1 INTRODUCTION

Volume 5 of this Environmental Impact Statement (EIS) for the Queensland Curtis LNG (QCLNG) Project assesses impacts of the proposed LNG Component, Shipping Operations and Ancillary Infrastructure against relevant environmental values.

The process for determining environmental values for the EIS is guided by Section 9 of the *Environment Protection Act 1994* (Queensland). Section 9 of the *EP Act (Qld)* defines an environmental value as:

(a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or (b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

For this volume of the EIS, a number of environmental factors or broad areas of investigation for which values can be ascribed, were identified and assessed in relation to:

1. whether the overall Project or its constituent Project Components would impact on each factor
2. the nature and degree of an impact on ecological health, public amenity or safety related to these environmental factors.

Environmental factors that were assessed to determine any environmental values, impacts and risks were:

- climate and climate change
- topography and geomorphology
- geology and soils
- land use and infrastructure
- land contamination
- terrestrial ecology
- marine ecology
- surface water resources
- groundwater resources
- coastal environment
- air
- noise and vibration
- road, rail, air and public transport
- shipping transport
- visual amenity
- waste management
- hazard and risk assessment.

Volume 5 describes the environmental values of the area affected by the construction, operation, decommissioning and rehabilitation of the LNG Component, Shipping Operations and associated Ancillary Infrastructure such as marine transportation facilities on the mainland at Gladstone and the Curtis Island Road/Bridge. QGC is not proposing to construct the Curtis Island Road/Bridge as part of the Project and, as such, will not be the proponent for construction or operation of the bridge and roads. Any management and mitigation measures included in this EIS applicable to the bridge and roads are included as recommendations only and are not commitments made by QGC.

This volume describes the potential adverse and beneficial impacts of these structures and associated activities on environmental values and addresses how adverse impacts can be mitigated and beneficial impacts can be supported.

The methodology for determining impacts on environmental values is defined in *Volume 1, Chapter 3* and a risk matrix summary for prior- and post-mitigation measures is detailed at the end of this volume in *Chapter 20*.

Cumulative impacts arising from the concurrent development of other proposed projects in the Gladstone region are also addressed in this volume.

1.1 *OVERVIEW OF LNG COMPONENT, SHIPPING OPERATIONS AND ASSOCIATED ANCILLARY INFRASTRUCTURE*

The proposed infrastructure and activities for which impacts are assessed in Volume 5 are outlined briefly below and described in detail in Volume 2.

- **LNG Component** – This involves the development, construction and operation of an LNG processing plant and export facility (LNG Facility), to be located on Curtis Island adjacent to the city of Gladstone, with ultimate capacity of up to 12 million tonnes per annum (mtpa). Nominally this will comprise three LNG trains, each of 3 to 4 mtpa production capacity. The LNG Component will also comprise a marine jetty and LNG loading and propane unloading facilities in Gladstone harbour. Impacts of the Export Pipeline from the point of The Narrows crossing to the LNG Facility are also included.
- **Shipping Operations** – Export of LNG produced from the LNG plant will be undertaken via loading operations into specialised LNG tanker ships operated by BG Shipping, a subsidiary of the BG Group plc, which will transport LNG from Gladstone to customers in Asia and other global export markets.

- **Ancillary Infrastructure** - associated with the LNG Component covered in the impact assessment of *Volume 5* includes infrastructure required to facilitate construction and long-term operational access to the LNG Facility on Curtis Island. Options to provide this access include the development of marine transportation facilities and barge/ferry operations; construction of a bridge and roads connecting Curtis Island to the Gladstone mainland (Curtis Island Road/Bridge); or a combination of both. Note that while impacts associated with the development of the Curtis Island Road/Bridge are discussed within this EIS, this infrastructure does not constitute a component of the QCLNG Project for which QGC is seeking approval under this EIS. This infrastructure will require a separate environmental approval process should the Department of Infrastructure and Planning (DIP) proceed with development.

Volume 6 provides a detailed description of the proposed development of new Shipping Channel infrastructure in the Gladstone harbour to access the LNG Facility. The proposed dredging works will largely be undertaken by a separate proponent, the Gladstone Ports Corporation (GPC). Therefore, approval for these dredging works is not sought under this EIS.

1.2 STUDIES AND MODELLING

Impact and risk assessment findings have been based on a combination of desktop assessments, field surveys and detailed modelling.

In circumstances where Project details, data or specific information was not available, the impact assessment and modelling was based on a ”worst case scenario” to ensure that impacts were not underestimated. Assumptions made in the assessment of impacts and risks, as well as limitations to the data and models used, have been explicitly stated in the respective chapters in *Volume 5.*

1.3 SUMMARY OF FINDINGS

This section provides a summary of the outcomes of the impact assessment studies undertaken for each identified environmental factor and environmental objective based on *Chapters 2 to 18* and accompanying annexes and appendices of *Volume 5.*

1.3.1 Climate and Climate Change

The Project environmental objective for climate and climate change is: to ensure that Project infrastructure design and proposed management strategies incorporate consideration for climatic extremes and future climate change.

Potential changes in climatic conditions and associated environmental risks that may manifest over the life of the Project have been, and will continue to be, considered during detailed design for the LNG Facility and associated Ancillary Infrastructure. These include changes in mean temperature, precipitation, high intensity rainfall events and cyclones, storm surges and storm tides and rising sea level.

These potential climatic changes were considered in terms of their possible impacts on operating/production efficiency of the LNG plant, water availability for the LNG Facility, structural integrity of infrastructure and bushfire risk.

Impacts to the receiving environment associated with the selected technology and location of infrastructure have been assessed in the EIS and are addressed in *Chapters 2 to 18* of *Volume 5*. Impacts relating to greenhouse gases are discussed in *Volume 7*. A summary of the impacts outlined in the Climate and Climate Change chapter is provided in *Table 5.1.1*.

