Australia Pacific LNG

Volume 4: LNG Facility

Chapter 13: Air Quality

Contents

13. Air quality ... 3

13.1 Introduction ... 3

13.1.1 Purpose ... 3

13.1.2 Scope of work ... 3

13.1.3 Legislative framework ... 4

13.1.4 National environment protection measure ... 4

13.2 Methodology ... 5

13.2.1 Sources of emissions ... 6

13.2.2 Dispersion modelling ... 7

13.2.3 Aviation safety assessment ... 8

13.3 Existing environment ... 8

13.3.1 Meteorology ... 8

13.3.2 Ambient air quality ... 9

13.4 Potential sources and impacts ... 13

13.4.1 Sources of air pollutants and emission rate quantification ... 13

13.4.2 Standards of emission concentrations ... 14

13.4.3 Results of air quality impact assessment ... 15

13.4.4 Air quality assessment summary ... 32

13.5 Aviation safety vertical plume velocity results ... 33

13.6 Mitigation and management ... 34

13.7 Conclusions ... 35

13.7.1 Assessment outcomes ... 35

13.7.2 Commitments ... 38

References ... 39

Figures

Figure 13.1 Seasonal distribution of wind speed and direction for Gladstone ... 9

Figure 13.2 Scenario 1 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility during normal operations, in isolation (units = µg/m³) ... 17

Figure 13.3 Scenario 1 - predicted annual average ground-level concentrations of NO_2 for LNG facility during normal operations, in isolation (units = µg/m³) ... 18

Figure 13.4 Scenario 1 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background (units = µg/m³) ... 19

Figure 13.5 Scenario 1 - predicted annual average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background (units = µg/m³) 20

Figure 13.6 Scenario 1 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background plus all other LNG facilities (units = µg/m³) 21

Figure 13.7 Scenario 1 - predicted annual average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background plus all other LNG facilitieis (units = µg/m³)...... 22

Figure 13.8 Scenario 1 - predicted maximum 8-hour average ground-level concentrations of carbon monoxide for the LNG facility during normal operations, with background (units = µg/m³) 23

Figure 13.9 Scenario 1 - predicted maximum 24-hour average ground-level concentrations of PM_{10} for LNG facility during normal operations, with background (units = µg/m³) 24

Figure 13.10 Scenario 1 - predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ for LNG facility during normal operations, with background (units = µg/m³) 25

Figure 13.11 Scenario 1 - predicted annual average ground-level concentrations of $PM_{2.5}$ for LNG facility during normal operations, with background (units = µg/m³) 26

Figure 13.12 Scenario 2 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility flares, in isolation (units = µg/m³) 29

Figure 13.13 Scenario 2 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility flares, with GAMSv3 background plus all other LNG facilities (units = µg/m³) 30

Figure 13.14 Scenario 2 - predicted maximum 8-hour average ground-level concentrations of carbon monoxide for the LNG facility flares with background (units = µg/m³) 31

Tables

Table 13.1 Relevant ambient air quality objectives for criteria air pollutants (EPP Air) 5

Table 13.2 Existing industries in the Gladstone region (for the 2007 to 2008 NPI reporting period) and comparison to the LNG facility 10

Table 13.3 Summary of annual measurements of nitrogen dioxide from the DERM Targinie monitoring sites 11

Table 13.4 PM_{10} concentrations at the Targinie Stupkins Lane and Targinie Swans Road monitoring sites 12

Table 13.5 Summary of total annual emissions from the LNG facility (normal operations) 14

Table 13.6 Point source emission standards comparison 15

Table 13.7 Predicted maximum concentrations at sensitive receptors for normal operation of the LNG facility 16

Table 13.8 Predicted maximum concentrations at sensitive receptors for non-routine operation of the LNG facility 28

Table 13.9 Predicted maximum 1-hour average ground-level concentrations of NO_2 and sulphur dioxides for LNG facility including shipping 32

Table 13.10 Summary of environmental values, sustainability principles, potential impacts and mitigation measures 36

13. Air quality

13.1 Introduction

13.1.1 Purpose

The purpose of this chapter is to describe the potential effect of the construction and operation of the liquid natural gas (LNG) facility on air quality for the Gladstone airshed. Decommissioning is not explicitly discussed as its effects will be similar to the construction phase. The chapter identifies the values of the air environment within the Gladstone region and quantifies the potential change in air quality in the context of those environmental values due to the operation of the LNG facility.

A detailed technical air quality impact assessment has been conducted and is included as Volume 5 Attachment 29.

Of its 12 sustainability principles, Australia Pacific LNG is guided by a subset of relevant principles when identifying potential impacts the Project may have on air quality for the Gladstone Region. The Australia Pacific LNG sustainability principles that relate to air quality are:

- Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas
- Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities.

These principles have been applied to identify management options to reduce air quality impacts from the construction and operation of the LNG facility on the Gladstone Region.

13.1.2 Scope of work

The scope of works for this chapter was to conduct investigations into air quality to meet the requirements set out in Chapter 3.6 of the terms of reference issued by the Coordinator-General for the LNG facility located near Laird Point, Curtis Island. This included consideration of the following components relating to air quality:

- Describing the air pollutant source characteristics, concentrations and emission rates
- Describing the local climate including the meteorological conditions important for the dispersion of air pollutants
- Discussing the existing air quality including emission rates of air contaminants from background sources within the region and Department of Environment and Resource Management (DERM) monitoring data
- Assessing air pollutants including NO_X, CO, PM_{10}, $PM_{2.5}$, SO_2, odour and hydrocarbons
- Assessing the cumulative impacts associated with the LNG facility with existing, future and planned industry

- Assessing the vertical plume velocities, associated with stack and flare emission sources during both normal and non-routine operating conditions, in relation to Civil Aviation Safety Authority (CASA) guidelines.

Greenhouse gas emissions are addressed in Volume 4 Chapter 14.

13.1.3 Legislative framework

The *Environmental Protection Act 1994* (EP Act) provides the framework for the management of the air environment in Queensland. The Environmental Protection (Air) Policy 2008 (EPP Air) was made under the EP Act and was gazetted in 1997. The EPP Air was revised in 2008 and came into force on 1 January 2009.

The objective of the EPP Air is:

> "...to identify the environmental values of the air environment to be enhanced or protected and to achieve the object of the Environmental Protection Act 1994, i.e. ecologically sustainable development."

The environmental values to be enhanced or protected under the EPP Air are the qualities of the environment that are conducive to:

- Protecting the health and biodiversity of ecosystems
- Human health and wellbeing
- Protecting the aesthetics of the environment, including the appearance of buildings structures and other property
- Protecting agricultural use of the environment.

The DERM must consider the requirements of the EPP Air when it decides an application for an environmental authority, amendment of a licence or approval of a draft environmental management plan. Schedule 1 of the EPP Air specifies air quality objectives for various averaging periods.

13.1.4 National environment protection measure

The National Environment Protection Council defines national ambient air quality standards and goals in consultation, and with agreement from, all state governments. These were first published in 1998 in the National Environment Protection (Ambient Air Quality) Measure (NEPM (Air)). Compliance with the NEPM (Air) standards is assessed via ambient air quality monitoring undertaken at locations prescribed by the NEPM (Air) and that are representative of large urban populations. The goal of the NEPM (Air) is for the ambient air quality standards to be achieved at these monitoring stations within ten years of commencement; that is in 2008. The EPP Air has adopted the NEPM (Air) goals as air quality objectives.

Relevant ambient air quality objectives

The air quality objectives specified in the EPP Air, as presented in Table 13.1, have been adopted for the air quality assessment.

Table 13.1 Relevant ambient air quality objectives for criteria air pollutants (EPP Air)

Indicator	Environmental value	Averaging period	Air quality objective[1] (µg/m³)	Number of days of exceedance allowed per year
Nitrogen dioxide	Health and wellbeing	1-hour	250	1
		1-year	62	N/A
	Health and biodiversity of ecosystems	1-year	33	N/A
Carbon monoxide	Health and wellbeing	8-hour	11,000	1
Particles as PM_{10}	Health and wellbeing	24-hour	50	5
Particles as $PM_{2.5}$	Health and wellbeing	24-hour	25	N/A
		1-year	8	N/A
Ozone	Health and wellbeing	1-hour	210	1
		4-hour	160	1

[1] Air quality objective at 0°C

N/A: Not applicable

For some air pollutants, the EPP Air does not specify air quality objectives. Where this is the case objectives have been determined from the following documents:

- National Environment Protection Measure (Ambient Air Quality) 1998
- NSW Department of Environment and Climate Change (NSW DECC) Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005)
- EPA Victoria (Vic SEPP) State Environment Protection Policy (Air Quality Management)
- World Health Organisation (WHO) Guidelines for Air Quality (Chapter 3) 2000
- Texas Commission on Environmental Quality Toxicological section list of Effects Screening Levels
- National Exposure Standards for Atmospheric Contaminants in the Occupational Environment (NOHSC:1003(1995))

13.2 Methodology

The following components were incorporated into the assessment of the potential impacts on air quality from the construction and operation of the LNG facility:

- Identification and quantification, where possible, of emissions sources and relevant air quality objectives.

- Assessment of meteorology and ambient air quality; background concentrations of CO and PM_{10} were based on DERM monitoring data in the region, $PM_{2.5}$ were based on DERM monitoring data from Springwood, Brisbane, no background concentrations were assumed for the assessment of hydrocarbons in accordance with conventional practice.
- Assessment of criteria pollutants (including NO_2, CO, PM_{10}, and $PM_{2.5}$) cumulative ground-level concentrations (incremental plus background) at sensitive receptor locations with the EPP Air quality objectives.
- Assessment of all other air pollutants (including SO_2 and hydrocarbons) by comparison of the maximum incremental ground-level concentration at sensitive receptor locations with the relevant air quality objectives.
- Assessment of odour by comparison of the maximum incremental ground-level concentration at sensitive receptor locations with the DERM guideline.
- Discussion and assessment of the potential for the generation of photochemical smog.

Of the potential emissions from the LNG plant, the key pollutant in relation to cumulative impacts is NO_2. Therefore the modelling assessment of NO_2 takes into account all current, approved and proposed industries in the Gladstone region. Other emissions (CO, PM_{10}, and $PM_{2.5}$) which are released in lower quantities for normal operation of the LNG plant, have been modelled and an appropriate background concentration added from measurements to account for other sources in the region (including non-industrial).

13.2.1 Sources of emissions

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

Dust emissions are notoriously difficult to quantify due to the variability with which they are produced depending on factors such as type and levels of construction and dust suppression activities, soil type and metrological conditions. The composition of engine exhaust emissions is expected to be primarily NO_X and CO with small quantities of hydrocarbons. However, due to the relatively low emission rates of mobile vehicles in comparison to the combustion emissions from gas turbines and hot oil heaters, it is not expected that air emissions during the construction phase will exceed those from operation of the LNG facility.

Emission sources during decommissioning activities will be similar in type and magnitude to the construction phase.

Consequently, due to the relative intensity, short duration and transient nature of construction and decommissioning emissions in the isolated area on Curtis Island, emissions sources from these phases have not been assessed in the air quality assessment.

Air emissions from sources associated with the operation of the gas turbines, gas-fired heaters and flares within the LNG plant have been quantified from the following:

- Project front end engineering design (FEED) parameters
- National pollutant inventory (NPI) emission estimation techniques
  - Combustion engines v3.0
  - Combustion in boilers v3.1

- USEPA AP-42 Emission factors
  - Chapter 3.1, Stationary gas turbines
  - Chapter 1.4, Natural gas combustion
  - Chapter 13.5, Industrial flares

13.2.2 Dispersion modelling

In order to predict ground level concentrations of criteria pollutants, the following components were incorporated into atmospheric dispersion modelling:

- Air emission rates based on the Project's FEED parameters
- Background sources of NO_2 based on GAMSv3 modelling for existing and approved sources, giving a cumulative assessment of Australia Pacific LNG emissions and the following sources:
  - Gladstone Power Station
  - Queensland Alumina refinery
  - Boyne Smelters
  - Rio Tinto Yarwun refinery Stage 1
  - Rio Tinto Yarwun refinery Stage 2 (approved but not built)
  - Cement Australia Yarwun plant
  - Orica Yarwun facility
  - Queensland Energy Resources (approved but not built)
  - Gladstone Pacific Nickel (approved but not built).
- Background sources of NO_2 based on GAMSv3 modelling for existing, approved and proposed sources, giving a cumulative assessment of Australia Pacific LNG emissions, the above sources and the following[1]:
  - Queensland Curtis LNG (QCLNG) at Curtis Island
  - Gladstone LNG (Santos) at Curtis Island
  - Gladstone LNG (Arrow) at Fisherman's Landing
  - SUN LNG at Fisherman's Landing
- Nested CALMET meteorological domain within the GAMSv3 at a fine scale resolution over the Australia Pacific LNG facility at Curtis Island
- CALMET inputs such as terrain and land use parameters were enhanced by the use of Geoscience Australia 9 second digital elevation model data, geographical information systems and aerial image information

[1] The Shell LNG facility has released an initial advice statement, but has yet to release an environmental impact statement and therefore emissions are not known and as such this facility has not been included in the assessment.

