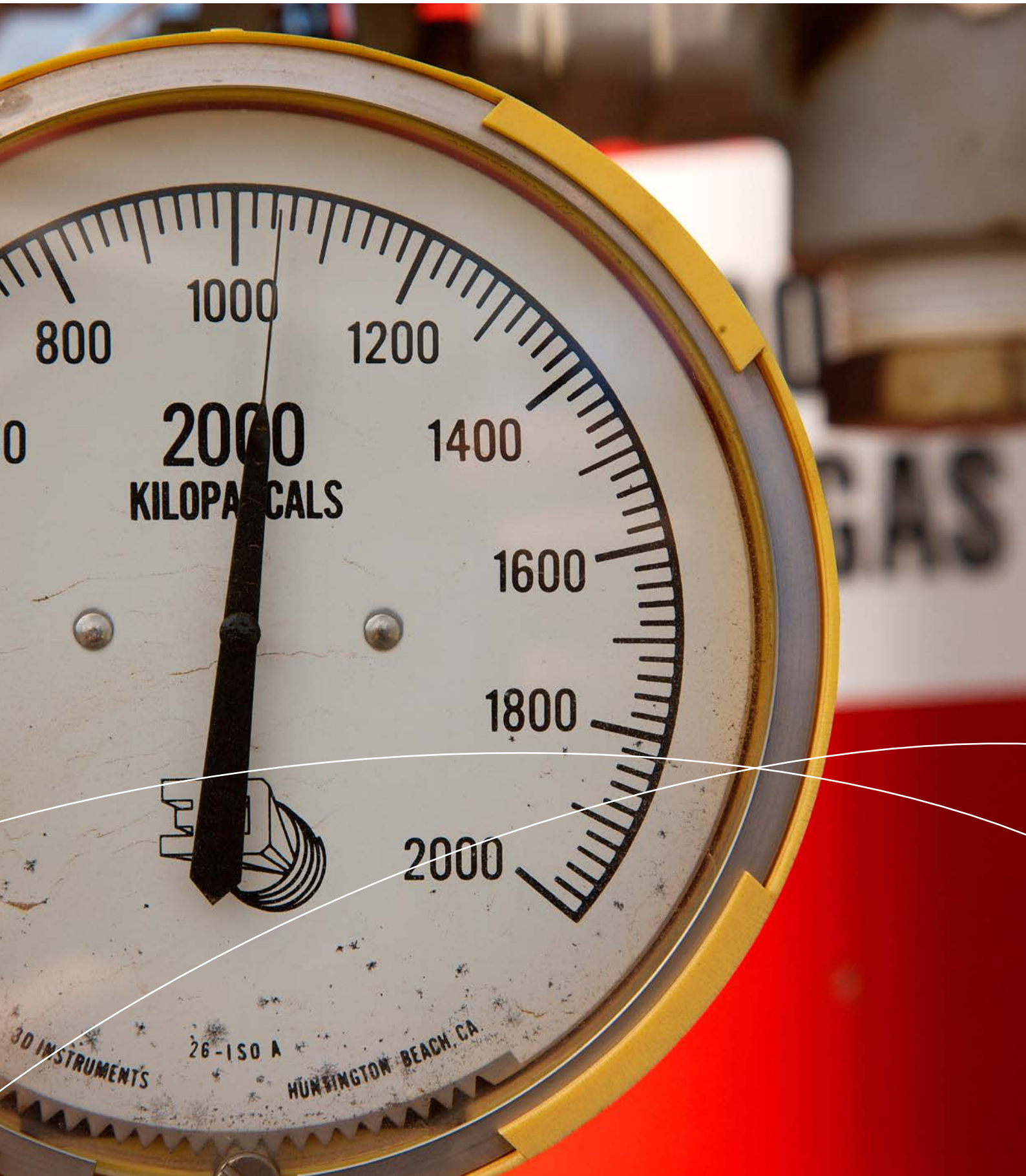
Air quality 15

Enter ▶ Go back to contents ▶



Contents

Tables

Figures

15 Air quality

15.1 Introduction

This section describes the existing air environment of the GFD Project area and surrounding regional area.

The region is predominantly rural with populations residing in regional townships connected by sealed highways or isolated rural homesteads connected by sealed or unsealed rural roads. The air environment is influenced by dust from traffic on unsealed roads, wind erosion of bare soils from agricultural and resources activities and dust storms, and air emissions from industrial activities such as power generation, quarries and resources projects. It is a subtropical region characterised by hot summer months with some rainfall, and cold dry winters.

The potential impacts arising from the GFD Project activities on air quality are described, mitigation measures identified and a framework for further assessment outlined. Detail of this assessment is provided in Appendix P: Air quality. Greenhouse gas emissions are covered in Section 16: Greenhouse gases.

This section has been prepared in accordance with section 4.10 of the Terms of reference for an EIS issued March 2013. The index to locate where each ToR requirement is met within this EIS is included in Appendix B: Terms of reference cross-reference.

15.2 Regulatory context

This EIS has been prepared in accordance with the State and Commonwealth legislative context as provided within Appendix C: Regulatory framework. The legislation, policies and guidelines that apply to air quality are outlined within Table 15-1.

Table 15-1 Regulatory context – air quality

Legislation, policy or guidance	Relevance to the GFD Project
National Environment Protection Measure (Cth) (NEPM) NEPMs are a special set of national objectives designed to assist in protecting or managing particular aspects of the environment such as air and water quality, the protection of amenity from noise, site contamination, hazardous wastes and the reuse and recycling of materials.	The NEPM for Ambient Air Quality (Air NEPM) and the NEPM for Air Toxics (Air Toxics NEPM) set ambient air quality standards and goals in Australia for a select number of pollutants. These standards have been adopted in Queensland in the *Environmental Protection (Air) Policy 2008*. The National Pollutant Inventory (NPI) NEPM requires Australian facilities (that meet specific thresholds with regard to fuel and chemical use) to report annually on their emissions to air, water and land (including transfers) of a prescribed list of substances. These emissions are then published on the internet in a searchable database as a means of providing the community and other stakeholders with information on emissions from industrial, commercial, residential and transport-related activities across Australia.

