

9.0 AIR EMISSIONS – RISKS AND MANAGEMENT

This PER and associated appendices make reference to both the Approved Gorgon Gas Development and the Revised Gorgon Gas Development, which is the subject of this PER. For clarification purposes, the following definitions are provided:

- ◆ “the Approved Gorgon Gas Development” or “the Approved Development” refers to the development proposed in the EIS/ERMP (Chevron Australia 2005a) and subsequently approved under Statement No. 748 and EPBC Reference: 2003/1294
- ◆ “the Gorgon Gas Development Revised and Expanded Proposal” or “the Revised Gorgon Gas Development” or “the Revised Proposal” refers to the development proposed in this PER, which is yet to gain approval
- ◆ “the Gorgon Gas Development” refers to the entire proposal. This descriptor may be used when the reference is being made to elements of “the Revised Proposal” described in the PER when they replace the elements of “the Approved Development” which have changed to create the final product as proposed in this PER.

9.1 Assessment Framework or Policy

9.1.1 EPA Objective

To maintain that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards (EPA 2004b).

9.1.2 Commonwealth Policy

The National Environment Protection Council (NEPC) has determined a number of measures for air quality including:

- ◆ National Environment Protection (Ambient Air Quality) Measure (NEPM) (NEPC 2003)
- ◆ National Environment Protection (Air Toxics) Measure (NEPC 2004).

The measures provide guidelines for levels of target species (including CO, NO₂ and SO₂) below which air quality is deemed to be acceptable. DEC has adopted NEPM guidelines for application in air quality management.

Further guidance on emission reduction technology specific to gas turbines is provided by the Australian Environment Council (AEC)/National Health and Medical Research Centre (NHMRC).

EPA Guidance Statement No. 15 (EPA 2000a) generally follows the guidelines established by these national organisations (Section 9.1.3.3).

As the workforce will be in proximity to the operations, the following sources of occupational exposure air quality measures/guidelines are also relevant to the assessment of the Revised Proposal:

- ◆ National Occupational Health and Safety Commission (NOHSC)/WorkSafe Australia (NOHSC 1995).

9.1.3 State (WA) Policy

9.1.3.1 DEC Guidelines – Ambient Air Quality Guidelines (DOE 2004)

This Guideline outlines the relevant standards used by the DEC for the assessment of the impacts of air emissions. Proposals are required to demonstrate compliance with:

- ◆ the NEPM for Ambient Air Quality (NEPC 2003; 2004)
- ◆ in the absence of a NEPM standard, the World Health Organisation (WHO) Guidelines for Air Quality (WHO 2000), with appropriate amendments to suit the Western Australian context
- ◆ in the absence of a NEPM standard or WHO guideline, criteria from another jurisdiction (once they have been assessed by DEC and found to be applicable to the Western Australian context).

9.1.3.2 DEC Guidelines – Air Quality Modelling Guidance Notes (DOE 2006b)

These Guidelines have been prepared to provide a clear understanding of the DEC's expectations with respect to air quality modelling and associated meteorological monitoring and/or modelling. Specifically, these Guidelines require:

- ◆ identification and quantification of all emissions to the atmosphere which have the potential for non-trivial impact on the environment
- ◆ for all those primary and secondary target species which cannot be dismissed as being of no significance, the proponent must provide model predictions of the impact of emissions on the various elements of the environment, in the form of concentrations and/or rates of deposition over the range of averaging periods normally associated with relevant standards for each target species, and assess the magnitude of this impact against the relevant standards
- ◆ inputs into the model (emissions estimates, background concentrations etc.) and model capability should contain sufficient detail to render the model accurate, incorporating considerations outlined in this Guideline
- ◆ presentation of modelling results in the prescribed form and with reference to appropriate standards as outlined in this Guideline.

9.1.3.3 EPA Guidance Statement No. 15 – Emissions of Oxides of Nitrogen from Gas Turbines (EPA 2000a)

This Guidance Statement requires proposals to demonstrate the following:

- ◆ All reasonable and practicable measures should be taken to minimise the discharge of waste into the environment.
- ◆ Multiple discharges of waste must not cause cumulative impacts beyond environmentally acceptable limits/standards/criteria. This depends upon the ambient conditions of the receiving environment, and therefore needs to be addressed on a case-by-case basis on advice from the EPA.