- CALPUFF runs for Australia Pacific LNG sources modelled on nested CALMET domain – Australia Pacific LNG model
- Air quality assessment for NO_2 based on combined GAMSv3 and Australia Pacific LNG model predictions

13.2.3 Aviation safety assessment

The aviation safety assessment included modelling of vertical plume velocities, associated with stack and flare emission sources during both normal and non-routine operating conditions. The methodology used is based on the guidelines for aviation safety published by CASA in Guidelines for conducting plume rise assessments *(*CASA 2004*).* The vertical plume velocities and vertical wind profiles have been generated using the prognostic weather model TAPM for a five year simulation period using data assimilation at three sites as configured in GAMSv3.

A cumulative assessment of aviation safety of the APLNG plumes and other existing or proposed industrial developments is not necessary as the plumes will not merge during normal operating conditions.

13.3 Existing environment

13.3.1 Meteorology

Wind speed and direction are important parameters for the transport and dispersion of air pollutants. Gladstone's coastal proximity, large deep water harbour and elevated terrain around Mt Larcom provide a number of complexities in the flow of winds across the region.

The annual distribution of wind speed and direction at Gladstone airport for the period 1 January 1996 to 30 June 2009 is presented as a seasonal wind rose diagram in Figure 13.1. The predominant annual wind flows at Gladstone are from the sector between the northeast and south-southeast with 62.0% of winds blowing from this direction. These winds tend to dominate the daytime flows and early evening winds, particularly during spring, summer and autumn months. During the cooler late autumn and winter months there is a more pronounced nocturnal (midnight to 6am) drainage flow, with winds blowing from the southern and western sectors between the south-southeast and the west for 50.1% of the time (autumn and winter only). Variations in seasonal wind patterns are largely influenced at a synoptic scale by the southeast trade winds.

Diurnal variations in wind flows across the Gladstone region are strongly influenced by sea breezes, resulting in a high percentage of easterly daytime winds. The sea breeze generally develops around 10-11am each day and is often preceded by a significant shift in wind direction from the more southerly and westerly night time drainage flows.

In summary the meteorological data shows the following:

- The site is dominated by moderate winds typical of a coastal location, with an average wind speed of 3.7m/s. This provides for relatively good dispersion conditions for stack sources.
- The prevailing wind direction at the site is from the east to south sector. Note Gladstone township is in the south to west sector as measured from the LNG facility site.
- Winds likely to carry emissions from the LNG facility over the population centre of Gladstone occur very infrequently. The air quality assessment shows the impact to be small and well below

air quality objectives on the rare occasions when the winds will take the plant emissions towards Gladstone.

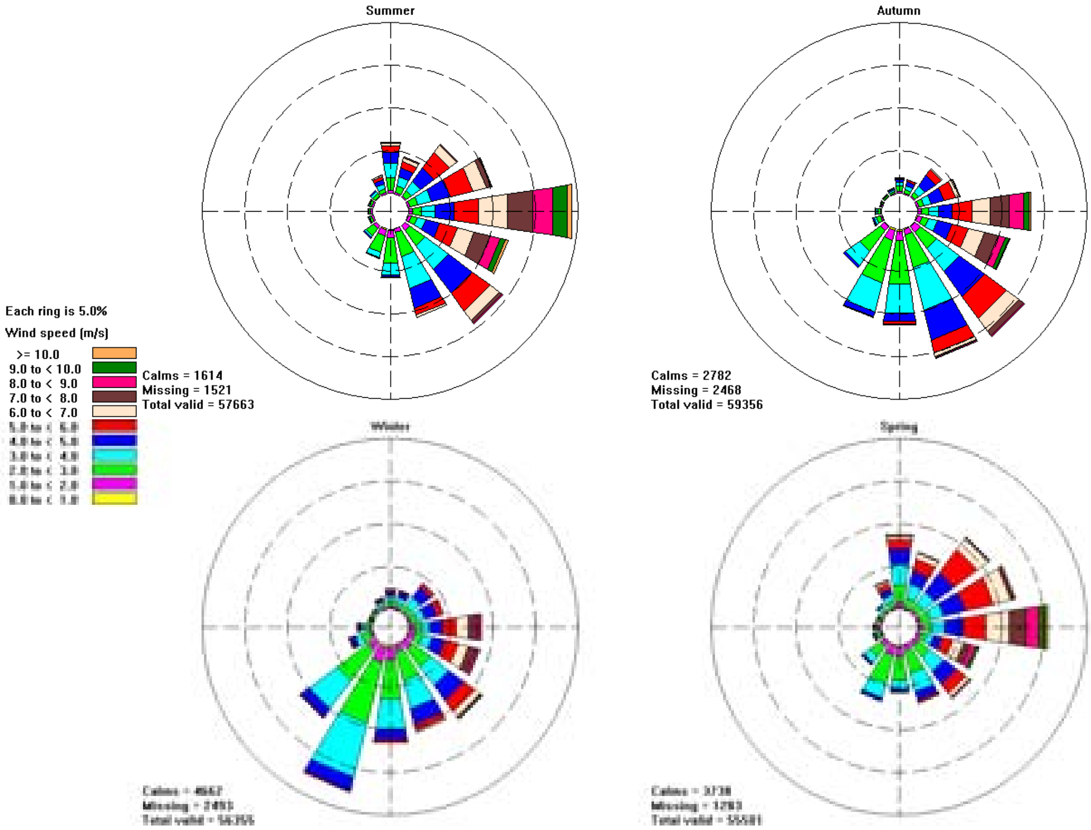

Figure 13.1 Seasonal distribution of wind speed and direction for Gladstone

13.3.2 Ambient air quality

Existing sources of air pollutants

There are a number of industries currently operating within the Gladstone regional airshed including a coal fired power station, two large alumina refineries, an aluminium smelter, an ammonium nitrate facility, coal handling and port facilities and a cement manufacturing facility. Emissions from industry include NO_X, CO, PM_{10}, SO_2 and various hydrocarbons. Further sources of air pollution include vehicle traffic and shipping bushfires, landfills, trains, exposed areas of land and construction activities.

Table 13.2 provides a comparison between existing industry emissions in Gladstone (based on NPI reporting requirements) and the LNG facility.

Table 13.2 Existing industries in the Gladstone region (for the 2007 to 2008 NPI reporting period) and comparison to the LNG facility

Source	Oxides of nitrogen (t/yr)	Carbon monoxide (t/yr)	PM_{10} (t/yr)	Sulphur dioxide (t/yr)
Alinta Asset Management (gas-supply meter stations)	-	-	-	-
Austicks Pty Ltd (wood product manufacturing)	4.5	12	10	0.5
Boyne Smelters Ltd (aluminium smelting)	123	65,660	204	11,792
Cement Australia Queensland Pty Ltd (cement production)	27	16	239	0.02
Gladstone Ports Corporation Queensland (port and water transport terminal operations)	508	128	822	221
NRG Gladstone Operating Services (fossil fuel electricity generation)	45,287	1,152	520	34,378
Orica Australia Pty Ltd (basic inorganic chemical manufacturing)	238	-	1.1	0.2
Queensland Alumina Ltd (alumina production)	8,188	1,201	425	3,800
Queensland Rail (railway rolling stock manufacturing and repair services)	17,413	14,144	329	131
Rio Tinto Aluminium Ltd (alumina production)	746,727	75,667	114,811	748,914
UNIMIN Australia Ltd (construction material mining)	70,600	32,970	108,400	5,740
Existing Gladstone industries[1]	55,210	68,292	2,444	50,947
Australia Pacific LNG [2]	3,295	2,407	221	Negligible
Australia Pacific LNG as % of existing industries	6%	4%	9%	0%

[1] Based on NPI reports for 2007-2008 period for existing industries only (no natural or anthropogenic emissions included)

[2] Estimated plant emissions for normal operations of 4 trains. All sources assumed to operate at 100% capacity for 8,760 hours per year

Air quality measurements

DERM operates a network of ambient air quality monitoring stations in Gladstone and surrounding areas that measure concentrations of NO_X, CO and PM_{10} amongst others. The key air pollutant for the LNG facility is NO_X. A summary of monitoring results is presented below.

Nitrogen dioxide

The maximum 1-hour average and annual average concentrations of NO_2 measured since 2001 at both the Targinie Stupkins Lane and Swanns Road monitoring stations are presented in Table 13.3. The EPP Air quality objective of 250µg/m^3 for the 1-hour average concentrations has not been exceeded at either of the Targinie monitoring stations for the years for which NO_2 data is available. Additionally, there were no exceedances of the EPP Air quality objective of 62µg/m^3 for annual average concentrations of NO_2.

Table 13.3 Summary of annual measurements of nitrogen dioxide from the DERM Targinie monitoring sites

Year	Maximum 1-hour average		Annual average	
	Targinie (Stupkins Lane) (µg/m³)	Targinie (Swanns Road) (µg/m³)	Targinie (Stupkins Lane) (µg/m³)	Targinie (Swanns Road) (µg/m³)
2001	96.5	78.1	10.3	6.2
2002	98.6	80.1	16.4	6.2
2003	84.2	71.9	8.2	6.2
2004	90.4	61.6	8.2	6.2
2005	96.5	80.1	8.2	6.2
2006	-	84.2	-	8.2
2007	-	73.9	-	6.2
2008	-	65.7	-	6.4
2009 [1]	-	78.0	-	-
EPP (Air) objective	250		62	

[1] Data period January – May 2009 inclusive

Carbon monoxide

A monitoring station at Beacon Avenue, Boyne Island has been recording carbon monoxide levels since 1 October 2008. The monitoring data for the period October 2008 to May 2009 shows a maximum 1-hour average carbon monoxide concentration of 749µg/m^3 and maximum 8-hour average concentration of 343µg/m^3, these are well below the EPP Air quality objective of 11,000µg/m^3.

Particulate matter

Table 13.4 presents the maximum and the 70th percentile PM_{10} concentrations for a 24-hour average from measurements at the Targinie Stupkins Lane monitoring station between 2001 and 2008. The years 2002 and 2005 were unusual with relatively high peak concentrations of PM_{10} recorded. The EPP Air quality objective for the 24-hour average concentrations of PM_{10} of 50 µg/m^3 was exceeded at the Stupkins Lane/Swans Road monitoring station on 26 occasions between 2001 and May 2009. The EPP Air quality objective was exceeded during the following periods:

- October to November 2001
- July, October and December 2002
- December 2004
- January to February 2005
- November 2006
- March and April 2008
- March and May 2009

The high events during 2002 were attributed to bushfires while those during 2005 were attributed to dust storms that occurred for two to three days over a significant portion of Queensland.

Table 13.4 PM_{10} concentrations at the Targinie Stupkins Lane and Targinie Swans Road monitoring sites

Year	Maximum 24-hour average (µg/m^3)	70th percentile 24-hour average (µg/m^3)
2001 [2]	93	20.4
2002 [2]	204	24.0
2003 [2]	50	20.1
2004 [2]	50	20.1
2005 [2]	222	17.9
2006 [2]	79	16.6
2007 [2]	36	15.4
2008 [2]	62	16.1
2009 [3]	64	20.4
EPP Air quality objective	50 [1]	--

[1] Five days of exceedances allowed per year
[2] Data recorded at Targinie Stupkins Lane
[3] Data recorded at Targinie Swans Road, period January to May 2009 inclusive

There are no long-term measurements of $PM_{2.5}$ for the Gladstone region, therefore data from the DERM monitoring station at Springwood (Brisbane) has been used for assessment of background air quality. Springwood is a semi-industrial and residential area and is therefore considered a conservative representation of $PM_{2.5}$ concentrations for the Gladstone airshed.

Air toxics

The clean and healthy air for Gladstone project is a Queensland Government initiative, established to gain a better understanding of air pollution in the Gladstone region, and to identify any potential risks to public health. The monitoring program established as part of the program covered a wide range of air pollutants. The Queensland Government published an interim human health risk assessment report for the Gladstone project area in 2009 (Queensland Health 2009). The report presents monitoring results for several air toxic species in the Gladstone region and reports that the maximum concentrations of these species were low or very low.

13.4 Potential sources and impacts

13.4.1 Sources of air pollutants and emission rate quantification

The air quality assessment incorporates air emission sources from operation of the LNG plant during both normal and non-routine operations. For the purposes of the atmospheric dispersion modelling study, normal operations refer to the day-to-day running of the LNG plant to produce LNG product. These production processes operate on a continual basis at a fixed location and include emissions generated by the combustion of coal seam gas (CSG) and the processing of CSG feed gas for export as LNG.

