accommodation facilities.Utilisation of the pipeline construction facility sites in Table 4.3.1 will progress along the pipeline corridor as construction progresses. During this time, the full workforce of approximately 1,500 personnel will be on site[1]. The 1,500 personnel on-site includes GLNG personnel, administration, subcontractors, accommodation support and deliveries.

Similar to above, a three-month period at the end of construction is anticipated for construction ramp-down and demobilisation, during which time approximately half the peak workforce will be on site, split between a main accommodation facility and a satellite accommodation facility at the Fairview end of the gas transmission pipeline.

Gas transmission pipeline construction is anticipated to be completed by the end of 2012, with commissioning at the beginning of 2013.

4.5.2.4 Traffic Movement Patterns

Personnel Movements

Construction of the proposed gas transmission pipeline is expected to occur over an 18 - 24 month period. Personnel will work 12 hours per day, seven days per week, working four weeks on with one week off. All construction personnel are assumed to be non-local on a fly-in/fly-out basis to be housed in accommodation facilities as described above.

Workers are expected to fly in to either Roma or Gladstone, depending on which is closer to the location of construction on the pipeline at the time. Workers will be transported by bus (approximately 20 passenger capacity) to the accommodation facilities. These transfers will occur once every four weeks per person. The traffic assessment assumes that rolling shift changes will occur approximately once per week to utilise buses for both the directions of travel to and from the airport. This approach also concentrates personnel travel on specific days, providing a more robust approximation of daily traffic for assessing road capacity impacts. Approximately 10 % of daily bus trips to and from the airport are assumed to occur in the project peak hours.

Daily movements of personnel will also include the transport of workers from accommodation facilities to the gas transmission pipeline corridor for construction activities. Approximately 20 % of total personnel is anticipated to be support staff for the accommodation facilities and construction depots and will not travel to the corridor. Of the workers travelling to the gas transmission pipeline corridor on a daily basis, approximately 15 % are expected to travel by 4WD (2 people per vehicle) and 85 % will travel by bus (20 passenger capacity). Daily traffic movements are expected to be evenly split between the morning and afternoon, as workers leave the accommodations in the morning and return from shift in the late afternoon.

Material/Equipment Movements

As described above, approximately 67 pipe truck loads per day will be delivered from the Port of Gladstone (assumed from Auckland Point Wharves) to the pipe laydown areas along the gas transmission pipeline corridor. These deliveries are anticipated to be spread throughout the day, with approximately 10 % of the daily trips estimated to occur in the peak hours.

Of the 67 daily truck trips for movement of equipment and materials as described above, deliveries are anticipated to be spread throughout the day, with approximately 10 % of the daily trips estimated to occur

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[1]The base case of 1,000 personnel on site is used throughout the EIS. The traffic and transport model used 1,500 personnel as a conservative measure to ensure pipeline construction workforce peak was included.

in the peak hours. These trips will mostly be from the construction depots to the gas transmission pipeline corridor.

Site Mobilisation/Demobilisation

Traffic movements associated with construction accommodation facilities mobilisation and demobilisation and construction depot setup are anticipated to occur several times as construction moves along the pipeline corridor. These activities will only be affecting the road network in these brief periods when equipment is moved from one accommodation facility to another or demobilised during the rainy season.

These periods of site setup and equipment movement are each expected to occur over one week. The mobilisation/demobilisation trips are anticipated to be spread throughout the day, with approximately 10 % of the daily trips estimated to occur in the peak hours.

4.5.2.5 Traffic Generation

Table 4.5.3 provides a summary of heavy and light vehicle movements for the mobilisation/ demobilisation, pipe haulage and daily movements of vehicles for each main accommodation facility location based on the description of traffic movement patterns above.

As shown in Table 4.5.3, approximately 450 daily trips are expected during the peak of construction of the gas transmission pipeline in 2011 and 2012. These daily trips are based on the full workforce being on site during the approximately 15 months of peak construction activities. In this period, approximately 165 peak hour trips are expected, which is mostly made up of personnel movements from the accommodation facilities to the gas transmission pipeline corridor.

Based on conservative estimates of approximately 15 - 20 operations personnel for inspection and general maintenance of the gas transmission pipeline, approximately 14,600 operations trips are estimated for each year after the construction of the pipeline. This equates to approximately 40 daily trips spread along the length of the gas transmission pipeline corridor.

Table 4.5.3 Construction Traffic Generation – Gas Transmission Pipeline

Year	2010	2011	2012
Peak Hour			
Heavy Vehicles	13	64	64
Light Vehicles	0	100	100
Total Vehicles	**13**	**165**	**165**
Daily Traffic			
Heavy Vehicles	135	243	241
Light Vehicles	0	204	202
Total Vehicles	**135**	**447**	**443**
Annual Traffic			
Heavy Vehicles	12,260	61,545	67,550
Light Vehicles	0	46,100	63,700
Total Vehicles	**12,260**	**107,645**	**131,250**

"Material by Rail" Option

The volumes of traffic generated by the gas transmission pipeline under the "Materials by Rail" option in 2011 and 2012 are consistent with the base case assessment with only a slight reduction in the 2011 trips.

No traffic for the gas transmission pipeline will be generated in 2010 under the "Materials by Rail" option assessment within Gladstone, as it is expected that pipe and associated materials will be delivered to laydown areas on the Gladstone end of the pipeline corridor first. Deliveries to the first four pipe laydown areas will all be by rail, and will not likely require any additional movement by road to the laydown areas. Truck movements will occur from the laydown areas to the pipeline corridor. This option is estimated to be more than half the total pipe transported, constituting over half the six months needed for pipe transport. Thus, no truck transport of pipe through Gladstone is anticipated in 2010.

The total trip reduction from 2010 to 2012 is estimated to be 14,500 trips. It should be noted that while total number of trips is fairly consistent, the length of truck trips will be much shorter as pipes are transported by rail as far as Moura and transported the remainder of the distance to the pipe/materials laydown areas by truck. It is estimated that a reduction in vehicle-km travelled of approximately 3,671,600 vehicle-km will occur with the "Materials by Rail" option, the majority of which will occur between 2010 and 2012.

4.5.2.6 Traffic Distribution

The distribution and assignment of traffic generated by the gas transmission pipeline to the roadway network has been determined from the traffic movement patterns above as well as likely sources and destinations for materials and equipment. Further details of origins and destinations of the gas transmission pipeline development trips are provided in Appendix J.

4.5.3 LNG Facility

4.5.3.1 Construction Deliveries

Estimates for delivery of construction equipment and materials to the LNG facility site over the four year period of the construction of Train 1 are provided in Table 4.5.4. Deliveries for Train 2 and Train 3 construction have been proportioned according to the estimated construction personnel for these phases.

It should be noted that these construction estimates have been based on a "stick-built" method of construction (that is built using unassembled materials on site). If a modular construction method is however chosen the number of loads delivered to the LNG facility construction site will be greatly reduced as modules will be pre-constructed elsewhere.

As part of this study, additional assumptions for the vehicle types and load carrying capacities in order to relate the quantities provided into actual vehicle trips have been made. These assumptions are provided in Table 4.5.4. All items except large pre-assembled items have been assessed as coming from the mainland by truck, and thus will need to be barged to Curtis Island during at least Train 1 construction (and possibly during Train 2 and 3 construction if the potential bridge to Curtis Island is not built).

Table 4.5.4 LNG Facility Construction Deliveries

Item	Quantity	Transport Assumptions
Potable Water	125,000 litres/day	By 20,000 litre tanker
Raw water	93,750 litres/day	By 20,000 litre tanker
Equipment	3,180 loads	By truck
Pipe	123,560 m	By truck (200 m per load)
Electrical	377,000 m	By truck (2,000 m per load)
Insulation	125,000 m^2	By truck (250 m^2 per load)
Fuel	2 tankers/month (assumed)	By 20 m^3 tanker
Concrete (1)	37,328 m^3	By truck (20 m^3 per load)
Grout	73 m^3	By Truck (6 m^3 per load)

Item	Quantity	Transport Assumptions
Steel	42,223 tonnes	By truck (10 tonnes per load)
Pavement	1,737 m^3	By truck (20 m^3 per load)
Paint	14 loads (assumed)	By truck (5 m^3 per load)
Miscellaneous Deliveries (assumed)	5 loads/day	50 % truck, 50 % light vehicles
Large indivisible pre-assemblies	77 items	To be shipped in – delivered directly to Curtis Island via barge

Note 1: Individual components will be delivered to site with batching on Curtis Island

4.5.3.2 Operation Deliveries

Deliveries during operation of the LNG facility are likely to be minimal, and include fuel and other materials and equipment. An indicative distribution of likely deliveries to the LNG facility is detailed in Table 4.5.5. All of these deliveries are likely to be from the mainland, with barge transport required to Curtis Island if the potential bridge is not built.

Table 4.5.5 Indicative Deliveries – LNG Facility Operations

Delivery Type	Vehicle Type	Number Trips	
		Train 1	Train 1,2 & 3
Refrigerants	Truck	2 per month	6 per month
Diesel	Truck	1 per month	3 per month
Chemicals	Truck	1 per month	3 per month
Other	Light Vehicle	10 per week	15 per week

4.5.3.3 Dredge Material Placement Facility

In addition to the main LNG facility construction workforce, approximately 50 personnel are expected to work on the construction of the dredge material placement facility at Laird Point on Curtis Island for the 18-month duration of construction (also refer Section 8.17). These workers are expected to travel by ferry from the mainland to the construction site daily, and are assumed to be 100 % local workforce (living in Gladstone and surrounds).

All materials for the dredge material placement facility are expected to be sourced locally from Curtis Island if possible. Detailed studies have not been performed in this regard, though for the purposes of this report no road transport of materials from the mainland has been assessed.

4.5.3.4 Traffic Movement Patterns

Construction Deliveries

The total deliveries to the construction site presented in Table 4.5.5 above have been estimated to be divided over the four year construction period, with 10 % of deliveries occurring in the first year (2010), 35 % occurring in each of the second and third years (2011 and 2012), and 20 % occurring in the fourth year of construction (2013). This is representative of the proportion of the work force employed for construction during these periods.

During the construction of Train 1, the potential bridge to Curtis Island may be under construction and all equipment and materials delivered by truck will be required to be barged to Curtis Island from the mainland. The wharf facilities at Auckland Point have been identified as a potential site for transfer of equipment and material and have been assumed in the preparation of this assessment. Equipment and materials will arrive at Auckland Point by road and will be either offloaded to a barge or transported via roll-on/roll-off ferry to Curtis Island.

The base case assessment assumes that the proposed bridge is to be constructed. In this case, construction traffic for Trains 2 and 3 of the LNG facility will utilise the bridge to Curtis Island. In the "No Bridge" option assessed, construction materials and equipment will continue to be transported by barge.

Some oversize or pre-assembled items are expected to arrive by ship and will be transported directly to the MOF on Curtis Island. These items are included in the construction delivery estimates in Table 4.5.4.

Approximately 10 % of the daily traffic movements associated with delivery of materials and equipment to the LNG facility construction site is estimated to occur during the morning and afternoon peak hours of the day.

Construction Personnel Movements

Construction personnel are anticipated to work a 10 days on and 4 days off roster in a fortnightly work cycle. All construction personnel are expected to be housed in workers accommodations on Curtis Island during their shifts. Each worker will travel to/from Curtis Island once per fortnight as they rotate onto or off their shift.

During the construction of Train 1 of the LNG facility, workers are expected to be local workers or distant workers that fly into Gladstone or drive from surrounding regional centres such as Rockhampton and will then be transported by bus to the ferry terminal in Gladstone, where they will be transported by ferry to Curtis Island. Auckland Point is the likely takeoff point for ferry operations and has been assumed in this assessment. It is estimated that 80 % of personnel will be transported by bus (20 passenger capacity) and 20 % will be via light private vehicle, with parking provided near the ferry terminal. These personnel movement patterns for Train 1 of the LNG facility are consistent for the base case and "No Bridge" option.

During the construction of Trains 2 and 3, the base case assessment assumes that the proposed bridge to Curtis Island will be available. Similar to above, personnel will be transferred to Curtis Island once every two weeks to stay in the accommodation facilities regardless of place of residence. Approximately 80 % of personnel will be transported by bus and 20 % by private vehicle.

Operations Personnel Movements

In the base case assessment all operations personnel are assumed to live in Gladstone and surrounds and travel daily by private vehicle to Curtis Island via the potential bridge. Shifts are such that all onsite workforce will likely be travelling during the project peak hours in the morning and afternoon.

For the "no bridge" option, operational personnel will travel daily by private vehicle to Auckland Point where a ferry will transfer staff to Curtis Island. It is estimated that there will be two (includes return) ferry trips per day from Auckland Point to the MOF on Curtis Island. Ferry capacities are expected to be approximately 150 passengers and will accommodate the estimated 80 staff required for operation of Train 1, through to the increase to approximately 130 staff for Train 3.

Dredge Material Facility Movements

The workforce for the construction of the dredge material placement facility will all live on the mainland and travel to Curtis Island by ferry daily. Similar to the other LNG facility workforce, transfer is assumed to take place from Auckland Point Wharf in Gladstone, with workers travelling to/from the ferry landing via private vehicle in the peak hours.

Laird Point is separated from the main LNG facility construction activities at Hamilton Point; therefore the MOF at Hamilton Point will not be used for transport of personnel and equipment to the dredge material placement facility. Barges and ferries to Laird Point should be scheduled in coordination with other LNG facility activities to include a triangular route between Gladstone Point, Hamilton Point and Laird Point to minimise the number of vessels travelling in the Port of Gladstone.

4.5.3.5 Traffic Generation

Table 4.5.6 presents the estimated traffic generated by the construction of the proposed LNG facility to use the external roadway network during each year of construction as well as during a typical weekday and peak hour. Table 4.5.7 presents the estimated traffic generated by the operations of the proposed LNG facility during each year of operations as well as during a typical weekday and peak hour. It should be noted that these estimates are based on the assumption that the construction of Train 2 and 3 of the LNG facility will follow in immediate succession to Train 1 construction.

The workforce traffic movements for the construction of the dredge material placement facility have been incorporated into the table, as they have similar travel patterns and trip types as the other LNG facility trips.

It should be noted that the traffic generation estimates for the “No Bridge” option assessed are identical to those presented in the base case assessment, though trips during construction of Trains 2 and 3 will travel on different routes than in the base case.

Traffic Distribution

The distribution and assignment of traffic generated by the LNG facility to the roadway network has been determined from the traffic movement patterns above as well as likely sources and destinations for materials and equipment. Further details of origins and destinations of the LNG facility development trips are provided in Appendix J.