9.2 Assessment of Potential Impacts

9.2.1 Overview

The emission of contaminants and subsequent change in ambient air quality has the potential to impact human health, welfare and amenity and to act as a stressor to vegetation.

Construction and operational phase air emissions have been reviewed for the Revised Proposal.

The increase in construction related emissions for the Revised Proposal compared to the Approved Development are considered to be insignificant (the duration of construction activities for the Revised Proposal has increased by approximately three to six months from that for the Approved Development). In addition, the duration of emissions during construction is minor compared to the operations phase.

The focus of the air quality assessment has been on the operational phase impacts. The detailed air quality assessment presented below has considered the cumulative impact of existing and approved sources of air emissions in the region and the emissions for the Revised Proposal. Due to a significant advance in engineering design, along with the use of a new version of the air quality model, results previously presented in the EIS/ERMP (Chevron Australia 2005a) are not directly comparable to the results of the assessment presented in this Section.

No unacceptable impacts to human health or the environment arise from the air emissions associated with the Revised Proposal. Predicted ambient air quality remains well below defined criteria for all modelled air emissions except for ozone in the non-routine case where CO₂ venting occurs. In this case, ground level concentrations stay below, but close to the 1-hr NEPM criteria.

It is considered that, with regard to air emissions, the Revised Proposal does not present significantly different environmental risk in comparison to the Approved Development.

A detailed description of air emission sources, meteorological data analysis, modelling methodology and model configuration is presented in Appendix G and summarised below.

9.2.2 Air Emissions

9.2.2.1 Air Emissions from Existing and Approved Projects

Air quality in the vicinity of the Revised Proposal is expected to be influenced by the following projects (existing and approved):

- ◆ Woodside LNG operations (including trains four [operational] and five [approved]) – Burrup Peninsula
- ◆ future approved Pluto LNG project – 190km north-west of Karratha
- ◆ existing Hamersley Iron Power Station - Dampier
- ◆ existing condensate production operations on Barrow Island (operated by the Barrow Island Joint Venture)
- ◆ existing Burrup Fertilisers ammonia production facilities – Burrup Peninsula
- ◆ shipping emissions (from above mentioned operations).

Other air emission sources in the region, such as Varanus Island, do not contribute significantly to the regional emissions concentrations and hence, have not been included in the model setup.

Collectively, the key air emissions from these operations are considered to be oxides of nitrogen (NO_x), particulates (PM₁₀), sulphur dioxide (SO₂), carbon monoxide (CO), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).

9.2.2.2 Air Emissions from the Approved Development

The key sources of air emissions during the operational phase of the Approved Development, as identified in the EIS/ERMP (Chevron Australia 2005a) include:

- ◆ power generation (4 turbines)
- ◆ process area compression gas turbines (4 turbines)
- ◆ heating medium heaters (furnaces)
- ◆ flaring of hydrocarbons (main plant flare and boil off gas (BOG) flare)
- ◆ CO₂ venting (non-routine)
- ◆ shipping (supply vessels and LNG and condensate tanker movements).

9.2.2.3 Air Emissions from the Revised Proposal

In comparison to the Approved Development, the Revised Proposal includes the following key additional sources of air emissions, being:

- ◆ one additional power generation turbine (a total of five gas turbine generators, all fitted with DLN burners). Note that as Gorgon Gas Development's engineering design has advanced it has been determined that all gas turbines will be fitted with DLN burners. At the time of the EIS/ERMP assessment, only process area compression gas turbines were designed to be fitted with DLN burners
- ◆ two additional process area compression gas turbines (a total of six gas turbines, all fitted with DLN burners and waste heat recovery units)
- ◆ one additional BOG elevated flare on hot stand-by (note the additional BOG flare is not a change from the Approved Development, but it was not identified as a source of emissions in the EIS/ ERMP (Chevron Australia 2005a).

The key air emissions from the Revised Proposal will be from the combustion of fuel gas in the process and power generation plant gas turbines, flaring hydrocarbons during routine and non-routine plant operations and CO₂ venting (non-routine in the event the CO₂ injection process is not operational). CO₂ venting occurs at the Acid Gas Recovery Units (AGRUs). While there are no additional point sources for CO₂ venting, the flow through the previously defined AGRU units will be increased during non-routine venting.

