APPENDIX E AIR ASSESSMENT REPORT

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Mahalo North Coal Seam Gas Project – Air Quality Assessment

Prepared for:

Epic Environmental

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Final

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Ground Floor, 16 Marie Street | PO Box 2217
Milton, Brisbane, Queensland, 4064, Australia

www.katestone.global
admin@katestone.com.au
Ph +61 7 3369 3699

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Contents

Tables

Figures

Glossary

Term	Definition
µg/m³	micrograms per cubic metre
mg/m³	milligrams per cubic metre
mg/Nm³	milligrams per normal cubic metre
%	percent
°C	degrees Celsius
K	Kelvin
g/s	grams per second
km	kilometres
m	metres
m/s	metres per second
m²	square metres
m³	cubic metres
m³/s	cubic metres per second
Nomenclature	**Definition**
O_2	oxygen
CO	carbon monoxide
NO	nitrogen monoxide
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
PM_{10}	particulate matter with a diameter less than 10 micrometres
Abbreviations	**Definition**
Air NEPM	National Environmental Protection (Ambient Air Quality) Measure
BoM	Bureau of Meteorology
DESI	Department of Environment Science and Innovation
EA	Environmental Authority
EP Act	*Environmental Protection Act 1994*
EPP (Air)	Environmental Protection (Air) Policy 2019
GCF	Gas compression facility
IOA	index of agreement
NEPC	National Environment Protection Council
NPI	National Pollutant Inventory
PL	Petroleum Lease
QLD	Queensland
RMSE	root mean square error
TAPM	The Air Pollution Model

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Epic Environmental to conduct an air quality assessment of the Mahalo North Coal Seam Gas Project (the Project) to assist Comet Ridge Mahalo North Pty Ltd (Comet Ridge) with an application for the Environmental Authority (EA).

Comet Ridge plans to construct and operate a greenfield coal seam gas facility on land that is covered by Authority to Prospect (ATP) 2048. The site is located approximately 41 km northeast of Springsure, in the Bowen Basin. The Project is expected to comprise of up to 68 wells (34 lateral and 34 vertical), gas gathering lines, a petroleum pipeline, and a gas compression facility. An engine will power wellhead pumps at every wellhead site and two engines will power equipment such as gas compression units, gas dehydration and separation units, and other ancillary equipment at the gas compression facility.

An initial air quality assessment was completed by Katestone in June 2023 and submitted to the Department of Environment, Science and Innovation (DESI) (the administering authority) on 20 October 2023. DESI provided an Information Request in response, dated 31 January 2024. This revised report addresses the comments received by DESI as well as incorporates changes to the management of emissions from the Waukesha units, (that now include a 3-way catalyst) and locations of some of the well head engines.

Dispersion modelling has been conducted using the dispersion model CALPUFF to model emissions of oxides of nitrogen (NO_X) and carbon monoxide (CO). Ground-level concentrations of these air pollutants have been predicted at nearby residential sensitive receptors and across a Cartesian grid of receptors and assessed against the relevant air quality objectives in the *Environment Protection (Air) Policy 2019* (EPP (Air)) and air quality standards specified in the *National Environment Protection (Ambient Air Quality) Measure 2021* (Air NEPM). A cumulative assessment has been conducted including the addition of ambient background concentrations of air pollutants. These background concentrations were determined from measurements collected at air quality monitoring stations in locations with intensive coal seam gas operations.

The assessment of the facility at maximum operations (i.e., all possible engines running continuously at 100% load) found:

- Predicted 8-hour average ground-level concentrations of CO are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 2.3% the EPP (Air) objective and Air NEPM standard.
- Predicted 1-hour average ground-level concentrations of NO_2 are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 4.1% of the EPP (Air) objective, and less than 6.2% of the Air NEPM standard.
- Predicted annual average ground-level concentrations of NO_2 are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 7.0% of the EPP (Air) objective, and less than 14% of the Air NEPM standard.
- The emission concentration of NOx for the Waukesha units is 428 mg/Nm^3 @ 7%O_2. This is below the emission limit specified in the NSW Protection of the Environment Operations (Clean Air) Regulation 2022 which is 450 mg/Nm^3 @ 7%O_2, therefore meeting best practice requirements.