Table 5.1.1 Summary of Climate and Climate Change Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short-term for impacts associated with extreme events and bushfires Long-term for impacts associated with changes in temperature and precipitation
Impact extent	Local
Impact likelihood	Unlikely

Overall assessment of impact significance: Negligible as mitigation measures have been, and will continue to be, incorporated into detailed design to reduce impacts of climatic extremes and potential climate change risks to the LNG Facility and associated Ancillary Infrastructure.

1.3.2 Topography and Geomorphology

The Project environmental objective for topography and geomorphology is: to maintain a stable landform that does not result in uncontrolled erosion.

The local topography and geomorphology of Curtis Island, The Narrows and mainland was considered to determine the extent to which the LNG Facility and associated Ancillary Infrastructure will alter existing landforms. Constraints or risks posed by topography and geomorphology to soil erosion, infrastructure design and location were also considered.

The ridgelines running to the east and south of the LNG Facility effectively serve as a barrier between the Facility and residents at South End. Similarly, the ridgelines prevent the LNG Facility from being visible from public view points within and around Gladstone City. The southern ridgeline also acts as an acoustic buffer attenuating noise and vibration impacts for sensitive receptors to the south and south-east of the LNG Facility.

The Curtis Island Road will run along a valley to the east of the LNG Facility for most of its length. This will screen views of the road from the mainland and South End.

Topography does not provide a screening effect to reduce the visibility of the Curtis Island Bridge or onshore material disposal from the surrounding areas.

Based on Queensland State Planning Policy (SPP) 1/03, landslide risks within the LNG Facility and immediate surroundings were assessed to be acceptable.

A summary of the impacts outlined in the Topography and Geomorphology Chapter is provided in *Table 5.1.2*.

Table 5.1.2 Summary of Topography and Geomorphology Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Positive for screening effect on LNG Facility and Curtis Island Road. Negligible for the impact of the LNG Facility based on scale. Negligible for risks posed by topography and geomorphology to construction and operation.
Impact type	Direct
Impact duration	Long-term
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance (visual and noise screening): Negligible to minor positive for visual and acoustic screening effect that the ridges and valleys on Curtis Island provide to sensitive receptors at South End, Gladstone and to the south and south-east of the LNG Facility.

Overall assessment of impact significance (changes in landform): Changes to landform associated with the LNG Facility are of minor negative significance.

1.3.3 Geology and Soils

The Project environmental objective for geology and soils is: to protect soils from contamination and erosion arising from Project activities.

The Gladstone area is considered the sixth most seismically active area in Australia and therefore a probabilistic seismic hazard assessment was undertaken to inform the design of the LNG Facility.

Soil erodibility and acid sulfate soil (ASS) potential was investigated at the LNG Facility site and along the road and pipeline corridor. The erosion potential of the soils is considered to be low for the LNG Facility site as it currently exists due to the shallow depth of the soil profiles, the presence of extensive colluvium cover, vegetation coverage and the relatively gentle topography of the site. Erosion control measures are proposed for construction activities undertaken in sodic soils, along water courses and during high rainfall events.

ASS were encountered on Curtis Island and along the road and pipeline corridor on the mainland. Appropriate mitigation measures will be required to mitigate the environmental impacts resulting from oxidation of potential acid sulfate soils (PASS).

The assessment of land suitability classified soils as Class C3 (Pasture Land) and, therefore, the LNG Facility and associated Ancillary Infrastructure will not impact on Good Quality Agricultural Land (GQAL). A summary of impacts outlined in the Geology and Soils Chapter is provided in *Table 5.1.3*.

Table 5.1.3 Summary of Geology and Soils Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative for soil erosion and ASS Negligible for impacts to GQAL
Impact type	Secondary impact as soil erosion and ASS could impact on water quality thereby affecting sensitive receptors in the marine environment
Impact duration	Short-term (limited to construction phase)
Impact extent	Local
Impact likelihood	Medium

Overall assessment of impact significance (soil erosion): Negligible for potential soil erosion if erosion mitigation measures are implemented effectively.

Overall assessment of impact significance (acid sulfate soils): Moderate negative due to the widespread distribution of PASS within the LNG Facility site and along the road and pipeline corridor on the mainland and on the island which could be disturbed during construction of the LNG Facility, road

and pipeline. However, impacts will be localised and risks and impacts can be avoided or reduced through the implementation of a detailed ASS Management Plan.

Overall assessment of impact significance (GQAL): Negligible as the LNG Facility and associated Ancillary Infrastructure will not affect GQAL.

1.3.4 Land Use and Infrastructure

The Project environmental objectives for land use and infrastructure are: *to minimise impacts on*

- existing townships and infrastructure
- agricultural or rural activities and potential long term uses of land.

The establishment of the LNG Facility on Curtis Island represents a change in historical and existing land use on the island. However, the expansion of the Gladstone State Development Area (GSDA) to include the Curtis Island Industry Precinct (CIIP) and the Restricted Development Precinct on Kangaroo Island, establishes the framework for future industrial land use and investment on Curtis Island and the development of an infrastructure corridor linking the mainland to Curtis Island. Therefore, the construction and operation of the LNG Facility is aligned with strategic planning direction in the Gladstone region. QGC's proposed LNG Facility is one of several LNG projects that intend to locate within the CIIP.

The establishment of the GSDA Environmental Management Precinct to the east of the CIIP will provide a significant buffer between the LNG projects and residents at South End.

Existing infrastructure in Gladstone has sufficient capacity to withstand the influx of construction and operations workforce. The LNG Facility will be self-sufficient for power, water and wastewater disposal and will, therefore, not impact on Gladstone infrastructure for these services. The existing landfill has sufficient capacity to receive waste requiring disposal. A summary of the impacts outlined in the Land Use and Infrastructure chapter is provided in *Table 5.1.4*.

Table 5.1.4 Summary of Land Use and Infrastructure Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Positive for LNG Component, Curtis Island Road/Bridge and disposal of dredge spoil adjacent to Fishermans Landing. Negligible for impacts on infrastructure
Impact type	Direct
Impact duration	Long-term
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance (land use): Negligible positive as establishment of the LNG Facility on Curtis Island and the Curtis Island Road/Bridge is consistent with the objectives of the GSDA.