Key plant and equipment that emits air pollutants includes:

- Gas turbines to drive compressors
- Gas turbines for power generation
- Hot oil heaters
- Acid gas removal unit
- Nitrogen rejection unit

Other activities of the LNG facility occur intermittently for a short duration, are mobile or are transient in nature. These activities are likely to intermittent sources of air pollutants. Emission sources in this category include:

- Dry gas flare (maintenance or upset conditions)
- Wet gas flare (maintenance or upset conditions)
- Marine flare (maintenance or upset conditions)
- Variable emissions from normal operating equipment during start up and shut down
- Construction activities
- Vehicle emissions
- LNG and liquid petroleum gas (LPG) carriers
- Tug boats
- Diesel generators

Volume 4 Chapter 3 provides a detailed description of the activities carried out on the LNG facility and conceptual block flow diagrams, discussion of unit operations and detailed list of all process inputs and outputs.

A quantitative assessment has been conducted for emissions associated with the gas flares during maintenance and upset or emergency conditions of the LNG facility. The worst case emergency conditions for a simultaneous release from the dry and wet gas flare has been assessed and presented in this chapter. This condition is an extremely conservative scenario as the dry and wet flare is not likely to operate simultaneously. Additionally, 100 per cent flare capacity was modelled for non-routine conditions when, in most conditions the flare will operate at approximately 20% capacity (this information is based on ConocoPhillips' experience at the Darwin LNG).

The berthing, loading/unloading and un-berthing of LNG and LPG carriers and the assisting tug boats may be conducted by a third party provider. Air quality impacts of shipping for the Australia Pacific LNG development were assessed based on other LNG developments.

The air pollutants considered in this assessment are primarily associated with the combustion of carbon based fuels such as CSG. Other sources include the venting of process units used for the removal of impurities such as CO_2 and N_2. Consequently, the air pollutants emitted and assessed include NO_X, CO, PM_{10}, $PM_{2.5}$ and various hydrocarbon species.

Reduced sulphur compounds such as hydrogen sulfide (H_2S) are not expected to be present in the CSG resource. H_2S will be removed, if required, during the pre-treatment phase of the gas liquefaction process in order to meet LNG specifications. Therefore H_2S in the gas turbine fuel will be minimised and hence SO_2 emissions will be negligible.

The emission rates of the key species of air pollutants likely to be generated by the LNG facility are summarised in Table 13.5. Detailed emission calculations are presented in Volume 5 Attachment 29.

Table 13.5 Summary of total annual emissions from the LNG facility (normal operations)

Source	Number of units operating	Emission rate (t/yr)			
		NO_X	CO	PM_{10}/ $PM_{2.5}$	THC[1]
Gas turbine compressor drivers	24	2,619	1,597	182	690
Power generation turbines	12[2]	617	761	34	216
Hot oil heaters	4	59	49	5	1
Total annual plant emissions	--	3,295	2,407	221	907

[1] Total hydrocarbons (THC) presented as methane equivalents.

[2] Modelling was based on 12 turbines operating, however Australia Pacific LNG are still finalising the turbine configuration including the potential use of 14 turbines based on manufacturers recommendation.

13.4.2 Standards of emission concentrations

The terms of reference for the Project state that the air quality impact assessment should include a comparison of the predicted level of emissions with the best practice national source emission standards.

In NSW, the Protection of the Environment Operations (Clear Air) Regulation 2002 provides standards of emission concentrations for scheduled premises. The standards for gas turbines and gas-fired boilers (assumed similar to the proposed heaters) are provided in Table 13.6, along with the project standard which has been used in the development of emission rates for the Australia Pacific LNG sources. Plant and equipment that is to be installed at the LNG facility will comply with these standards of concentration.

Table 13.6 Point source emission standards comparison

Air impurity	Applicability	NSW standard of concentration	Project standard[1]
Oxides of nitrogen (as NO_2)	Gas turbines	70mg/Nm^3 (35 ppm)	25ppm
	Heaters/boilers	350mg/Nm^3 (170 ppm)	170ppm
PM_{10}	All combustion equipment	50mg/Nm^3	50mg/Nm^3
CO	All combustion equipment	125mg/Nm^3	125mg/Nm^3
	Firewater pumps	5,880mg/Nm^3	5,880mg/Nm^3
VOC	All combustion equipment	40mg/Nm^3	40mg/Nm^3
	Firewater pumps	1,140mg/Nm^3	1,140mg/Nm^3

[1] Project standards provided by Bechtel for Australia Pacific LNG sources (Bechtel Oil, Gas and Chemicals Inc 2009)

13.4.3 Results of air quality impact assessment

This section presents the results of the air quality impact assessment for nitrogen dioxide (NO_2), particulate matter with an aerodynamic diameter less than ten microns (PM_{10}), $PM_{2.5}$, carbon monoxide (CO), ozone, odour and all identified hydrocarbons for the normal and non-routine operating conditions. Further details of the air quality impacts for the LNG facility are detailed in Volume 5 Attachment 29.

Normal operations – scenario 1

Table 13.7 provides a results summary of predicted air quality impact assessment for NO_2, PM_{10}, $PM_{2.5}$, CO, ozone and odour. Further discussion of each of the potential air quality pollutants is discussed below.

Table 13.7 Predicted maximum concentrations at sensitive receptors for normal operation of the LNG facility

Air impurity	Averaging period	Australia Pacific LNG only (µg/m³)	Background (µg/m³)	Australia Pacific LNG plus background (µg/m³)	Air quality objective (µg/m³)
NO_2	1 hour	12.5	85	85	250
	Annual	0.16	5.9	5.9	62[1] /33[2]
PM_{10}	24 hour	0.9	24	25	50
$PM_{2.5}$	24 hour	0.9	7.3	8.2	25
	Annual	0.02	6.6	6.6	8
CO	8 hour	33.4	125	158	11,000
Ozone	1 hour	13	110	123	210
Odour	1 hour	0.2ou[3]	n/a	0.2ou[3]	1.0ou[3]

[1] Human health and well being
[2] Health and biodiversity of ecosystems
[3] ou = odour unit

Nitrogen dioxide

The assessment of the maximum 1-hour average ground-level concentrations of NO_2 has been made for the 99.9th percentile value.

The results of the modelling indicated that the predicted maximum short-term and long-term concentrations of NO_2 are low and well below the air quality objectives. The concentrations within the region are dominated by existing sources with only a minor contribution due to the addition of the LNG facility.

Figure 13.2 and Figure 13.3 present the predicted maximum 1-hour and annual average ground-level concentrations of NO_2, respectively, for the LNG facility during normal operations operating in isolation.

Figure 13.4 and Figure 13.5 present the predicted maximum 1-hour and annual average ground-level concentrations of NO_2, respectively, for the LNG facility during normal operations operating including existing and approved industries (GAMSv3).

Figure 13.6 and Figure 13.7 present the predicted maximum 1-hour and annual average ground-level concentrations of NO_2, respectively, for the LNG facility during normal operations and including existing and approved industries (GAMSv3) and the other proposed LNG facilities in the Gladstone region.

The plots show that the maximum short-term concentrations due to the plant are predicted to occur on site and on elevated terrain to the north and at Mount Larcom. The highest annual average concentrations are predicted to occur to the northwest of the site due to the dominance of winds from the southeast.

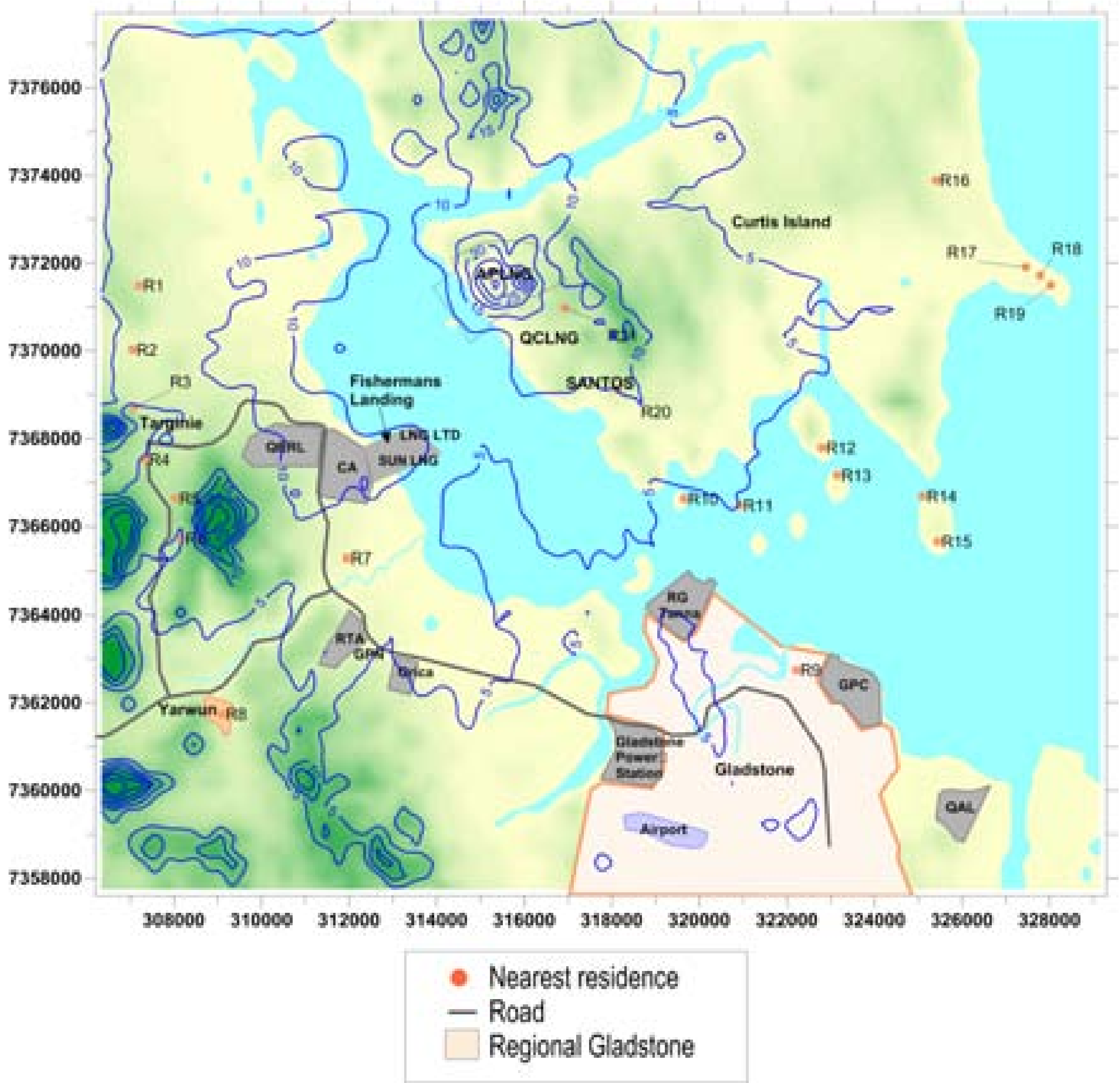

Figure 13.2 Scenario 1 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility during normal operations, in isolation (units = µg/m³)