The assessment has demonstrated that the maximum ground-level concentrations of NO_2 and CO are predicted to be below the air quality objectives at all sensitive receptor locations and across the study area. Thus, it is concluded that the Project will not have a significant impact on local air quality.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Epic Environmental to complete an air quality assessment of the Mahalo North Coal Seam Gas Project (the Project). Epic Environmental has been engaged by Comet Ridge Mahalo North Pty Ltd (Comet Ridge) to prepare the Environmental Authority (EA) application to authorise petroleum activities within the petroleum lease (PL).

Comet Ridge plans to construct and operate a greenfield coal seam gas facility on land that is covered by PL1128. The site is located approximately 41 km northeast of Springsure, in the Bowen Basin. The Project is expected to comprise of the following:

- Up to 68 wells (34 lateral and 34 vertical)
- Gathering lines
- Petroleum pipeline
- Gas compression facility (GCF).

At each well site, engines (i.e., generators) will power wellhead pumps that will generate emissions primarily of oxides of nitrogen (NO_X) and carbon monoxide (CO). Engines will also be used at the gas compression facility (GCF) emitting both NO_X and CO.

An initial air quality assessment was completed by Katestone in June 2023 and submitted to the Department of Environment, Science and Innovation (DESI) (the administering authority) on 20 October 2023. DESI provided an Information Request in response, dated 31 January 2024. This revised report addresses the comments received by DESI on 31 January 2024 and includes updates to proposed operations, including management of emissions from the Waukesha units, (that now include a 3-way catalyst) and locations of some of the well head engines.

2. RESPONSE TO INFORMATION REQUEST

The comments received by DESI in relation to air quality are presented in Table 1 along with an explanation of how and where they are addressed in the report.

Table 1 Comments from the administering authority (DESI)

Item	Issue	Katestone comments
13	Issue Table 1 of the Air Report lists the ambient air quality objectives for *Environmental Protection (Air) Policy 2019* (EPP (Air)) and the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM). The Air NEPM values presented for NO_2 and CO have been superseded by the updated objective in 2021. The latest Air NEPM emission standards consider emerging evidence about the health impacts of NOx and other emissions, as reported by the World Health Organisation. Action required Please provide a discussion on how the activity emissions will contribute to the best practice ambient emission concentrations in line with the most recent NEPM values.	The initial air quality assessment (Document reference D22067-3) (June 2023 assessment) and this revised assessment presented the air quality objectives and standards as specified in the: - *Environmental Protection (Air) Policy 2019* - *National Environment Protection (Ambient Air Quality) Measure* 2021. These are discussed in Section 3 and Table 2 of this report. Predicted ground-level concentrations are compared to these values in Table 8 of this report.
14	Issue Appendix G- 'Air Quality Assessment'- provides an air quality technical report for the project but includes no details on emission controls. The report uses a NO_X emission rate of 6.15 g/s for each of the engine parameters for the gas compressing equipment. This is substantially above emission rates that could be considered best practice. For comparison, the US performance standard for NO_X for engines of this type is 2g/hp/hr. The emissions rate proposed is equivalent to approximately 11.65 g/hp/hr. The EU directive 2015/2193 would place a limit of 190 mg/Nm^3 for new engines, and the standard of concentration under the NSW Protection of the Environment Operations (Clean Air) Regulation 2021 is 450 mg/m^3 at 3% O_2. Further, the report uses a CO emission rate of 4.80 g/s for each of the engine parameters for the gas compressing equipment. The standard of concentration for CO emissions for engines of this type under the NSW Protection	The two engines proposed to power equipment at the GCF have been revised since the June 2023 assessment. Equipment at the GCF will be powered by two Waukesha 7044 Generation 5 gas compressors fitted with emissions controls in the form of a 3-way catalyst and silencer. The 3-way catalyst and silencer will significantly reduce emissions of key pollutants to air compared to the units assessed in the June 2023 assessment. The Waukesha engines assessed in the June 2023 assessment had an exhaust concentration of 4,648 mg/Nm^3 @ 7%O_2 for NO_X, and 3,634 mg/Nm^3 @ 7%O_2 for CO. The post-treatment NO_X emission concentration in the exhaust of each of the Waukesha engines is 372 mg/Nm^3 @ 7%O_2. The post-treatment CO emission concentration is also 372 mg/Nm^3 @ 7%O_2. A buffer of 15% has been applied to the exhaust concentration of NO_X and CO for use in the air quality assessment and recommended EA Condition

<table>
<tr><th>Item</th><th>Issue</th><th>Katestone comments</th></tr>
<tr><td></td><td>
of the Environment Operations (Clean Air) Regulation 2021 is 125 mg/m^3 at 3% O_2.