The key air emissions associated with the Revised Proposal from the combustion of natural gas include CO₂ and NO_x, together with some CO and non-combusted hydrocarbons or volatile organic compounds VOCs. There may also be traces of PM₁₀ and sulphur dioxide (SO₂). During CO₂ venting, trace quantities of H₂S and BTEX (precursor to ozone formation) would also be vented to the atmosphere with the CO₂.

The key emissions anticipated to be influenced by the change from the Approved Development to the Revised Proposal are CO, NO_x, PM₁₀ and SO₂. Refer to Section 12 for detailed discussion relating to greenhouse gases.

A conceptual layout of the Revised Proposal Gas Treatment Plant highlighting the proposed location of the key emission sources is shown in Figure 9.1.

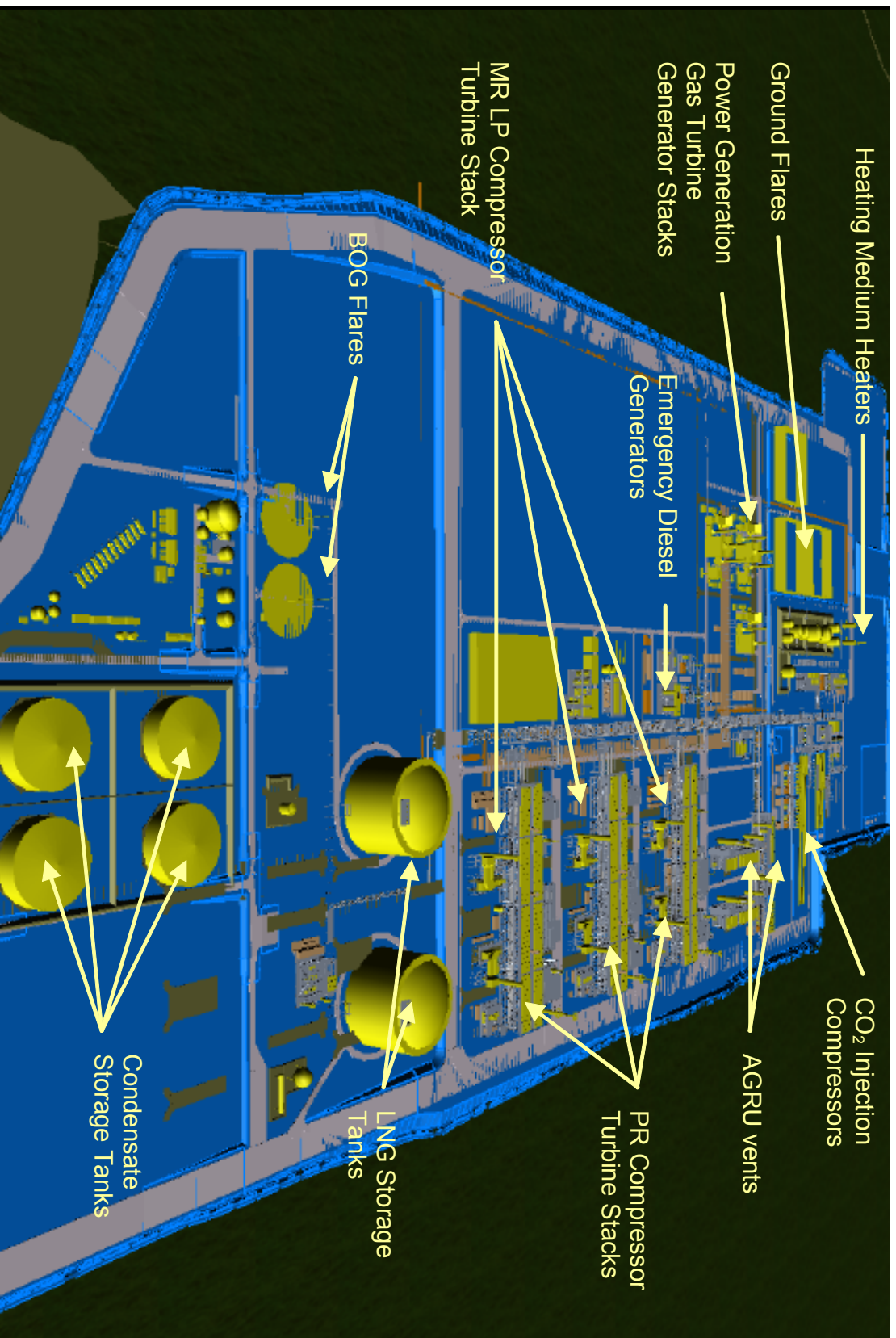


Figure 9.1: Conceptual Layout of Proposed 3 x 5 MTPA Gas Processing Facility

9.2.3 Atmospheric Dispersion Modelling Methodology

9.2.3.1 Atmospheric Dispersion Model

Atmospheric dispersion modelling of key air emissions under a series of operating conditions has been performed and the results (ground level concentration of target species) assessed and compared to relevant criteria. The air quality assessment was carried out in accordance with DEC (formerly known as DOE) Guidelines for Air Quality Modelling (DOE 2006b).