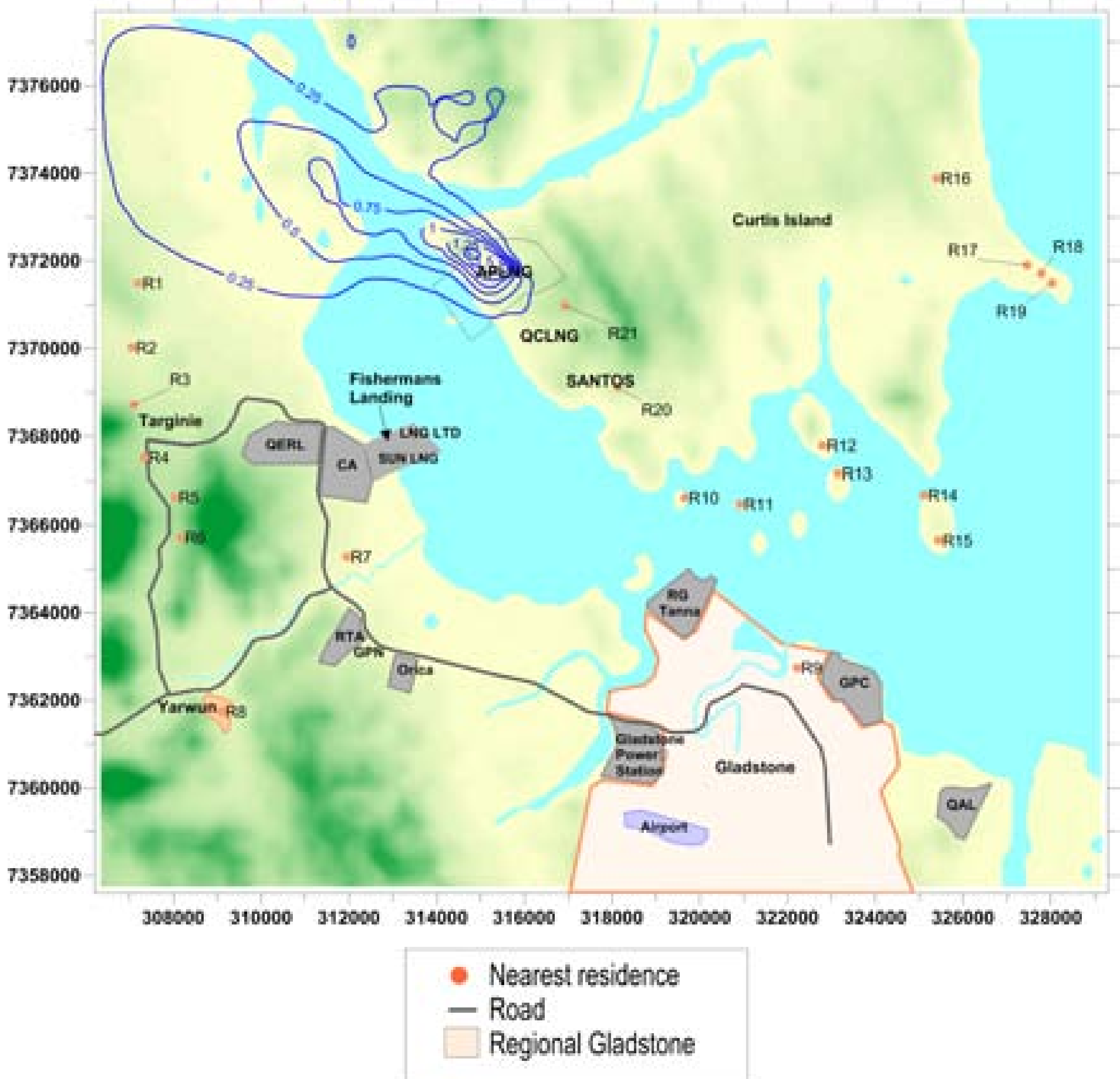

Figure 13.3 Scenario 1 - predicted annual average ground-level concentrations of NO_2 for LNG facility during normal operations, in isolation (units = µg/m³)

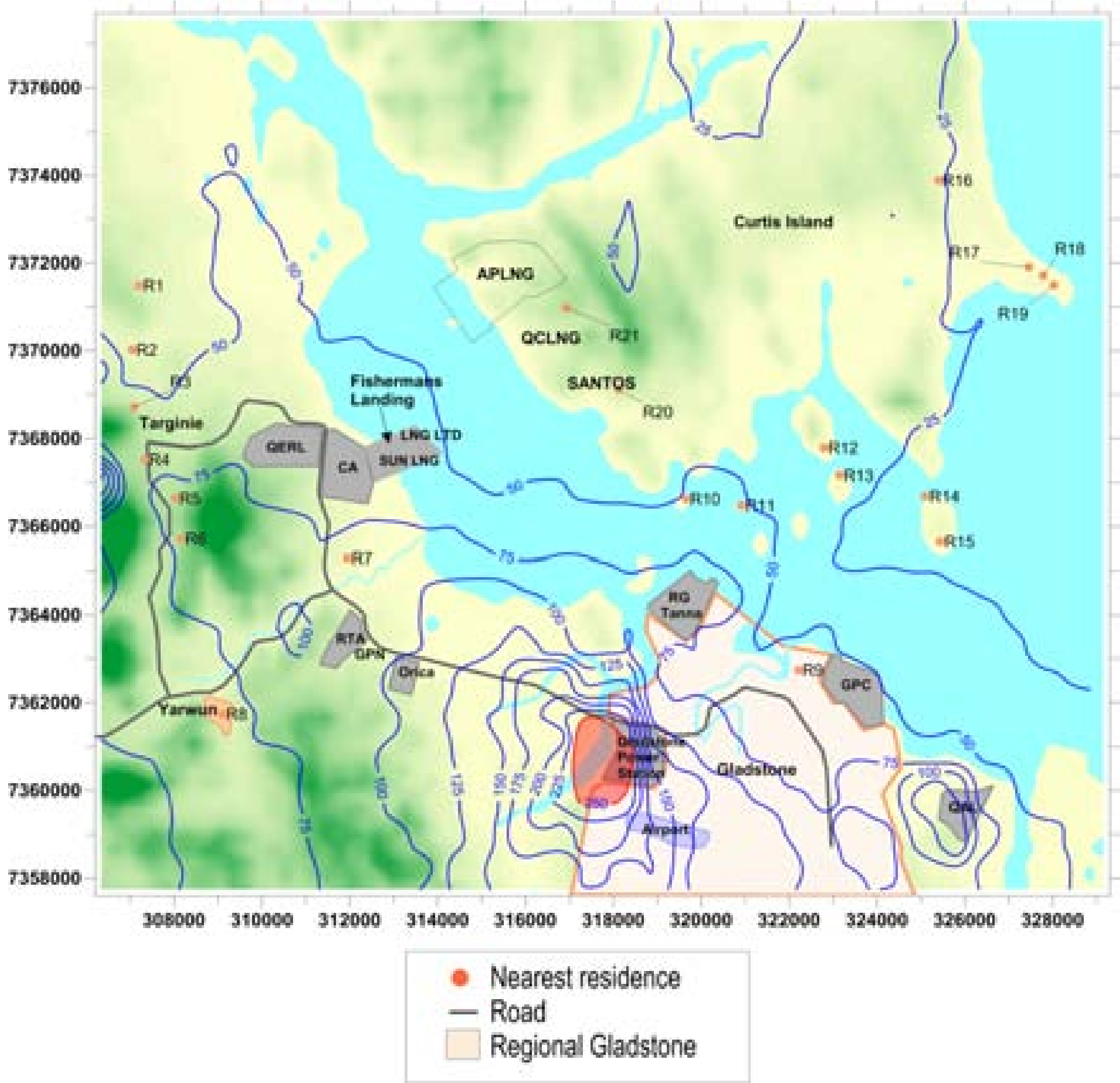

Figure 13.4 Scenario 1 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background (units = µg/m³)

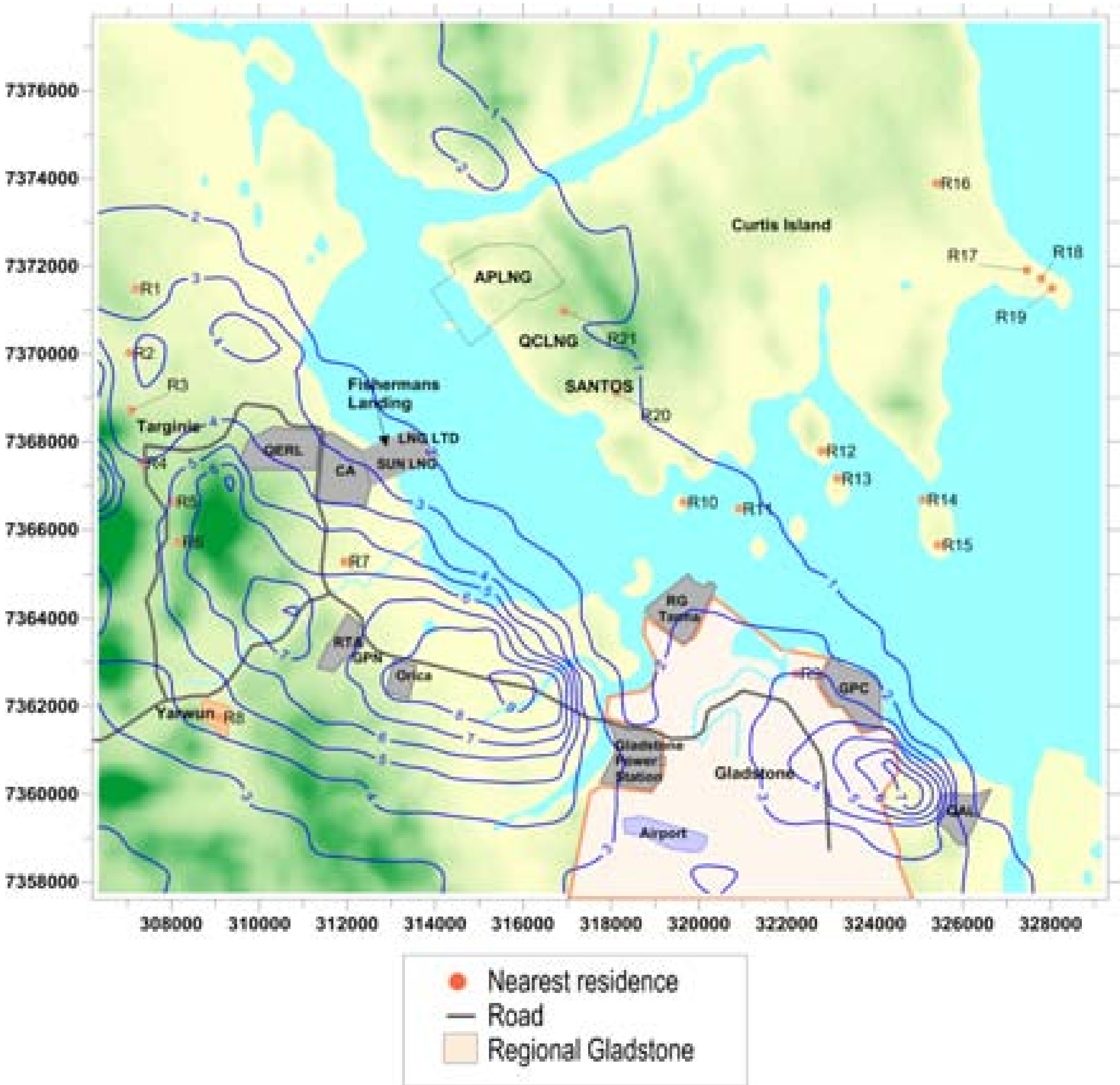

Figure 13.5 Scenario 1 - predicted annual average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background (units = µg/m³)

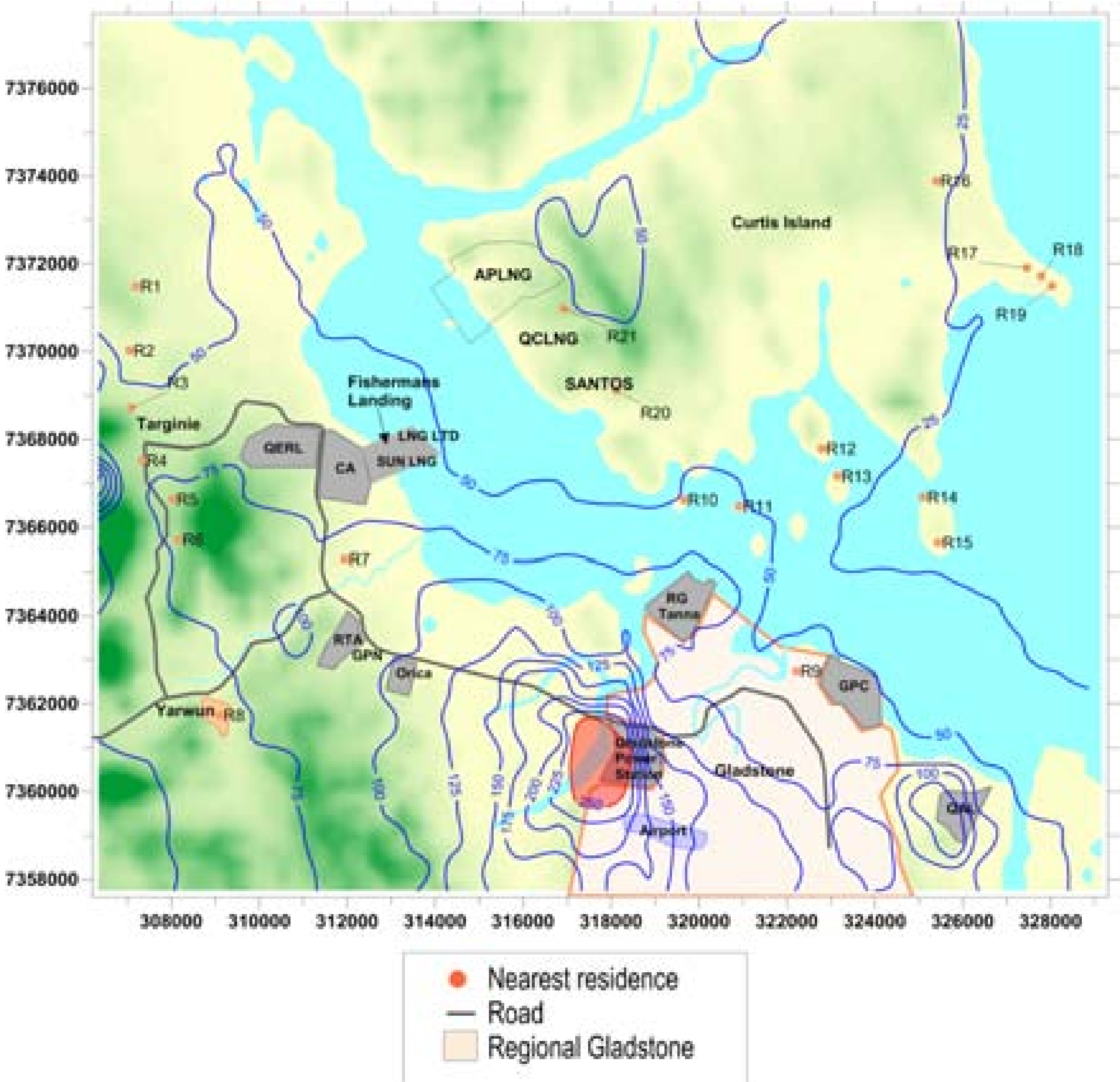

Figure 13.6 Scenario 1 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background plus all other LNG facilities (units = µg/m³)