<u>Action required</u>

1. In order to develop reasonable conditions, please identify what NO_X controls will be put in place to ensure that best practice emission rates can be achieved.

2. For each of the release points proposed, complete the Table-Point source air release limits as shown below.

<table>
<tr><th>Release point and description</th><th>Min. release height above ground (m)</th><th>Min. velocity (m/sec)</th><th>Min. temperature (°C) <delete if not applicable></th><th>Contaminant</th><th>Max. concentration release limit (g/s)</th><th>Max. mass release limit <delete if not applicable></th><th>Monitoring Frequency</th></tr>
<tr><td>Example</td><td>5</td><td>37.56</td><td>852K</td><td>CO</td><td>4.8 g/s</td><td></td><td></td></tr>
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licence limits. The increase in the exhaust NO_X concentration to 428 mg/Nm^3 @ 7%O_2, and the CO concentration to 428 mg/Nm^3 @ 7%O_2, is to allow for any degradation in the equipment over time to ensure the equipment remains compliant with limits specified in the licence. Actual emissions of NO_X and CO from the Waukesha units will be below the concentrations specified.

The assessed post treatment NO_X emission concentration in the exhaust of each of the Waukesha engines of 428 mg/Nm^3 @7%O_2 is below the following referenced best practice values:

• The European Union (EU) directive 2015/2193 of 190 mg/Nm^3 @ 15%O_2
• The NSW Protection of the Environment Operations (Clean Air) Regulation 2022 of 450 mg/Nm^3 @ 7%O_2

Whilst the assessed post treatment CO emission concentration in the exhaust of each of the Waukesha engines of 428 mg/Nm^3 @ 7%O_2 is above the NSW Protection of the Environment Operations (Clean Air) Regulation 2022 standard of 125 mg/Nm^3 @ 7%O_2, the implementation of the emissions control technology on the units has resulted in a significant reduction in emissions of both NO_X and CO, and NO_X, the key pollutant of interest, satisfies the relevant emission standard limits. In addition, the results of the air quality assessment show that the predicted maximum incremental ground-level concentrations of CO due to the Project are, at most, 0.07% of the EPP (Air) objective and Air NEPM standard.

The recommended Conditions of Approval in relation to air for the Project informed by the results of the air quality assessment are provided in Section 8 of this report. Conditions relate to release points and contamination limits to air (Table 7).
</td></tr>
</table>

3. LEGISLATIVE FRAMEWORK FOR AIR QUALITY

3.1 Environmental Protection (Air) Policy

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. The EP Act gives the administrating authority (i.e., Department of Environment Science and Innovation (DESI)) the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. *The Environmental Protection (Air) Policy* (EPP (Air)) was made under the EP Act and gazetted in 1997; the EPP (Air) was revised and reissued in 2019.

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 objective 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 health and biodiversity of ecosystems
- human health and wellbeing
- protecting the aesthetics of the environment, including the appearance of building structures and other property and
- protecting agricultural use of the environment.

The administering authority 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 indicators and objectives for specific air pollutants.

The EPP (Air) defines air quality objectives for enhancing or protecting the environmental values. The objectives relevant to the key air pollutants that may be generated from the Project are presented in Table 2.

Also relevant is DES' *Application requirements for activities with impacts to air*, which outlines the information to be provided as part of the application process for environmentally relevant activities and how the information is used. This outlines how the proposed activity will be assessed by comparison with the requirements stipulated in the EP Act. In particular, this requires an application to include, if applicable:

- description of the site and surrounding areas, including topography, prevailing winds and ambient air quality (covered in Section 5 and Appendix A of this report)
- identification of any nearby sensitive places must be identified and assessed appropriately (covered in Section 5.2 of this report)
- identification and evaluation of possible impacts on air quality (covered in Section 7 of this report)
- Proposed management of emissions (covered in Section 6 of this report).