Legislation, policy or guidance	Relevance to the GFD Project
Environmental Protection (Air) Policy 2008 (Qld) (EPP Air) EPP Air intends to protect the qualities of the air environment that are conducive to human and ecosystem health, the appearance of natural and developed structures and agricultural use of the environment. The policy provides a framework for making consistent and informed decisions about the air environment, including indicators and objectives.	To the extent that it is reasonable to do so, air emissions must be dealt with in the following order of preference: • Avoid (e.g. using technology that avoids air emissions) • Recycle (e.g. reusing in another industrial process) • Minimise (e.g. treating air emissions before disposal) • Manage (e.g. locating a thing that releases air emissions in a suitable area to minimise the impact of the air emissions). A review of the extent to which GFD Project mitigation measures reflect the management hierarchy is presented in Table 14 of Appendix P: Air quality. Schedule 1 of the EPP Air prescribes air quality objectives to be complied with for the pollutants of concern in this assessment.
Protection of the Environment Operations (Clean Air) Regulations 2010 (NSW) This regulation controls emissions from wood heaters, open burning, motor vehicles and fuels and industry.	There are no source emission standards set in Queensland, instead the Queensland Department of Environment and Heritage Protection (EHP) refers to the guidance on in-stack emission limits specified in the *Protection of the Environment Operations (Clean Air) Regulations 2010*. This assessment applies the relevant limits set for NO_X and CO emissions from new plant under Schedule 4 'Standards of concentration for scheduled premises: general activities and plant' to assess compliance.
Emission estimation technique manual for oil and gas extraction and production (Department of the Environment, Water, Heritage and the Arts, 2010) This manual describes the recommended approaches to estimating emissions and transfers from the oil and gas industry for reporting to the NPI.	The NPI emission estimation technique (EET) manual provides guidance to assist in the estimation and reporting of emissions and transfers of NPI substances to the NPI. Emissions and transfers from gas field development and normal operational activities are reportable to the NPI if the relevant reporting thresholds for NPI substances are exceeded.

This EIS seeks to obtain primary approvals for the project including the Queensland Government Coordinator-Generals Report and Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Cth) approval.

Application for or amendments to existing environmental authorities will occur subsequent to this EIS process. Other subsequent approvals required after the EIS process has been completed, corresponding triggers and legislative frameworks applicable to the GFD Project are identified in Section 2: Project approvals.

Approval of this EIS will trigger a number of subsequent approvals required for the GFD Project to proceed. Approvals will be required on tenure and off-tenure. Section 2: Project approvals summarises the key approvals necessary for the planning, construction, operations and decommissioning of the GFD Project. The triggers for each approval, the relevant administering authority and application details are provided. Consultation on the subsequent approvals will be ongoing with the administering authorities.

15.3 Assessment methodology

This assessment describes the air quality values and assesses the GFD Project's potential impacts on these values. Impacts were assessed using the compliance assessment methodology, which assesses the degree to which the GFD Project complies with quantifiable criteria set out in the EPP Air. The compliance assessment methodology is described in section 5.6.3 of Section 5: Assessment framework and in Appendix P: Air quality.

As described in Section 4: Project description, the final number, size and location of the GFD Project components will be determined progressively over the life of the project and will be influenced by the location, size and quality of the gas resources identified through ongoing field development planning processes. The potential air emission types and sources identified in Table 15-2 are representative of infrastructure and activities that may be required. The assessment methodology is given in Table 15-2 for each air pollutant.

Table 15-2 Summary of identified air emissions, sources and assessment methodologies

Potential air emissions	Air emission sources during GFD Project phases			Assessment methodology
	Construction	Operations	Decommissioning	
Particulate matter (PM)	Clearing, topsoil removal and earthworks. Vehicles, trucks and other mobile equipment. Concrete batching.	Vehicle movements on unpaved roads. Wind erosion of disturbed soils.	Rehabilitation activities such as grading and topsoil spreading. Vehicles, trucks and other mobile equipment. Demolition activities (possibly including blasting)	Emissions of particulate matter have been assessed qualitatively. Quantitative assessment of particulate emissions from vehicles travelling on unpaved roads is subject to an extremely high level of uncertainty. These emissions are most appropriately managed through the implementation of appropriate planning and mitigation measures.
Oxides of nitrogen (NO_X) Carbon monoxide (CO) Volatile organic compounds (VOCs)	Vehicles, trucks and other mobile equipment.	Gas-fired turbine compressors, alternators and triethylene glycol (TEG) dehydrator reboilers at gas compression facilities. Flares. Reciprocating engines at wellheads. Vehicles, trucks and other mobile equipment.	Vehicles, trucks and other mobile equipment.	Atmospheric dispersion modelling has been performed to assess local impacts of NO_X and CO emissions from sources at gas compression facilities including compressors, reciprocating engines, TEG reboilers and flares. Non-methane VOC emissions from gas compression facilities will be minor and have been assessed qualitatively. Emissions of NO_X, CO and VOCs from traffic emissions have been assessed qualitatively based on the projected maximum increase in vehicle numbers relative to existing traffic levels.

Potential air emissions	Air emission sources during GFD Project phases			Assessment methodology
	Construction	Operations	Decommissioning	
Sulfur dioxide (SO_2)	Diesel vehicles, trucks, generators and other equipment.	Diesel backup generators, pumps and other stationary equipment. Diesel vehicles, trucks and other mobile equipment	Diesel vehicles, trucks, generators and other equipment.	Emissions of SO_2 will be minor and have been assessed qualitatively.
Odour	Sewage treatment plants at accommodation camps.	Sewage treatment plants at accommodation camps.	Sewage treatment plants at accommodation camps.	Potential odour emissions will be highly localised to the source and be dispersed within the immediate environment; therefore odour-related nuisance impacts are not expected. Should Santos GLNG receive complaints related to odour, an odour impact assessment would be performed for the activity/facility of concern in accordance with the EHP guideline Odour Impact Assessment from Developments (EHP, 2013).

Air dispersion modelling has been used to predict NO_x and CO impacts from the proposed GFD Project activities. This modelling has been used to assess the extent to which the GFD Project complies with published assessment criteria (see section 15.4) and the extent of mitigation and management measures that may be required to achieve compliance. The degree to which the GFD Project complies with these guidelines has been used as a measure of the level of impact.

Modelling was performed using the AUSPLUME dispersion model to simulate the dispersion of air emissions from representative major GFD Project facilities. Emissions were assessed for four separate meteorological datasets indicative of possible development locations. As the locations of the future major facilities will be identified as the GFD Project develops, the approach used in this assessment has been designed to provide a conservative assessment of downwind impacts from three worst case scenarios:

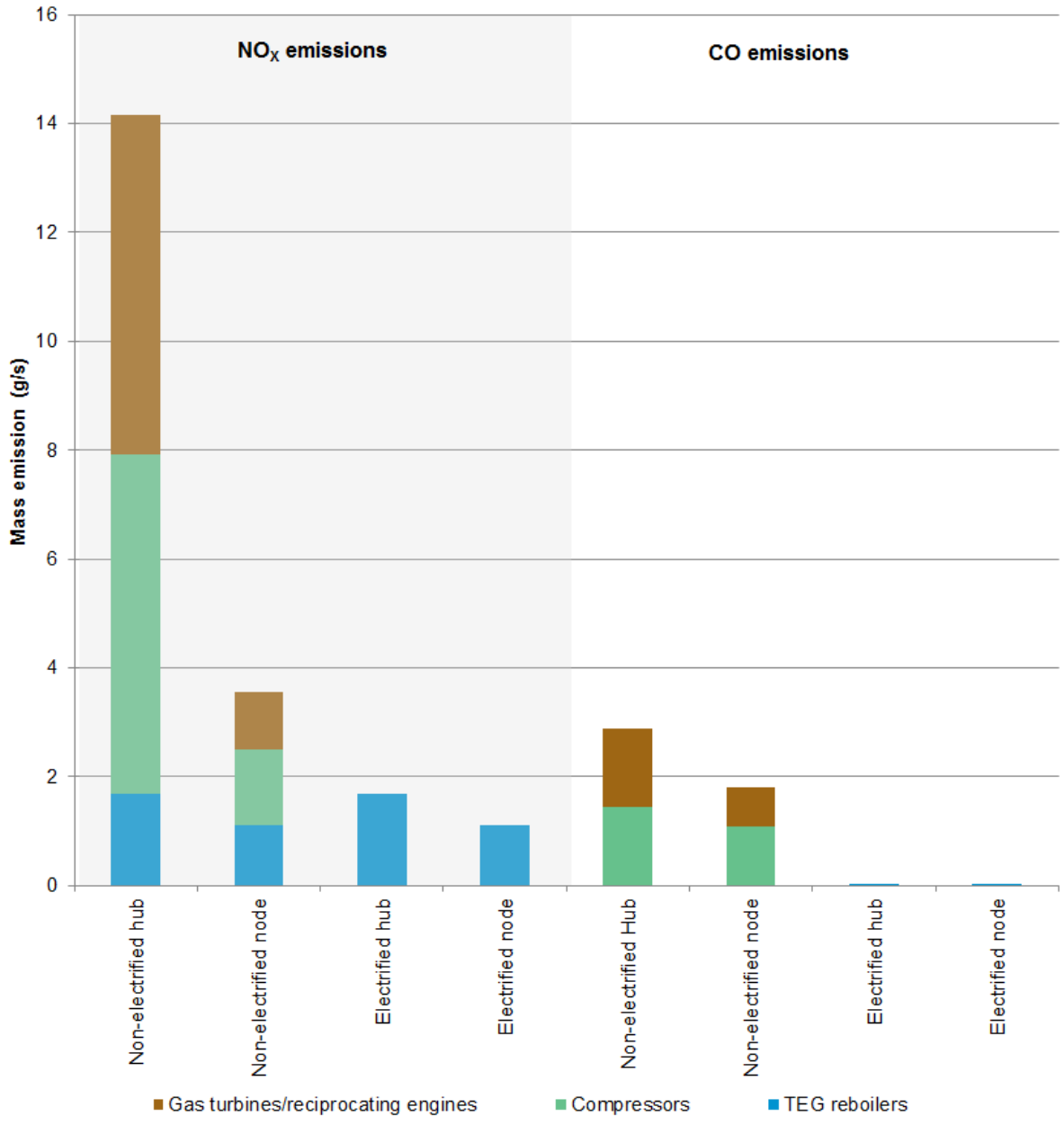
- A nominal large hub compression facility (240 TJ/day) – normal operations
- A nominal large hub compression facility (240 TJ/day) – major flaring event
- A nominal nodal compression facility (80 TJ/day) – normal operations.

The infrastructure at each of the facilities will include gas compression and treatment equipment consistent with those already present or being constructed for the approved GLNG Project. Where Santos GLNG is generating power, gas turbines (10–20 MW) will be installed at gas compression and water management facilities; however, in some cases power may be supplied from reciprocating gas engines or via direct gas engines. This energy supply will support operation of gas compression, water management and the operation of proximal wells.

A comparison of the total emissions for non-electrified (not grid connected) and electrified (grid connected) gas compression facilities (normal operating conditions) is presented in Figure 15-1 to illustrate the reduction in emissions that will occur when a facility is connected to the grid (based on the representative equipment numbers and emission data used in this assessment).

Figure 15-1 also illustrates the difference in the total emissions from a hub gas compression facility compared to a nodal gas compression facility in both electrified and non-electrified configurations. The 240 TJ/day hub gas compression facility used in this assessment is considered to be a representative example of the largest facility that would be constructed as part of the GFD Project, while the 80 TJ/day nodal gas compression facility is representative of a more 'typical' field gas compression facility.

Figure 15-1 Indicative reduction in air emissions from electrification of gas compression facilities



The modelling results were used to assess the potential for exceedances of the compliance criteria (section 15.4) and, if applicable, the extent of mitigation that may be required to ensure compliance at sensitive receptors. As preferred locations for individual facilities and details of the required size and number of engines and other fuel-burning equipment become known during the ongoing field development process, more detailed site-specific modelling assessments will be performed to take into account factors such as surrounding topography and land use.

15.4 Environmental values

15.4.1 Air quality objectives

The EHP's air quality guidelines are published in the EPP Air. The air quality objectives prescribed in Schedule 1 of the EPP Air (in micrograms per cubic metre (µg/m^3) and parts per million (ppm)) are shown in Table 15-3 for the emissions relevant to this study.

Table 15-3 Ambient air quality guidelines

Indicator	Environmental value	Air quality objectives		Averaging period	Allowable exceedence
		µg/m^3 (0°C)	ppm		
NO_2	Health and wellbeing	250	0.12	1 hour	1 day/year
		62	0.03	1 year	None
	Health and biodiversity of ecosystems	33	0.016	1 year	None
CO	Health and wellbeing	11,000	9	8 hours	1 day/year
PM_{10}	Health and wellbeing	50	-	24-hours	5 days/year
$PM_{2.5}$	Health and wellbeing	25	-	24-hours	-
		8	-	Annual	

15.4.2 Sensitive receptors

The ambient air quality criteria set out in the EPP Air (Table 15-3) are designed to protect human health and the biodiversity of ecosystems, and to preserve amenity of land use. For the purpose of assessing potential air quality impacts, sensitive receptors may include:

- Dwellings
- Library or educational institutions
- Childcare centres or kindergartens
- Schools or playgrounds
- Hospitals, surgeries or other medical institution
- Commercial and retail activities
- Protected areas
- Parks or gardens that are open to the public
- Agricultural land.

New infrastructure for the GFD Project will be located in rural areas at significant distances from major population centres; as a result, most of the sensitive receptor types listed above will not be relevant. The types of sensitive receptors expected to be relevant to the GFD Project are scattered rural dwellings, agricultural land and protected areas.