The potential reclamation of land north of Fisherman's Landing using dredge material will create additional port land which will be a positive impact of major significance from a land use perspective.

Overall assessment of impact significance (infrastructure): Negligible as existing capacity can accommodate requirements of the LNG Facility and Ancillary Infrastructure.

1.3.5 Land Contamination

The Project's environmental objective for land contamination is: to protect land from contamination arising from Project activities and ensure that any existing contaminated land is not disturbed, or if disturbed is appropriately managed and/or rehabilitated.

Based on the results of a Phase I and II Environmental Site Assessment (ESA) for the LNG Facility Site there is no indication of existing environmental contaminants due to former activities. No specific management and mitigation measures to address existing contamination are proposed.

The construction and operation of the LNG Facility poses a risk of soil, groundwater and receiving water contamination from the storage and handling of hydrocarbons and chemicals and from the ablution facilities and sewage treatment works.

Storage and handling of hydrocarbons and chemicals will comply with relevant legislation and mitigation and monitoring measures are proposed to reduce the contamination risks.

A summary of the impacts outlined in the Land Contamination chapter is provided in *Table 5.1.5*.

Table 5.1.5 Summary of Land Contamination Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct impacts to soil, groundwater and receiving waters potentially leading to secondary impacts to terrestrial and marine ecosystems
Impact duration	Short-term provided contaminated sites are remediated effectively
Impact extent	Local
Impact likelihood	Unlikely

Overall assessment of impact significance: Minor, due to the localised impact in the unlikely event of a spill, provided that proposed mitigation measures are implemented effectively to reduce the risk of land contamination, recommended monitoring is undertaken and sites are remediated if land contamination does occur.

1.3.6 Terrestrial Ecology

The Project environmental objective for terrestrial ecology is: to undertake Project activities such that impacts on abundance and distribution of terrestrial flora, fauna and ecological communities are minimised.

The study area for the terrestrial ecology study included the LNG Facility site, the pipeline corridor on Curtis Island, as well as the Curtis Island Road, Mainland Road and Bridge Approach for completeness and context.

The study area contains a biodiversity assemblage that is typical of coastal Queensland environments. Due to ongoing disturbance (the presence of feral species and historic land-use), habitat condition is considered to be degraded and contains few native species of conservation significance. No threatened vegetation communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999* occur within, or within the vicinity of, the study area. No terrestrial flora, amphibians, reptiles or mammals of state or national conservation significance are expected to occur within the study area.

Two fauna species of regional significance (Yellow-bellied Glider and Beach-stone Curlew) and four bird species of state significance, listed under the *Nature Conservation Act (NC Act) 1992* (Squatter Pigeon, Beach Stone-curlew, Eastern Curlew and Powerful Owl) were recorded within the study area. The Squatter Pigeon is also a species of national significance due to its listing as a threatened species (vulnerable) under the *EPBC Act.* The study area also supports ecologically significant proportions of the population for four *EPBC Act* listed migratory bird species (Bar-tailed Godwit, Eastern Curlew, Whimbrel and Common Greenshank). Of these, the Eastern Curlew is the only species which is in decline within the study area.

Management measures have been recommended to provide strategies for minimising and offsetting the impact of the LNG Facility and Ancillary Infrastructure on the terrestrial ecology of the area and to limit adverse impacts on significant species.

LNG Facility and Pipeline on Curtis Island

Regional ecosystems (RE) occurring within the study area that are considered likely to be impacted by the LNG Facility and pipeline corridor on Curtis Island include one Endangered RE (12.3.3) and two Of Concern REs (12.3.11 and 12.11.14).

The Endangered RE (12.3.3) that occurs within the LNG Facility site was generally in good condition. Approximately 40 ha of this RE is proposed to be removed from the LNG Facility site and pipeline corridor on Curtis Island. Offsets have been proposed to account for unavoidable impacts to the RE.

Approximately 13 ha of the Of Concern REs (12.3.11) and (12.11.14) are proposed to be cleared for the LNG Facility and pipeline corridor on Curtis Island. Offset recommendations have been made to account for an equivalent of 18 ha or greater of the Of Concern RE.

The LNG Facility in unlikely to have a significant impact on listed migratory bird species or on Squatter Pigeon. However, it would contribute to the loss of foraging habitat and potential nest and roost sites for the Powerful Owl on Curtis Island. A summary of the Terrestrial Ecology impacts relating to the LNG Facility is provided in *Table 5.1.6*.

Table 5.1.6 Summary of Terrestrial Ecology – LNG Facility Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct and cumulative
Impact duration	Permanent for RE and dependent on additional data regarding Powerful Owl use of the site and distribution across Curtis Island
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Moderate to major due to permanent loss of Endangered RE and loss of habitat for the Powerful Owl which is listed as a threatened species under the Queensland *NC Act*.

Curtis Island Road and Mainland Road and Bridge Approach

An assessment of Terrestrial Ecology along the Curtis Island Road, Mainland Road and Bridge approach was undertaken and results are discussed in *Volume 5 Chapter 7*.

1.3.7 Marine Ecology

The Project environmental objective for marine ecology is: to undertake Project activities such that impacts on abundance and distribution of marine flora, fauna and ecological communities are minimised.

Impacts on marine ecology were considered for the construction and operation of the Materials Offloading Facility, Loading Jetty, the Curtis Island Bridge and the Pipeline crossing of The Narrows. Impacts of shipping activities, dredging

for the Swing Basin and new Shipping Channel for the LNG Facility, disposal of dredge material to the north of Fisherman's Landing and discharges from the LNG Facility were also considered although impacts arising from dredging of shipping channels have not been assessed in detail.

The most important impacts anticipated to occur during the construction phase arise as a result of the dredging and reclamation required to prepare and install infrastructure and dispose of the dredged material. Impacts include direct impacts on habitats such as seagrasses and mangroves, as well as secondary impacts on water quality and behavioural changes by mobile marine species that will potentially be temporarily disturbed by increased turbidity or noise. Changes to bathymetry and currents/tidal flows are unlikely to have a significant impact on sensitive marine receptors.