This air quality assessment has been conducted in accordance with these requirements.

3.2 National Environment Protection (Ambient Air Quality) Measure

The National Environment Protection Council (NEPC) defines national ambient air quality standards and goals in consultation, and with agreement from all Australian state and territory governments. *National Environment Protection (Ambient Air Quality) Measure 2021* (Air NEPM) contains, amongst other parameters, standards for nitrogen dioxide (NO_2) and CO. Compliance with the Air NEPM standards is determined by ambient air quality monitoring undertaken at locations prescribed by the Air NEPM and that are representative of large urban populations.

3.3 Air quality objectives

Table 2 Ambient air quality objectives (lowest of EPP (Air) and Air NEPM)

Pollutant	Environmental value[(a)]	Averaging period	Air quality objective ($\mu g/m^3$)[(b)]	Reference
NO_2	Health and wellbeing	1-hour	250 / 164	EPP (Air) / Air NEPM
		1-year	62 / 31	EPP (Air) / Air NEPM
	Health and biodiversity of ecosystems	1-year	33	EPP (Air)
CO	Health and wellbeing	8-hour[(c)]	11,000	EPP (Air) and Air NEPM

Table notes:
[(a)] As prescribed by the EPP (Air)
[(b)] At STP, 0°C and 1atm
[(c)] Rolling 8-hour average based on 1-hour averages

4. AIR QUALITY ASSESSMENT METHODOLOGY

4.1 Existing environment

The assessment includes an analysis of the characteristics of the existing environment (Section 5) in the Project area that are important for the dispersion of air pollutants and that may influence the level of air pollutants at sensitive receptors. Characteristics include terrain features, regional land uses, existing sources of emissions, existing ambient pollutant concentrations and the locations of sensitive receptors relative to the sources.

4.2 Emissions

4.2.1 Construction

Emissions from construction activities are expected to be minimal and of no significance considering the distances between the activities and nearest sensitive receptors. Mitigation measures for consideration during construction are provided in Section 6.

4.2.2 Operation

Emissions from the operation of the facility will derive from the engines used to power the wellhead as well as those used at the GCF. Emission rates for the engines, as well parameters relating to the emission stacks, are gathered from specification sheets provided by the manufacturer of the engines. Section 6 further details the specification of the engines and their emission rates.

4.3 Meteorology

The dispersion modelling assessment was conducted using the most recent versions of the TAPM (version 4.0.5) and CALMET (version 6.5.0) models at the time of undertaking the study. A site-specific meteorological data file was generated for the Project site by coupling the prognostic model TAPM with the diagnostic metrological model CALMET.

The coupled TAPM and CALMET modelling system was developed to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale, and local atmospheric conditions, detailed topographic and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models such as CALPUFF.

Technical details of the TAPM and CALMET model configurations are provided in Appendix A.

4.4 Dispersion modelling

The CALPUFF model (version 7.2.1) has been used for dispersion modelling. CALPUFF is an advanced non-steady-state air quality modelling system. Twelve months of modelled meteorological data was used as input for the dispersion model to include all weather conditions likely to be experienced in the region during a typical year. These twelve months were chosen from the most representative year from analysis of 6 years of previous data, as described in Appendix A.

Emission sources were configured in CALPUFF based on the information for each source detailed in Section 6.2.

Details of the model configuration are provided in Section A2 of Appendix A.

4.5 Nitric oxide to nitrogen dioxide conversion

NO_X in exhaust plumes is made up of both nitric oxide (NO) and nitrogen dioxide (NO_2). Typical NO:NO_2 ratios at the point of release to the atmosphere are around 90%:10%. Once in the atmosphere, NO can undergo chemical transformation to form NO_2. The rate at which this conversion occurs depends on the solar reactivity of the atmosphere, presence of other molecules such as ozone, and time since release from the source.

NO_2 is more toxic than NO and is the reason why NO_2 has air quality assessment criteria rather than NO. As NO_X emitted from the engines is primarily NO (approximately 90%), it is important to adequately quantify the transformation of NO to NO_2 for comparison with assessment criteria.