15.4.3 Ambient air quality

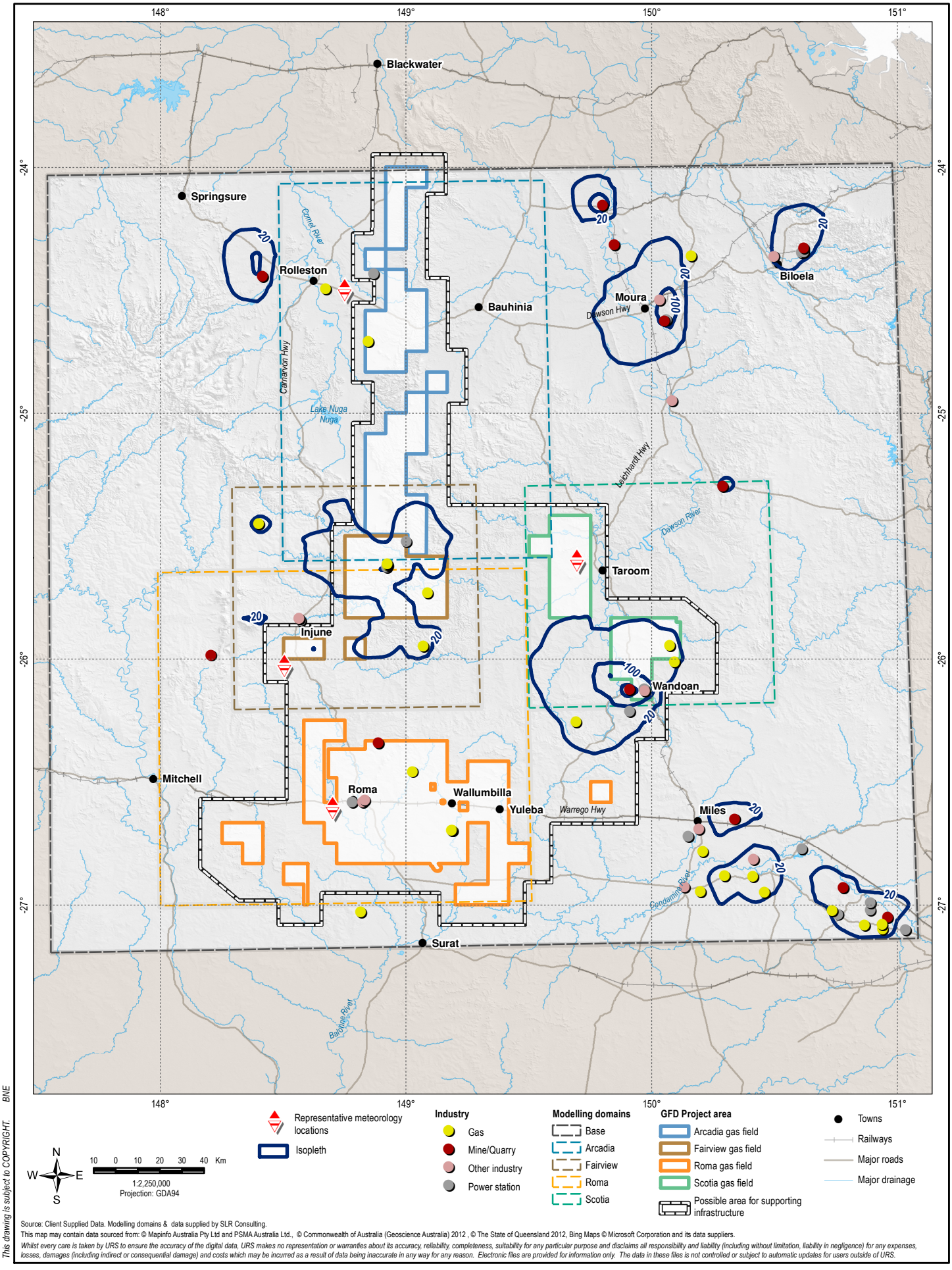
Sources of fugitive air emissions such as dust from traffic on unsealed roads, wind erosion of bare soils from agricultural and resources activities and dust storms are difficult to quantify as they are highly variable and seasonally dependant. Monitoring records collected between 2003 and 2010 from the ambient air quality monitoring station at Toowoomba (nearest to the GFD Project area i.e. 330 km east-southeast of Roma) indicate background levels of NO_2 (1 hour average), CO (8 hour average) and PM_{10} (24 hour average) are below the EPP Air guideline objectives (Table 15-3).

An estimation of existing ambient concentrations of NO_2 and CO due to air emissions from industrial activities such as power generation, quarries and resources projects was based on a modelling analysis of emission data reported to the NPI for industrial and commercial sources within the modelling domain (a 300 km (east-west) by 350 km (north-south) area centred on GFD Project area). Within this modelling domain, power stations were the main source of NO_X emissions during 2010/2011, while mines and quarries were the main sources of CO emissions.

The background annual average NO_2 concentrations and 8-hour average CO concentrations are predicted to be well below guideline levels across the modelling domain. The peak background 1-hour average NO_2 concentrations vary significantly across the modelling domain, with elevated concentrations predicted in localised areas surrounding the significant existing emission sources as shown in Figure 15-2.

Conservative estimates of background NO_2 and CO concentrations used in this assessment were the worst case ground level concentrations predicted by the modelling within the areas identified as potential locations for GFD Project infrastructure in each gas field.

The background 8-hour average CO concentrations identified for use in the assessment based on this approach are far below the relevant guideline. The background peak 1-hour NO_2 concentrations and annual average NO_2 concentrations estimated in the Arcadia, Fairview and Roma gas fields are also low compared to the relevant guidelines. These are modelled in Figure 12 and 13 in Appendix P: Air quality. There are areas in the Scotia gas field that are predicted by the modelling to experience more elevated background NO_2 concentrations. These areas are close to existing sources, in particular mines and power stations, and it is considered likely that the model predictions close to these sources are conservatively high; however, they have been used as a worst case estimate of potential background concentrations.



Source: Client Supplied Data. Modelling domains & data supplied by SLR Consulting.

Santos GLNG Project

GFD PROJECT EIS

PEAK 1-HOUR AVERAGE NO_2 BACKGROUND CONCENTRATIONS ($\mu g/m^3$)

URS

AIR QUALITY

Figure: 15-2

File No: 42627064-g-1036d.mxd | Drawn: MH | Approved: RS | Date: 21-08-2014 | Rev. D | A4

15.5 Potential impacts

The activities associated with the air emission sources listed in Table 15-2 are similar to those activities currently approved within the Arcadia, Fairview, Roma and Scotia gas fields. The GFD Project will result in an incremental increase in the quantity and geographical spread of such emissions.

The approach used in this assessment has been to model representative worst case and typical surface facilities to assess the potential for exceedances of compliance criteria and provide information on mitigation strategies such as separation distances from sensitive receptors, stack heights and/or emission exit velocities. As preferred locations for individual facilities are identified through the ongoing field development process, and details of the required size and number of engines and other fuel-burning equipment become known, more detailed modelling will be performed to enable an assessment of the potential impacts at sensitive receptors (if relevant).

Potential impacts to air quality environmental values are outlined in Table 15-4.

Table 15-4 Potential impacts to air quality environmental values

Environmental value	Potential impact
Health and wellbeing	Air emissions from the GFD Project contribute to an exceedence of one or more of the air quality objectives for NO_2, CO, PM_{10} or $PM_{2.5}$ in Table 15-3.
Health and biodiversity of ecosystems	Air emissions from the GFD Project contribute to an exceedence of the air quality objectives for NO_2 in Table 15-3.
Regional air quality	Acid deposition or acid rain caused by concentrations of SO_x or NO_x.
	Formation of photochemical smog caused by reaction of VOCs.

The timeframe for construction activities associated with the GFD Project will vary significantly in both scale and duration, ranging from two to three weeks for a well lease to one to three years for gas compression facilities.

There is potential for particulate matter (dust) and vehicle emissions associated with unmitigated construction works to result in a moderate to high magnitude impact within 500 m of receptors. Where construction activities are undertaken greater than 500 m from receptors potential particulate matter and vehicle emissions are considered to be a low magnitude impact with pollutant levels compliant to the adopted air quality assessment objectives. The GFD Project's design criteria will include a requirement for gas compression facilities to be located further than 500 m from sensitive receptors and hence a detailed quantitative dust modelling assessment of these impacts is not warranted. Mitigation measures to control fugitive dust emissions during construction or decommissioning and rehabilitation works are discussed in section 15.6.