No significant impacts to *EPBC Act* listed threatened and migratory fish, marine mammal or marine reptile species are predicted to result from construction or operation of the proposed infrastructure and activities. This is due to the small number of individuals from these species that utilise the area and the likelihood that individuals would continue to utilise parts of the affected marine environment despite construction and operations related activities.

Marine ecological impacts associated with the possible Mainland Road and Bridge Approach are addressed in *Volume 5 Chapter 8*.

A summary of the impacts outlined in the Marine Ecology Chapter is provided in *Table 5.1.7*.

Table 5.1.7 Summary of Marine Ecology Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct and secondary
Impact duration	Permanent loss of habitat as a result of infrastructure that is constructed in the marine environment Short-term changes to water quality and impacts on marine receptors in the event of a spill Long-term impacts associated with vessel movements, lighting and discharges to the marine environment during the life of the Project
Impact extent	Local
Impact likelihood	High for loss of habitat resulting from infrastructure construction, land reclamation

Impact assessment criteria	Assessment outcome
	and dredging Unlikely for spills High for impacts associated with vessel movements, lighting and discharges to the marine environment during the life of the Project

Overall assessment of impact significance: Minor negative for the LNG Component, Shipping, Dredging and the Curtis Island Bridge, provided that proposed management measures are implemented to maintain structure and function of marine ecosystems and protect the biodiversity and integrity of populations of listed species within the study area. No significant impacts to *EPBC Act* listed threatened or migratory marine species are predicted due to the small number of individuals likely to use the area.

1.3.8 Surface Water Resources

The Project environmental objective for surface water resources is: to protect as much as practicable surface waters from contamination, diversion of natural flows, and sedimentation so as to preserve the ecological health, public amenity and safety of surface waters.

There are no Ramsar wetlands in the vicinity of the LNG Facility or associated Ancillary Infrastructure. However, Port Curtis (the Port of Gladstone) and The Narrows are listed as Nationally Important Wetlands in the Directory of Important Wetlands in Australia (DIWA). There are no lacustrine or perennial palustrine wetlands in the vicinity of the LNG Facility. However, riverine wetlands containing periodic or moving water are found in the vicinity of the LNG Facility.

The LNG Facility is not located within a Water Resource Area. There are no major water storages or perennial fresh surface waterbodies in the vicinity of the LNG Facility. However, a number of overland flow paths and ephemeral streams serve as drainage channels during intermittent rainfall events. Two main watercourses flow through the site from north-east to south-west. Detailed engineering design for the LNG Facility will take into account watercourses, site topography and surface stormwater runoff in designing the stormwater management structures to prevent flooding, soil loss and erosion during rainfall events.

The LNG Facility will include a reverse osmosis plant [sourced from seawater] as the primary water supply source for both construction and operations and will, therefore, not impact on local or regional water resources. As there is no downstream surface water abstraction, the LNG Facility will not impact on

water supply to third parties. A summary of the impacts outlined in the Surface Water Resources chapter is provided in *Table 5.1.8*.

Table 5.1.8 Summary of Surface Water Resources Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negligible
Impact type	Direct
Impact duration	Permanent
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Negligible as there are no significant surface water resources within the LNG Facility site and the facility and associated Ancillary Infrastructure will not impact on local or regional surface water supply or quality. Changes to watercourses and catchment characteristics as a result of the construction of the LNG Facility are factored into the design of the stormwater management system.

1.3.9 Groundwater Resources

The Project environmental objective for groundwater resources is: groundwater resources need to be protected from contamination to ensure that the ecological health, public amenity or safety of those that rely on groundwater is maintained.

Groundwater data from boreholes within 3 km of the LNG Facility site indicate that groundwater quality is poor (brackish and salty).

No groundwater will be abstracted during construction or operation of the LNG Facility as water demands will be met by the reverse osmosis plant (with some potential makeup by stormwater collected in site sediment ponds during construction). Apart from risks of groundwater contamination arising from the accidental spillage of fuels and chemicals, seepage from onshore dredge spoil disposal and assuming ASS are managed in accordance with the ASS Management Plan, impacts on groundwater quality are not expected. A summary of the impacts outlined in the Groundwater Resources chapter is provided in *Table* 5.1.9.

Table 5.1.9 Summary of Groundwater Resources Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Long-term
Impact extent	Local
Impact likelihood	Unlikely

Overall assessment of impact significance: Minor, provided that mitigation measures are implemented for the storage and handling of fuel and chemicals, dredge spoil disposal and ASS.

1.3.10 Coastal Environment

The Project environmental objective for coastal environment is: to protect as much as practicable the coastal environment from Project activities that may impact on ecological health, public amenity or safety

The LNG Facility is largely situated outside the erosion prone areas of the marine environment. Marine infrastructure located within erosion prone areas will require protection from coastal processes.

Coastal areas of high conservation significance are largely avoided with the exception of areas vegetated by marine plants.

Direct and secondary impacts on marine water quality or coastal hydrodynamics associated with dredging and wastewater discharge from the sewage treatment and reverse osmosis plant are not considered to be significant. Changes in water quality are within the bounds of natural variability of the marine ecosystem. Implications of dredge spoil placement in the Western Basin of the Port of Gladstone north of Fisherman's Landing will require further investigation.

The establishment of the Swing Basin and marine facilities and the associated increase in shipping activities within the Port of Gladstone will have a minor impact on public access and useability of the coastal waters and coastal landscape values.

A summary of the impacts outlined in the Coastal Environment Chapter is provided in *Table 5.1.10*.