There are various methods for estimating NO_2 concentrations from model predictions of NO_X as the plume disperses from the emission point. A simple and common approach has been taken for this assessment; it has been conservatively assumed that, for annual averaging periods, all NOx converts to NO_2. This will result in an over-prediction of actual annual average NO_2 concentrations. For 1-hour averaging periods, a more realistic approach has been taken assuming that 30% of NO_X is NO_2 (Bofinger et al, 1986).

4.6 Presentation of results

Modelling results have been presented as ground-level concentrations at sensitive receptors as well as contours across the modelling domain and are presented in Section 7. Results have been presented for the Project in isolation and with the inclusion of ambient background levels representative of the study area (as discussed in Section 5.3.2).

4.7 Limitations and uncertainty

This study relies on the accuracy of several data sets that feed into the dispersion model, all of which will have uncertainties associated with them. The input data sets include:

- Meteorological monitoring observations from the Bureau of Meteorology
- Air quality monitoring observations from the DESI
- Emissions data provided by the Project team
- Synoptic and surface information datasets from CSIRO.

It is also important to note that numerical models are based on an approximation of governing equations and will inherently be associated with some degree of uncertainty. The more complex the physical model, the greater the number of physical processes that must be included. There will be physical processes that are not explicitly accounted for in the model and, in general, these approximations tend to lead to an over prediction of air pollutant levels.

The dispersion model has been configured with conservative assumptions and, therefore, the assessment is likely to overpredict potential impacts of the Project.

5. EXISTING ENVIRONMENT

5.1 Local terrain and land-use

The Project is located in Central Queensland, roughly 75km southeast of Emerald and 45km north of Rolleston. Figure 1 displays a terrain map of the area surrounding the Project site. The Project is in a mid-lying area, between 160m and 240m Australian Height Datum (AHD). The terrain surrounding the proposed development increases slightly roughly 38km to the east, reaching a peak of about 360m AHD.

Land-use around the Project Site of interest primarily consists of grazing and agricultural land-use. There also exists mining land in the vicinity. Major industries relevant to air quality include coal mining and associated practices.