Major sources of operations air emissions are limited to the hub and nodal gas compression facilities particularly where these facilities are not electrified. A discussion of the potential air quality impacts associated with operational emissions from large hub and nodal gas compression facilities is provided in the sections below.

Other sources of air emissions associated with the GFD Project operations phase such as vehicle movements, small gas-fired engines at wellheads, flaring at exploration wells etc., have a low potential for air quality impacts and are most appropriately managed through the implementation of management measures included in the relevant GLNG management framework documents (see section 15.6).

15.5.1 Hub gas compression facility – normal operations

The maximum predicted downwind 1-hour average NO_2 concentrations for a nominal large hub gas compression facility (up to 240 TJ/day), excluding and including peak estimated background ground level concentrations are shown in Figure 15-3 and Figure 15-4, respectively. Figure 15-3 shows the incremental impacts predicted for a hub gas compression facility operating in isolation (being the same in the four gas fields). Figure 15-4 provides the worst case cumulative assessment including maximum background ground level concentrations estimated by the regional modelling study for each gas field.

The plots show that the incremental 1-hour concentrations predicted are well below the relevant ambient air quality guideline downwind of the facility, and that the variations in meteorological conditions across the study area do not have a significant impact on the maximum incremental ground level concentrations predicted. The maximum downwind NO_2 concentrations are predicted to return to background levels within approximately 500 m of the hub gas compression facility. As discussed in section 0, these impacts are predicted for a non-electrified hub gas compression facility. Once connected to the grid, NO_X emissions will decrease by at least 75%, which will result in a proportional reduction in off tenure NO_2 concentrations.

Figure 15-3 Hub gas compression facility – maximum 1-hour average NO_2 concentrations, excluding peak background concentrations

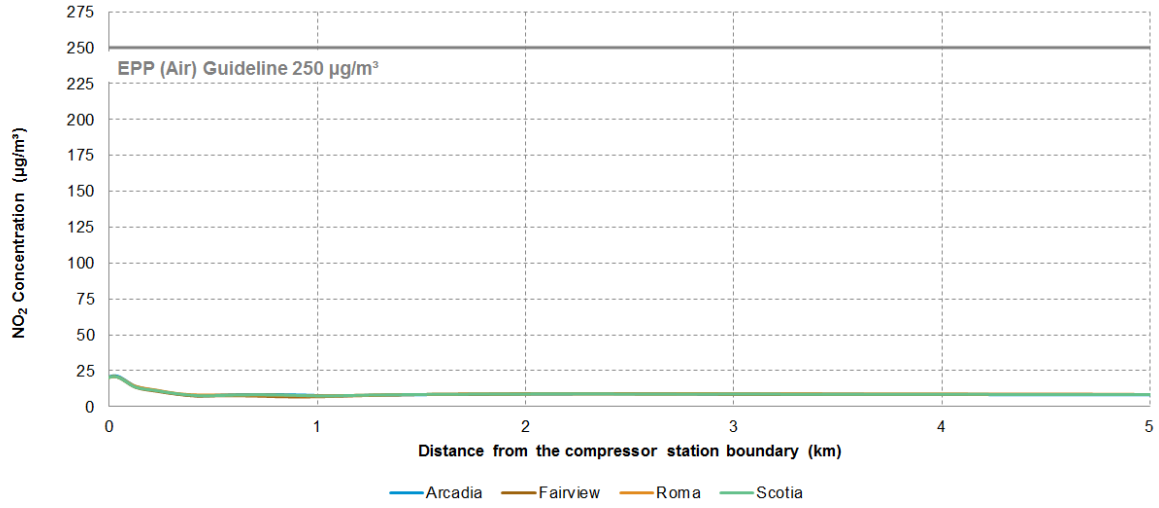
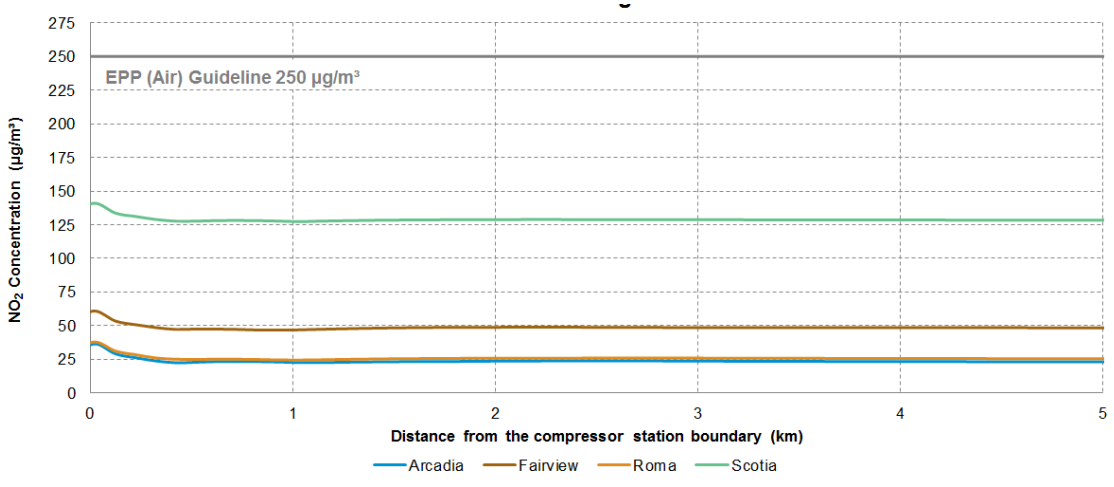


Figure 15-4 Hub gas compression facility – maximum 1-hour average NO_2 concentrations, including peak background concentrations



Emissions of CO for a nominal large hub gas compression facility were also modelled to provide estimates of potential maximum downwind CO concentrations. This modelling showed that under worst case meteorological conditions, the 8-hour CO concentrations predicted downwind of the facility are far below the ambient air quality guideline (less than 2%) and would not result in a significant increase above existing background levels. There do not appear to be constraints with respect to the capacity of the local airshed to assimilate these emissions.

15.5.2 Hub gas compression facility – maximum flaring scenario

The maximum predicted incremental and cumulative 1-hour average NO_2 concentrations for a maximum flaring scenario at a nominal large hub gas compression facility are shown in Figure 15-5 and Figure 15-6, respectively.