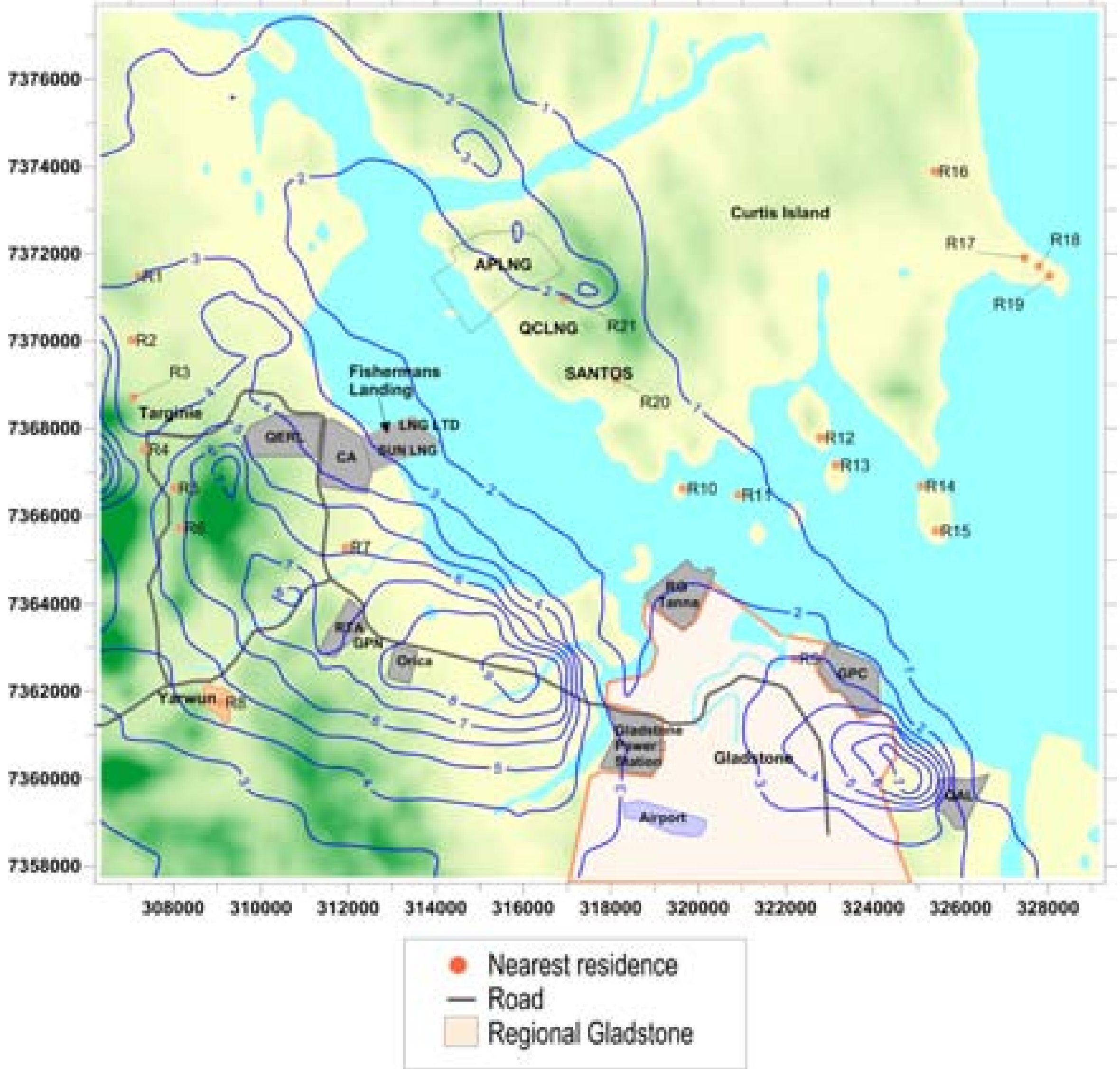

Figure 13.7 Scenario 1 - predicted annual average ground-level concentrations of NO_2 for LNG facility during normal operations, with GAMSv3 background plus all other LNG facilities (units = µg/m³)

Carbon monoxide

The assessment of the maximum 8-hour average ground-level concentrations of CO has been made for the 100th percentile value. Table 13.7 presents a summary of the predicted maximum 8-hour average ground-level concentrations of CO at sensitive receptors, in isolation, and including background. Figure 13.8 presents the predicted maximum 8-hour average ground-level concentrations of CO for the LNG facility during normal operations and including background.

The modelling results indicate that ground-level concentrations due to emissions from the LNG facility are low and well below the air quality objectives. The cumulative impacts are dominated by the background level of CO due to other sources of CO in the region. The combined concentrations are only a few percent of the air quality objective. The contour plot indicates maximum concentrations are predicted to occur on site and on elevated terrain to the north of the site.

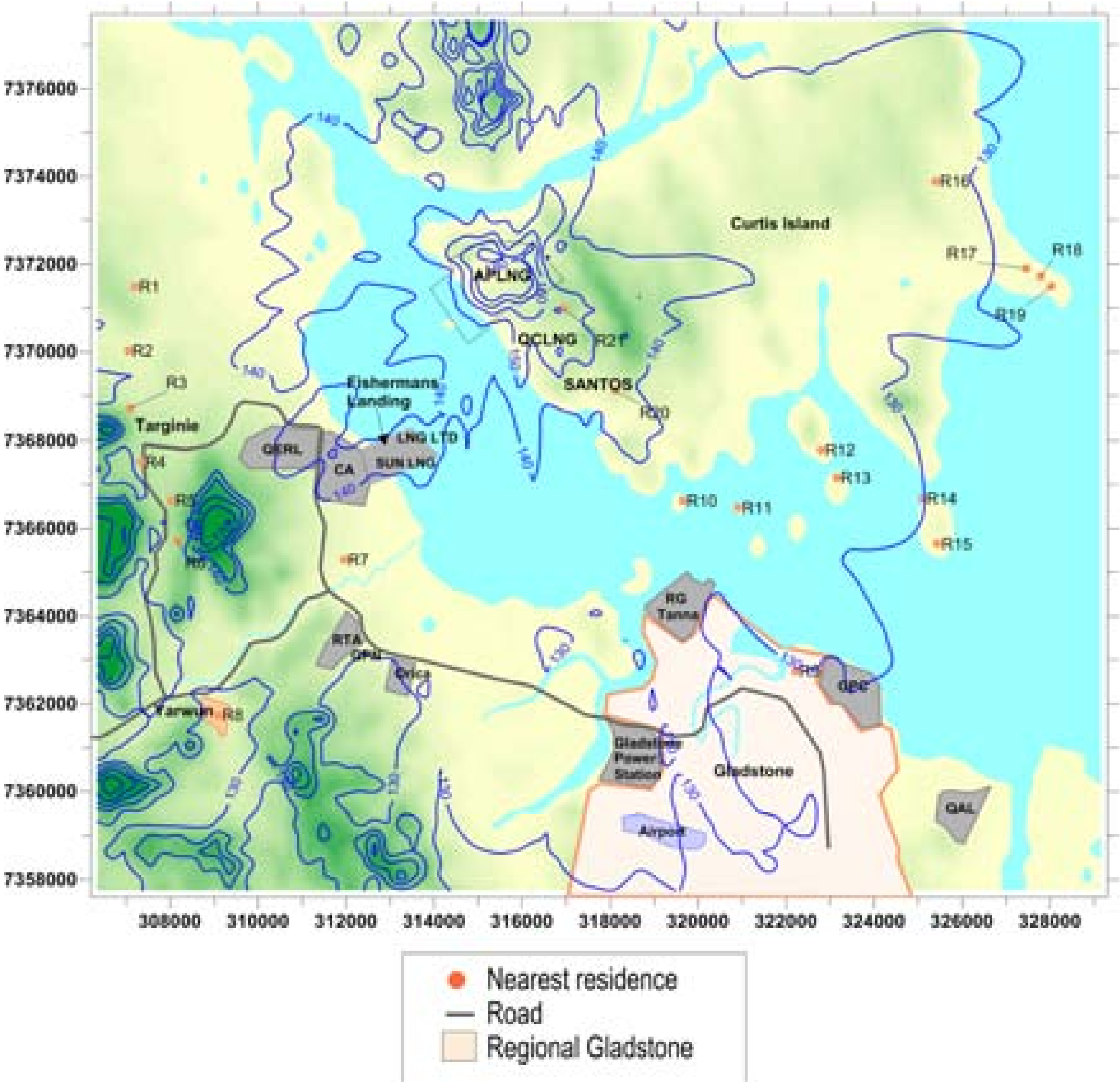

Figure 13.8 Scenario 1 - predicted maximum 8-hour average ground-level concentrations of carbon monoxide for the LNG facility during normal operations, with background (units = µg/m³)

PM_{10} and $PM_{2.5}$

The assessment of ground-level concentrations of PM_{10} and $PM_{2.5}$ has been made for the 100th percentile value. Table 13.7. shows the summarised results for PM_{10} and $PM_{2.5}$ at sensitive receptors.

The modelling results indicate that the ground-level concentrations of PM_{10} and $PM_{2.5}$ due to the emissions from the LNG facility in isolation are low and well below the air quality objectives. The cumulative concentrations are dominated by the background level due to other sources in the region including natural and industrial sources. The combined effect of the facility and background sources is also below the ambient air quality objectives for PM_{10} and $PM_{2.5}$.

Figure 13.9 and Figure 13.10 present the predicted maximum 24-hour average ground-level concentrations of PM_{10} and $PM_{2.5}$ respectively for the LNG facility during normal operations and including background. Annual average concentrations of $PM_{2.5}$ for the LNG facility during normal operations and including background are presented in Figure 13.11.

The contour plots indicate maximum 24-hour average concentrations are predicted to occur close to the site and on elevated terrain to the north of the site. The highest annual average concentrations of $PM_{2.5}$ are predicted to the northwest of the site due to the predominant wind direction.