Table 5.1.10 Summary of Coastal Environment Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct and secondary
Impact duration	Short-term for impacts to hydrodynamics and marine water quality
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Minor, as the LNG Facility and associated Ancillary Infrastructure (with the exception of dredging and associated material disposal as outlined in Volume 6), is unlikely to significantly affect current and future functioning of the coastal environment and is compatible with the management intent of the *Curtis Coast Regional Coastal Management Plan*, the *Gladstone Ports Corporation 50-year Strategic Plan* and the GSDA. Dredging and associated offshore spoil disposal to the north of Fishermans Landing could have a negative impact of moderate significance on coastal processes.

1.3.11 Air

The Project environmental objective for air quality is: to preserve ambient air quality to the extent that ecological health, public amenity or safety is maintained.

Emissions from the LNG Facility during the operations phase include nitrogen dioxide ($N0_2$), carbon monoxide (CO) and particulate matter (PM_{10}). Emissions from LNG carriers also include sulphur dioxide (SO_2).

Air quality modelling took into account predicted operations phase emissions from the LNG Facility, associated shipping, existing emission sources within Gladstone and emissions estimated for the three other proposed LNG projects within Gladstone (Sun LNG and the Gladstone LNG projects on Curtis Island and Fisherman's Landing).

Air quality assessment predicts that, during normal operations, there will be no exceedence of the Queensland Environmental Protection (Air) Policy (EPP (Air) air quality objectives for $N0_2$, CO, PM_{10}, SO_2 hydrocarbon species and odorous compounds at any sensitive receptor arising from operation of the LNG Facility. The contribution of the LNG Facility to photochemical activity in the Gladstone region was assessed to be, at worst, minor and unlikely to be of concern.

During non-normal plant operations (i.e. upset conditions) requiring dry gas flaring, the one-hour average ground-level concentration of $N0_2$ is exceeded in close proximity to the Gladstone Power Station when existing emission sources within the Gladstone region are taken into consideration. This exceedance is largely attributed to $N0_2$ emissions from the power station. Predicted ground-level $N0_2$ concentrations in close proximity to the LNG Facility fall well below air quality objectives.

During non-normal plant operations requiring marine gas flaring, there are no exceedences of air quality objectives for predicted one-hour average ground-level concentration of $N0_2$ beyond the boundary of the LNG Facility taking into account existing emission sources within the Gladstone region. However, the predicted one-hour average ground-level concentration for $N0_2$ does exceed the air quality objective in close proximity to the Marine Flare and wharf facilities.

For both the dry gas flaring and marine gas flaring scenarios, maximum concentrations of CO do not exceed air quality objectives across the modelling domain. Furthermore, predicted ground-level concentrations of hydrocarbons are very low and none are likely to be present in sufficient quantities to cause asphyxiation.

Emissions generated during construction activities are likely to consist of engine exhausts from vehicles and diesel generators (mainly NOx and CO with small quantities of hydrocarbons) and from dust generated by earthworks and vehicle movements on sealed and unsealed roads. The generation of air emissions from construction activities will be short term and intermittent, and can be relatively well managed through the implementation of an Environmental Management Plan (EMP). It is not expected that construction phase emissions will exceed those from normal conditions. A summary of the impacts outlined in the Air Chapter is provided in *Table 5.1.11*.

Table 5.1.11 Summary of Air Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Long-term for emissions during normal operations Short-term for emissions during construction, non-normal operations and from LNG carriers
Impact extent	Local
Impact likelihood	High for normal operations and shipping Low for non-normal operations

Overall assessment of impact significance: Minor for both construction and operations phase. No exceedences of EPP (Air) air quality objectives at

sensitive receptors are predicted for emissions from the LNG Facility during normal operations taking into account background levels and other proposed LNG projects. Predicted exceedences of air quality objectives from dry or marine gas flaring during non-normal operations and from LNG carriers are of short-duration and are not predicted to occur at sensitive receptors.

Aviation Safety Risk

The Project value for aviation safety risk is: to comply with the Australian Civil Aviation Safety Authority (CASA) guidelines for vertical industrial exhausts (plumes) to ensure that the Project has no adverse implications for aviation safety.

The LNG Facility consists of a number of stacks that emit industrial exhausts that have the potential to generate vertical plume velocities above the LNG Facility. As the Gladstone Airport is located approximately 10.3 km to the south of the proposed LNG Facility, an aviation safety assessment has been conducted in accordance with CASA requirements for vertical plume velocities under both normal and non-normal (flaring) operating scenarios, to establish at what height the plumes could exceed the critical threshold of 4.3 m/s and the dimensions of plumes under these circumstances. This was used to determine whether these plumes exceed CASA's aviation safety guidelines.

The Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) protection surfaces are between 300 to 350 m above ground level for the LNG Facility. These protection surfaces are established to guarantee aircraft a certain minimum obstacle (including plume) clearance.

For normal operating conditions, there is a potential for the average plume vertical velocity to exceed 4.3 m/s up to a maximum height of approximately 500 m above ground level at a maximum downwind distance of approximately 200 m. A plume with vertical velocity exceeding 4.3 m/s is likely to exceed PAN-OPS (300 m) for 44 hours per year or 0.5 per cent of the time. Of all the sources assessed for normal operations, the highest critical height for the 0.1 percentile is approximately 450 m above ground level.

For non-normal operating conditions (planned events), the operating condition likely to generate the highest plume is the Dry Gas Flare release during start up conditions. This event is likely to occur two to four times per year for a duration of 12-24 hours. During start-up conditions the plume generated by the flare is expected to penetrate the PANS-OPS at the site for half the time at a vertical velocity above 4.3 m/s. The 0.1 percentile critical plume height (when operation for all year is assumed) is almost 1,500 m above ground level. Taking into account the expected hours of operation of the flare, the plume is expected to penetrate the PANS-OPS at the site on approximately 50 hours per year and the 0.1 percentile is reduced to approximately 550 m. The horizontal extent of the plume that exceeds a vertical velocity of 4.3 m/s is expected to be, on average, approximately 450 m, and up to 650 m on one occasion.