Figure 15-5 Maximum flaring scenario – maximum 1-hour average NO_2 concentrations, excluding peak background concentrations

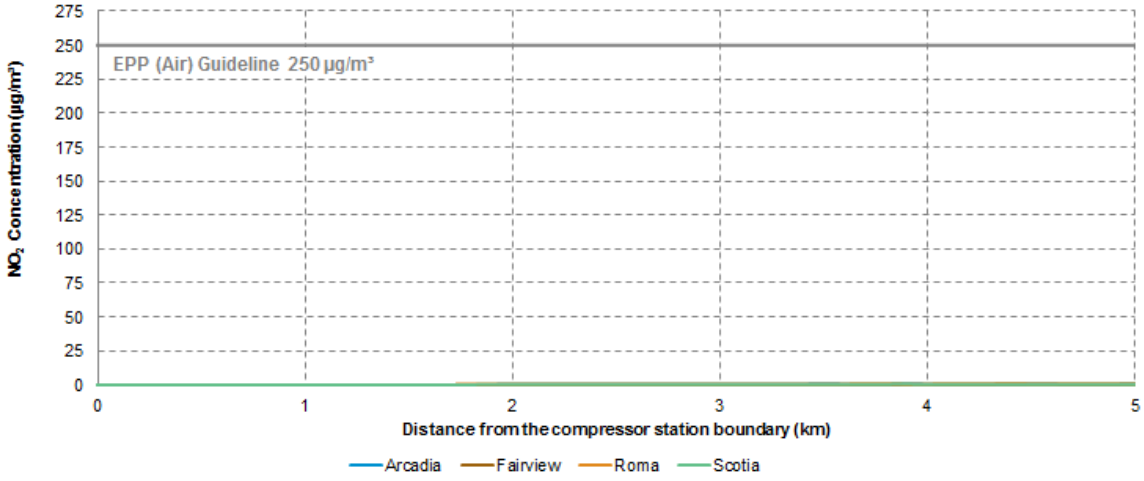
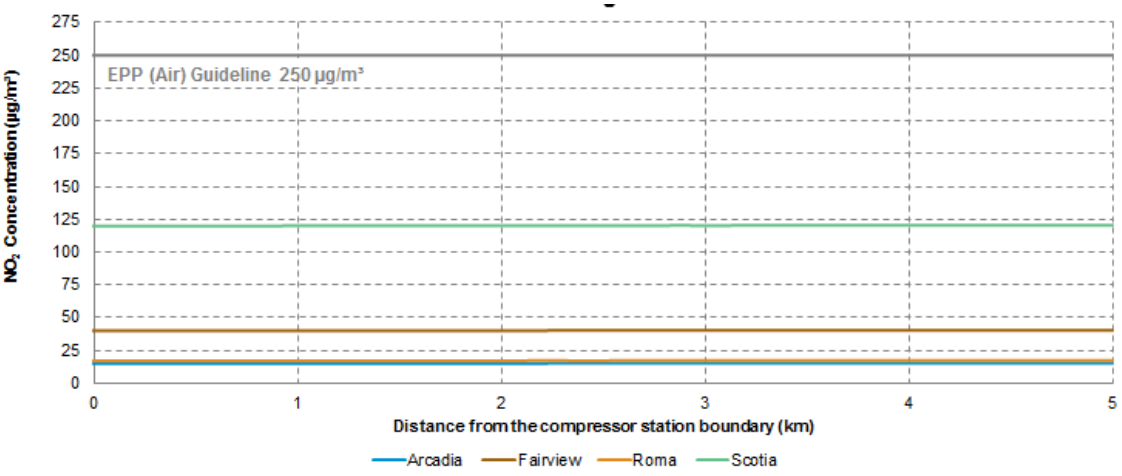


Figure 15-6 Maximum flaring scenario – maximum 1-hour average NO_2 concentrations, including peak background concentrations



The plots show that incremental 1-hour average concentrations predicted are negligible (and the same in the four gas fields) and far below the relevant ambient air quality guideline downwind of the facility. The high buoyancy of the plume due to high temperature of the flare means that the emissions are well dispersed and do not have a significant impact on background ground level concentrations. During a major flaring event, other infrastructure at the hub gas compression facility would not be operating and therefore would not be contributing to off-tenure ambient concentrations.

15.5.3 Nodal gas compression facility

The maximum predicted downwind 1-hour average NO_2 concentrations for a nodal gas compression facility (up to 80 TJ/day), excluding and including maximum estimated background ground level concentrations, are shown in Figure 15-7 and Figure 15-8, respectively. The plots show that incremental (being the same in the four gas fields) and cumulative 1-hour concentrations predicted are below the ambient air quality guideline downwind of the facility and that the variations in meteorological conditions across the GFD Project area do not have a significant impact on the maximum incremental ground level concentrations predicted.

Figure 15-7 Nodal gas compression facility – maximum 1-hour average NO_2 concentrations, excluding peak background concentrations

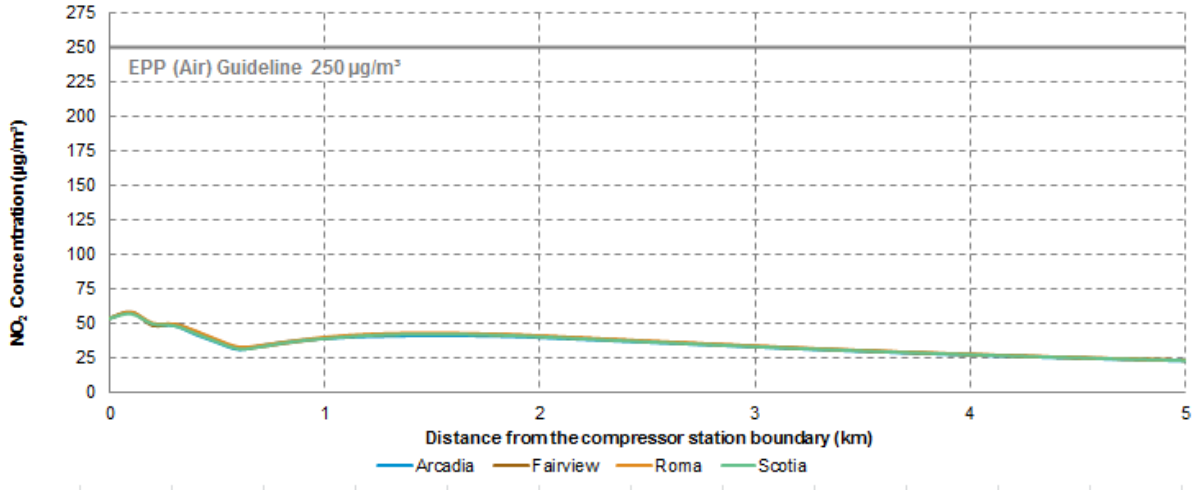
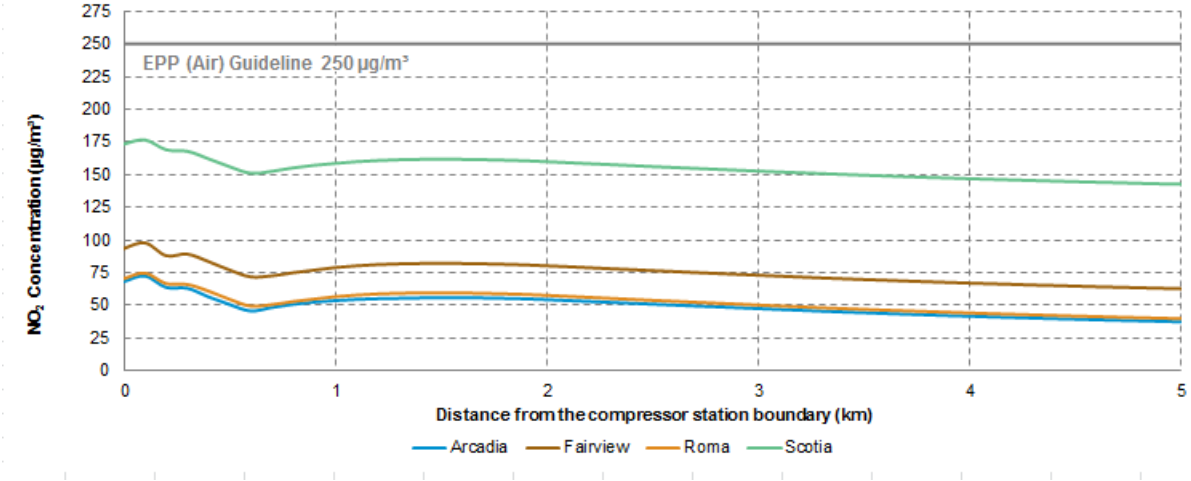