For this assessment, the atmospheric dispersion model TAPM (The Air Pollution Model) was utilised. TAPM is a prognostic three-dimensional model designed by CSIRO that can be used to predict meteorological and air quality parameters on an hourly basis (Physick and Blockley 2001). The TAPM modelling package consists of a model and databases of synoptic meteorology, terrain and land use categories for the Australasian region. The region covered by the model extends approximately 300 km from Barrow Island across to the mainland with the Burrup Peninsula to the northern extent and Onslow to the south.

A detailed description of the meteorological data analysis, modelling methodology and model configuration is presented in Appendix G.

9.2.3.2 Receptors of Interest

The existing Chevron Camp and the proposed Gorgon Construction Village/Turnaround Camp are the selected sensitive receptor locations on Barrow Island. These locations are presented in Figure 9.2.

The potential impact of emissions to the health of the workforce located on Barrow Island has also been assessed under the routine and non-routine operating conditions.

Potential impacts to native vegetation have also been considered.

9.2.3.3 Air Quality Criteria

Air quality criteria in this assessment have been sourced from those listed in Section 9.1.

These criteria have been used to assess whether air emissions are harmful to human health and/or, the environment. The assessment criteria are summarised in Table 9.1.

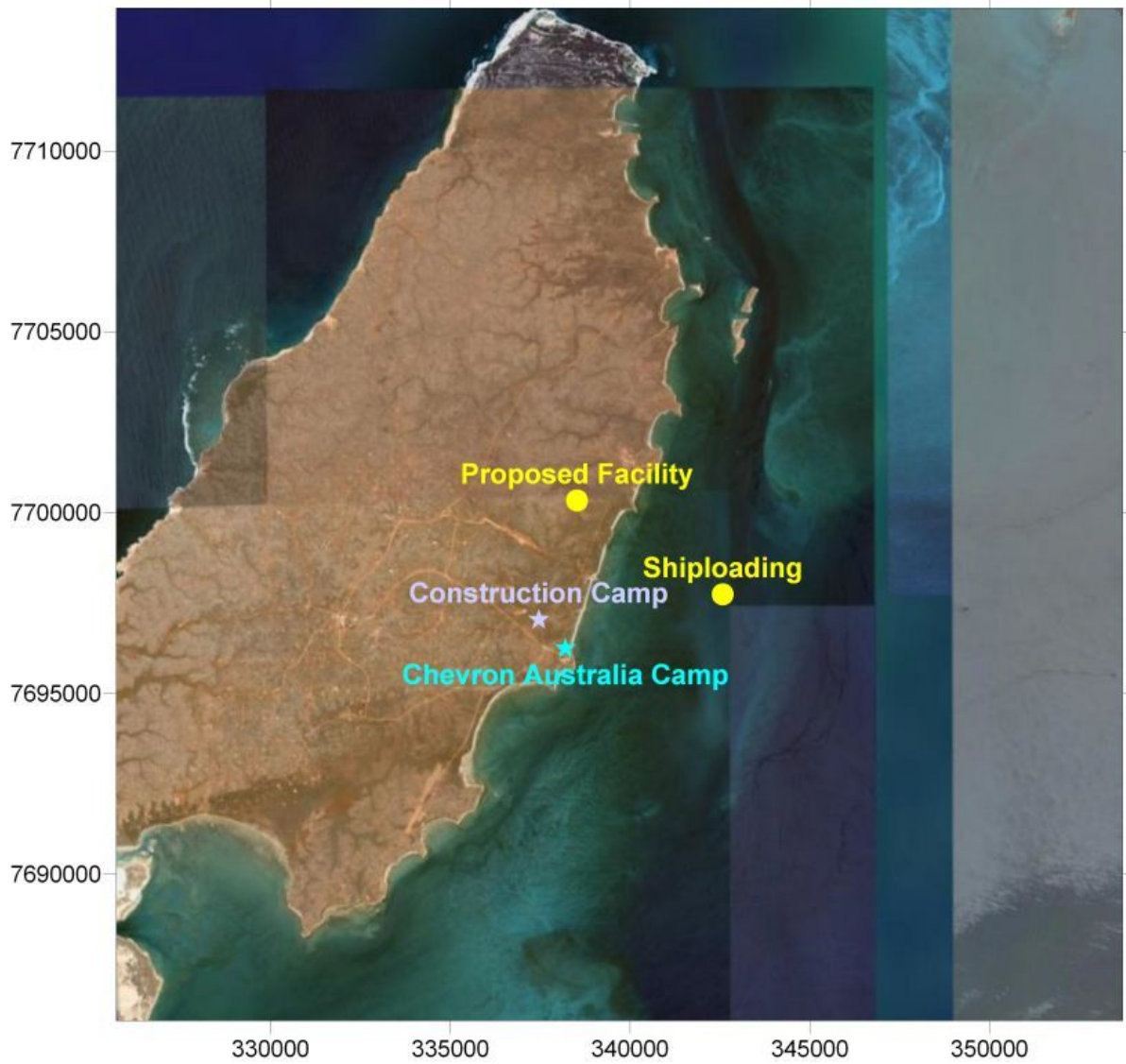


Figure 9.2: Location of Proposed Processing Facility, Shiploading and Sensitive Receptors

Table 9.1: Assessment Criteria

Emission Species	Criteria Category	Averaging Period	Assessment Criteria ($\mu\text{g}/\text{m}^3$)	Reference
SO ₂	Human Health Sensitive Receptors	1-hour	571	NEPM (NEPC 2003; 2004)
		24-hour	229	
		Annual	57	
	Human Health Occupational	8-hour TWA	5 200	WorkSafe (NOHSC 1995)
	Vegetation	Annual	8-16 kg/ha	WHO (WHO 2000)
NO ₂	Human Health Sensitive Receptors	1-hour	246	NEPM (NEPC 2003; 2004)
		Annual	62	
	Human Health Occupational	8-hour TWA	5–600	WorkSafe (NOHSC 1995)
	Vegetation (NO _x)	Annual	5–35 kg/ha ¹	WHO (WHO 2000)
		Annual	15–20 kg/ha ²	