For non-normal operating conditions (unplanned events or emergency releases), the operating condition likely to generate the highest plume is the emergency operation of the Dry Gas Flare. This event is likely to occur less than once per year and last for a duration of approximately 20 minutes. During the unscheduled emergency operation of the Dry Gas Flare the vertical velocities generated by the extremely buoyant plume are expected to exceed the PANS-OPS height of 300 m under almost all meteorological conditions. However, as the expected frequency of this event is less than one hour per year, the 0.1 percentile is actually below the PAN-OPS due to the extreme unlikely occurrence of an emergency flare event. The horizontal extent of the plume that exceeds a vertical velocity of 4.3 m/s is expected to be, on average, approximately 500 m, and up to 730 m on one occasion. The flare flame height is expected to be less than 160 m above ground level during worst case meteorological conditions. A summary of the impacts regarding Aviation Safety risk outlined in the Air chapter is provided in *Table 5.1.12*.

Table 5.1.12 Summary of Aviation Safety Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Long-term
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Major as the vertical plumes from the LNG Facility are likely to exceed the 4.3 m/s critical velocity at the established PAN-OPS protection surface above the LNG Facility site at certain times during normal and non-normal operations. This issue will require discussion with CASA.

1.3.12 Noise and Vibration

The Project environmental objective for noise and vibration is: to ensure that ecological health, public amenity or safety is maintained and not intrusively impacted on by noise and vibration sources.

Noise and vibration impacts on sensitive receptors are effectively limited by the distance between the construction and operations phase activities and the closest residential receptors. The topography of Curtis Island serves as a natural noise barrier to residences at South End and to the south and south-east of the LNG Facility.

The noise and vibration assessment for the construction phase considered construction activities at the LNG Facility site and along the export pipeline corridor within the Gladstone region (east of Calliope -Targinie Road), as well as marine transport of equipment and personnel from Auckland Point (Gladstone) to the LNG Facility site and road traffic noise within Gladstone.

Construction of the LNG Facility should be inaudible at noise sensitive receptors under most conditions during the day and under all conditions during night-time works. There are no noise criteria for day-time work. During neutral weather conditions construction noise from the LNG Facility may be audible at the residential property on Tide Island.

Predicted worst case noise levels from construction barges and ferries indicates noise levels will be inaudible at all residential receptors other than on Tide Island. However the levels will be below existing average L_{10} noise levels and will be transient.

Construction of the potential bridge is expected to be inaudible at the nearest residential receptor.

Road traffic generated during construction will include vehicles travelling to the Auckland Point laydown areas. The main road to access the Auckland Point laydown area is Port Access Road which is designed as a heavy vehicle route. Impacts from road transport will, therefore, be negligible.

The Auckland Point Laydown Area is located among existing rail and industrial areas and hence while some site activities may be audible, these are expected to have a low impact on the nearest residential areas.

Construction activities such as pile driving and vibratory rollers can produce significant vibration levels at close range (e.g. 50 m). However, as the nearest off-site vibration sensitive receptors will be several kilometres away, these activities will not cause a vibration impact.

For the operations phase, the assessment considered activities at the LNG Facility and LNG vessels within the Port of Gladstone. Predicted operational noise levels are below the relevant Environmental Protection Agency (EPA) criteria for all locations under neutral and typical weather conditions.

Under adverse conditions (temperature inversion and calm winds), predicted operational noise levels are below the relevant criteria for all locations except at Tide Island, the closest sensitive receptor to the LNG Facility site. The exceedance of 5dB(A) under adverse conditions is expected to occur only occasionally as temperature inversions infrequently form over water, and winds are calm for only 14 per cent of the time. As this is less than the 30 per cent referred to in the EPA EcoAccess Guideline *Planning for Noise Control*, this exceedance is not expected to be significant.

The predicted linear-weighted noise levels meet the EPA Draft criterion for low frequency noise, thus no further assessment is required at this time as the levels are unlikely to cause complaints due to low frequency noise.

Predicted worst case noise levels (based on noise levels for ships under full power) for LNG vessels indicate noise will be inaudible at all locations other than on Tide Island. Impact will be transient and hence shipping traffic is not expected to have a significant noise impact on the residence at Tide Island.

The LNG Facility and equipment primarily involves rotating machinery, which will transfer relatively low levels of vibration to the ground. Hence operation of the LNG Facility will not produce significant levels of ground vibration. A summary of the impacts outlined in the Noise and Vibration chapter is provided in *Table 5.1.13*.

Table 5.1.13 Summary of Noise and Vibration Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short-term for construction and shipping noise and vibration and shipping noise Long-term for noise and vibration generated during operations
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Minor, as construction and operations phase noise and vibration for the LNG Facility and associated Ancillary Infrastructure are not predicted to impact on sensitive receptors under most conditions. Predicted exceedences of EPA noise criteria will be experienced infrequently by residents of Tide Island during adverse weather conditions (temperature inversion and calm winds) and by passing LNG carriers.

1.3.13 Road, Rail, Air and Public Transport

The Project environmental objective for road, rail, air and public transport is: to ensure that use of roads, rail and other transport infrastructure does not impact on ecological health, public amenity or safety of those who use or are in proximity to transport infrastructure.

The assessment of impacts to road, rail, air and public transport reflects a worst case scenario. Amendments to workforce size, construction camp locations and transport requirements during construction and operations which were made subsequent to the assessment, are anticipated to have lower traffic and transport impacts.

Based on increases in traffic volumes during construction, the impact assessment indicated that improvements to the road network may be required at a number of locations within Gladstone. Upgrades will require negligible amounts of vegetation clearing. Concept design layouts have been prepared, including stormwater drainage requirements.

Maintenance contributions for impacts to road pavements were assessed as not being required.

QGC does not intend to move any appreciable volume of freight or personnel via the Queensland Rail network and, therefore, impacts on the rail network and services are predicted to be negligible.

Shuttle bus services will be provided for construction personnel at the start and end of each shift. Impacts to the existing Gladstone taxi fleet, public transport service and pedestrian and cycle networks are, therefore, expected to be negligible.