Figure 15-8 Nodal gas compression facility – maximum 1-hour average NO_2 concentrations, including peak background concentrations



Based on these results, it is concluded that the local airshed would have sufficient capacity to assimilate these emissions.

Maximum ground level concentrations predicted for the nodal gas compression facility are higher than those predicted for the large hub gas compression facility, despite the total emissions being lower. This is due to the lower exit velocity used for the reciprocating engines.

Emissions of CO for a nominal nodal gas compression facility were also modelled to provide estimates of potential maximum downwind CO concentrations. This modelling showed that even under worst case meteorological conditions, the 8-hour CO concentrations predicted downwind of the facility are far below the ambient air quality guideline (approximately 2.5%) and would not result in a significant increase above existing background levels. There do not appear to be constraints with respect to the capacity of the local airshed to assimilate these emissions.

15.5.4 Traffic

The road network providing access to the gas fields are a combination of sealed State-controlled roads carrying a large volume of traffic travelling at high speeds ranging from 80 to 110 km/h and both sealed and unsealed (gravel) rural access roads with lower traffic volumes and speeds. Background and GFD Project-related traffic volumes are detailed in Section 11: Traffic and transport. This data shows that the projected maximum increase in vehicle numbers relative to existing traffic levels varies significantly depending on the section of road; however maximum daily traffic volumes remain within the estimated background traffic volumes.

The minor incremental increase in traffic and associated vehicle emissions will be spread over a wide area that is not expected to contribute significantly to regional air pollution levels (NOx, CO and SO_2). In addition, studies of vehicle emissions near major highways have shown that the ambient concentrations these pollutants such as NOx and CO reduce to background levels within 50 m or 100 m of a major road (HEI, 2010), hence localised impacts would be negligible.

There is potential for vehicles travelling on unsealed roads passing close to sensitive receptors to give rise to nuisance dust impacts. The estimation of particulate emissions associated with vehicles travelling on unpaved roads is subject to an extremely high level of uncertainty and therefore a quantitative assessment of impacts associated with these emissions is not appropriate. These impacts are most appropriately managed through the constraints planning process (e.g. GFD Project infrastructure to be located with landholder agreement and consultation on location of roads and tracks), logistics planning to minimise traffic volumes on these roads, appropriate maintenance of road surfaces (including dust suppression) and ongoing driver training, as set out in Table 15-5.

15.5.5 Regional air quality

Based on the large regional area and predicted compliance with the NO_2 concentration limits in the EPP Air and the absence of detectable concentrations of sulfur in the gas, the GFD Project will not significantly contribute to acid deposition. Further, the absence of large non-methane VOC emissions will limit the contribution of the GFD Project to regional photochemical smog levels. Given this, the GFD Project is not expected to require management or mitigation of air emissions to control regional impacts, with the airshed having sufficient capacity for the assimilation and dispersion of emissions associated with the GFD Project.

15.6 Mitigation measures

Santos GLNG's management framework (Section 6: Management framework) is based on a clear set of environment, health and safety expectations so that there is a consistent, efficient approach across the project.

Santos GLNG adopts the commitments within the Santos Ltd environmental policy and controls outlined in Environment Hazard Standard *EHS05 Air emissions* required to manage risks of specific hazards associated with air emissions to acceptable levels, which includes:

- **Planning and approvals:** Potential air emissions must be considered during planning of operations and activities. Appropriate internal and/or external environmental approvals will be obtained prior to construction for proposed activities that have potential to create air emissions.
- **On-ground activity:** Operations, facilities and work activities are conducted in a manner that minimises potential for pollution of air by release of emissions and in accordance with relevant environmental approvals, environmental authorities and management plans.
- **Decommissioning:** Decommissioning and rehabilitation activities will minimise impacts from air emissions.
- **Monitoring and reporting:** Exceedences will be reported to EHS Toolbox and to the relevant authority. When received, complaints about air emissions (e.g. dust, odour) will be reported to EHS Toolbox and to the relevant authority.

15.6.1 Management plans and strategies

Santos GLNG is committed to implementing the management plans and strategies described in Table 15-5 to manage the potential air quality impacts of the GFD Project. The measures discussed in this section will be considered during the planning and scheduling of GFD Project activities to minimise air quality impacts at potential receptors.

It should be noted that an assessment of NO_2 and CO emissions during operation predicted compliance with the objectives for the preservation of health and wellbeing and biodiversity of ecosystems. These air emissions were predicted to have a low impact and do not require specific mitigation measures. Potential impacts on regional air quality are predicted to be minimal with the GFD Project operations not being a dominant source contribution to regional NO_2 levels. Other emissions are at very low and minor levels and will comply with the air quality assessment objectives.

Table 15-5 Management measures – air quality

Management framework	Description and mitigation measures
Environmental protocol for constraints planning and field development (the Constraints protocol)	The Constraints protocol applies to all gas field related activities. The scope of the Constraints protocol is to: • Enable Santos GLNG to comply with all relevant State and Federal statutory approvals and legislation • Support Santos GLNG's environmental policies and the General Environmental Duty (GED) as outlined in the EP Act • Promote the avoidance, minimisation, mitigation and management of direct and indirect adverse environmental impacts associated with land disturbances • Minimise cumulative impacts on environmental values. The Constraints protocol provides a framework to guide placement of infrastructure and adopts the following management principles: • Avoidance — avoiding direct and indirect impacts • Minimisation — minimise potential impacts • Mitigation — implement mitigation and management measures • Remediation and rehabilitation — actively remediate and rehabilitate impacted areas • Offset — offset residual adverse impacts in accordance with regulatory requirements. The Constraints protocol enables the systematic identification and assessment of environmental values and the application of development constraints to effectively avoid and/or manage environmental impacts.
Draft environmental management plan (Draft EM plan)	The Draft EM plan identifies the environmental values potentially affected by the GFD Project and proposes measures to manage the risk of potential adverse impact to these environmental values. The Draft EM plan comprises: • Environmental values potentially affected by the GFD Project • Environmental management objectives and associated management measures • Environmental monitoring and reporting • Coal seam water management • Proposed conditions. Air quality controls detailed in the Draft EM plan will be implemented, including measures such as: • Monitoring of pollutant concentrations will be undertaken for registered discharge points in accordance with the environmental authority (EA). Production rate and plant status will be recorded during the test period. • Site-specific air dispersion modelling studies will be performed to identify potential impacts to air quality from proposed fuel burning equipment capable of burning at least 500 kg of fuel in an hour. • Contaminants emitted from fuel burning equipment point sources will be emitted via appropriately designed stacks (i.e. at a suitable release height) for maximum dispersion. • The selection of compressor engines and other fuel burning equipment for new surface facilities will have the manufacturers' specifications taken into account to ensure that pollutant emission levels will comply with EA emission limits. • Fuel burning equipment will be maintained and operated in accordance with the manufacturers' specifications to ensure pollutant emissions are minimised. • If blasting is required as part of demolition activities, Santos GLNG will develop and implement a Blast Management Plan in accordance with the EA. • A no-burning of waste policy will be implemented to prevent smoke generation and fire control procedures will be implemented during operations.