4.5.3.7 LNG Shipping through the Great Barrier Reef

Shipping in the Great Barrier Reef Marine Park (the Marine Park) is managed by several government agencies including the Australian Maritime Safety Authority, Maritime Safety Queensland, the Great Barrier Reef Marine Park Authority and the Department of Infrastructure, Transport, Regional Development and Local Government. The Great Barrier Reef Marine Park Authority (GBRMPA) is the principal adviser to the Australian Government on the management and development of the Marine Park. GBRMPA’s role includes regulating the entry and use of the Marine Park by ships and other vessels through the Great Barrier Reef Marine Park Zoning Plan 2003 (the Zoning Plan).

As prescribed by the Zoning Plan, ships may transit the Marine Park through the General Usage Zone (light blue) or through other designated shipping areas by permit. Figure 4.5.1 shows the zones surrounding the Port of Gladstone.

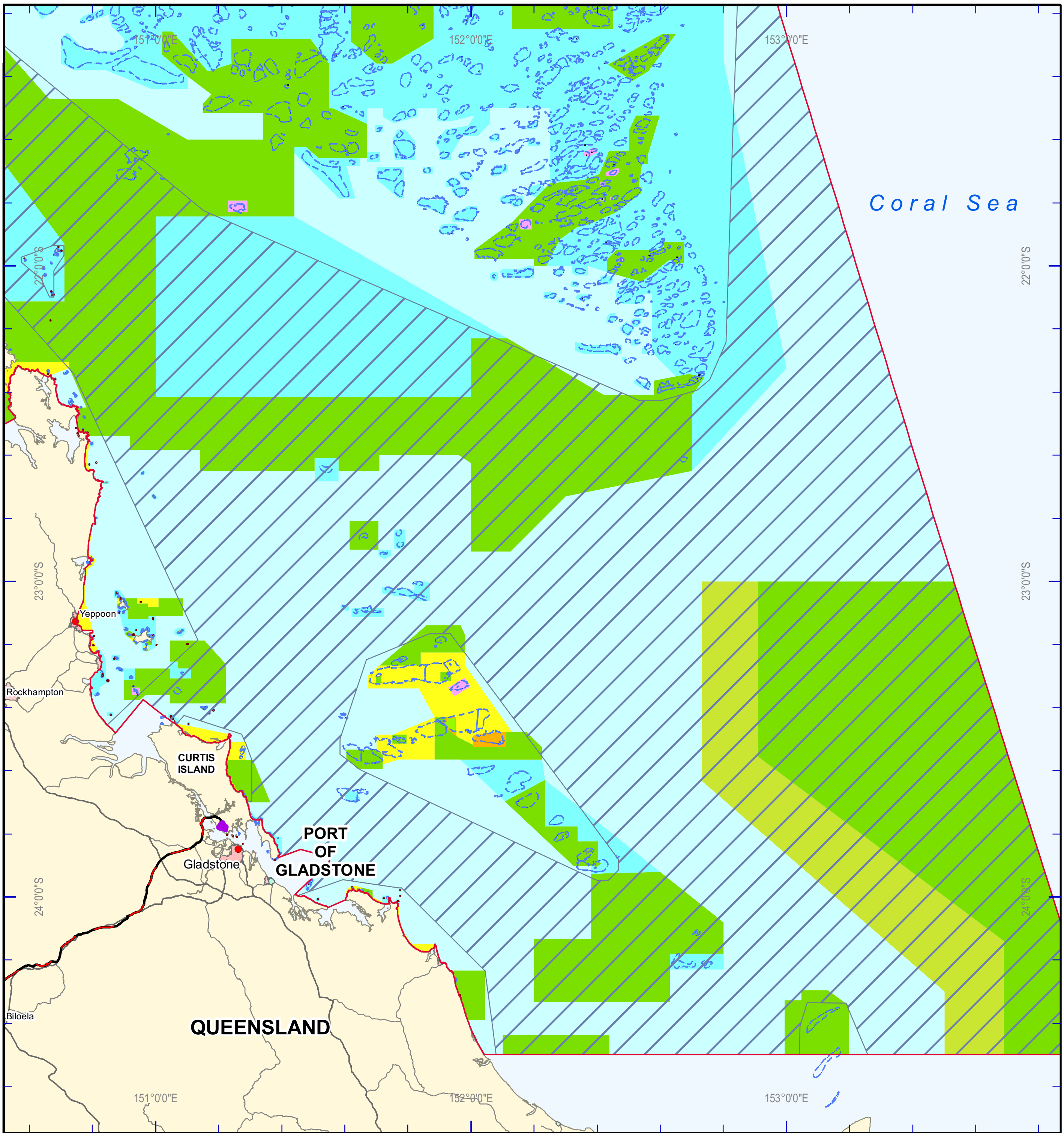
The shipping area designated in the Zoning Plan is designed to minimise the potential impact on the shipping industry whilst having regard for Australia’s international obligations. The placement of the designated shipping area reflects vessel usage patterns in the inner and outer shipping routes, existing recommended tracks, and new routes to allow for growth in shipping (GBRMPA, 2003a).

Table 4.5.6 LNG Facility Traffic Generation – Construction

Year (current estimate)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Construction	**Train 1**				**Train 2**				**Train 3**			
Peak Hour Volumes												
Light Vehicles (Delivery and Personnel)	51	95	88	17	17	42	38	11	17	42	38	11
Bus - Personnel	5	14	13	3	3	8	8	2	3	8	8	2
Heavy Vehicles	3	3	3	3	2	3	3	2	2	3	2	2
Total Vehicles	**59**	**112**	**104**	**23**	**21**	**53**	**49**	**15**	**21**	**53**	**48**	**15**
Daily Volumes												
Light Vehicles (Delivery and Personnel)	210	386	359	75	72	176	160	49	72	176	160	49
Bus - Personnel	20	55	50	13	13	33	30	8	13	33	30	8
Heavy Vehicles	28	34	34	28	17	26	26	23	17	26	24	19
Total Vehicles	**258**	**475**	**443**	**116**	**102**	**235**	**216**	**80**	**102**	**235**	**214**	**76**
Annual Volumes												
Light Vehicles (Delivery and Personnel)	18,611	50,544	34,128	10,390	10,130	20,862	19,209	7,686	10,130	20,862	19,209	7,686
Bus - Personnel	2,080	5,720	5,200	1,352	1,300	3,432	3,120	832	1,300	3,432	3,120	832
Heavy Vehicles	8,680	11,523	11,523	8,346	5,249	8,370	8,370	6,464	5,249	8,370	7,654	5,275
Total Vehicles	**29,371**	**67,787**	**50,851**	**20,088**	**16,678**	**32,664**	**30,699**	**14,981**	**16,678**	**32,664**	**29,983**	**13,792**

Table 4.5.7 LNG Facility Traffic Generation – Operations

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Operation	**Train 1**				**Train 2**				**Train 3**			
Peak Hour Delivery Volumes												
Light Vehicles (Staff and Deliveries)	100	100	100	100	135	135	135	135	170	170	170	170
Trucks (Fuel and Deliveries)	0	0	0	0	0	0	0	0	0	0	0	0
Total Vehicles	**100**	**100**	**100**	**100**	**135**	**135**	**135**	**135**	**170**	**170**	**170**	**170**
Daily Volumes												
Light Vehicles (Staff and Deliveries)	203	203	203	203	273	273	273	274	344	344	344	344
Trucks (Fuel and Deliveries)	3	3	3	3	3	3	3	3	3	3	3	3
Total Vehicles	**206**	**206**	**206**	**206**	**276**	**276**	**276**	**277**	**347**	**347**	**347**	**347**
Annual Volumes												
Light Vehicles (Staff and Deliveries)	56,437	56,437	56,437	56,712	77,352	77,352	77,352	77,559	98,199	98,199	98,199	98,199
Trucks (Fuel and Deliveries)	483	483	483	621	621	621	621	724	724	724	724	724
Total Vehicles	**56,920**	**56,920**	**56,920**	**57,333**	**77,973**	**77,973**	**77,973**	**78,283**	**98,923**	**98,923**	**98,923**	**98,923**



GBR Marine Park Zoning 2003

TYPE

- General Use
- Habitat Protection
- Conservation Park
- Buffer
- Scientific Research
- Scientific Research (closed to public access)
- Marine National Park
- Preservation
- Commonwealth Island

- Reef
- Rock (exposed)
- Rock (submerged)
- Cay
- Designated Shipping Area
- Great Barrier Reef Marine Park Boundary

- LNG Facility
- Gas Transmission Pipeline
- Major Towns
- Major Roads

N W E S

Kilometers
0 5 10 20 30 40 50

Scale 1:2 000 000 (A4)
Datum : GDA 94

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Client	Project	Title
LNG / URS	GLADSTONE LNG PROJECT ENVIRONMENTAL IMPACT STATEMENT	GREAT BARRIER REEF MARINE PARK ZONING AND DESIGNATED SHIPPING AREAS

Drawn: MG	Approved: JB	Date: 21-04-2009	Rev. B
Job No.: 4262 6220	File No.: 42626220-g-1030.mxd	Figure: 4.5.1	A4

GLNG Shipping

As described in Section's 3.3.3 and 3.9, the LNG will be stored and transported as an unpressured liquid in ships specifically designed to transport LNG. LNG carriers (LNGC) are double-hulled ships and are specially designed to prevent leakage or rupture. For the 3 - 4 Mtpa Train 1 LNG facility (assuming 155,000 m^3 capacity ships), there will be approximately 50 ship loads of LNG exported each year, or about one ship per week. This rate will increase to 160 ships per year or about one ship every 2 days when the three trains have been constructed and the production rate increases to 10 Mtpa. Using larger ships will involve correspondingly fewer ship movements.

It is intended that the LNGCs will be chartered by third parties.

These ships will navigate through the Marine Park within the designated shipping area before entering the Port of Gladstone, and again navigate through the Marine Park Shipping Area when leaving the Port of Gladstone.

The level of shipping through the designated shipping channels is approximately 2,000 ship movements per year. The typical ships using these channels carry products like coal, sugar, iron ore and oil.

The LNGC will represent an increase of 5 % in shipping movements for the first LNG train rising to an increase of ship movements of 16 % for three LNG trains.

It is also recognised that the LNGC's may use shipping channels which are beyond the eastern boundary of the Marine Park, therefore avoiding potential impacts on the Marine Park.

Risks to the Environment

In 2003 the GBRMPA finalised a Great Barrier Reef and Torres Strait Shipping Impact Study. The report identified a series of risks posed to the Great Barrier Reef by shipping. These risks included:

- Maritime incidents in the region - shipping accidents can occur through collisions, groundings, foundering or stranding. Groundings and collisions make up around 45 % of shipping accidents;
- Oil pollution and spills;
- Harmful effects of anti-fouling systems;
- Introduced invasive marine pests- ballast water and hull fouling;
- Discharge of waste at sea;
- Air quality;
- Interaction between trading ships and small craft;
- Anchorages;
- Erosion and bottom disturbance; and
- Heritage and cultural considerations.

The impact study then identified mechanisms for addressing the potential adverse impacts, and these were incorporated as appropriate into the Zoning Plan.

The following describes how the identified risks relate to the shipping activities of the GLNG Project.

Maritime incidents in the region

The LNG industry has had an impressive safety record over the last 47 years (URS, 2007). Since international commercial LNG shipping began in 1959, for example, tankers have carried over 33,000 LNG shipments without a serious accident at sea or in port. Insurance records and industry sources show that there were approximately 30 LNG tanker safety incidents (e.g. leaks, groundings or collisions) through 2002. Of these incidents, 12 involved small LNG spills, which caused some freezing damage but did not ignite. Two incidents caused small vapour vent fires, which were quickly extinguished.

Section 3 provides more details on ship design, and Section 3 provides more detail on the safety risks associated with an LNG leak.

Oil pollution and spills

According to Lloyd's Register (2008), all newer ships have double hull protection around the forward and aft bunker fuel tanks. However, on some of the approximately 30 year old LNGCs, the engine room bunker fuel tanks are not within the double hull. For fuel efficiency and boiloff rate reasons, many of these older vessels will no longer be carrying LNG cargo by the time Gladstone LNG terminal starts operations.

As described in Section 3, the LNGCs are most likely to be powered by gas turbines and will carry no or very limited quantities of bunker fuel.

The likelihood of a bunker spill is almost non-existent, which can be said about a cargo tank breach as well.

Harmful effects of anti-fouling systems

The International Maritime Organisation has developed a protocol for banning the use of Tributyl tin (TBT) on all ocean going ships by 2008 (GRRMPA, 2009). No TBT is to be applied or reapplied after 1 January 2003 and by 1 January 2008, no ships will have TBT on their hulls, or at the least, any existing TBT must be covered. In Australia, this initiative is being supported through the Antifouling Program as part of Australia's Oceans Policy.

Introduced invasive marine pests - ballast water and hull fouling

In 1998, the Australian Government announced its intention to develop a national system for addressing introduced marine species in Australia's Oceans Policy (GBRMPA, 2009). Since that time, the National Introduced Marine Pests Coordination Group (comprising representatives from the Australian Government and State and Territory Governments, marine industries, scientists and conservation organisations) has been developing a National System for the Prevention and Management of Marine Pest Incursions. The National System has three core elements:

1) **Prevention:** mechanisms to reduce the risk of introduction and translocation of marine pests;
2) **Emergency response:** systems to ensure coordinated emergency responses to any new incursions and translocations; and
3) **Ongoing management and control:** a coordinated management system for the ongoing management and control of introduced marine pests already in Australian waters.

In April 2005, an Intergovernmental Agreement on a National System for the Prevention and Management of Marine Pest Incursions was signed by the Australian Government and several State and Territory Governments (GBRMPA, 2009). The Agreement was developed to ensure that measures to address introduced marine species are coordinated across jurisdictional boundaries, and that they are consistent with current or future international agreements relating to introduced marine species.

International measures are also being taken to prevent the introduction of these species in Australian waters from ballast water (GBRMPA, 2009). An International Convention for the Control and Management of Ships Ballast Water and Sediments 2004 was recently developed to help reduce the risk of harmful aquatic organisms and pathogens being introduced by ships entering ports. Although it has yet to come into force, the Convention specifies that ballast water exchange should occur outside of the Great Barrier Reef Marine Park. When these requirements cannot be met, areas may be designated where ships can conduct ballast water exchange.

Santos will keep abreast of the national and international legislative requirements, and will ensure that charter parties adopt the necessary controls to ensure compliance with any international conventions.