Numbers of personnel passing through Gladstone and Rockhampton airports would vary during the construction phase and is expected to have a minor to moderate impact on air passenger movements during the two to three month peak construction phase. This may require the equivalent of an additional 50-seater Dash 8-300 service every fortnight during the peak construction phase.

Impacts associated with the operations phase will be significantly lower due to the smaller workforce numbers and smaller volumes of materials and equipment that will need to be transported to site. A summary of the impacts outlined in the Road, Rail, Air and Public Transport chapter is provided in *Table 5.1.14*.

Table 5.1.14 Summary of Road, Rail, Air and Public Transport Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short-term for construction phase traffic impacts Long-term for operations phase traffic impacts
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Minor as the LNG Facility will not impose a significant impact on the state or local controlled road or rail networks, or to transport infrastructure, facilities or services provided that recommended mitigation measures are implemented.

1.3.14 Shipping Transport

The Project environmental objective for shipping transport is: to ensure that Project shipping does not impact on ecological health, public amenity or safety of those who use or are in proximity to waterways utilised by Project shipping

Shipping activities associated with the construction and operation of the LNG Facility were assessed for impact on existing shipping and boating activities in Australian territorial waters and through the Great Barrier Reef Marine Park as well as within the bounds of the Port of Gladstone. Potential foreshore damage resulting from wave action associated with Project-related shipping was considered as were requirements for tugs and pilots.

During construction, shipping activities will include barge and ferry movements from Auckland Point to Curtis Island to transfer personnel, equipment, materials and waste to and from the LNG Facility site. This will result in a significant increase in vessel movements within the Port of Gladstone during the peak construction phase. However, as ferries will be high speed, highly manoeuvrable and not constrained to existing major shipping channels due to their relatively low draft, impacts on other Port shipping operations are not anticipated to be significant. The lower number of water taxis and ferries required during the operations phase will have a negligible impact on bulk shipping operations.

The proposed 300 m safety zone for construction around the Materials Offloading Facility (MOF) will not extend into existing shipping channels and will, therefore, not impact on the movement of large vessels within the Port. However, this safety zone will pose a minor constraint to the movement of smaller recreational vessels that currently utilise the channel between Curtis Island and South Passage Island.

The predicted increase in cargo vessels visits to the Port of Gladstone resulting from LNG vessels associated with the Project is well within the expectations of the Port Strategic Plan and is a viable component of the current and projected future role of the Port of Gladstone as a strategic industrial port for Queensland. However, the proposed shipping buffer zone for manoeuvring LNG and LPG vessels through the port will impact on recreational users due to the associated moving restriction zone that will be enforced during transit. The degree of impact on recreational users will be influenced by transit time as well as tidal and meteorological conditions. Indicative transit times are 3.6 hours for incoming vessels and 3.1 hours for outgoing vessels. With three trains operational approximately 186 Project LNG vessels will enter the Port annually.

Due to the requirements for LNG vessels to be escorted to the LNG Facility by four tugs, additional escort tugs will be required to augment the Port of Gladstone's current fleet of tugs. QGC will work with the commercial supplier under licence from Gladstone Ports Corporation (GPC) to ensure appropriate tug capacity is available. Tug masters and pilots will continue to undergo specific training to manage LNG vessels.

The movement of LNG vessels through the Great Barrier Reef Marine Park is predicted to represent a 3 per cent increase over current large vessel movements and is, therefore, unlikely to have a significant impact on current shipping activities. Following consultation with Maritime Safety Queensland (MSQ), QGC has decided that BG Group-operated LNG shipping associated with the Project will not transit the GBRMP via the inner route and will use the Outer Route only.

A summary of the impacts outlined in the Shipping Transport chapter is provided in *Table 5.1.15*.

Table 5.1.15 Summary of the Shipping Transport Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Long-term (life of Project)
Impact extent	Local
Impact likelihood	Extremely unlikely for potential mainland foreshore damage and impacts to existing large vessel movements through the Great Barrier Reef Marine Park and the Port of Gladstone High for impacts on existing recreational users during transit of LNG/LPG vessels through the Port of Gladstone

Overall assessment of impact significance: Minor, as movement restrictions imposed on recreational users during LNG/LPG vessel transit through the Port of Gladstone are temporary and geographically limited. Increases in shipping/vessel movements associated with the construction and operation of the LNG Facility are not expected to impact on large vessel movements within the Great Barrier Reef Marine Park or the Port of Gladstone, or result in damage to the foreshore.

1.3.15 Visual Amenity

The Project environmental objective for visual amenity is: to preserve the visual amenity of the landscape as far as practicable.

Visual and lighting impacts of the LNG Facility were assessed. Assessment of the possible Curtis Island Bridge was also undertaken for context.

No significant visual impact from the LNG Facility, proposed Mainland Road Bridge Approach and Curtis Island Bridge is expected on views from local residences.

The LNG Facility is expected to impact on landscape values of major significance on Curtis Island. However, the impact on the Great Barrier Reef World Heritage Area is already attenuated in this location by the presence of the Port of Gladstone in the viewshed. Therefore, this area is not 'pristine' or representative of the "exceptional natural beauty" assigned to the World Heritage and National Heritage values. In addition, the designation of the Curtis Island Industry Precinct as an extension to the Gladstone State Development Area (GSDA) reflects the intent of the Queensland Government to develop the area as an industrial precinct. Given this, the landscape and visual impact of the proposed LNG Facility is consistent with the designated land use and general expansion of industry around the Port of Gladstone.

The pristine natural "wilderness" area of The Narrows passage landscape as recognised at international, national and state level would be affected by the proposed bridge and approach road.

A summary of the impacts outlined in the Visual Amenity chapter is provided in *Table 5.1.16*.

Table 5.1.16 Summary of Visual Amenity Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Long-term for LNG Facility Permanent for Curtis Island Bridge
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Major due to impacts on landscape values that are recognised at an international, national and state level. However, the GSDA designation of the Curtis Island Industry Precinct and the Restricted Development Precinct on Kangaroo Island overrides compatibility issues between landscape significance and the high visual impacts associated with the LNG Facility and associated Ancillary Infrastructure.