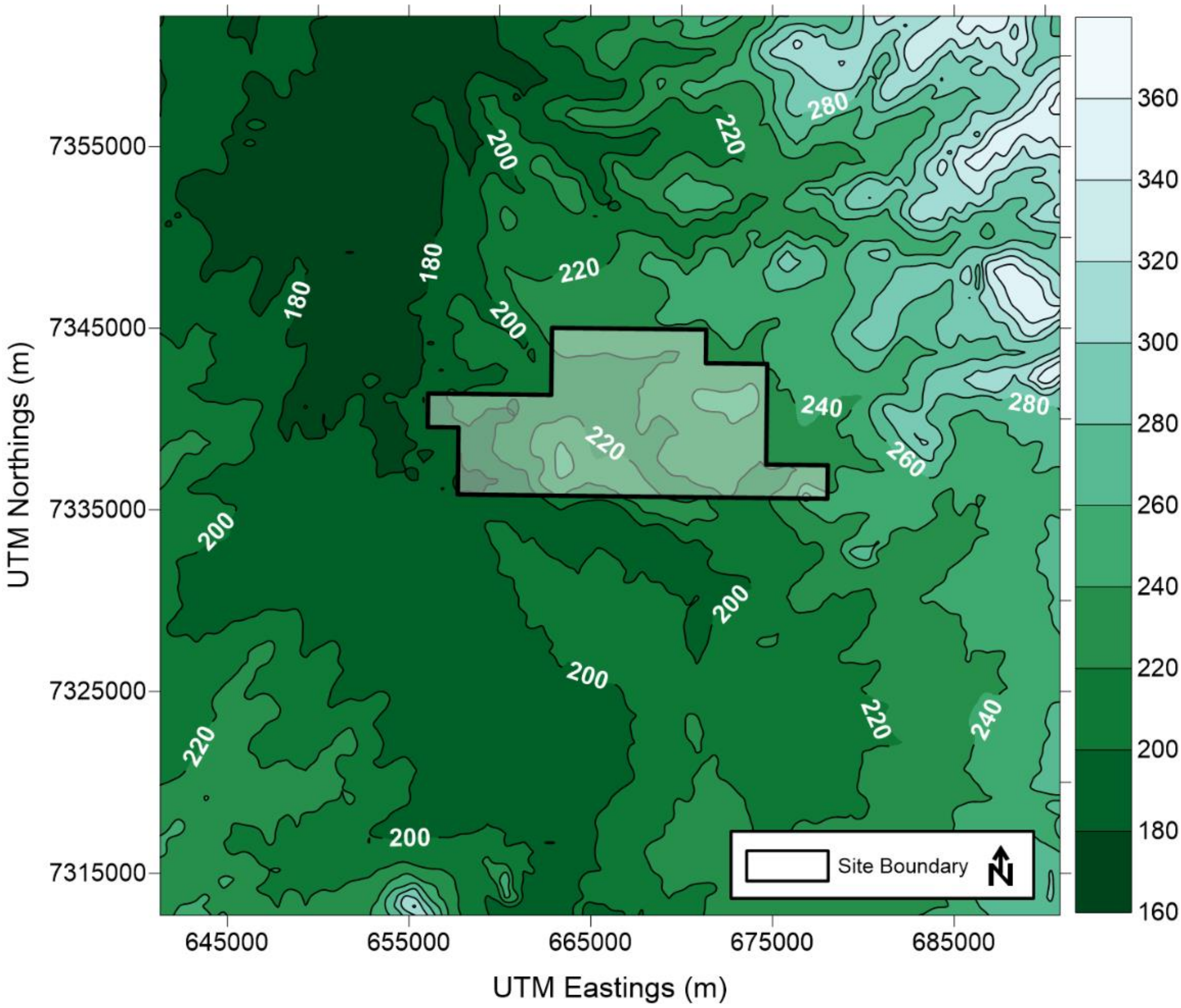


Figure 1 **Terrain surrounding the site boundary**

5.2 Sensitive receptors

Receptors in the vicinity of the Project were identified and provided by Epic Environmental. These are described in Table 3 and shown in Figure 2. All receptors identified are residential receptors.

Table 3 Nearest sensitive receptors to the Project

Receptor ID	Description	Easting (m)	Northing (m)	Distance from GCF(a) (km)
R1	Meroo	663156	7337313	2.6(b)
R2	Struan-Ringers Quarters	667959	7336696	2.3(b)
R3	Struan Homestead	668354	7336097	2.9(b)
R4	Togara	674656	7344948	11.6

Table notes:
(a) Centre of GCF is 665760mE, 7337444mN.
(b) Within the site boundary