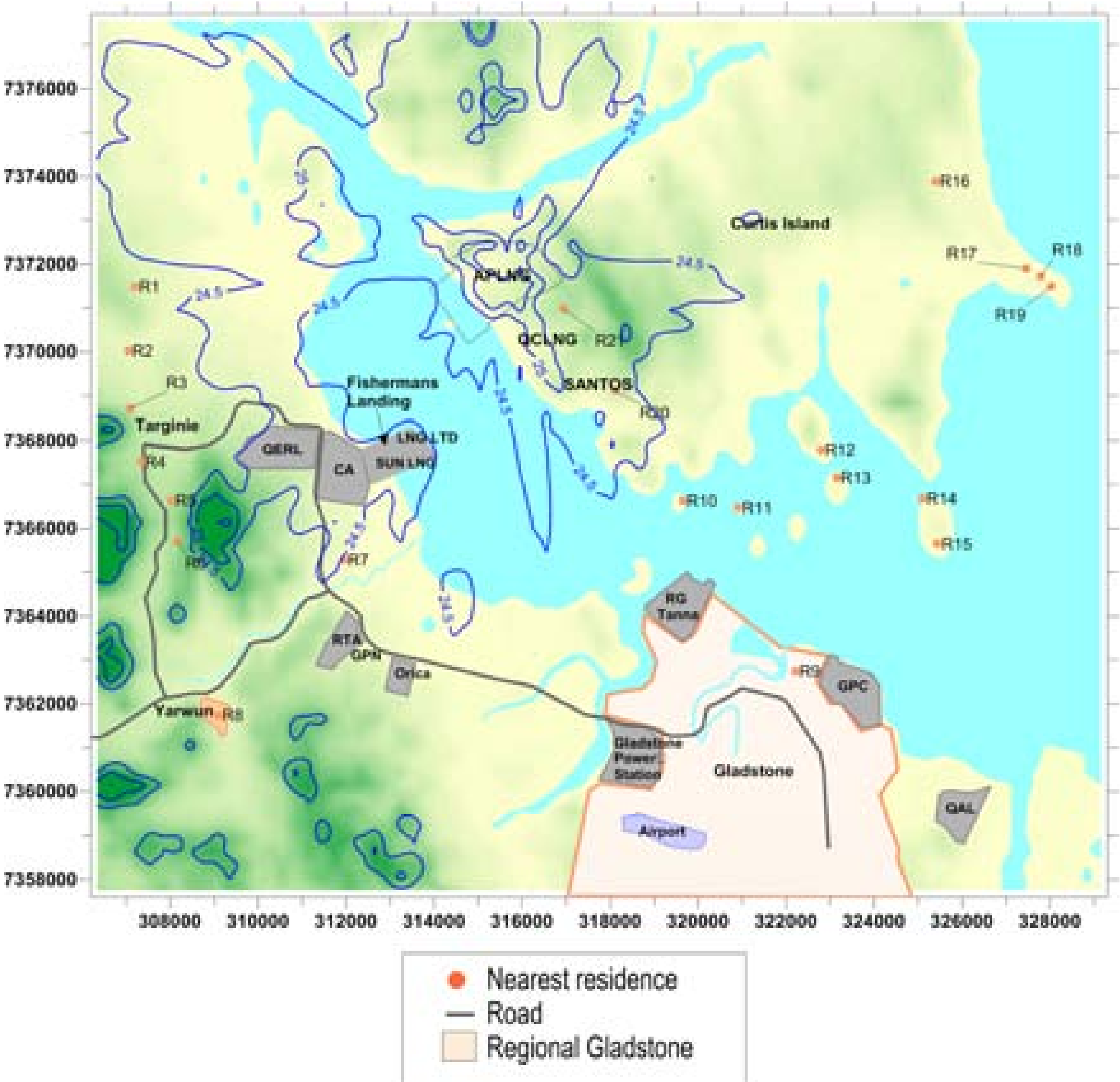

Figure 13.9 Scenario 1 - predicted maximum 24-hour average ground-level concentrations of PM_{10} for LNG facility during normal operations, with background (units = µg/m³)

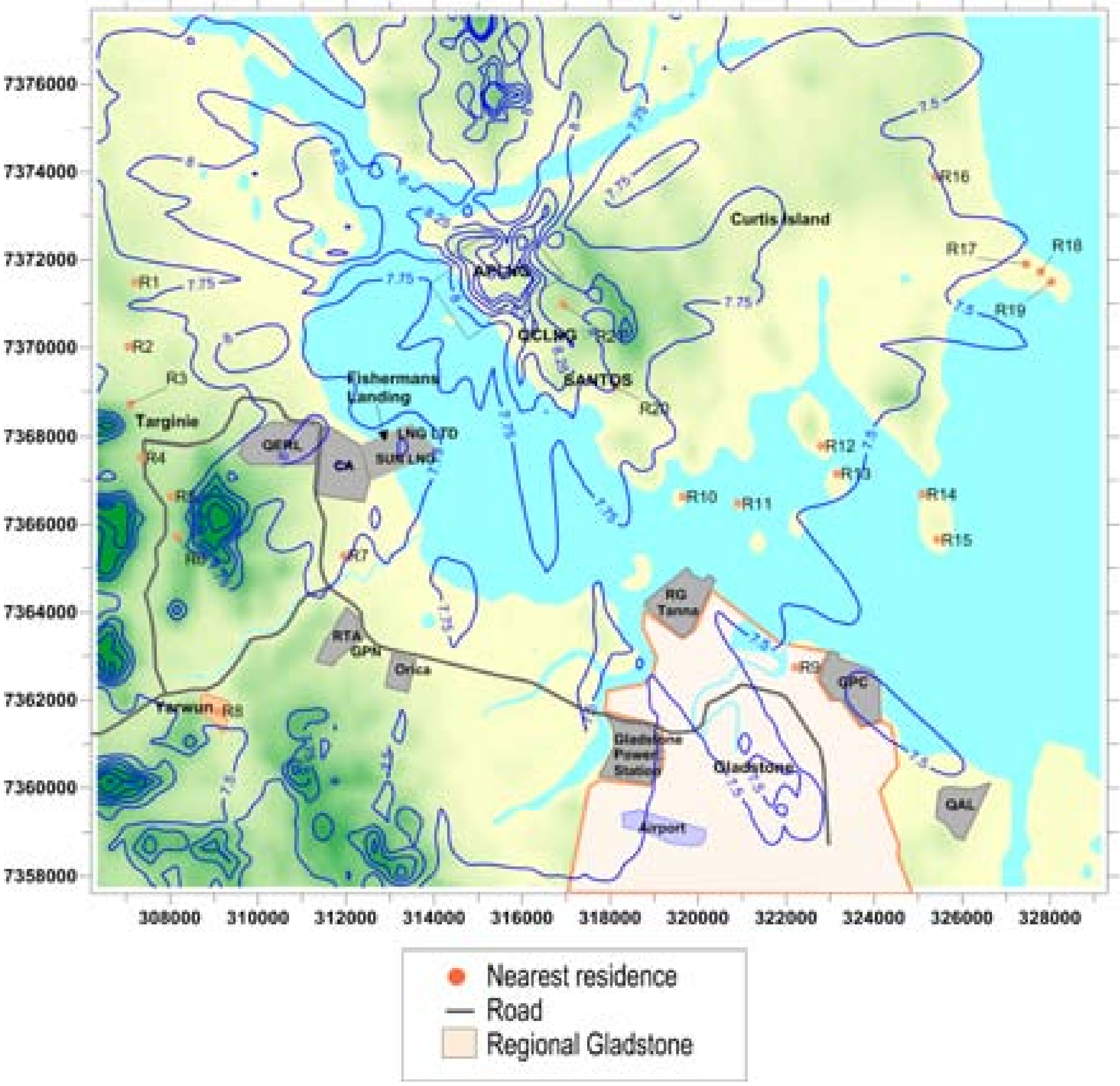

Figure 13.10 Scenario 1 - predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ for LNG facility during normal operations, with background (units = μg/m³)

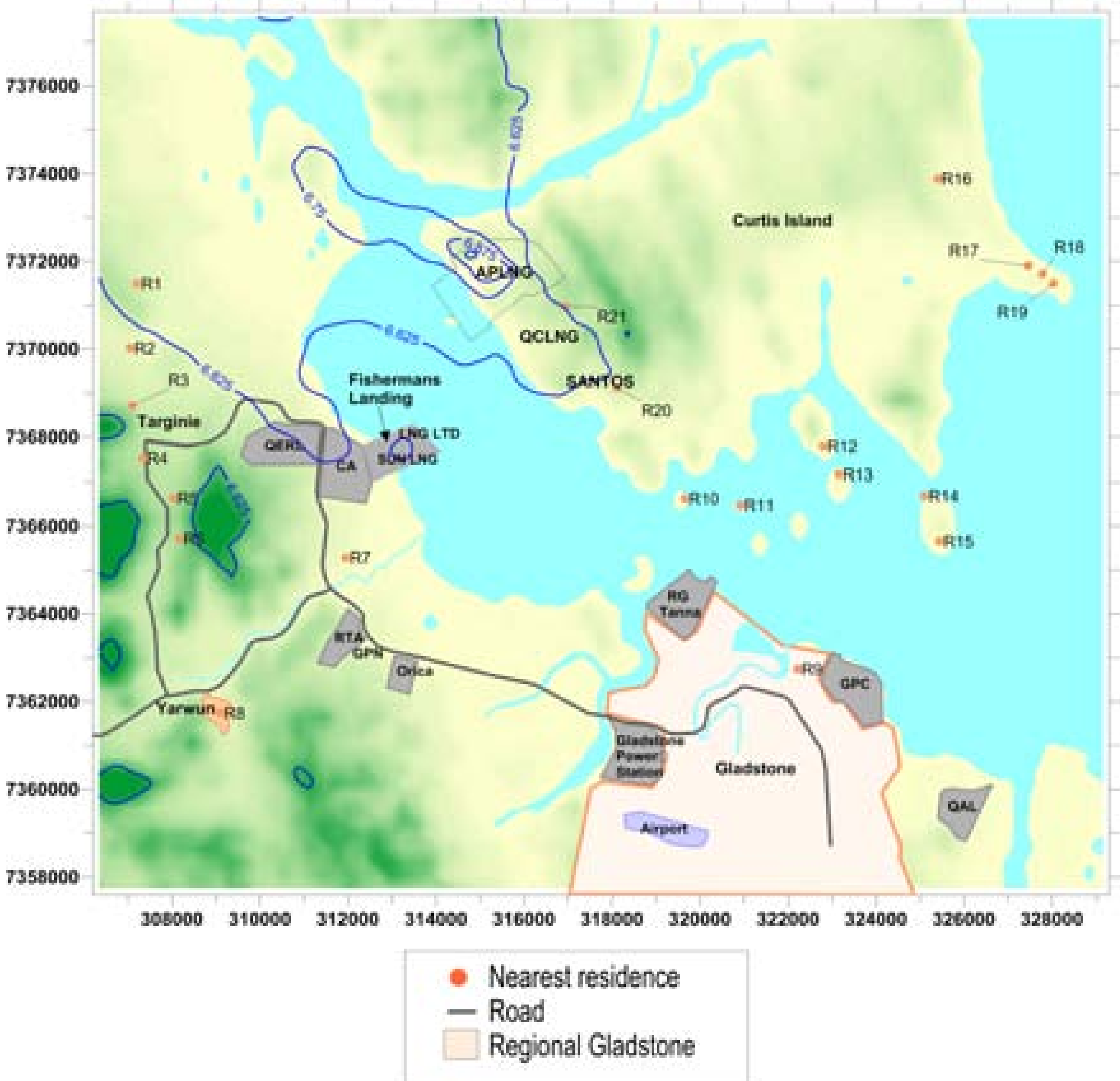

Figure 13.11 Scenario 1 - predicted annual average ground-level concentrations of $PM_{2.5}$ for LNG facility during normal operations, with background (units = µg/m³)

Hydrocarbons

Thirty-four identified hydrocarbon species associated with emissions from the LNG facility were modelled, none were found to exceed the ambient air quality objectives at sensitive receptor locations. The highest predicted ground-level concentration of a hydrocarbon compound at a sensitive receptor relative to its air quality objective is 4.9% for acrolein. The predicted concentrations (which are extremely conservative because CSG is such a lean gas) at sensitive receptors are considerably below the air quality objectives.

Photochemical smog

The assessment of photochemical smog impacts has been conducted assuming 100% conversion of NO_2 to ozone. This is an extremely conservative assumption. The current atmospheric environment in Gladstone receives very low ozone levels with only a few hours per year receiving levels slightly above background concentrations.

The peak predicted contribution of the proposed LNG facility to levels of NO_2 at a sensitive receptor is 12.5µg/m^3. Consequently, the predicted maximum incremental increase of ozone at this location is estimated to be 13µg/m^3. This is an extremely conservative assumption as the most affected sensitive receptor, for which this assessment is made, is situated approximately two kilometres to the southeast of the LNG facility. Ozone is a secondary air pollutant that transforms via several photochemically catalysed reactions of oxides of nitrogen (NO_X) and other volatile organic compounds over time during plume transport, with concentrations peaking approximately 10-15km downwind. Consequently, an assessment of the potential for ozone transformation at the most affected receptor, in close proximity to the LNG facility provides a worst case estimate.

Adding the maximum contribution due to the proposed LNG facility at the most affected sensitive receptor to the maximum ozone concentration recorded at the Targinie monitoring station of 110µg/m^3 results in a maximum ozone concentration of 123µg/m^3, which is less than 60% of the ambient air quality objective of 210µg/m^3 for a 1-hour average. Therefore, the contribution of the proposed LNG facility to regional photochemical activity is at worst, minor and unlikely to be of any cause for concern or require further assessment.