PM ₁₀	Human Health Sensitive Receptors	24-hour	50	NEPM (NEPC 2003; 2004)
		Annual	30	
O ₃	Human Health Sensitive Receptors	1-hour	214	NEPM (NEPC 2003; 2004)
	Human Health Occupational	8-hour TWA	200	WorkSafe (NOHSC 1995)
H ₂ S	Human Health Occupational	8-hour TWA	14 000	WorkSafe (NOHSC 1995)

NOTES:

¹ critical load for nitrogen.

² specified by WHO for lowland dry heathlands as nitrogen.

9.2.3.4 Modelling Scenarios

In the absence of appropriate ambient air quality monitoring data for the Barrow Island location, atmospheric dispersion modelling of the existing and approved sources (for the Approved Gorgon Gas Development identified in Section 9.2.2.1) was undertaken to define the existing air quality.

A series of operating scenarios (both routine and non-routine) were modelled to assess the potential impacts arising from the discharge of emissions to the atmosphere from the Revised Proposal. The non-routine operations modelled are considered to represent reasonable worst-case conditions, and include:

- ◆ a cold start-up, i.e. start up of the facility after a prolonged shutdown, expected to occur at least once a year for a six hour period
- ◆ a process emergency shut-down, either planned or unplanned, that results in some gas being directed to the flare system for up to an hour
- ◆ a Reservoir Carbon Dioxide Injection System shutdown, planned or unplanned, resulting in reservoir CO₂ venting from the acid gas removal units to the atmosphere (trace quantities of H₂S will also be vented in this situation).

9.2.4 Results of Atmospheric Modelling

The air emission modelling was completed for the cumulative impacts of existing operations, approved projects and the Revised Proposal during operations. The maximum predicted concentration anywhere within the defined air quality assessment area (grid) is also reported and compared to the assessment criteria. A detailed discussion of all the modelling results is presented in Appendix G, including graphical representation (contour concentrations).

In summary, no unacceptable impacts to human health or the environment arise due to the air emissions associated with the Revised Proposal. All emissions modelled are within the assessment criteria.