Discharge of waste at sea

The International Convention for the Prevention of Pollution from Ships (MARPOL, 73/78) regulates the discharge of operational ship-sourced pollutants (GBRMPA, 2009). Within the Great Barrier Reef, MARPOL is implemented through the Protection of the Sea (Prevention of Pollution) from Ships Act 1983, Transport Operations (Marine Pollution) Act 1995 and the Great Barrier Reef Marine Park Act 1975.

MARPOL has six technical annexes, each regulating a particular type of pollution. Annexes I and II regulate oil and bulk noxious liquid substances. The MARPOL annexes describe the conditions under which these substances can be discharged, as well as design specifications for ships to minimise these discharges.

In addition, MARPOL places a duty on the ship's Master or operator to report any incident that involves a discharge or probable discharge of oil, noxious liquid substances or harmful packaged substances (GBRMPA, 2009). The ship's Master or operators are also obliged to report any damage, failure or breakdown that affects the safety of the ship or reduces the ship's ability to navigate safely.

Santos will expect charter parties to comply with the requirements specified through MARPOL.

Air quality

Minimising the impact of air pollution is addressed through annex VI of MARPOL (GBRMPA, 2003). The key features of the convention include the prohibition of deliberate emissions of ozone depleting substances, including halons and chlorofluorocarbons (CFCs); limits on emissions of nitrogen oxides (NOx) from diesel engines; and prohibition of the incineration on board ship of certain products, such as contaminated packaging materials and polychlorinated biphenyl's (PCBs).

Santos will expect charter parties to comply with the requirements specified through MARPOL.

Interaction between trading ships and small craft

The 2003 GBRMPA impact study identified that between 1991 and mid-2002, the Australian Transport Safety Bureau (ATSB) investigated 12 collisions between trading ships and smaller vessels off the coast of Queensland. Nine of the collisions occurred in the waters of the Great Barrier Reef and in all cases except one, the smaller vessel was a fishing trawler. The ATSB also investigated two reports of close quarters between trading vessels in the Great Barrier Reef.

The reports of the investigations identified non-compliance with aspects of the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) by both trading ships and fishing vessel crews. Non compliances included inadequate watch keeping, failing to keep a proper lookout, unsafe speed or inappropriate lights and were factors in most of these collisions. Other contributing factors included lack of marine training of crews of fishing vessels and fatigue.

GLNG will expect charter parties to comply with COLREGS.

Anchorages

The 2003 GBRMPA impact study identified that impacts of anchoring can be ameliorated by identification of preferred anchorage sites where anchoring will cause minimal environmental impact, or provision of dedicated public or private mooring points (GBRMPA, 2003). GLNG will expect charter parties to comply with the Zoning Plan, and undertake best environmental practices when anchoring.

Erosion and bottom disturbance

GLNG will expect charter parties to comply with the requirements of the Zoning Plan.

Heritage and cultural considerations

GLNG will expect charter parties to comply with the requirements of the Zoning Plan.

4.5.4 Curtis Island Access Road and Potential Bridge Construction

One option currently being investigated for long-term access to Curtis Island is the construction of an access road and bridge to cross Port Curtis between Friend Point and Laird Point, linking Curtis Island with the mainland. The alternate option to providing the bridge is to continue barge and ferry operations of personnel and equipment/materials from the mainland to Curtis Island for the construction and operations of all production trains of the LNG facility. The need for such a bridge and road is still being assessed by relevant stakeholders, however for the purpose of this assessment the construction of the road and bridge has been considered as the base case.

The construction of the road and bridge works are anticipated to generate a significant amount of traffic over the approximately 18 - 24 months of construction. The traffic associated with the potential access road and bridge has been considered in conjunction with construction traffic generated by the LNG facility. The construction of the Curtis Island access road and bridge is likely to begin in the third quarter of 2011.

A summary breakdown of total expected construction deliveries needed for the bridge construction is provided in Table 4.5.8.

Table 4.5.8 Bridge Construction Delivery Movements

Activity	Estimated Total Movements (Two-way Trips)	Vehicle Classification	Estimated Weekly Movements (Two-way Trips)
Site Mobilisation	28	Heavy Vehicle/Truck	28 / week
Foundation – Piles	2,293	Heavy Vehicle/Truck	100 / week
Abutments	56	Heavy Vehicle/Truck	14 / week
Pile Caps	575	Heavy Vehicle/Truck	60 / week
Piers	771	Heavy Vehicle/Truck	78 / week
Superstructure	443	Heavy Vehicle/Truck	36 / week
Bridge Asphalting and Finishes	180	Heavy Vehicle/Truck	141 / week 84 / week
Ground Improvement - Placement	11,515	Heavy Vehicle/Truck	397 / week
Ground Improvement - Removal	11,515	Heavy Vehicle/Truck	768 / week
Road Earthworks	11,916	Heavy Vehicle/Truck	476 / week
Road Asphalting/Sealing	1,252	Heavy Vehicle/Truck	360 / week
Site Demobilisation	28	Heavy Vehicle/Truck	28 / week
Subtotal	**40,572**		
Personnel Movements		Light Vehicle	1,500 / week

4.5.4.1 Trip Generation

Table 4.5.9 presents the expected traffic to be generated by the construction of the bridge for each year of construction as well as for a weekday and peak hour. Similar to the other project components, it has been assumed that deliveries will be spread throughout the day, with approximately 10 % of deliveries occurring during each of the peak hours. Approximately 25 % of personnel trips (light vehicles) to the bridge construction site are estimated to occur during each of the project peak hours.

It should be noted that under the "No Bridge" option, the bridge is not assumed to be constructed, thus reducing the total traffic added to the road network in Gladstone by almost 300,000 trips over a three year period (2011 - 2013).

Table 4.5.9 Bridge Construction Traffic Generation

Year	2011	2012	2013
Peak Hour Volumes (One-way Trips)			
Light vehicle trips	45	109	63
Heavy vehicle trips	40	50	34
Total Trips	**85**	**159**	**97**
Daily Volumes (One-way Trips)			
Light vehicle trips	192	448	263
Heavy vehicle trips	400	504	337
Total Trips	**592**	**952**	**600**
Annual Volumes (One-way Trips)			
Light vehicle trips	25,344	139,716	36,360
Heavy vehicle trips	19,373	56,546	17,324
Total Trips	**44,717**	**196,262**	**53,684**

4.5.4.2 Trip Distribution

The distribution and assignment of traffic generated by the construction of the potential access road and bridge to the roadway network has been determined from the traffic movement patterns above as well as likely sources and destinations for materials and equipment. Further details of origins and destinations of the bridge construction trips are provided in Appendix J.

4.6 Assessment Methodology

The traffic impact assessment has been divided into three key components including:

- Intersection Capacity Impact Assessment;
- Roadway Link Capacity Impact Assessment; and
- Pavement Impact Assessment.

Analysis was undertaken for "without development" and "background plus development" traffic scenarios through the peak stages of construction and operation of the project components as well as for the 10-year design horizon.

Intersection analysis considers the capacity of relevant intersections based on the Degree of Saturation (DOS) identified using the SIDRA computer analysis package. The assessment also considers turn lane requirements in accordance with the DMR "Road Planning and Design Manual." Intersection queuing has been considered to identify whether intersection turn lane lengths are adequate to accommodate the expected queue lengths.

Impacts of the GLNG Project on midblock link capacity of road segments were assessed using the daily two-way traffic demand to identify if the current road cross-sections will be sufficient for future year and development demands.

Pavement impacts have been assessed to determine if the proposed project necessitates bringing forward of pavement rehabilitation works or increases the need for regular road maintenance.

4.6.1 Assessment Scenarios

Because of the varied timing and phasing associated with the construction and operations of the three components of the GLNG Project, a scoping exercise was undertaken to determine the assessment scenarios that will provide a conservative yet representative reflection of the traffic impacts of the project.

The factors considered in this exercise were the overlap in timing between traffic generation of each of the project components, the locations of each project component in relation to the others, and the duration of activity associated with the project components.

Table 4.6.1 shows the total peak hour traffic generation of the construction and operations of all proposed project components for each year. As shown, year 2012 was identified to have the highest total peak hour trip generation, with the following project activities occurring during this time:

- LNG facility Train 1 construction;
- Curtis Island access road and bridge construction;
- Gas transmission pipeline construction; and
- Construction and operations of the CSG fields.

Year 2012 was subsequently selected as the year of assessment for the intersection capacity impact assessment. Road network elements were analysed in 2012 with expected background growth only (4 % p.a. in Gladstone and surrounds, and 6 % p.a. on rural roadways plus cumulative project traffic), as well as with background growth plus GLNG Project traffic.

Table 4.6.1 Overall Project Peak Traffic Generation – Peak Hour

Year	Light Vehicles	Heavy Vehicles	Total
2010	91	64	155
2011	297	190	487
2012	**365**	**212**	**577**
2013	172	137	310
2014	**214**	**99**	**312**
2015	240	104	344
2016	237	114	351
2017	210	103	313
2018	251	104	355
2019	278	108	386
2020	275	115	390
2021	247	102	349
2022	272	99	371
2023	273	59	332
2024	**273**	**53**	**326**
2025	273	55	329
2026	274	51	325
2027	274	51	325
2028	274	51	325
2029	275	49	324
2030	275	50	326

Year 2014 was selected for analysis as it is the opening year of Train 1 production of the LNG facility and gas transmission pipeline construction activities are finished. The 2014 assessment scenario includes traffic generated by construction and operations of the CSG fields and construction of Train 2 of the LNG facility, which has been assumed to be built in immediate succession to Train 1. This assessment scenario provides a more realistic reflection of the near-term impacts of the proposed GLNG Project, since the gas transmission pipeline construction activities only generate traffic for a finite period of time and the other project activities continue for more sustained periods. As shown in Table 4.6.1, total traffic generation also peaks in 2019 with the following project activities overlapping:

- Train 2 LNG facility construction;
- Train 1 LNG facility operations;
- Gas transmission pipeline operations; and
- Construction and operations of all three CSG field areas.

Year 2024 was also assessed as a 10-year design horizon from the opening year of operations of Train 1 of the LNG facility. This scenario assesses the long-term impacts of the proposed GLNG Project. As shown in Table 4.6.1 above, peak hour traffic is generally consistent from 2024 onward and includes operations traffic for all GLNG Project components.

Based on the above, the following scenarios were assessed for intersection capacity impacts:

- 2012 background;
- 2012 background plus development;
- 2014 background;
- 2014 background plus development;
- 2024 background; and
- 2024 background plus development.

Roadway link capacity and pavement impacts were assessed for each year of the project life under both “background” and “background plus development” scenarios.

4.6.1.1 Options Assessment Scenarios

A review of the peak hour traffic generated by all components of the GLNG Project was undertaken to ensure the assessment years were appropriate for the “No Bridge” and “Materials by Rail” option assessments. Further details are provided in Appendix J.

“No Bridge” Option

A significant decrease in traffic from the base case to the “No Bridge” option was found. The “No Bridge” option results in a reduction of 294,650 trips due to the removal of traffic associated with the bridge construction in 2011-2013. For all other years the total peak hour traffic generation is identical. Thus it was concluded that the assessment years of 2012, 2014 and 2024 are appropriate for the “No Bridge” option.

“Materials by Rail” Option

A slight decrease in peak hour traffic from the base case to the “Materials by Rail” option in 2010 and 2011 was found. This is due to the reduction of pipe delivery by road, with most of the reduction occurring in 2010 because of construction sequencing. For all other years the total peak hour traffic generation is identical.

Because the peaks of traffic generation for the “Materials by Rail” option are the same as for the base case and traffic volumes are identical during these peaks, there is no need to undertake additional intersection analysis for the option assessment. Intersection impacts will be the same for the “Materials by Rail” option as for the base case. This is also reinforced by the fact that the majority of peak hour traffic is generated by the proposed LNG facility and access road and bridge to Curtis Island, both of which have the same traffic generation for this option assessment.

4.7 Intersection Capacity Impact Assessment

The key intersections have been analysed for each of the scenarios outlined above using the SIDRA Intersection 3.2 analysis program (SIDRA). This program calculates the operation of intersections based on input parameters, including geometry and traffic volumes. As an output SIDRA provides values for the DOS, queues and delays. The DOS is a commonly used value, which is essentially a volume to capacity ratio.

The critical DOS rates are provided in Appendix J and have been adopted in accordance with AUSTROADS guidelines. A DOS exceeding these values indicates that the intersection is nearing its operational capacity. Above these values, users of the intersection are likely to experience unsatisfactory queuing and delays.

4.7.1 Intersection Impact Assessment Methodology

The process used to undertake the intersection impact assessment for the development included the following steps:

- Identify intersections that could be impacted significantly by the proposed development;
- Identify intersections that will come close to practical capacity with the addition of the proposed development;
- Obtain and analyse the background traffic at the identified intersections;
- Determine background road network traffic peaks and development traffic peaks;
- Add the cumulative impact traffic to the existing background traffic volumes to come up with the background traffic to be used in the analysis of the identified intersections;
- Identify the various components of the proposed development that will impact the road network; and
- Determine the traffic generated from the various components of the proposed development and combine with the background traffic. These volumes are to be used in the analysis of the identified intersections.

4.7.1.1 Background Traffic

Background traffic was acquired predominantly from DMR intersection turning movement counts with some intersection counts undertaken by Austraffic. These counts were obtained for the intersections identified as being significantly impacted by the proposed development. These counts were undertaken throughout 2005, 2006, 2007 and 2008 and were all increased using background growth rates (4 % p.a. within Gladstone and 6 % p.a. outside of Gladstone) to 2008 volumes.

Information for all the intersections that were assessed, including their count year, source and growth rate applied, are presented in Appendix J.

4.7.1.2 Traffic Peak Periods

The overall road network peak hour periods were determined by summing the 15-minute count data for all intersections in the study area. This identified that the morning road network peak occurred from 7:45 - 8:45 am with the afternoon road network peak occurring from 4:30 - 5:30 pm.

It was recognised that the morning peak travel periods associated with construction and operations of the LNG facility, dredge material placement facility and potential Curtis Island access road and bridge will not likely coincide with the overall road network peaks identified above. This is reinforced by the fact that during construction of Train 1 of the LNG facility all personnel will be required to travel by ferry to Curtis Island, with total travel taking up to one and a half hours.

Because LNG facility construction workers will be transferred to Curtis Island for 10 days at a time, arrival on the island is not necessarily confined by shift times. Similarly, it is assumed that personnel travelling to the potential Curtis Island access road and bridge construction site and dredge material placement facility will travel to the site early in the morning before the roadway network peak hour, but will likely travel home in the afternoon during the roadway network peak period of 4:30 - 5:30 pm.

Considering the above, the peak hours assumed for the GLNG development activity are from 6:00-7:00 am for the morning development peak and from 4:30 - 5:30 pm for the afternoon development peak. Projects included as cumulative background traffic in this assessment were reviewed and were found to utilise similar project peak hours as those described above.