1.3.16 *Waste Management*

The Project environmental objectives for waste management are:

- To minimise waste generation and maximise reuse and recycling of waste products
- To transport, store, handle, and dispose of waste in a manner that does not cause contamination of soil, air or water.

Waste minimisation and cleaner production technologies, as well as legal requirements, have been considered throughout Project development. Waste production will be reduced through avoidance (where possible), recovery, re-use, recycling and efficient use of resources. Disposal of solid waste is the last resort method of disposal. Best practice will be applied to the maintenance of on-site waste disposal areas and through the use of environmentally responsible waste contractors for off-site waste disposal. A summary of the impacts outlined in the Waste Management chapter is provided in *Table 5.1.17*.

Table 5.1.17 Summary of Waste Management Impacts

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Long-term
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Minor, assuming the waste management hierarchy is applied and all solid, liquid and hazardous wastes are treated, transported and disposed of in accordance with applicable waste management legislation. Impacts of moderate significance may occur in the event that on-site retention dams containing contaminants overflow during high rainfall events resulting in marine discharges that exceed legislated standards.

1.3.17 *Hazard and Risk Assessment*

The Project environmental objective for hazard and risk assessment is: to protect ecological health, public amenity and safety of those on site or in proximity to the site from hazardous events.

The proposed LNG Facility is similar to many active LNG liquefaction and export terminals around the world. The industry's safety record over the past

45 years has been excellent with no member of the public having been fatally injured as a result of a spill, fire or explosion at one of these facilities. In 35 years, modern LNG storage tanks using 9 per cent nickel-steel (as proposed for the QCLNG Project), have never suffered a crack failure and LNG ships have covered more than 185 million kilometres in the past 42 years without a major incident.

The hazards and risks associated with the construction, operation and decommissioning of the QCLNG Project's LNG Facility and associated LNG and LPG shipping were assessed using a Quantitative Risk Assessment approach. A bushfire hazard assessment was also undertaken.

LNG Facility

The design and siting of the LNG Facility results in public risk levels that are acceptable in terms of Hazardous Industries Planning Advisory Paper (HIPAP) guidelines. In addition, when vulnerability zones for the largest credible events associated with the LNG Facility are overlaid on the proposed plot plan, the radiant and overpressure levels necessary to cause damage according to HIPAP10 guidelines, have minimal impact on offsite areas. Toxic releases have the potential to impact offsite areas at an irritation level only.

Ship Loading/Unloading at the LNG Facility Jetty

The risks associated with the berth loading and unloading meet the injury risk criterion of 50-in-a-million at residential areas. The risks also meet the fatality risk criteria of 0.5-in-a-million at sensitive land uses, 1-in-a-million at residential areas, 10-in-a-million at commercial areas and 50-in-a-million at (potential) neighbouring industrial facilities.

The group risk of accidents during the transfer operations affect predominantly the personnel on the ship and jetty who are controlling and monitoring the transfer. The risk to people located in the LNG Facility and the support tug are much lower. The risks are considered to fall within the As Low as Reasonably Practicable (ALARP) region.

In summary, the location proposed for the LNG/LPG berth meets the risk criteria because it is sufficiently distant from other land users and the controls on the risks are sufficiently strong.

Shipping Transit in Port of Gladstone

Gladstone Port is extremely safe, with navigation features, support systems and redundancy all contributing towards a low risk of an incident during transit.

There are a number of hazards with potential for a major incident should there be a lack of sufficient control in managing the transit of the LNG carriers to the berth. Key hazards include the passage through the Outer Channel, transit past other facilities at Auckland Point and other berths, and interaction between the LNG carrier and support vessels during transit.

The route through the port meets industry criteria for channel draught, angles of turn and turning basin even for large beam LNG vessels. A high level comparison with industry criteria determined that the channel width was less than recommended. However, it is accepted that specific modelling of transit through the port can provide acceptable specific requirements for channel width. A reduced channel width is acceptable given a scenario-specific risk assessment and implementation of appropriate mitigation measures. Such an assessment and demonstration of acceptability is being undertaken as part of the ongoing shipping simulation studies and is also being addressed through potential channel expansion as outlined in *Volume 6* of this EIS.

The quantitative assessment of all incidents (such as a collision, grounding, allision, capsizing, sinking, or exposure to specific hazardous conditions) occurring during the transit shows that the likelihood is extremely low, less than 2.1×10^{-4} per LNG carrier visit. The likelihood of an incident resulting in a release of LNG or bunker fuel spill is even lower, less than 2.1×10^{-6} per LNG carrier visit.

Shipping Transit through Great Barrier Reef Marine Park

The overall Outer Route to be used is extremely safe, with navigational features, support systems, rules, guidelines, control measures and redundancy all contributing towards a low risk of an incident during transit.

There are a number of hazards with potential for a major accident should there be a lack of sufficient control in managing the transit. Key hazards are centred on collision and grounding. Accidents could potentially result in release of cargo, bunker fuel or ballast water, which could cause severe environmental damage and or impacts to the island communities and to tourism.

The quantitative assessment of the main accident incidents – grounding, collision, whale/ship strike – occurring during transit, show that the likelihood of any of these events is extremely low. Given the occurrence of a collision or grounding incident, the likelihood of cargo, bunker fuel or ballast water release is estimated as 5.4×10^{-6} per ship visit for single hull vessels, and 1.6×10^{-7} per ship visit for double hull vessels. Even though the likelihood of release of bunker fuel for single hull ships is low, the use of double hull protection reduces the likelihood further by an order of magnitude.

The frequency of ships striking whales in the Great Barrier Reef and Torres Strait is very low, the frequency of occurrence being estimated to be approximately 3.16×10^{-4} per year.

Bushfire Hazard

The bushfire hazard assessment determined a minimum asset protection zone (APZ) between bushfire hazard and buildings of 37.5 m. Recommendations for reducing bushfire risks were provided.