Odour

A qualitative assessment of the potential for odour impacts has been conducted based on odour thresholds of individual compounds. The assessment was based on the predicted maximum ground-level concentration at the most affected sensitive receptor. Pollutants considered were NO_2 and odorous hydrocarbons with a maximum ground-level concentration of greater than one percent of their air quality objective.

By definition, one odour unit (1ou) is equivalent to the odour threshold of a substance or a mixture of substances. Consequently, the DERM odour guideline (EPA 2004) of 1ou (for a tall wake free stack) is equivalent to the substance's odour threshold. Therefore, if the predicted ambient concentration of the substance is below the substance's odour threshold, it is unlikely that the odour associated with the substance will be detected. This assessment does not account for any synergistic effects that may alter the odour character or odour threshold of the substance, and does not account for the concentrations of the compounds in the gas mixture at the 1ou odour concentration level. Predicted ground-level odour concentrations for identified pollutants are summarised in Table 13.7. Note that the assessment has been made against the maximum percentile, while the odour guideline is for a 99.5th percentile. This will give a conservative assessment.

The modelling results indicate that the potential levels of odour due to emissions from the LNG facility are very low and well below the DERM odour guideline of 1ou.

Non-routine operations - scenario 2

This section present the results for the non-routine operations of the LNG facility and the release from the flares, during plant upset or emergency conditions. As this is a short-term operating scenario annual averages have not been included. It should also be noted that particulate emissions are not expected from the flares.

Table 13.8 provides a summary of predicted air quality impact assessment for NO_2 and CO, the key air quality contaminates from the non-routine scenario. This is discussed below.

Table 13.8 Predicted maximum concentrations at sensitive receptors for non-routine operation of the LNG facility

Air impurity	Averaging period	Australia Pacific LNG only (µg/m³)	Background (µg/m³)	Australia Pacific LNG plus background (µg/m³)	Air quality objective (µg/m³)
NO_2	1 hour	18.4	85	85	250
CO	8 hour	372	125	497	11,000

Nitrogen dioxide

The assessment of the maximum 1-hour average ground-level concentrations of NO_2 for the LNG facility flare has been made for the 99.9th percentile. Figure 13.12 presents the contours for the LNG facility flares in isolation. Figure 13.13 presents the contours for the LNG facility flares with the addition of background sources (GAMSv3) and all other proposed LNG facilities in Gladstone.

Table 13.8 provides a summary of the maximum 1-hour and annual averages for the non-routine operation.

The modelling indicates that the predicted maximum concentrations of NO_2 are low and well below the air quality objectives. The maximum concentrations within the region are dominated by existing sources with only a minor contribution due to the addition of the LNG facility flares.

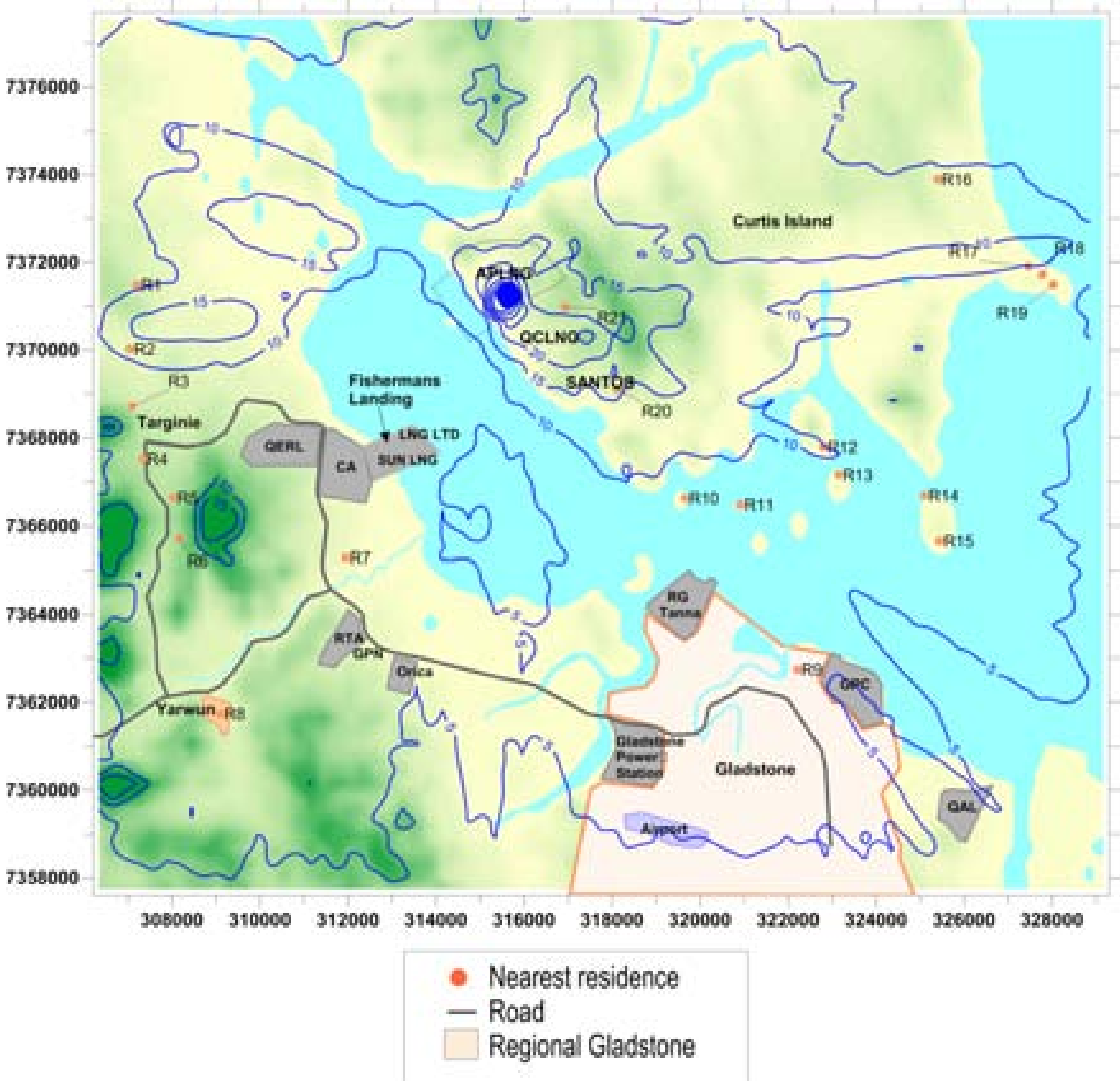

Figure 13.12 Scenario 2 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility flares, in isolation (units = µg/m³)

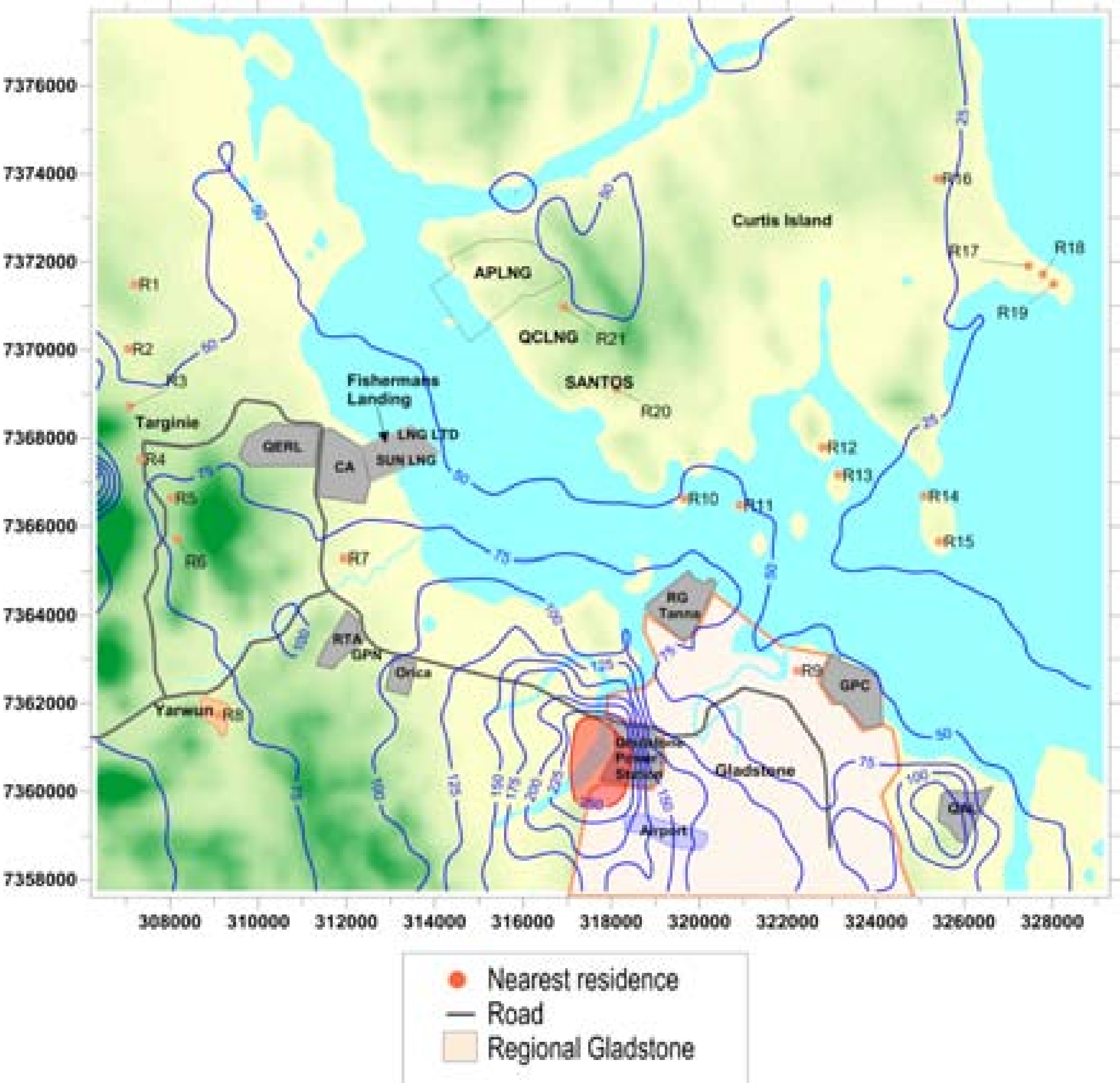

Figure 13.13 Scenario 2 - predicted maximum 1-hour average ground-level concentrations of NO_2 for LNG facility flares, with GAMSv3 background plus all other LNG facilities (units = µg/m³)

Carbon monoxide

The assessment of the maximum 8-hour average ground-level concentrations of CO for the flares has been made for the 100th percentile. Contours are presented for the LNG facility flares with the addition of a background concentration (Figure 13.14). The results are summarised in Table 13.8.

The modelling indicates that the predicted maximum concentrations of CO are low and well below the air quality objectives. The maximum concentrations are predicted approximately 3km to the southeast of the LNG facility.