9.2.5 Potential Impact to Human Health (Sensitive Receptors)

This section summarises the atmospheric dispersion modelling results with regard to the sensitive receptor locations and the relevant NEPM assessment criteria.

9.2.5.1 Modelling Results for Existing and Approved Projects

Model predictions show that the existing concentrations of NO₂ (both short and long-term duration) are relatively low across the regional model grid when compared with the assessment criteria (based on the NEPM standards). The maximum predicted 1-hour, and annual NO₂ concentrations are very low, being 6.1% and 0.3% of the respective assessment criteria (based on the NEPM standards) at the existing Chevron Camp on Barrow Island.

The model prediction for ozone demonstrates the regional influence of emissions sources on the Burrup Peninsula. Both the 1-hour ozone and 4-hour ozone concentration on Barrow Island are within the assessment criteria (based on the NEPM standards). The maximum concentrations on the larger modelling grid are equivalent to 61.2% and 63.6% of the assessment criteria, respectively and occur near the Burrup Peninsula on mainland Western Australia. Predicted ozone levels at Barrow Island are significantly lower, with the 1-hour maximum concentration at the Chevron Camp being 35.5% of the NEPM criteria.

Model predictions show that the existing concentrations of SO₂ (both short and long-term duration) are relatively low across the regional model grid when compared with the assessment criteria, (based on the NEPM standards). The maximum predicted 1-hour, 24-hour and annual SO₂ concentrations are very low, being 0.1%, 0.04% and 0.02% of the respective assessment criteria (based on the NEPM standards) at the existing Chevron Camp on Barrow Island.

These modelled results (i.e. concentrations well below relevant assessment criteria on Barrow Island) are to be expected, given the relatively small sources currently located on Barrow Island and the scale of development and emissions from the Burrup Peninsula.

9.2.5.2 Modelling Results for the Revised Proposal

Table 9.2 and Table 9.3 summarise the maximum modelled emissions concentrations at the Chevron Australia Camp and the proposed Gorgon Construction Village, respectively. These results are presented for existing and approved operations and for routine and non-routine operation of the Revised Proposal, as a percentage of the assessment criteria (based on NEPM standards).

Table 9.2: Maximum Predicted Percentages of Assessment Criteria at Existing Chevron Camp

Air Emission	Assessment Criteria ($\mu\text{g}/\text{m}^3$) (NEPC 2003; 2004)	Averaging Period	Percentage of Assessment Criteria				
			Existing and Approved	Revised Proposal			
				Routine	Cold Start	Emergency Shutdown	CO ₂ Venting
NO ₂	246	1-hour	6.1	8.1	33.3	6.5	7.7
O ₃	214	1-hour	35.5	37.9	46.7	37.9	93.5
SO ₂	571	1-hour	0.1	0.9	0.7	0.5	0.9
PM ₁₀	50	24-hour	n/a	0.6	0.6	0.6	1.6

Table 9.3: Maximum Predicted Percentages of Assessment Criteria at Proposed Gorgon Construction Village

Air Emissions	Assessment Criteria ($\mu\text{g}/\text{m}^3$) (NEPC 2003; 2004)	Averaging Period	Percentage of Assessment Criteria				
			Existing and Approved	Revised Proposal			
				Routine	Cold Start	Emergency Shutdown	CO ₂ Venting
NO ₂	246	1-hour	7.3	8.5	33.3	8.5	8.5
O ₃	214	1-hour	35.5	37.9	46.7	37.9	93.5
SO ₂	571	1-hour	0.1	1.1	1.1	0.5	1.1
PM ₁₀	50	24-hour	n/a	0.6	0.7	0.6	1.6

Elevated levels of ozone are predicted to occur during non-routine CO₂ venting events. The modelling for this non-routine condition was conducted for every hour of the year, making the results extremely conservative.

9.2.6 Potential Impact to Occupational Health (Workforce)

The potential impact of emissions to the health of the workforce located on Barrow Island has also been assessed under the routine and non-routine operating conditions.

No unacceptable impacts to the occupational health of the workforce arise from the emissions associated with the Revised Proposal. All air emissions modelled are well below the relevant occupational exposure criteria. The maximum concentration for all emissions modelled was less than 15% of the relevant occupational health criteria (H₂S).

Table 9.4 summarises the maximum modelled emission concentrations on Barrow Island. These results are presented as a percentage of the assessment criteria (based on WorkSafe standards [NOHSC 1995]).