For simplicity, the AM peak periods in this report are referred to as the “early” and “late” peak periods. The “early peak” periods refer to the development peak periods (6:00 - 7:00 am). The “late peak” period refers to the road network peak period (7:45 - 8:45 am). As above, the afternoon peak hour is estimated to occur at the same time for the road network and the GLNG Project. The following three peak hour periods were assessed for the intersection capacity impact analysis:

- Morning early peak hour: 6:00 – 7:00 am;
- Morning late peak hour: 7:45 - 8:45 am; and
- Afternoon peak hour: 4:30 - 5:30 pm.

Up to 50 % of daily personnel movements were assumed to occur in each of the development peak hours (morning early peak and afternoon peak), reflecting a typical morning/afternoon shift pattern. It was assumed that delivery trips will be spread throughout the day, with 10 % of daily trips occurring in each of the development peak hours. Approximately 10 % of daily personnel movements were estimated to occur in the road network morning peak (morning late peak).

4.7.1.3 Cumulative Impacts of Other Projects

As indicated in Section 4.4.4, only the Moura Link-Aldoga Rail Project, Wiggins Island Coal Terminal Project and Gladstone Pacific Nickel Refinery Project had suitable information available for inclusion in this assessment. The other projects identified as potentially having a cumulative impact on the development did not have traffic data that could be used in the assessment and were not included in the cumulative impacts. Potential traffic from the projects not included has been accounted for in the background traffic growth rates applied.

The cumulative traffic from each development were reviewed and combined for each assessment year. This involved identifying the development traffic at the various scenario years and combining them to identify the total additional trips that were to be generated by the cumulative projects. The cumulative number of trips was then combined to the background volumes for the scenario years to give the total background traffic volumes in each assessment year.

4.7.2 Intersection Analysis

The following intersections were identified for analysis based on the potential for the proposed GLNG Project to impact on their operations:

- Gladstone - Mount Larcom Road/Calliope River Road/Targinie Road intersection;
- Gladstone - Mount Larcom Road/Hanson Road/Landing Road intersection;
- Hanson Road/Red Rover Road intersection;
- Hanson Road/Blain Drive/Alf O’Rourke Drive intersection;
- Bruce Highway/Gladstone - Mount Larcom Road intersection;
- Glenlyon Road/Port Access Road/Railway Street intersection;
- Dawson Highway/Glenlyon Road/Bramston Street intersection;
- Dawson Highway/Don Young Drive/Kirkwood Road intersection;
- Dawson Highway/Blain Drive/Herbertson Street intersection;

- Dawson Highway/Philip Street intersection;
- Dawson Highway/Aerodrome Road intersection;
- Bruce Highway/Dawson Highway intersection; and
- Bruce Highway/Calliope River Road intersection.

A description of each of these intersections and the detailed outcomes of the impact assessment are provided in Appendix J.

4.7.3 Intersection Analysis Summary

Table 4.7.1 summarises the intersection analysis and any works required to mitigate development impacts under the base case and "No Bridge" option. As discussed in Section 4.6.1.1, the "Materials by Rail" option will have the same intersection impacts as the base case.

4.7.4 Project Mitigation Summary

To mitigate the impact of the development on intersections within Gladstone, Santos will contribute to upgrades needed at the following intersections:

4.7.4.1 Base Case Scenario:

- Hanson Road/Red Rover Road;
- Hanson Road/Blain Drive/Alf O'Rourke Drive;
- Dawson Highway/Blain Drive/Herbertson Street; and
- Dawson Highway/Philip Street.

4.7.4.2 "No Bridge" Option:

- Hanson Road/Red Rover Road;
- Dawson Highway/Glenlyon Road/Bramston Street;
- Dawson Highway/Blain Drive/Herbertson Street; and
- Dawson Highway/Philip Street.

Further details on the mitigation measures proposed by the GLNG Project are included in Table 4.7.1 and Appendix J.

Table 4.7.1 Intersection Analysis Summary

<table>
<tr><th rowspan="2">Intersection</th><th rowspan="2">Existing Layout</th><th colspan="2">Upgrade Treatment</th></tr>
<tr><th>Base Case / “Material by Rail” Option</th><th>“No Bridge” Option</th></tr>
<tr><td>Gladstone - Mount Larcom Road/ Calliope River Road/ Targinie Road</td><td>Four -way channelised priority intersection</td><td colspan="2">No GLNG contribution is anticipated.
The existing form has sufficient capacity for all scenarios.</td></tr>
<tr><td>Gladstone - Mount Larcom Road/Hanson Road/Landing Road</td><td>Three-way channelised priority intersection</td><td colspan="2">No GLNG contribution is anticipated.
The existing form has sufficient capacity for all scenarios.</td></tr>
<tr><td>Hanson Road/Red Rover Road</td><td>Two-lane roundabout</td><td colspan="2"><u>GLNG upgrades:</u>
Short right turn lane on west leg of Gladstone – Mt Larcom Road and additional circulating width.
Short right turn lane on south leg of Red Rover Road and additional circulating width.
Note: Duplication of Hanson Road is being planned by DMR. In lieu of GLNG implementing the upgrading works identified above, the option of making a contribution to the intersection upgrade could be considered. This will allow intersection improvements to be incorporated into the four lane upgrading works. Development traffic forms (4.8 % base case, 0.3 % “No Bridge” option) of the combined background and development traffic in 2012.</td></tr>
<tr><td>Hanson Road/Blain Drive/Alf O’Rourke Drive</td><td>Single-lane roundabout</td><td><u>GLNG upgrades:</u>
Short right-turn lane on west leg of Hanson Road and additional circulating width.
Continuous left-turn lane from south leg of Blain Drive.
<u>Note:</u> Duplication of Hanson Road is being planned by DMR. In lieu of GLNG implementing the upgrading works identified above, the option of making a contribution to the intersection upgrade could be considered. The development traffic forms 3.7 % of the combined background and development traffic in 2012. This will allow intersection improvements to be incorporated into the four lane upgrading works.</td><td>No GLNG contribution is anticipated.
The intersection exceeds practical capacity with background traffic but the development does not make the intersection operation any worse</td></tr>
<tr><td>Bruce</td><td>Three-way</td><td colspan="2">No GLNG contribution is anticipated.</td></tr>
</table>

Intersection	Existing Layout	Upgrade Treatment	
		Base Case / "Material by Rail" Option	"No Bridge" Option
Highway/Gladstone - Mount Larcom Road	channelised priority intersection	The existing form has sufficient capacity for all scenarios.	
Glenlyon Road/Railway Street/Port Access Road	Four-way signalised intersection	**No GLNG contribution is anticipated.** The existing form has sufficient capacity for all scenarios.	
Dawson Highway/Glenlyon Road/Bramston Street	Four-way signalised intersection	**No GLNG contribution is anticipated.** The intersection exceeds practical capacity with background traffic but the development does not make the intersection operation any worse. Programmed improvements at this intersection have been identified in the Roads Implementation Program for 2009/2010 ($100,000). DMR advise that these works will include phasing changes and lane marking changes to improve operation of the traffic signals.	**GLNG upgrades:** **Extension of turn lanes on the northwest, southeast and southwest legs.** Programmed improvements at this intersection have been identified in the Roads Implementation Program for 2009/2010 ($100,000). DMR advise that these works will include phasing changes and lane marking changes to improve operation of the traffic signals.
Dawson Highway/Don Young Road	Three-way channelised priority intersection	**No GLNG contribution is anticipated.** The intersection exceeds practical capacity with background traffic but the development does not make the intersection operation any worse. Gladstone Regional Council planning for the Kirkwood Road project indicates Kirkwood Road will align with Don Young Drive and form a grade separated intersection providing far superior intersection performance. There is no timing proposed for this work.	
Dawson Highway/Blain Drive/Herbertson Street	Two-lane roundabout	**GLNG upgrades:** **Short left slip lane on southern leg of Dawson Highway.** **Pavement marking of left lane on western leg to allow all turn movements.** The improvements ensure the operation of the intersection is no worse compared to the background traffic scenario with the existing intersection form.	
Dawson Highway/Philip Street	Two-lane roundabout	**GLNG contribution to intersection upgrade based on use by development traffic.** Intersection exceeds practical capacity with background traffic and development traffic creates further impact. DMR are planning upgrade works and the option of making a contribution to the intersection upgrade could be considered. The development traffic forms **(6.1 % in base case, 3.4 % in "No Bridge" option)** of the combined background and development traffic in 2012.	

<table>
<tr><th rowspan="2">Intersection</th><th rowspan="2">Existing Layout</th><th colspan="2">Upgrade Treatment</th></tr>
<tr><th>Base Case / “Material by Rail” Option</th><th>“No Bridge” Option</th></tr>
<tr><td>Dawson Highway/Aerodrome Road</td><td>Four-way signalised intersection</td><td colspan="2">No GLNG contribution is anticipated.
The intersection exceeds practical capacity with background traffic but the development does not make the intersection operation any worse.</td></tr>
<tr><td>Bruce Highway/Dawson Highway</td><td>Four-way channelised priority intersection</td><td colspan="2">No GLNG contribution is anticipated.
Grade separation of intersection planned by DMR to be completed in next 5 years.</td></tr>
<tr><td>Bruce Highway/Calliope River Road</td><td>Three-way channelised priority intersection</td><td colspan="2">No GLNG contribution is anticipated.
The existing form has sufficient capacity for all scenarios.</td></tr>
<tr><td>Dawson Highway/Kariboe Street/Callide Street</td><td>Four-way priority intersection</td><td colspan="2">No GLNG contribution is anticipated.
The intersection exceeds practical capacity with background traffic but the development does not make the intersection operation any worse.</td></tr>
</table>

4.8 Roadway Link Capacity Impact Assessment

This section considers the roadway link requirements based on assessment of the daily road link volumes with and without the proposed development.

The adopted maximum capacity thresholds have been adopted based upon the AUSTROADS Guide to Traffic Engineering Practice and previous work. The thresholds adopted for this assessment were split between urban and rural roads and are presented in Appendix J. The key roads considered in this assessment include:

- Dawson Highway;
- Gladstone - Mt Larcom Road;
- Hanson Road;
- Carnarvon Highway;
- Leichhardt Highway;
- Bruce Highway;
- Gladstone - Benaraby Road;
- Burnett Highway; and
- Warrego Highway.

Assessment of roadway link capacity was undertaken for each year of the expected GLNG Project life (2010 to 2034).

4.8.1 Background Traffic Volumes

The background daily two-way traffic volumes on each of the road sections were determined based upon existing AADT volumes and intersection counts provided by DMR and Council. Growth rates of 4 % p.a. and 6 % p.a. have been applied to urban and rural road segments respectively, to establish future background traffic volumes.

The projected background traffic volumes are presented in Appendix J. In reviewing the background traffic volumes, the roadway sections presented in Table 4.7.1 were found to require upgrading. A review of the background plus development volumes revealed that no additional roadway segments fail because of the GLNG Project traffic. Further detailed examination of the critical road sections was carried out to determine if the capacity breakpoint was reached earlier due to addition of GLNG development traffic than with background traffic only. This exercise serves to determine the “bring forward” cost responsibility of the proposed development on segments it significantly impacts.

Table 4.8.1 below indicates, for the road segments that reach capacity, the years when the capacity threshold is reached under “background” as well as “background plus development” traffic.

4.8.2 Development Traffic Impacts

Bring forward cost contributions are recommended on any section where the project creates the need to bring forward upgrades by one year or more. Based on this traffic assessment summarised in Table 4.8.1, the GLNG Project is responsible for a contribution to the bring forward cost of two sections (approximately 6 km) of Gladstone - Mount Larcom Road under the base case.

Under the “Materials by Rail” option the GLNG development impacts are the same. Under the “No Bridge” option assessment the development is responsible for a contribution to the bring forward cost of upgrades on two sections of the Dawson Highway within Gladstone (approximately 2.2 km) and one section of Gladstone-Mount Larcom Road (approximately 1.4 km).

4.8.3 Project Mitigation Summary

4.8.3.1 Base Case Mitigations

To mitigate the impact of the development on mid-block capacity under the base case scenario (and "Materials by Rail option), Santos will contribute an appropriate portion of the bring forward cost of the upgrading of the sections of road summarised in Table 4.8.1.

Table 4.8.1 LNG Roadway Link Upgrades – Base Case and "Material by Rail" Option

Road	Section	Upgrade	Bring Forward (years)	% GLNG Contribution (% 2009 Cost)
Gladstone - Mt Larcom Road	Red Rover Road to Power Station Road (1.0 km)	2 to 4 lanes	1.4	4.7 %
	Power Station to Reid Road (5.0 km)	2 to 4 lanes	1.4	4.7 %

This cost of the upgrade works is unknown but Santos will contribute the cost difference of approximately 4.7 % of the total cost, calculated by discounting the construction costs back from 2020 and 2019 at an inflation rate of 7 % (specified by DMR). DMR has started the planning work to duplicate Gladstone - Mount Larcom Road to four lanes.

4.8.3.2 "No Bridge" Option

To mitigate the impact of the development on mid-block capacity under the "No Bridge" option, Santos will contribute an appropriate portion of the bring forward cost of the upgrading of the sections of road summarised in Table 4.8.2.

Table 4.8.2 LNG Roadway Link Upgrades – "No Bridge" Option

Road	Section	Upgrade	Bring Forward (years)	% GLNG Contribution (% 2009 Cost)
Dawson Highway	Gladstone - Mt Larcom Road to Breslin Street (1.5 km)	4 to 6 lanes	1.4	1.8 %
	Breslin Street to Blain Drive (0.7 km)	4 to 6 lanes	1.3	2.0 %
Gladstone - Mt Larcom Road	Dawson Highway to Hilderbrand Street (1.4 km)	2 to 4 lanes	1.4	1.9 %

This cost of the upgrade works is unknown but Santos will contribute the percent of total construction cost shown in Table 4.8.3, calculated by discounting construction costs back from 2020 and 2019 at an inflation rate of 7 % (specified by DMR).