Management framework	Description and mitigation measures
Erosion and sediment control management plan (ESCMP)	The plan identifies erosion and sedimentation risk and provides an erosion and sediment control strategy that incorporates understanding of the risk inherent to local land resource characteristics. The plan will be implemented which includes measures such as: • Construction activities will aim to reduce exposure of disturbed areas to the minimum time period required, with progressive revegetation or rehabilitation as soon as practicable after the completion of construction. • Stabilisation of disturbed areas, including stockpiles, through the use of measures such as mulch, erosion blankets and establishment of ground cover.
Chemical and fuel management plan (CFMP)	The plan will be implemented for the safe handling and storage of chemicals and fuels including minimising fugitive emissions as per appropriate regulations and guidelines.
Rehabilitation management plan	The Rehabilitation management plan outlines the rehabilitation objectives for Project-related disturbances within the GFD Project Area. This includes the phasing of rehabilitation to first achieve stabilisation and subsequently final rehabilitation for disturbances to land (i.e. ground surface). The Rehabilitation management plan: • Describes Santos GLNG's approach to rehabilitation • Identifies key rehabilitation objectives and criteria to deem rehabilitation success • Outlines general rehabilitation actions to be undertaken by Santos GLNG when rehabilitation a disturbance • Provides an overview of monitoring and maintenance actions to be conducted on rehabilitated areas.
Decommissioning and abandonment management plan (DAMP)	The plan describes the management framework in place for when petroleum activities cease. The objectives of the plan are to: • Undertake decommissioning of assets in a manner that complies with regulatory requirements and minimises the risk of environmental harm • Undertake decommissioning activities in a manner that meets stakeholder expectations • Leave a landform that is stable and compatible with intended post-closure land use • Provide for the beneficial reuse of Santos GLNG infrastructure constructed to third parties (e.g. landholders or local authorities) where an appropriate agreement has been signed by both parties and regulatory authorities are satisfied. Dust minimisation measures detailed in the plan will be implemented, including measures to mitigate and manage the potential for nuisance dust and other air quality impacts such as: • Dust suppression (water, mulching or alternative measures) will be applied to exposed surfaces that are generating dust. Dust suppression will be maintained and effort increased during periods of high risk (e.g. high winds). • Landholders with the potential to be impacted by dust emissions will be consulted with prior to the commencement of activities.
Road-use management plan	The Road-use management plan was developed to manage the impact associated with the implementation of the Santos GLNG Project It will be adapted to manage the potential impacts resulting from the GFD Project. The objectives of the plan include: • Manage the efficiency of the road network impacted including state controlled roads and local government roads • Ensure user safety and safe operation of vehicles • Minimise impacts on road infrastructure condition • Minimise traffic related complaints and incidents to maintain community amenity. Dust control measures will be implemented to ensure road-user safety and the safe operation of project vehicles in line with Queensland Department of Transport and Main Roads standards.

15.6.2 Monitoring and review

The air quality impacts predicted in this assessment will be verified during the detailed design phase to confirm the air emission impacts of the final design and location of GFD Project infrastructure. The verification will include prediction air pollutant concentrations adopting the following:

- Site-specific meteorological modelling based on fuel burning infrastructure
- Dispersion modelling incorporating representative background air quality levels, localised terrain and land use data and locations of sensitive receptors.

Where the verification of potential impacts identifies the need for further impact controls, additional mitigation measures to minimise emissions to the atmosphere could include:

- Increasing the stack heights for key sources
- Investigating alternative locations further from sensitive receptors or with improved local dispersion characteristics, or
- Use of low NO_x technology, such as staged combustion systems.

Monitoring of air emissions will be performed in accordance with the Draft EM Plan. This will include monitoring in accordance with regulatory requirements.

Verification of the effectiveness of dust management measures will be achieved through ongoing consultation with landholders and monitoring of complaints records.

The activities proposed as part of the GFD Project are not anticipated to have the potential to generate odour nuisance impacts. Should Santos GLNG receive complaints related to odour, an odour impact assessment would be performed for the activity/facility of concern in accordance with the EHP guideline *Odour Impact Assessment from Developments* (EHP, 2013).

15.7 Conclusions

The assessment has concluded that particulate matter (dust) emissions arising from pre-mitigated construction, demolition and rehabilitation works occurring within 500 m of sensitive receptors may result in nuisance impacts requiring mitigation and management. Where such activities are undertaken greater than 500 m from receptors, potential dust impacts will generally be low and compliant with the adopted air quality assessment objectives and unlikely to require specific mitigation and management. Through the implementation of existing management and mitigation controls from the Santos GLNG management framework, it is expected potential impacts from particulate emissions can be mitigated to comply with relevant air quality objectives.

The assessment of air pollutant emissions during operation focused on NO_2 and CO from gas compression facilities as these will be the key emission sources. Other emissions would be emitted at very low and minor levels that would comply with the air quality assessment objectives. Dispersion modelling for NO_2 and CO determined that predicted concentrations from gas compression activities under normal operations and during flaring (commissioning and emergency) would comply with objectives for the preservation of health and wellbeing and biodiversity of ecosystems. These air emissions will have a low impact and will not require specific mitigation measures. Potential impacts on regional air quality are expected to be minimal with the GFD Project operations not a dominant source contribution to regional NO_2 levels.

The predicted air quality impacts in this assessment will be verified by remodelling during the ongoing field development phase to confirm the air emission impacts of the final design and location of GFD Project infrastructure. The verification will include prediction of air emission concentrations adopting the following:

- Site-specific meteorological modelling based on fuel burning infrastructure
- Dispersion modelling incorporating representative background air quality levels, localised terrain and land use data, and known locations of sensitive receptors
- Where the verification of potential impacts identifies the need for further controls, these could include:
  - Increasing the stack heights for key sources
  - Investigating alternative locations further from sensitive receptors or with improved local dispersion characteristics
  - Using low NOx technology, such as staged combustion systems.