Table 9.4: Maximum Predicted Ground Level Concentration on 1-Km Modelled Grid During Routine and Non-Routine Operating Conditions

Air Emission	Assessment Criteria TWA ($\mu\text{g}/\text{m}^3$) (NOHSC 1995)	Averaging Period	Percentage of Assessment Criteria				
			Existing	Revised Proposal			
				Routine	Cold Start	Emergency Shutdown	CO ₂ Venting
NO ₂	5 600	8-hour	0.14	0.25	1.5	0.22	0.28
O ₃	200	8-hour	30	38	41	37	50
SO ₂	5 200	8-hour	0.001	0.12	0.11	0.08	0.12
H ₂ S	14 000	8-hour	NA	NA	NA	NA	12.7

9.2.7 Potential Impact to Vegetation

The potential impact of emissions on the vegetation of Barrow Island has been assessed by comparison to the WHO standards (WHO 2000) for the deposition of SO₂ and NO₂. In the absence of local standards, and as agreed to in the scoping stages of the assessment process (Chevron Australia 2008d), it has been determined that these criteria are the most relevant available.

The modelled deposition rates in the region around Barrow Island due to the air emissions associated with the Revised Proposal are well within the specified limits. Results (contour concentrations) are provided in Appendix G. The results are summarised in Table 9.5.

Table 9.5: Maximum Predicted Deposition Rates in the Region

Air Emissions	Assessment Criteria (kg/ha/annum) (WHO 2000)	Maximum on Grid – Existing and Approved (kg/ha/annum)	Maximum on Grid Revised Proposal (kg/ha/annum)
SO ₂	8–16	0.02	0.16
NO ₂	5–35 (critical load for nitrogen) 15–20 (critical load for heathlands)	0.34	0.61

9.3 Proposed Management Actions

The GJVs will undertake the following approach to the management of air emissions from the Revised Proposal:

- ◆ best practice management in the design and construction of the LNG facilities
- ◆ installation of DLN technology on turbines to minimise NO_x emissions

The management of air quality impacts will be addressed by several EMPs, systems and monitoring programs that are required under conditions prescribed for the Approved Development under Statement No. 748 and Commonwealth approval EPBC Reference: 2003/1294.

As part of the implementation of Statement No. 748, the proponent will submit the following, which will include discussion of air quality:

- ◆ Terrestrial and Subterranean Environment Protection Plan
- ◆ Best Practice Pollution Control Design
- ◆ Air Quality Management Plan

- ◆ Marine Facilities Construction EMP
- ◆ Horizontal Direction Drilling Management and Monitoring Plan
- ◆ Offshore Gas Pipeline Installation Management Plans

The objectives and key management actions for each of these documents are detailed in Section 15.0.

Operations and construction environmental management plans for the Revised Proposal will also be developed to be consistent with Commonwealth Approval Decision EPBC Reference: 2003/1294.

The purpose, scope and objectives of the EMPs, programs and systems required under the conditions of approval for the Approved Development have been reviewed and it is considered that the air emissions – related impacts and risks associated with the Revised Proposal can be effectively managed under the Ministerial Conditions already set by the Western Australian Minister for the Environment (and described in Statement No. 748) for the Approved Development. No additional measures or controls are anticipated to be necessary to manage the potential air quality impacts associated with the Revised Proposal.

9.4 Predicted Environmental Risk

Based on the modelling completed, the air emissions arising from the routine operation of the Revised Proposal can be managed to achieve the EPA's objective for air quality (i.e. air emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses).

Similarly, the conservative approach adopted for the modelling of air emissions during the non-routine upset conditions, also demonstrates that the potential impacts are manageable during these periods and the desired environmental outcome is achieved.

The addition of the Gorgon Gas Development as a regional emission source will influence ground level concentrations of emissions both at Barrow Island and on the mainland in the vicinity of the Burrup Peninsula. However, there are no unacceptable cumulative impacts related to air emissions as a result of the Gorgon Gas Development. The relative increase in regional concentrations is not significant, and the EPA's air quality objective in the region is achieved.

Based on these results, the GJVs are confident that the changes associated with the Revised Proposal can be effectively managed under the Ministerial Conditions already set by the Western Australian Minister for the Environment (and described in Statement No. 748). No additional measures or controls are anticipated to be necessary to manage the potential air quality impacts.