Table 4.8.3 Roadway Link Capacity Breakpoints (Base Case Assessment)

Road	Section	Background Traffic		Background + Development Traffic		Bring Forward Amount (years)
		Volume	Year	Volume	Year	
Dawson Highway (46A)	Breslin Street to Blain Drive	36,687	2032	36,687	2032	0.0
Dawson Highway (46A)	Blain Drive to Philip Street	37,226	2024	36,277	2023	0.3
Dawson Highway (46A)	Philip Street to Penda Avenue	37,154	2016	37,286	2016	0.1
Dawson Highway (46A)	Penda Avenue to Chapman Drive	36,801	2021	36,801	2021	0.0
Dawson Highway (46A)	Chapman Drive to Don Young Drive	18,430	2016	18,430	2016	0.0
Dawson Highway (46A)	Don Young Drive to Harvey Road	18,175	2034	18,175	2034	0.0
Dawson Highway (46A)	Tognalini - Baldwin Road to Biloela	15,074	2026	15,077	2026	0.0
Gladstone - Mt Larcom Road	Dawson Highway to Hilderbrand Street	36,178	2033	36,319	2033	0.0
Gladstone - Mt Larcom Road	Hilderbrand Street to Blain Drive	18,462	2027	18,021	2026	0.2
Gladstone - Mt Larcom Road	Blain Drive to Red Rover Road	18,666	2019	18,409	2018	0.7
Gladstone - Mt Larcom Road	**Red Rover Road to Power Station**	**15,247**	**2020**	**15,467**	**2019**	**1.4**
Gladstone - Mt Larcom Road	**Power Station to Reid Road**	**15,247**	**2020**	**15,467**	**2019**	**1.4**
Gladstone – Bernaraby Road	Dawson Highway to Sun Valley Road	36,504	2022	36,504	2022	0.0
Gladstone – Bernaraby Road	French Street to Gen Eden Drive	15,5431	2019	15,431	2019	0.0
Gladstone – Bernaraby Road	Glen Eden Drive to South Trees Drive	15,431	2019	15,431	2019	0.0
Gladstone – Bernaraby Road	South Trees Drive to Boyne Island Road	15,431	2019	15,431	2019	0.0

4.9 Pavement Impact Assessment

Analysis has been conducted to identify the pavement impacts of the heavy vehicle movements to and from the project. This assessment included both the construction and operational stages of the project and was undertaken from the start of construction in 2010 through to 2034.

The pavement assessment comprised two components, the impact on the timing of pavement rehabilitation and the increased need for regular maintenance. Both assessments were based on a comparison of the cumulative Equivalent Standard Axle (ESA) load with and without the development. Analysis was only undertaken on SCR as no road data was available from local Councils for local roads. The methodology for the pavement impact assessment has been based on guidelines provided by the DMR.

4.9.1 Pavement Rehabilitation Requirements

The impact on pavement rehabilitation considered the existing and terminal roughness deficiency. Utilising an existing pavement roughness count, the year at which a pavement reaches its terminal roughness was then calculated.

The cumulative number of ESAs loaded onto the roadway segment to the terminal year was then calculated based on the ESA loading along the haulage routes. The background volumes were based on classified (by vehicle type) AADT volumes with a cumulative heavy vehicle growth rate of 3 % pa. For the Bruce Highway a value of 2.9 ESAs for each heavy vehicle was applied. For all other SCRs, 3.2 ESAs for each heavy vehicle was used. These ESAs are as specified by the DMR.

The classified development heavy vehicle volume was then used to determine additional annual ESA loadings produced along the haulage routes as a result of development traffic added to the network. The annual background and development ESA loading was combined and the cumulative number of ESAs on a given link was then calculated for successive years.

The year when cumulative ESA loading reached terminal roughness was compared between background and background plus development scenarios and the difference in time between the two scenarios was then established. Outputs for the pavement impact analysis are provided at Appendix J.

4.9.1.1 Development Impacts

Contributions towards pavement rehabilitation will only be made where the development will bring forward the need for rehabilitation by more than one year. The road sections that meet this criterion are shown in Table 4.9.1.

Two road segments on the Carnarvon Highway, one road segment on the Warrego Highway and one road segment on the Dawson Highway have been identified as requiring pavement rehabilitation works one or more years earlier with the GLNG Project than with background traffic. Cost input data for rehabilitation of roads has been provided by DMR Central District and includes costs of rehabilitation based on road seal width and cost inflation rate of 7 % per annum. Based on these inputs, the bring forward cost of the required works is approximately $3.1 M (2009 dollars).

These pavement rehabilitation impacts and mitigations are the same for all traffic options assessed.

Table 4.9.1 Pavement Rehabilitation Impacts and Contributions

Road	Section	Direction	Length (km)	Rehabilitation Year		Bring Forward Amount (years)	% of Total Cost	Bring Forward Cost Contribution
				Without Development	With Development			
Carnarvon Highway 24D	CH. 3m to CH. 18 Roma - Taroom Road	Northbound	15	2016.7	2015.1	1.6	6.8 %	$171,276
		Southbound	15	2016.7	2015.3	1.4	5.9 %	$148,839
Carnarvon Highway 24D	Roma - Taroom Road to Injune	Northbound	72	2018.7	2015.7	3.0	11.7 %	$1,413,423
		Southbound	72	2018.7	2016.0	2.7	10.4 %	$1,258,826
Dawson Highway 46 C	Fitzroy Dev. 85A Intersection to Duaringa/Woorabinda Intersection	Westbound	6.6	2019.3	2017.9	1.4	4.9 %	$54,925
Warrego Highway	KM135.5 to Roma	Westbound	6.2	2018.3	2017.1	1.2	4.5 %	$46,997
							Total	**$3,094,300**

4.9.2 Road Maintenance Requirements

The obligations for the maintenance of the SCR network impacted upon by the proposed development have been calculated by dividing the number of development ESAs loaded onto a particular roadway segment by the background ESAs for an analysis year. This has been reported as a percentage for each link and each year of the development from 2010 until 2034 in the detailed assessment.

A 5 % significance criterion has been adopted for the assessment based on DMR guidelines. This warrant is triggered in the assessment period for a number of the links. Based on these triggered criteria and using the DMR given information for annual maintenance costs and inflation (7 % per annum) in calculating the net present value, the cost of maintaining the roads impacted by the GLNG Project are provided in Table 4.9.2.

The cost per heavy vehicle trip generated by the various components of the GLNG Project and the cost per heavy vehicle-kilometre travelled for each transport option are provided in Table 4.9.2.

4.9.3 Project Mitigation Summary

The analysis of the pavement impact of the development on the state controlled road network indicates that the GLNG Project will be responsible for the added maintenance cost for a number of sections of road for a number of scenario years tested. Table 4.9.2 below shows the costs for which the GLNG Project will be responsible in regards to the pavement maintenance impacts, based on the information and methodology provided by DMR.

Table 4.9.2 GLNG Pavement Maintenance Costs

Assessment Scenario	Total Cost ($2009)	Heavy Vehicle Trips	Cost per Trip	Cost per Heavy Vehicle-km
Base Case	$16,241,400	3,277,685	$4.96	$0.071
”No Bridge” Option	$16,219,150	3,184,450	$5.09	$0.071
”Materials by Rail” Option	$15,829,575	3,263,050	$4.85	$0.070

4.10 Environmental Impacts

There are a range of potential environmental impacts that could result from the development or increased use of road networks. These include potential impacts to surface water, air, flora, fauna etc. These environmental impacts are addressed in the respective sections of the EIS.

4.11 Pedestrian and Cycle Network Impacts

The Gladstone City Council *Walk-Cycle Network Improvement Plan* was reviewed to determine any potential impact on recommendations and strategies for the existing or proposed pedestrian and cycle network. The GLNG Project is not expected to significantly impact on existing or proposed pedestrian and cycle networks outlined in the Gladstone City Council *Walk-Cycle Network Improvement Plan.*

Hanson Road (Gladstone - Mount Larcom Road) is the only road network element identified in the plan which is also expected to require upgrades due to GLNG Project activities. The plan recommends improvements to the Hanson Road corridor which include provision of wide shoulders and footpaths along the entire road. The GLNG Project is expected to require bring forward cost contributions to the duplication of Hanson Road (Gladstone - Mount Larcom Road) from Red Rover Road to Reid Road. Implementation of the recommendations for pedestrian and cycle improvements to this section of road should be recognised by DMR when the design of the upgrades has occurred.

The intersection improvements recommended for the GLNG Project at Hanson Road/Red Rover Road and Hanson Road/Blain Drive/Alf O'Rourke Drive (identified in Section 4.7) should seek to also incorporate pedestrian and cycle facilities into the design in order to achieve the planning goals along

Hanson Road. This should be incorporated into the ultimate design of intersection upgrades, which are mostly necessitated by background traffic growth.

4.12 Access Standards

4.12.1 Intersections

Access locations to the CSG fields and gas transmission pipeline from the SCR network have been assumed based on logistics of transport and locations of construction activities for each component. These locations will be refined as contractors finalise plans, and appropriate access standards will be sought in order to maintain a safe and efficient road network.

Chapter 13 of the DMR Road Planning and Design Manual (RPDM) provides guidelines on the required intersection form for minor roads with the SCR network, based on traffic volumes expected on both roads. It is anticipated that based on the volumes of traffic currently on the roads in the project study area and the volumes of traffic generated by the GLNG Project, Basic Right Turn treatment (BAR) and Basic Left Turn Treatment (BAL) treatments is the minimum standard required. Further details on intersection standards are provided in Appendix J.

4.12.2 Rural Road Widths

Traffic associated with construction and operation of the CSG field and gas transmission pipeline components can increase traffic volumes considerably when compared to background traffic, because of relatively low background traffic west of the Bruce Highway. When planning access routes to the various project components, the project will ensure that the appropriate standard of road and seal width is provided for the expected levels of traffic. The DMR *Road Planning and Design Manual - Chapter 7: Cross Section* has been used to determine appropriate seal and carriageway widths. Further details on rural road width standards are provided in Appendix J.

4.13 Summary Impact Assessment

4.13.1 CSG Fields

4.13.1.1 Access Arrangements

A summary of specific CSG field site access requirements and upgrades (mitigation measures) is presented in Appendix J. A review of the potential access points to the proposed CSG fields found most access points from the Carnarvon Highway to be to an acceptable standard. The existing intersection of Carnarvon Highway/Mulcahys Road is a basic priority T-intersection with shoulder lane markings. As a large number of right-turns from the Carnarvon Highway are expected to be generated by the proposed development the intersection will be upgraded to the BAR and BAL standards contained in Chapter 13 of the DMR Road Planning and Design Manual (RPDM).

Any other proposed CSG field access road intersections with SCR will be upgraded to the appropriate turn lane and road width standards as discussed in Section 4.12 above.

Mulcahy Road has been identified as a potential major access road to the CSG fields. It includes both narrow seal and gravel sections of road. The DMR Roads Implementation Program identifies $407,000 worth of pave and seal works for 2008/09 from ch 6.0 km to ch 10.7 km. This road will be improved to a standard able to accommodate the increased development traffic expected. The recommended AUSTROADS standard is a carriageway width of 9.2 m and a seal width of 7.2 m including 0.5 m sealed shoulders for roads carrying 150 – 500 vpd. The GLNG Project will ensure that the road upgrade is completed to the recommended AUSTROADS standards. Flood immunity standards will be agreed with the local Council.

Arcadia Valley Road has also been identified as a potential major access road to the CSG fields. It includes a mixture of gravel and sealed road construction. In 2010/11 the Roads Implementation Program identifies $220,000 of pavement rehabilitation work. This road will be improved to a standard able to accommodate the increased development traffic expected. The recommended AUSTROADS standard is a carriageway width of 9.2 m and a seal width of 7.2 m including 0.5 m sealed shoulders for roads carrying 150 – 500 vpd. The GLNG Project will ensure that the road upgrade is completed to the recommended AUSTROADS standards. Flood immunity standards will be agreed with the local Council.

4.13.1.2 Impacts on Network

Traffic capacity impacts to the road network by the proposed CSG fields are not expected to be significant because of the relatively low levels of traffic generated over a relatively large area. Additionally, the existing traffic volumes on most roads in the vicinity of the CSG fields are at such low levels that the roads operate with significant spare capacity and the proposed field development traffic will not trigger capacity upgrades.

In combination with the traffic generated by the construction of the gas transmission pipeline, the CSG field development traffic triggers the bringing forward of pavement rehabilitation on two road segments on the Carnarvon Highway, one segment of the Dawson Highway and one road segment on the Warrego Highway (these have been identified as requiring pavement rehabilitation works one or more years earlier with the GLNG Project than with background traffic). The GLNG bring forward cost responsibility of these works is approximately $3.1 M (net present value) based on pavement rehabilitation rates supplied by DMR.

4.13.1.3 Seasonal Considerations

A field review of access routes to the proposed gas fields identified locations where road flooding warnings are currently signed and where poor road conditions may occur during the wet season.

Arcadia Valley Road will serve a large portion of project traffic associated with CSG field development activities for the Arcadia gas fields. The road is primarily a gravel road, and is signed for no heavy vehicle access during wet weather. Additionally, a location approximately 0.5 km southwest of Glenidol Road is signed for seasonal flooding. CSG field development activities may need to shut down in the wet season should there be problems gaining access to site.

4.13.2 Gas Transmission Pipeline

4.13.2.1 Access Arrangements

A summary of specific gas transmission pipeline site access requirements and upgrades (mitigation measures) is presented in Appendix J. Access track design and planning will include consultation with relevant landholders and regulatory authorities to determine the exact location of the access, and if the access points are to be permanent or temporary.

For the traffic impact analysis, the locations and associated access points to the main accommodation facilities and construction depots along the pipeline corridor were assumed to be located as discussed in Section 4.3.2.2 above. Access is expected to be gained from the SCR network. The minimum intersection standard for intersections with the SCR network is a BAR/BAL treatment as described in Section 4.12.1. If no other traffic is using the access road then the AUSTROADS standard is a carriageway width of 7.5 m and a seal width of 4.5 m for roads carrying 1-150 vpd. If the access is temporary a lesser standard than this may be suitable.

4.13.2.2 Impacts on Network

The impacts of the proposed gas transmission pipeline construction will only be seen on the road network for an approximately two year period during 2011 and 2012, spread between several locations of workers accommodations facilities/construction depots along the pipeline corridor as described in Section 4.3.2

above. These impacts will be seen in the form of additional construction related traffic and minor disruptions to roads due to the construction of the pipeline across or under roads.

Roadway capacity and pavement impacts specifically attributed to the construction and operation of the proposed gas transmission pipeline are expected to be very low.

The construction of the western sections of the pipeline will add heavy vehicle traffic to the road network that partially contributes to the need to bring forward the pavement rehabilitation on the Carnarvon Highway.

4.13.2.3 Road and Rail Crossings

Detailed pipeline route planning has been undertaken and is presented in Section 3. Maps detailing the route and all potential locations that the gas transmission pipeline crosses roads and railroad corridors are provided in Appendix J.

Road Crossings

A review of the proposed gas transmission pipeline corridor was undertaken to identify key locations where the corridor will cross roads. The pipeline corridor is proposed to cross the roads listed in Table 4.13.1.