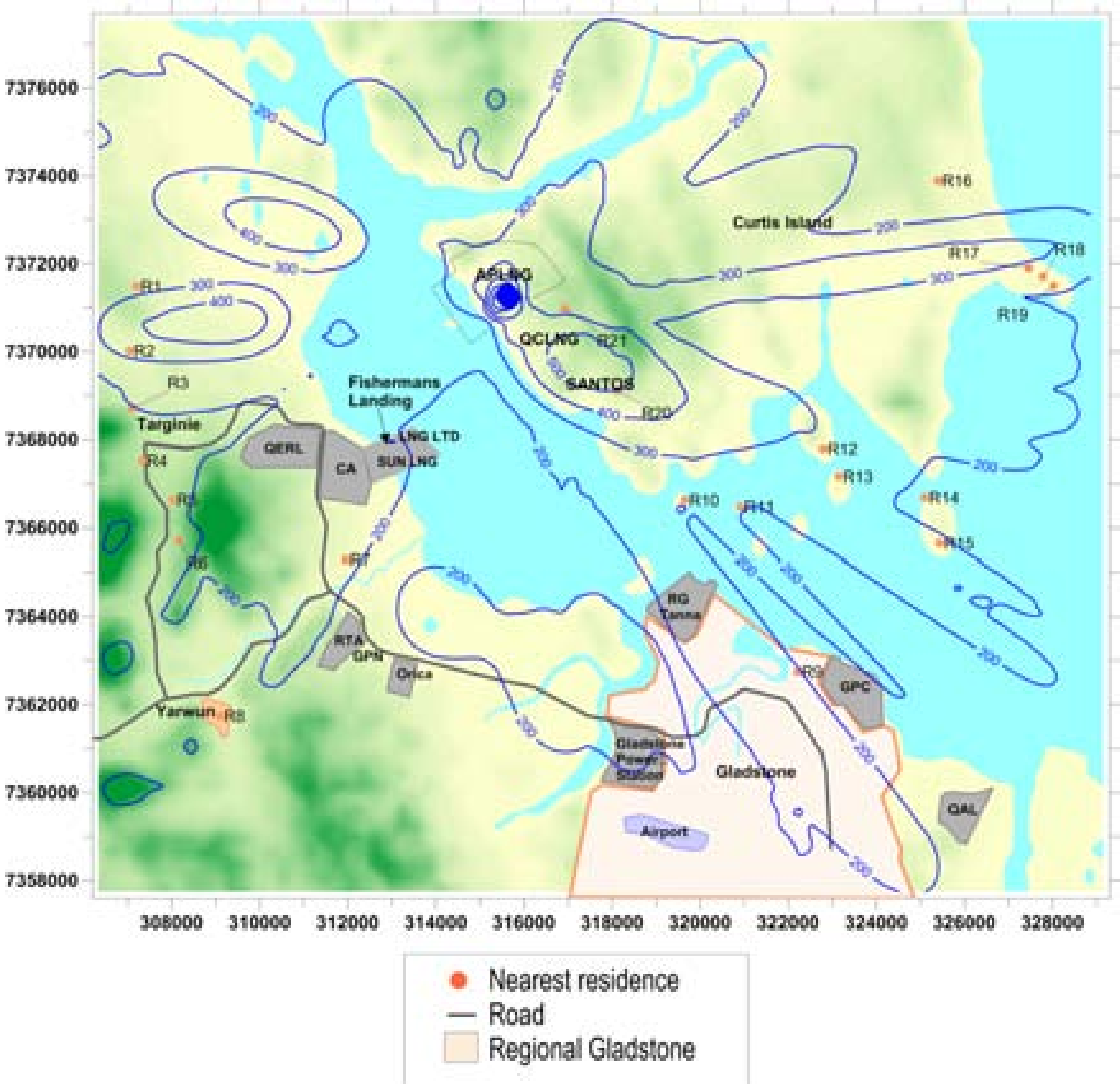

Figure 13.14 Scenario 2 - predicted maximum 8-hour average ground-level concentrations of carbon monoxide for the LNG facility flares with background (units = µg/m³)

Shipping

The modelling of the potential emissions due to shipping associated with the LNG facility indicates the impacts are minimal and well below the air quality objectives at all sensitive receptors. Table 13.9 presents the results for the normal operations of the facility plus the potential emissions associated with shipping (LNG carriers and tug boats at dock). As this is a short term operating scenario, long term averages have not been included.

Table 13.9 Predicted maximum 1-hour average ground-level concentrations of NO_2 and sulphur dioxides for LNG facility including shipping

	Air impurity	
	NO_2 (µg/m³)	SO_2 (µg/m³)
Maximum 1-hour average (location R4)	24.6	18.7
Air quality objective	250	570

13.4.4 Air quality assessment summary

The assessment of potential effects on air quality associated with emissions from the LNG facility has been carried out using atmospheric dispersion modelling. The following conclusions can be drawn from the assessment:

- Mass emission rates of priority pollutants from the Australia Pacific LNG facility are between 0-9% compared with the total load from all industrial sources located within the air shed.
- Ground-level concentrations of all air pollutants associated with the LNG facility are well below the air quality objectives at all sensitive receptors. The closest sensitive receptors identified and assessed are the QCLNG and Santos LNG facilities. The closest residential receptor is located on isolated islands in Port Curtis, approximately 6km to the southeast.
- Based on the cumulative impact assessment undertaken, ground-level concentrations of all air pollutants associated with the LNG facility, with existing and approved industries (using GAMSv3) and all proposed LNG facilities, are predicted to be below the air quality objectives at all sensitive receptors.
- Nitrogen dioxide was found to be the most important air pollutant. Ground-level concentrations of nitrogen dioxide due to the LNG facility are predicted to be below the air quality objectives during normal operations accounting for existing sources of nitrogen dioxide in the region and other LNG facilities proposed for the region. The incremental increase in nitrogen dioxide is at most 5% of the air quality objective for nitrogen dioxide.
- For all pollutants the contribution to the regional air quality is dominated by existing sources, which includes industrial, anthropogenic and natural sources.
- The modelling results indicate that, of the 34 identified hydrocarbon species potentially associated with emissions from the LNG facility, none were found to exceed the ambient air quality objectives at sensitive receptor locations. The highest predicted ground-level concentration of a hydrocarbon compound at a sensitive receptor relative to its air quality objective less than 5%.
- The modelling of the potential emissions due to shipping associated with the LNG facility indicates the impacts are minimal and well below the air quality objectives at all sensitive receptors. Maximum increment of NO_2 and SO_2 of less than 10% and 4% of air quality objective respectively at sensitive receptors for shipping plus normal operation of the plant.

13.5 Aviation safety vertical plume velocity results

An assessment of the vertical velocities associated with stack exhaust plumes at the proposed LNG facility was carried out, based on the guidelines for aviation safety published by the CASA in Guidelines for conducting plume rise assessments (CASA 2004).

The aim of the assessment was to investigate the vertical and horizontal extent of the plume from various sources at the facility, and to estimate the height and downwind distance at which the average vertical plume velocities diminish to the critical value of 4.3m/s. The Gladstone Airport Development Plan (Sullivan, 2008) describes a PANS-OPS (surface above which planes can fly) over the LNG facility of 400m above ground.

The frequencies with which the plume exhaust velocities under normal and non-routine operating conditions achieve or exceed the PANS-OPS above the facility have been assessed. A cumulative assessment of the potential enhancement of vertical velocities due to merging of plumes has been taken into consideration for the LNG facility emission sources. However, the separation distance between the LNG facility and other proposed developments located on Curtis Island is sufficient to neglect the need for a cumulative assessment of all plumes as they will not overlap to results in an enhancement of the plume vertical velocities.

In relation to aviation safety, during normal plant operations the following conclusions can be drawn from the assessment:

- There is a potential for the average plume vertical velocity to exceed 4.3m/s up to a maximum height of approximately 850m above ground level at a maximum downwind distance of approximately 166m. The maximum height is dominated by the merged plume from the gas turbine compressors
- The merged plume from the gas turbine compressors is likely to cause the vertical velocity to be greater than 4.3m/s at and above the PANS-OPS (400m) for approximately 28 hours per year or 0.32% of the time
- Of all the plumes considered for normal operations, the highest critical height for the 0.1 percentile is approximately 550m above ground level (merged gas turbine compressors).

During non-routine LNG facility operations an upset event such as flaring may occur. The following conclusions can be drawn from the conservative assessment:

- Each LNG production train will have a planned shutdown scheduled to occur several years apart with associated maintenance and start-up flaring.
- A plume from the marine stack flare would have a vertical velocity greater than 4.3m/s above the height of the PANS-OPS (400m) for approximately 28 hours per year or 0.38% of the time, when assumed operation for every hour of the year.
- The wet or dry gas ground flare, which will typically operate if emergency depressurisation of the plant is required is likely to generate a plume with vertical velocities above 4.3m/s well above the PANS-OPS under all conditions.
- An emergency release from the wet or dry gas ground flare is predicted to have a very low frequency of occurrence, with duration of approximately 20 minutes while the plant depressurises, but can potentially occur at any time. Under depressurisation, the ground flare is likely to exceed the PANS-OPS above the site to a considerable vertical distance.

- During commissioning of each train the dry and wet gas flares will be used. The emissions for the flares during commissioning will be less than the worst cases modelled for the non-routine operation scenario, and therefore have not been assessed.

Flaring configuration investigations and optimisation are continuing during the design phase which may incorporate the marine flare within the ground flare enclosure.

Discussions between Australia Pacific LNG, Gladstone Regional Council airport services and CASA will be required to determine an appropriate course of action to manage any potential impacts to aviation safety.

13.6 Mitigation and management

Mitigation measures to reduce potential emissions during construction of the LNG facility include:

- Develop and implement an environmental management plan to include measures to minimise emissions of dust.

Mitigation measures to reduce potential emissions during operation of the LNG facility include:

- Use of CSG as the fuel source where practicable, in preference to liquid or solid fuels
- Use of power generators equipped with dry low NOx technology, and aero-derivative gas turbine drivers equipped with dry low emission (DLE) technology
- Use of waste heat recovery to supply process heat
- Capture and re-liquefaction of excess gas generated during ship loading in the LNG process rather than being flaring
- Use of closed loop sampling systems to minimise fugitive emissions
- Implement a preventative maintenance program aimed at ensuring equipment is operating efficiently to minimise emissions to the atmosphere
- Implement a stack monitoring program
- Provide easily accessible stack points in equipment as appropriate to enable emissions to be determined.

Emissions during decommissioning activities such as the generation of dust from vehicle movements and earthworks will be similar to the construction phase and will be addressed in the decommissioning phase of the environmental management plan which will be developed closer to the time of decommissioning.

Mitigation measures to minimise impacts to aviation safety during normal and non-routine operation of the LNG facility include:

- Provide a ground flare instead of an elevated flare for the main vapour relief system
- Continue investigation of incorporating marine flare in the ground flare enclosure
- Implement a preventative maintenance program aimed at ensuring equipment is operating efficiently to minimise the need for flaring
- Consult with CASA and Gladstone Regional Council airport services to determine an appropriate course of action to manage any potential impact to aviation safety.

13.7 Conclusions

13.7.1 Assessment outcomes

This chapter was undertaken to identify potential impacts of the LNG facility in terms of the air quality impacts on the Gladstone airshed and develop mitigation measures in accordance with the Australia Pacific LNG sustainability principles.

Table 13.10 summarises the key potential risks, the mitigation actions to reduce the impact of the risk, and the residual risk. The residual risk is categorised as either negligible, low, medium, high, or very high. A full description of the risk assessment methodology is given in Volume 1 Chapter 4.

Table 13.10 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental values	Sustainability principles	Potential impact	Possible cause(s)	Mitigation and management measures	Residual risk level
To protect the health and biodiversity of ecosystems Human health and wellbeing To protect the aesthetics of the environment, including the appearance of buildings structures and other property To protect agricultural use of the environment.	Minimising adverse environmental impacts and enhancing environmental benefits associated with Australia Pacific LNG's activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in its operational areas Identifying, assessing, managing, monitoring and reviewing risks to Australia Pacific LNG's workforce, its property, the environment and the communities affected by its activities	LNG facility emissions exceeding air quality objectives for normal and non-routine LNG facility operations causing impacts to sensitive receptors and onsite workers	Operation of the LNG facility, particularly operation of the gas turbines to drive compressors, gas turbines for power generation, hot oil heaters, dry gas flare (maintenance or upset conditions) and wet gas flare (maintenance or upset conditions)	Use CSG as the fuel source where practicable Use power generators equipped with dry low NOx technology, and aero-derivative gas turbine drivers equipped with DLE technology Use waste heat recovery to supply process heat Capture and re-liquefaction of excess gas generated during ship loading in the LNG process Implement preventative maintenance program Implement a stack monitoring program	Low
		Plumes impacts to aviation safety	Operation of the LNG facility, particularly merged plumes from normal and non-routine operations	Consultation with CASA and Gladstone Regional Council airport services to determine an appropriate course of action to manage any potential impact to aviation safety Continue investigation of incorporating marine flare in the ground flare enclosure	Medium

Environmental values	Sustainability principles	Potential impact	Possible cause(s)	Mitigation and management measures	Residual risk level
		LNG facility construction causing impacts to sensitive receptors and onsite workers	Construction of the LNG facility, particularly dust generated by earthworks and vehicle movements and exhaust emissions such as NO_X, CO and hydrocarbons	Develop and implement a environmental management plan to include measures to minimise emissions of dust	Low

13.7.2 Commitments

Australia Pacific LNG will:

- Ensure emissions of pollutants to the atmosphere are minimised and air quality objectives are met
- Develop and implement a stack monitoring program to ensure that the air quality objectives and emission standards are achieved.

References

Bechtel Oil, Gas and Chemicals Inc 2009, *Australian Pacific LNG Project – Emissions, Discharge and Disposal Plan*, report prepared for Australia Pacific LNG, 28 September 2009.

Civil Aviation Safety Authority (CASA) 2004, *Guidelines for Conducting Plume Rise Assessments, AC139-05(0), June 2004,* viewed October 2009, <http://casa.gov.au/rules/1998casr/139/139c05.pdf>

Environmental Protection Agency, 2004 *Guideline – Odour Impact Assessment from Developments,* Ecoaccess: environmental licences and permits, viewed October 2009, <http://www.derm.qld.gov.au/register/p01344aa.pdf>

Queensland Health 2009, *Clean and Healthy Air for Gladstone Project – Interim Human Health Risk Assessment Report, October 2009*, viewed November 2009, <http://www.derm.qld.gov.au/register/p03078aa.pdf>