Table 4.13.1 Roads Crossed by Pipeline Corridor

State Roads	Local Roads – Sealed	Unsealed Roads
Dawson Highway (5 locations)	Fairfield Road	Fairview Road
Leichhardt Highway	Moura Bindaree Road	Beilba Road
Burnett Highway	Banana Mungi Road	Glenidol Road
Gladstone - Mount Larcom Road	Theodore Baralaba Road	Oombabeer Road
Bruce Highway	Baralaba Banana Road	Bears Lagoon Road
	Baldine Defence Road	Blacks Road
	Johnson Parrys Road	Rockford Road
	Belldeen Greycliffe Road	Mount Alma Road (3 locations)
	Prospect Creek Road	Wycheproof Road
	Jambin Dakenba Road	Targinie Road
	Mallinsons Road	
	Callide Kilburnie Road	
	Kilburnie Road	
	Inverness Road	

The gas transmission pipeline will also cross numerous other local farm and CSG field development tracks in rural areas.

Road crossings are typically categorised based on the road formation type, which generally relates to the construction method. Crossing design and construction methods cater for the size and quantity of vehicles that frequent the road. The types of road crossing methods expected are summarised below, along with the road types associated with the construction method:

- **Open cut:** unformed & formed tracks, gravel roads and bitumen roads;
- **Bored (cased or uncased):** bitumen roads and major highways; and
- **Horizontal Direction Drill (HDD) (cased or uncased):** major highways.

Regardless of the crossing method, the pipeline will be built to standards contained in *AS 2885: Pipelines – Gas and Liquid Petroleum* and will have thicker walled sections under road and rail crossings and may be reinforced with concrete slabs.

Open Cut Crossings

The proposed pipeline will be constructed across unformed and gravel tracks, gravel roads and lower order bitumen roads. These roads are mostly in rural locations and carry low volumes of traffic to local properties or small population catchments. Many of the unformed tracks and gravel roads are used only for farm, mine or other industrial activity and carry little to no traffic on daily basis.

Most roads proposed to be crossed by the pipeline via open cut construction can be bypassed via other access tracks. Santos will consult with any affected residents or landholders and prepare a traffic management plan in accordance with Main Roads Standard Specification MRS11.02 prior to temporarily cutting off access on these roads.

Boring or HDD

Where the gas transmission pipeline is proposed to cross under the major state highways shown in Table 4.13.1, the pipe will be placed under the road surface by boring or HDD to avoid significant disruption to traffic on these roads.

Rail Crossings

A review of the proposed gas transmission pipeline corridor was undertaken to identify the location where the pipeline will cross existing railroads. The proposed pipeline corridor crosses the rail lines in the following locations:

- Moura Short Railway north of the Davis Road crossing;
- Dawson Valley Branch Railway between Argoon and Dakenba (adjacent to Jambin Dakenba Road);
- Moura Short Railway along Dawson Highway; and
- North Coast Line in Aldoga adjacent to Gladstone - Mount Larcom Road.

Railway crossings will be either bored or HDD crossings and will be installed according to specifications within *AS 4799-200: Installation of Underground Utility Services and Pipelines within Railway Boundaries*. Boring or HDD methods as specified in the Australian Standard will allow trains to operate during construction with negligible impact to rail operations.

4.13.2.4 Pipeline Crossing Impacts to Existing Infrastructure

A review of existing utilities and other infrastructure was undertaken at the pipeline road crossing locations to identify potential construction impacts. This was done in the form of a 'dial before you dig' request. This exercise identified that the following services will likely be impacted in some way along the length of the pipeline at the rail and road crossing locations:

- Queensland Gas Pipeline (QGP);
- Jemena gas pipeline;
- Ergon services;
- Gladstone Regional Council water facilities;
- Envestra gas pipeline;
- Gladstone Area Water Board water pipeline;
- Telstra services; and
- Vision Stream fibre optic cable.

A further detailed analysis of impacts to these services will be undertaken at the design stage and again prior to construction of the pipeline when the exact pipeline corridor location is determined.

4.13.2.5 Material by Rail

The option of transporting pipe, associated materials and personnel by rail to the gas transmission pipeline corridor has been assessed as a transport option, with results presented in a supplementary report included in Appendix J. Santos' primary reason for investigating this option is to reduce traffic in and around Gladstone to improve the overall road safety of the GLNG Project.

Road Traffic Reductions

By transporting pipe and materials and personnel by rail, the total road traffic generation for the gas transmission pipeline will be reduced by approximately 14,500 trips under the "Material by Rail" option. It should be noted that while this is not a significant reduction in total road traffic for the gas transmission pipeline, the length of truck trips will be much shorter as pipes are transported by rail as far as Moura and transported the remainder of the distance to the pipe laydown areas by truck. It is estimated that a reduction in vehicle-km travelled of approximately 3,671,600 vehicle-km will occur with the "Materials by Rail" option, the majority of which will occur between 2010 and 2012.

Rail Traffic

Train trips for the "Materials by Rail" option are based on the expected rate of delivery of pipe by ship into Port of Gladstone at one ship per month with a capacity of 6,000 pipe joints. Assuming train lengths of 50 cars, it is estimated that approximately 24 trains will be needed each month to clear the stock out of the Port of Gladstone. A conservative estimate of trains added to the rail network during the six months of pipe delivery is one per day. These additional train trips are expected to be on the Moura Line from Auckland Point in Gladstone to the west as far as Moura.

If personnel are transported to accommodation facilities by rail, it is expected that all personnel being transported will fit on one passenger train, and shift changes will be such that both directions of train travel will be utilised. Based on this, approximately one passenger train per week is expected to be added to the Moura rail system.

Further discussion on the traffic impacts of the "Materials by Rail" option compared to the base case assessment is provided in Appendix J.

4.13.2.6 Seasonal Considerations

It is likely that construction will continue through the wet season unless prolonged periods of rain or flooding occur. Construction of the pipeline may need to shut down and/or demobilise during periods of prolonged rain or seasonal flooding should these prevent ongoing construction or access to the work sites.

4.13.3 LNG Facility

4.13.3.1 Access Arrangements

Access to Curtis Island during construction of Train 1 of the proposed LNG facility will take place via ferries and barges from port facilities within Gladstone. A summary of specific LNG facility site access arrangements for both freight and personnel are presented in Appendix J.

4.13.3.2 Marine Transport Movements

Construction Deliveries

Deliveries of materials and equipment by truck for each phase of construction for the LNG facility will include aggregate, cement, piping, structural steel, electrical materials and instrumentation. Table 4.5.4 summarises the estimated number of truck movements into Gladstone that will be required to be transferred to the LNG facility site on Curtis Island.

The number of barges needed to transport the LNG facility materials to Curtis Island from the mainland has been based on an estimate of approximately 4 trucks per barge trip, with some trucks being carried on personnel ferry trips at 2 trucks per ferry. For the base case, all materials for the construction of Train 1 of the LNG facility will be required to be barged to Curtis Island, since the bridge will not yet be operational.

For the "No Bridge" option, materials for all construction of the LNG facility (Trains 1. 2 and 3) will be required to be barged to Curtis Island.

Table 4.13.2 provides a comparison of barge round trip movements for the base case and the "No Bridge" option. As shown, approximately 2,400 more barge movements are needed for the "No Bridge" option than for the base case. These movements are expected to be spread over several years during the construction of Trains 2 and 3 of the LNG facility.

Table 4.13.2 LNG Facility Barge Movements

Construction Stage	Truck Deliveries	Barge Movements (Round Trip)	
		Base Case	"No Bridge' Option
Train 1	8,400	2,500	2,500
Train 2	4,400	0	1,200
Train 3	4,400	0	1,200

Personnel Ferry Movements

Total ferry movements for the transport of personnel to the accommodation facilities on Curtis Island have been estimated for the construction of the LNG facility. These estimates are based on the shift patterns described above for personnel and an assumed ferry capacity of 150 passengers, consistent with the CEO Marine Transport Strategy in Appendix J. A summary of the ferry trips required to transport construction personnel to Curtis Island for each year of construction is provided in Table 4.13.3.

Table 4.13.3 LNG Facility Construction Ferry

Construction Stage	Year	Yearly Peak Personnel	Ferry Trips Per Year	Ferry Trips per Train
Train 1	2010	1484	258	1,500
	2011	3080	535	
	2012	2940	511	
	2013	1120	195	
Train 2	2014	890	155	900
	2015	1848	321	
	2016	1764	307	
	2017	672	117	
Train 3	2018	890	155	900

Construction Stage	Year	Yearly Peak Personnel	Ferry Trips Per Year	Ferry Trips per Train
	2019	1848	321	
	2020	1764	307	
	2021	672	117	

As shown in the table, approximately 1,500 ferry trips will be needed for Train 1 construction. This is consistent between the base case and the "No Bridge" option since the bridge will not be operational during Train 1 construction. During Trains 2 and 3 however, no ferry movements will be needed for personnel in the base case assessment, and approximately 900 will be needed for each of Train 2 and 3 under the "No Bridge" option.

Operational personnel for the LNG facility is significantly lower than construction personnel, but will be required to travel to Curtis Island every day. Based on the number of personnel and shifts for LNG facility operations, it is estimated that approximately 2 ferry round trips movements per day are needed, equating to approximately 730 trips per year.

4.13.3.3 Impacts on Network

Because of the long term nature and scale of construction and operational activities at the proposed LNG facility, some traffic impacts are anticipated due to the addition of development traffic. Additionally, the roadways within Gladstone carry a higher volume of traffic in relation to the rest of the project area. The intersection capacity assessment identified several intersections around Gladstone which need upgrading (or contributions to upgrades) due specifically to the addition of GLNG development traffic.

The intersection, roadway capacity and pavement impacts are summarised in Sections 4.7 through 4.9 above and detailed in Appendix J.

4.13.3.4 Required Infrastructure

A new road may be constructed from the end of Landing Road to the potential bridge site at Friend Point. This new road will be constructed as part of the overall bridge project.

4.14 Development Mitigation Measures

4.14.1 General

A road use management plan has not been specifically developed as part of this EIS. However, it will be provided in the next level of detail as part of the development approval or operational works (e.g. as part of any construction EMPs). Any road use management plan developed to support approvals applications for operational works would comprise a construction management plan with input on the construction traffic, and/or operation and safety management plan for the daily operational requirements of the project.

At this stage of the project only general details are known which allow impacts to be considered for impacts and mitigation works but are not specific enough to formulate a contractor's final road use management plan. Options are still under consideration (e.g. bridge vs. no bridge, and pipeline material by rail or road).

The principles for a road use management plan are summarised below, with further details provided in the full technical study in Appendix J, specifically the following sections:

1) CSG Field (sections 2.1, 4.1, 6.6, 8.4, 9.0 and 10);
2) Gas Transmission pipeline (sections 2.2, 4.2, 6.6, 7.3, 8.4, 9.0 and 11);
3) LNG facility (sections 2.3, 4.3, 7.3, 9.0, 12 and Appendix C of Appendix J); and
4) Bridge to Curtis Island (sections 4.4, 7.3 and 9.0).

Additionally, the following sections in Appendix J provide generic input into the road use management plan for all sections as required:

- Sections 3.1, 3.2 and 3.3, which describe the existing road characteristics in terms of speed limits, widths, number of lanes, shoulder conditions, traffic volumes and crash history which will be used to determine the appropriateness of using the road and its limitation; and
- Sections 3.4 to 3.9, which describe the potential constraints and impact on the construction and operation from other projects and planned future upgrades.

4.14.1.1 Traffic Management

Construction works will impact on public roads and the rail network in some locations, generally where the pipeline crosses a public road or railway track. Under these circumstances Santos will ensure traffic management plans are prepared consistent with the DMR Specification MRS11.02 Provision for Traffic and the Manual of Uniform Traffic Control Devices (MUTCD). It is expected the principles applied when controlling traffic on public roads will also apply to the numerous access drives and tracks crossed along the pipeline corridor.

4.14.1.2 Heavy and Oversized Loads

Vehicles carrying plant and material over SCR and local roads will comply with the vehicle mass limit requirements set out in the Transport Infrastructure Act 1994. Heavy vehicle routes in the project area have been identified by Queensland Transport and have been used to identify the appropriate routes for haulage of equipment and materials to the various project sites. The approved heavy vehicle routes are included in Appendix J.

It should be noted that the Dawson Highway through the Calliope Range should not be used for oversize loads because of steep grades and winding roads. Road upgrade works on this section of the Dawson Highway are programmed to occur from 2008/09 through to 2012/13 and delays may occur at times due to construction works. After this time, the road is expected to be constructed to a standard to allow use by oversize loads.

4.14.1.3 Environmental

As discussed in Section 4.10 there are a range of potential environmental impacts that could result from the development or increased use of road networks. The appropriate mitigation measures to these identified potential impacts are presented in the respective sections of the EIS.

4.14.2 CSG Fields

Existing access roads and tracks will be used wherever practicable and all project related movements will be restricted to approved access tracks. Access planning will include consultation with all relevant landholders and regulatory authorities.

New access roads within the CSG field development area are expected to be needed, which generally will be built to a low volume, unpaved, rural road standard in accordance with relevant local government and landholder requirements.

Considering the project impact assessments undertaken, a breakdown of the specific CSG field site access requirements and upgrades (mitigation measures) is presented in Appendix J. To mitigate the impact of development on the roads providing access to the CSG fields, the GLNG Project will contribute an appropriate amount to the cost of the following:

- Provide appropriate turn lane treatments at CSG field access locations with SCR based on standards in the DMR RPDM;
- Ensure appropriate seal width is provided on access roads to the CSG fields, based on expected daily traffic volumes;

- Upgrade the Carnarvon Highway/Mulcahy Road intersection to provide the minimum BAR/BAL turn treatments;
- Upgrade Mulcahy Road (approximately 25 km) to a carriageway width of 9.2 m and a seal width of 7.2 m including 0.5 m sealed shoulders. Flood immunity standards will be agreed with the local Council;
- Upgrade Arcadia Valley Road to a carriageway width of 9.2 m and a seal width of 7.2 m including 0.5 m sealed shoulders. Flood immunity standards will be agreed with the local Council; and
- Injune-Taroom Road will be improved to a standard able to accommodate the increased development traffic expected, as summarised in Table 4.4.1 above. The GLNG Project will complete any necessary road upgrades to the recommended AUSTROADS standards. Flood immunity standards will be agreed with the local Council.

4.14.3 Gas Transmission Pipeline

To mitigate the impact of the construction of the gas transmission pipeline a number of measures are proposed to be implemented:

- The location of access roads to pipeline workers accommodation and construction depots have still to be determined, however where these intersect with the SCR network a minimum standard of treatment will be required. This will depend on the amount of existing and development traffic and will be at least a BAR/BAL intersection treatment including appropriate safety signage;
- The recommended minimum standard for access roads used to access the workers accommodation facilities and construction depots is a carriageway width of 7.5 m and a seal width of 4.5 m for roads carrying 1-150 vpd. Due to the temporary nature of the access a lesser standard than this may be suitable;
- To minimise disruption to the existing road and rail networks the following treatments are proposed for traversing road or rail facilities:
  - **Open cut:** unformed & formed tracks, gravel roads and bitumen roads;
  - **Bored (cased or uncased):** bitumen roads and major highways; and
  - **HDD (cased or uncased):** major highways and rail crossings.
- A number of service authorities have services in the vicinity of the pipeline and further investigation of services is required at the pipeline design and construction phases;
- Once the pipeline contractor has been appointed and details of the pipeline delivery and workers' accommodations locations determined, a road use management plan will be prepared for the pipeline construction. This plan will address all relevant issues including the standard of the roads proposed to be used, traffic volumes, access conditions, hours of operation, safety provisions, traffic impacts, dust control etc. This plan will be developed in consultation with the DMR and the local Councils. Individual landholders will be consulted over reinstatement standards on private property; and
- Transport of pipe by rail from Gladstone to the pipeline construction depots is currently being investigated as a mitigation measure. It will significantly reduce the number of trucks on the road network, especially in the Gladstone urban area.

4.14.4 LNG Facility

To mitigate the impact of the LNG facility and potential bridge construction on the Gladstone road network the following is proposed:

- Provide workers accommodations on Curtis Island to reduce the amount of personnel travel to/from the construction site on a daily basis.
- Provide workers transport to the construction site. The assessment assumes that 80 % of personnel will arrive at the ferry terminal by bus, and 20 % will arrive by private vehicle and will require car

parking near the ferry terminal. Parcels of port land adjacent to the Auckland Wharf area are being investigated with the GPC to provide car parking and other areas to assist with project logistics.

- Upgrade or contribute to the upgrade of the following intersections:
  - Hanson Road/Red Rover Road;
  - Hanson Road/Blain Drive/Alf O'Rourke Drive;
  - Dawson Highway/Blain Drive/Herbertson Street; and
  - Dawson Highway/Philip Street.
- The cost of intersection upgrades is unknown, though contributions will be based on the operational impacts or the traffic volumes added at the intersections.
- Contribute to the bring forward cost of the upgrading works of the following sections of road. The GLNG Project will be responsible for approximately 4.7 % of the upgrade costs:
  - Gladstone - Mount Larcom Road from Red Rover Road to Power Station (approximately 1.0 km) – bring forward 1.4 years from 2020 to 2019; and
  - Gladstone - Mount Larcom Road from Power Station to Reid Road (approximately 5.0 km) – bring forward 1.4 years from 2020 to 2019.

4.14.5 Options Assessment

4.14.5.1 "Material by Rail" Option

The quantitative impacts of the "Material by Rail" option for the gas transmission pipeline construction phase have been found to be comparable to those found for the base case assessment of the GLNG Project, being:

- Intersection impacts are identical to the base case. The reduction of truck trips does not occur during the peak year of development traffic generation;
- Roadway segment capacity impacts are the same as the base case. The reduction in trips for the "Material by Rail" option occurs early in the project whereas mid-block capacity upgrades are required in the later years of the project; and
- Pavement impacts for pavement rehabilitation are identical to the base case, though the GLNG contribution required for road maintenance is approximately $400,000 less for the "Material by Rail" option.

The benefits of the "Material by Rail" option are the reduction in heavy vehicle traffic using the roadway network, especially within Gladstone and along the Dawson Highway. Also, while not all deliveries of pipe by road can be eliminated, the distance travelled by road is significantly reduced by transporting pipe by rail from Gladstone as far as Moura. It is estimated that a reduction in 14,500 trips and approximately 3,671,600 vehicle-km travelled will occur with the "Material by Rail" option, the majority of which will occur between 2010 and 2011.

The reduction in vehicle movement has operational benefits in that less heavy vehicle movement will occur along the Dawson Highway and side road delivery routes. This has the potential to make the Dawson Highway marginally safer from a road safety perspective due to less conflict between trucks and other vehicles. An additional advantage is that heavy vehicle movement will not occur across the Calliope Range where major deviation works are proposed during the pipe delivery period.

Figure 4.14.1 identifies the location of intersection upgrades and mid block capacity improvements required in the Gladstone area for the "Material by Rail" option. These impacts are the same as assessed for the base case scenario.

4.14.5.2 "No Bridge" Option

Investigation of the impact of the "No Bridge" option shows a reduction of 294,650 trips primarily due to no bridge construction traffic being added to the road network. The quantitative impacts of the "No Bridge" option for the GLNG Project have been found to be comparable to those found for the base case assessment of the GLNG Project, with the following notable differences:

- Intersection impacts within Gladstone result in intersections closer to the central city needing to be upgraded. This is understandable given that Auckland Point is the origin of trips to Curtis Island;
- Roadway segment capacity improvements for the "No Bridge" option are required in the urbanised central city streets in Gladstone rather than on the urban fringe (as in base case). Upgrading constraints are likely to be more significant in the city centre resulting in higher cost and more delay during construction; and
- Pavement impacts for pavement rehabilitation are the same as for the base case. Road maintenance costs are approximately $22,000 less for the "No Bridge" option because of the removal of bridge construction traffic.

Travel Time Impacts

The CEO Marine Transport Study (Appendix J) prepared as a supplement for the base case scenario estimates that during Train 1 construction of the LNG facility (when the bridge is not yet in place), the travel time to the accommodation facilities on Curtis Island from the mainland will be approximately 84 minutes. This is an approximation of the travel time that can be expected for personnel for the life of the LNG facility under the "No Bridge" option.

Under the base case scenario in which the bridge is available for operations of the LNG facility and construction of Trains 2 and 3, travel from Gladstone will be by road only and will only take approximately 27 minutes, assuming a trip of approximately 32 km at an average speed of 70 km/h. Factoring in some intersection delays, total travel time could be between 30 to 40 minutes. Though these are approximations of personnel travel times, it is apparent that the provision of the bridge to Curtis Island makes transport for personnel much more efficient. It is expected that the total travel time with the bridge in place will be almost twice as fast as travel using the ferry without the bridge.

Additional Marine Traffic Movements

The "No Bridge" option was found to generate considerably more marine traffic during the construction of the LNG facility, especially during construction of Trains 2 and 3. A summary comparison of the estimated barge and ferry movements is provided in Table 4.14.1.

Table 4.14.1 LNG Facility Shipping Movements

Construction Stage	Base case			"No Bridge" Option		
	Barge	Ferry	Total	Barge	Ferry	Total
Train 1	2,500	1,500	4,000	2,500	1,500	4,000
Train 2	0	0		1,200	900	2,100
Train 3	0	0		1,200	900	2,100

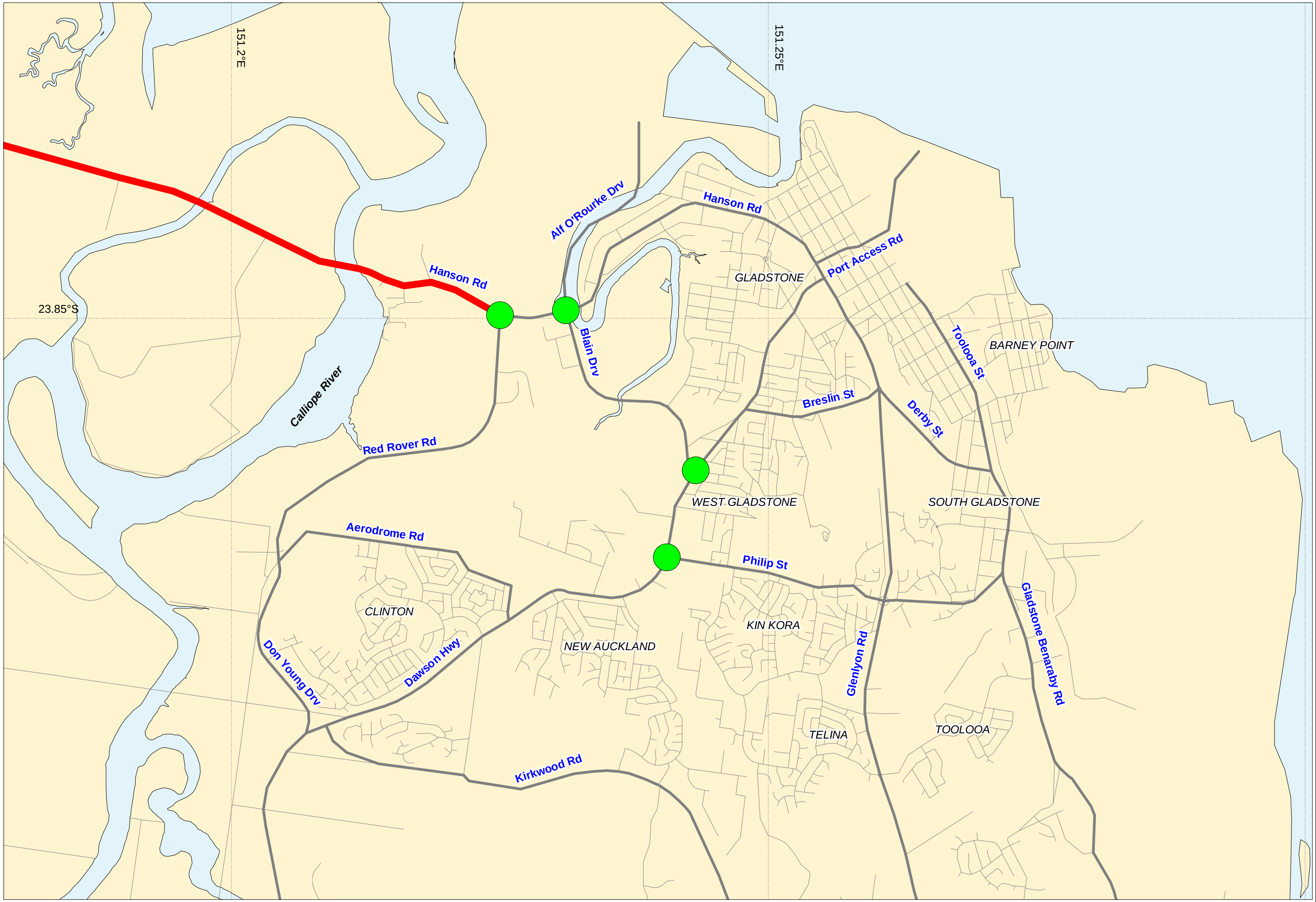
The impacts of increased marine traffic movement include:

- The increase in ambient underwater noise in Gladstone harbour due to the movement of marine vessels (see Section 8.10);
- The potential impact to marine fauna will include the increased interaction of marine fauna with the transportation of equipment, materials and staff by barge/vessel/ferry required for the GLNG project (see Section 8.4); and

- The selection of ferries will also determine whether there will be an increase in ferry/marine fauna interaction. The faster the vessel the more likely that boat strikes will occur (see Section 8.4).

The impacts of all options are summarised in Table 14.14.2 and Figures 4.14.1 and 4.14.2 identify the location of intersection upgrades and mid block capacity improvements required in the Gladstone area for each option.

Table 4.14.2 below summarises the potential impacts and mitigations discussed in this section.



N W E S

0 1 2km

Scale 1:50 000 (A4)
Datum: GDA94

Developer Impacted Intersection

Developer Impacted Road Link

Source: This map may contain data which is sourced and Copyright. Refer to Section 18.2 of the EIS for Ownership and Copyright. Cardno Eppell Olsen 17-03-2009.

Client

URS

LNG

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Drawn: CA | Approved: JB | Date: 21-04-2009

Job No: **4262 6220** | File No: 42626220-g-1043.wor

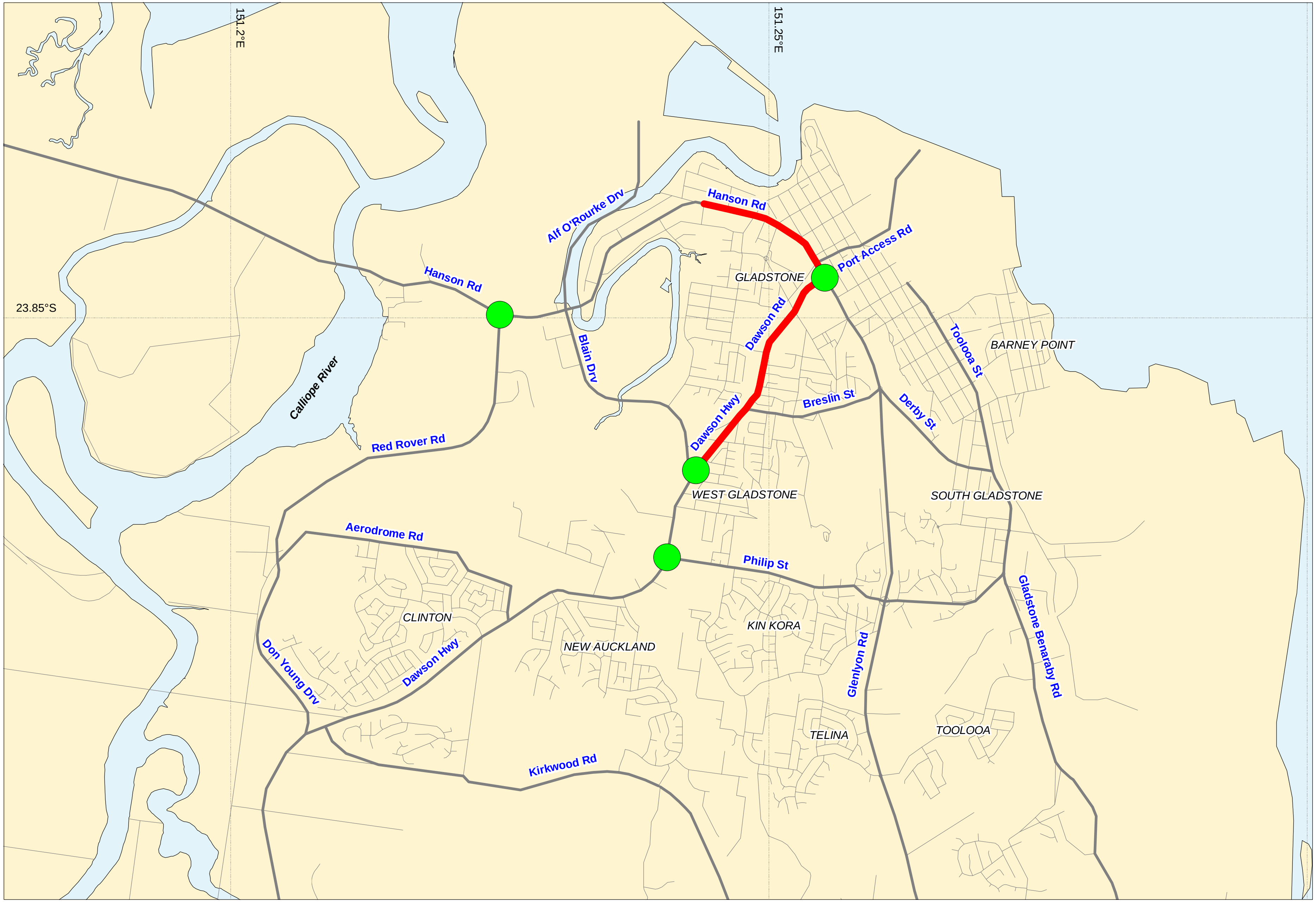
Title

BASE CASE / RAIL OPTION INTERSECTION & MIDBLOCK IMPROVEMNTS RECOMMENDED IN GLADSTONE

Figure: **4.1.4.1**

Rev:B

A4



N W E S

0 1 2km

Scale 1:50 000 (A4)
Datum: GDA94

Developer Impacted Intersection
Developer Impacted Road Link

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Client

URS

Project

GLADSTONE LNG PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

NO BRIDGE OPTION INTERSECTION & MIDBLOCK IMPROVEMENTS RECOMMENDED IN GLADSTONE

Drawn: CA | Approved: JB | Date: 21-04-2009

Job No: **4262 6220** | File No: 42626220-g-1044.wor

Figure: **4.14.2** | Rev:B | A4

Table 4.14.2 Summary of Potential Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction			
Road	Intersection Capacity	• Hanson Road/Red Rover Road – Short right-turn lane on the western approach of Hanson Road and additional circulating width; and – Short right-turn lane on south leg of Red Rover Rd & additional circulating width. Note: Duplication of Hanson Road is being planned by DMR. In lieu of the developer implementing the upgrading works identified above, the option of making a contribution to the intersection upgrade could be considered. The development traffic forms 4.8 % of the combined background and development traffic in 2012. This will allow intersection improvements to be incorporated into the four lane upgrading works.	Mitigate the reduction in available intersection capacity caused by traffic added by the GLNG Project. Mitigation measures ensure that intersection operations are no worse with the development than experienced without the development in the existing intersection form.
		• Hanson Road/Blain Drive/Alf O'Rourke Drive – Short right-turn lane on the western approach of Hanson Road and additional circulating width; and – Continuous left-turn lane on the south leg of Blain Drive. Note: Duplication of Hanson Road is being planned by DMR. In lieu of the developer implementing the upgrading works identified above, the option of making a contribution to the intersection upgrade could be considered. The development traffic forms 3.7 % of the combined background and development traffic in 2012. This will allow intersection improvements to be incorporated into the four lane upgrading works.	
		• Dawson Highway/Blain Drive/Herbertson Street – Short left slip lane on southern leg of Dawson Highway; and – Pavement marking of left lane on western leg to allow all turn movements.	
		• Dawson Highway/Philip Street – The intersection exceeds practical capacity with background traffic and development traffic creates further impact worse. DMR are planning upgrade works and the option of making a contribution to the intersection upgrade could be considered. The development traffic forms 6.1 % of the combined background and development traffic in 2012.	
	Road Link Mid-block Capacity	• Contribute to the upgrading from 2 to 4 lanes of: – Gladstone - Mount Larcom Road from Red Rover Road to Power Station	Mitigate the reduction in available roadway capacity

Aspect	Potential Impact	Mitigation Measures	Objective
		(approximately 1.0 km) – bring forward 1.4 years from 2020 to 2019; and – Gladstone - Mount Larcom Road from Power Station to Reid Road (approximately 5.0 km) – bring forward 1.4 years from 2020 to 2019. The cost of upgrades is unknown, though the developer can expect to pay approximately 4.7 % of the total cost (in 2009 dollars). DMR has started the planning work to duplicate Gladstone - Mount Larcom Road to four lanes and negotiation with DMR regarding the timing of the planned upgrade (not currently in the RIP) and the developer's contribution is recommended.	attributed to the GLNG Project traffic.
	Pavement Rehabilitation	• Carnarvon Highway (CH. 3m to CH. 18 Roma - Taroom Road) – contribute $320,115 • Carnarvon Highway (Roma - Taroom Road to Injune) – contribute $2,672,249 • Dawson Highway (Fitzroy Dev. 85A Intersection to Duaringa/Woorabinda Intersection) – contribute $54,925 • Warrego Highway (KM135.5 to Roma) – contribute $46,997 • Total contribution to pavement rehabilitation = $3,094,300 (2009 $)	Mitigate the pavement damage attributed to the GLNG Project.
	Pavement Maintenance	Contribute $16,241,400 (2009 $) to cost of pavement maintenance	Mitigates the increased need for pavement maintenance of the SCR network caused by heavy vehicle traffic attributed to the GLNG Project.
	Construction Works	• Management of traffic through the preparation and implementation of traffic management plans in accordance with DMR specification MRS11.02 and the Manual of Uniform Traffic Control Devices (MUTCD); • Ensure heavy and oversize loads use the haulage routes defined by Queensland Transport. Permits will be required for such loads; • Control of dust as specified in MRS11.02 Provision for Traffic, and; • Control of weeds, pest and disease in accordance with DMR specification MRS11.16E – Establishment and Monitoring Works.	Mitigate the general impacts of construction works associated with the GLNG Project
	CSG field access to state controlled road network	• Provide appropriate turn lane treatments at CSG field access locations with SCR based on standards in the DMR RPDM – Chapter 13; • Ensure appropriate seal width is provided on access roads to the CSG fields, based on expected daily traffic volumes;	Provide roads and intersections to appropriate design standards able to accommodate existing traffic and the expected

Aspect	Potential Impact	Mitigation Measures	Objective
		– Upgrade the Carnarvon Highway/Mulcahy Road intersection to provide the minimum BAR/BAL turn treatments; – Upgrade Mulcahy Road to a carriageway width of 9.2m and a seal width of 7.2m including 0.5m sealed shoulders. Flood immunity standards will need to be agreed with the local Council; – Upgrade Arcadia Valley Road to a carriageway width of 9.2m and a seal width of 7.2m including 0.5m sealed shoulders. Flood immunity standards will need to be agreed with the local Council; – Injune-Taroom Road should be improved to a standard able to accommodate the increased development traffic expected recognising that 10 km of pavement rehabilitation works are already proposed in 2012/2013. It is recommended that the developer complete any necessary road upgrades to the recommended AUSTROADS standards. Flood immunity standards will need to be agreed with the local Council.	increase in traffic attributable to the GLNG Project.
	Gas transmission pipeline access to state controlled road network	• The location of access roads to pipeline workers accommodation and construction depots have still to be determined however where these intersect with the SCR network a minimum standard of treatment will be required. This will depend on the amount of existing and development traffic and should be determined using Chapter 13 of the RPDM; • The recommended minimum standard for access roads used to access the workers accommodation and construction depots is a carriageway width of 7.5 m and a seal width of 4.5 m for roads carrying 1-150 vpd. Due to the temporary nature of the access a lesser standard than this may be suitable.	Provide roads and intersections to appropriate design standards able to accommodate existing traffic and the expected increase in traffic attributable to the GLNG Project.
	Road crossings of pipeline	• The following treatments are recommended for traversing road facilities: – Open cut: unformed & formed tracks, gravel roads and bitumen roads; – Bored (cased or uncased): bitumen roads and major highways; and – HDD (cased or uncased): major highways and rail crossings.	To minimise disruption to the existing road network
	Pipeline construction activities	• A road use management plan will need to be prepared for the pipeline construction. This plan will address all relevant issues including the standard of the roads proposed to be used, traffic volumes, access conditions, hours of operation, safety provisions, traffic impacts, dust control etc. This plan will be developed in consultation with the DMR and the local Councils. Individual landholders will need to be consulted over reinstatement standards on private property.	To mitigate the impact of traffic generated by the construction of the gas transmission pipeline on the regional road network.

Aspect	Potential Impact	Mitigation Measures	Objective
		• Transport of pipe by rail from Gladstone to the pipeline construction depots has been investigated as a mitigation measure. Queensland Rail is currently being engaged to determine the feasibility of offloading pipe to train at Auckland Point wharves, to be transported as far as Moura. This will reduce the number of trucks on the road network by 14,500 trips predominantly in the Gladstone urban area. The total vehicle-km travelled by heavy vehicles is expected to be reduced by 3,671,600 veh-km. Pipe will then be transported the remainder of the distance to the construction depots by truck. This option has been assessed as the "Materials by Rail" option. The quantitative impacts of the "Material by Rail" option for the gas transmission pipeline construction have been found to be comparable to those found for the base case assessment of the GLNG Project. – Intersection impacts are identical to the base case. The reduction of truck trips does not occur during the peak year of development traffic generation; – Roadway segment capacity impacts are the same as the base case. The reduction in trips for the "Material by Rail" option occurs early in the project whereas mid-block capacity upgrades are required in the later years of the project; – Pavement impacts for pavement rehabilitation are identical to the base case, though the developer contribution required for road maintenance is approximately $400,000 less for the "Material by Rail" option.	
	LNG facility and bridge construction activities	• Provide worker accommodation on Curtis Island to decrease need for daily personnel trips to work. • Provide transport to the Curtis Island construction site and workers accommodation. • The option of not providing the potential bridge to Curtis Island has been assessed as the "No Bridge" option. This will decrease traffic in Gladstone by 294,650 trips. Whereas the "No Bridge" option reduces the vehicle trips due to construction of the bridge, the long term impact is greater travel time to Curtis Island (30 - 40 minutes estimated by road and bridge compared to 85 minutes by ferry) and more barge traffic movement. This option also attracts more trips to Auckland Point with GLNG project traffic having to travel through central city streets. The quantitative impacts of the "No Bridge" option for the GLNG Project have been found to be comparable to those found for the base case assessment, with the following notable differences: – Intersection impacts within Gladstone result in intersections closer to the central city needing to be upgraded. This is understandable given that Auckland Point is the origin of trips to Curtis Island;	To mitigate the impact of traffic generated by the construction of the LNG facility on the Gladstone road network

Aspect	Potential Impact	Mitigation Measures	Objective
		– Roadway segment capacity improvements for the "No Bridge" option are required in the urbanised central city streets in Gladstone rather than on the urban fringe (as in base case). Upgrading constraints are likely to be more significant in the city centre resulting in higher cost and more delay during construction; – Pavement impacts for pavement rehabilitation are the same as for the base case. Road maintenance costs are approximately $22,000 less for the "No Bridge" option because of the removal of bridge construction traffic.	
Rail	Gas transmission pipeline rail crossings	• The following treatments are recommended for traversing rail facilities: – Bored or HDD crossings installed to AS4799-2000: Installation of Underground Utility Services and Pipelines within railway Boundaries.	To minimise disruption to the existing rail network
Marine	Ferry and Barge Movements associated with LNG facility construction and operations	• Provide worker accommodations on Curtis Island to minimise number of ferry movements for transport of personnel. • Provide access road and bridge to Curtis Island to minimise the travel time to Curtis Island and the number of trips undertaken by barge and ferry. • Construct the LNG facility by modular construction method and transport pre-assembled modules by ship to MOF at Curtis Island to reduce the number of barge movements from the mainland to Curtis Island.	To minimise the amount of marine traffic added to the Port of Gladstone
Operation			
Road, Rail and Marine	Intersection Capacity Road link mid-block capacity Pavement rehabilitation and maintenance CSG field, Pipeline and LNG facility	• Operational traffic is minimal compared to construction traffic and can be accommodated within the road network improvements proposed for the GLNG Project including intersection upgrades, road sealing and widening, and pavement rehabilitation works. • Provision of an access road and bridge to Curtis Island will minimise the travel time to Curtis Island, reduce through traffic movement from the central city area and the number of trips undertaken by barge and ferry.	Mitigate the general impacts of operational works associated with the GLNG Project
Decommissioning and Rehabilitation -Covered in the construction and operation activities outlined above			

4.15 Summary of Findings

The total amount of traffic generated by the GLNG Project has a peak during the construction phase at 2012. Operational traffic has minimal impact. The highest volumes of traffic are generated through construction of the LNG facility (Train 1) and the potential bridge to Curtis Island. However, there is still a significant amount of construction traffic associated with the CSG fields and gas transmission pipeline construction.

A number of mitigation measures are proposed, including:

- Intersection upgrades;
- Road construction;
- Payment of contributions for rehabilitation and maintenance of the SCR network;
- Payment of bring forward costs for an intersection upgrade;
- Provision of workers accommodation on Curtis Island to minimise traffic movements;
- Designation of preferred transport routes; and
- Provision of buses for the transport of workers.

Together, these measures are considered sufficient to mitigate the traffic and transport impacts of the proposed GLNG Project. These mitigation measures would be further developed as part of any road use management plan, which would be provided in the next level of detail as part of the development approval or operational works (e.g. as part of any construction EMPs). Any road use management plan developed to support approvals applications for operational works would comprise a construction management plan with input on the construction traffic, and/or operation and safety management plan for the daily operational requirements of the project.

The two alternative options of the “No Bridge” option and the “Material by Rail” option will both reduce the amount of traffic on the road network associated with movement of people and materials. The “Material by Rail” option will have the following influences:

- Intersection impacts are identical to the base case. The reduction of truck trips does not occur during the peak year of development traffic generation;
- Roadway segment capacity impacts are the same as the base case. The reduction in trips for the “Material by Rail” option occurs early in the project whereas mid-block capacity upgrades are required in the later years of the project; and
- Pavement impacts for pavement rehabilitation are identical to the base case, though the GLNG contribution required for road maintenance is approximately $400,000 less for the “Material by Rail” option.

The “No Bridge” option will have the following influences on traffic:

- Intersection impacts within Gladstone result in intersections closer to the central city needing to be upgraded. This is understandable given that Auckland Point is the origin of trips to Curtis Island;
- Roadway segment capacity improvements for the “No Bridge” option are required in the urbanised central city streets in Gladstone rather than on the urban fringe (as in base case). Upgrading constraints are likely to be more significant in the city centre resulting in higher cost and more delay during construction; and
- Pavement impacts for pavement rehabilitation are the same as for the base case. Road maintenance costs are approximately $22,000 less for the “No Bridge” option because of the removal of bridge construction traffic.