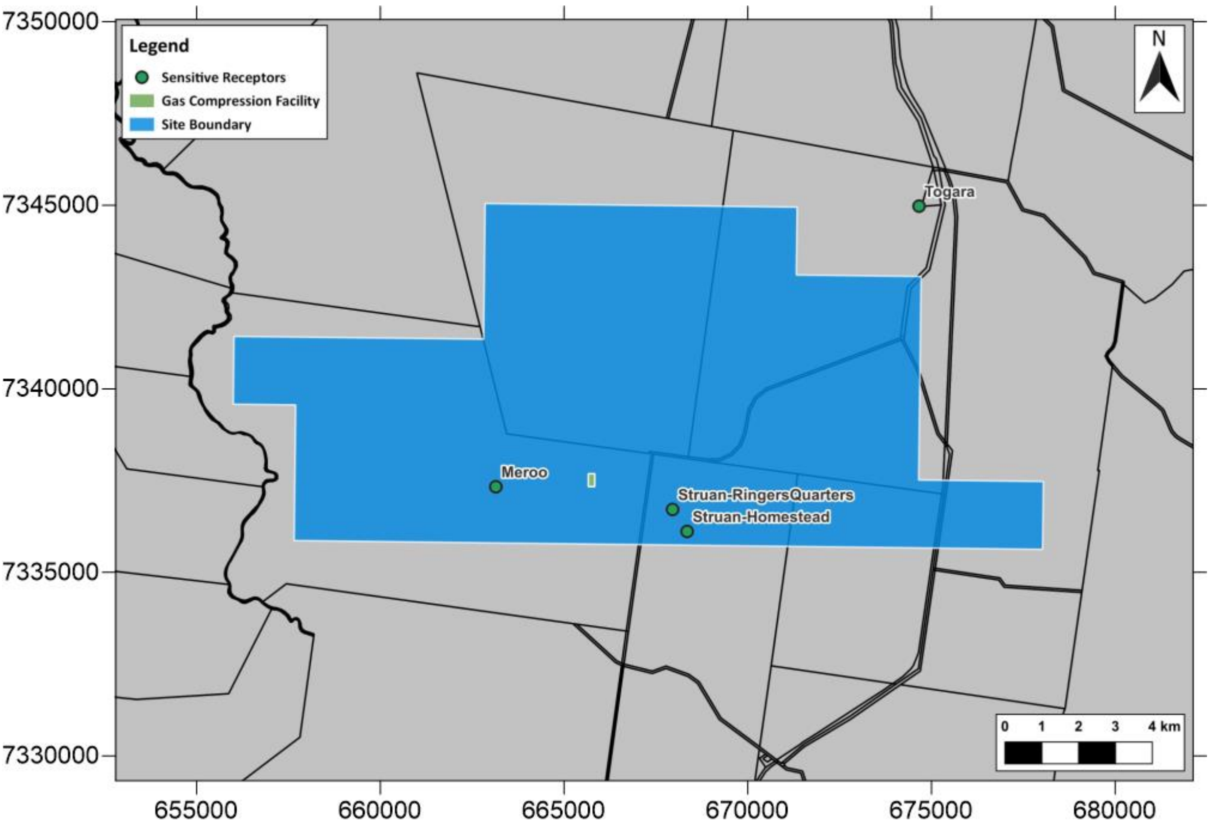


Figure 2 Nearest sensitive receptors

5.3 Existing air quality

5.3.1 Existing sources of emissions

Table 4 lists all facilities that reported oxides of nitrogen and carbon monoxide to the NPI within a 50 km radius of the Project during the 2020/21 reporting period. Though these industries operate in the regional airshed, there are no sources large enough to report to NPI within the model domain of this assessment (25 km radius of the Project site). Thus, it can be concluded that the ambient air quality is generally good.

Table 4 Existing emissions sources and their emissions (kg) reported to NPI in financial year 2020/21 within 50km of the GCF

Facility Name	NO_X	CO	Distance from GCF[(a)] (km)
Blackwater Mine	3,016,000	2,592,000	41
Glencore Coal Rolleston Open Cut Mine	1,144,018	424,346	47
Goonoo Feedlot	6,295	3,654	36
Meteor Downs Mine	154,422	68,611	48
North Denison	218,663	27,387	48
Table notes: (a) Centre of GCF is 665760mE, 7337444mN.			

5.3.2 Existing ambient air quality

DES is responsible for undertaking ambient air quality monitoring in Queensland. DES conducts monitoring at several monitoring stations in the region, as shown in Figure 3. Each monitoring station is located for a specific purpose such as measuring air quality near industry, measuring air quality at roadside or to demonstrate compliance with the requirements of the Air NEPM.

Ambient data of NO_X does not exist at any three of the locations identified in Figure 3. Each of the sites identified in Figure 3 only monitors particulate matter data (PM_{10} and $PM_{2.5}$), which is not relevant to the operational modelling conducted in this assessment. As shown in Table 4, there are no sources of emission within the model domain of the assessment (25 km) and as such, it is unlikely that concentrations of NO_X will be significant. Nevertheless, to gain insight into potential background levels of air pollutants due to coal seam gas fields, the ambient air quality data from the DES station at Hopeland in southeast Queensland has been analysed for the 2017 to 2021 period. Whilst located 363km away from the Project, the Hopeland station is near to intensive coal seam gas production, with coal mines operating in the region and will therefore serve as a conservative representation of ambient air quality. The data is presented in Table 5 along with the background levels used in this assessment.

Table 5 Background air quality measured at Hopeland DES monitoring station

Pollutant	Averaging Period	Assessment criterion (µg/m³)	Concentration (µg/m³)					
			2017	2018	2019	2020	2021	Used in assessment
NO_2	1-hour[a]	**164**	4.11	4.11	4.11	4.11	4.11	**4.11**
	Annual	**31**	4.05	4.05	3.81	3.68	3.43	**4.05**
CO	8-hour[(a)]	**11,000**	250	178	250	203	143	**250**
Table notes: (a) Concentrations derived as the 70th percentile of data								

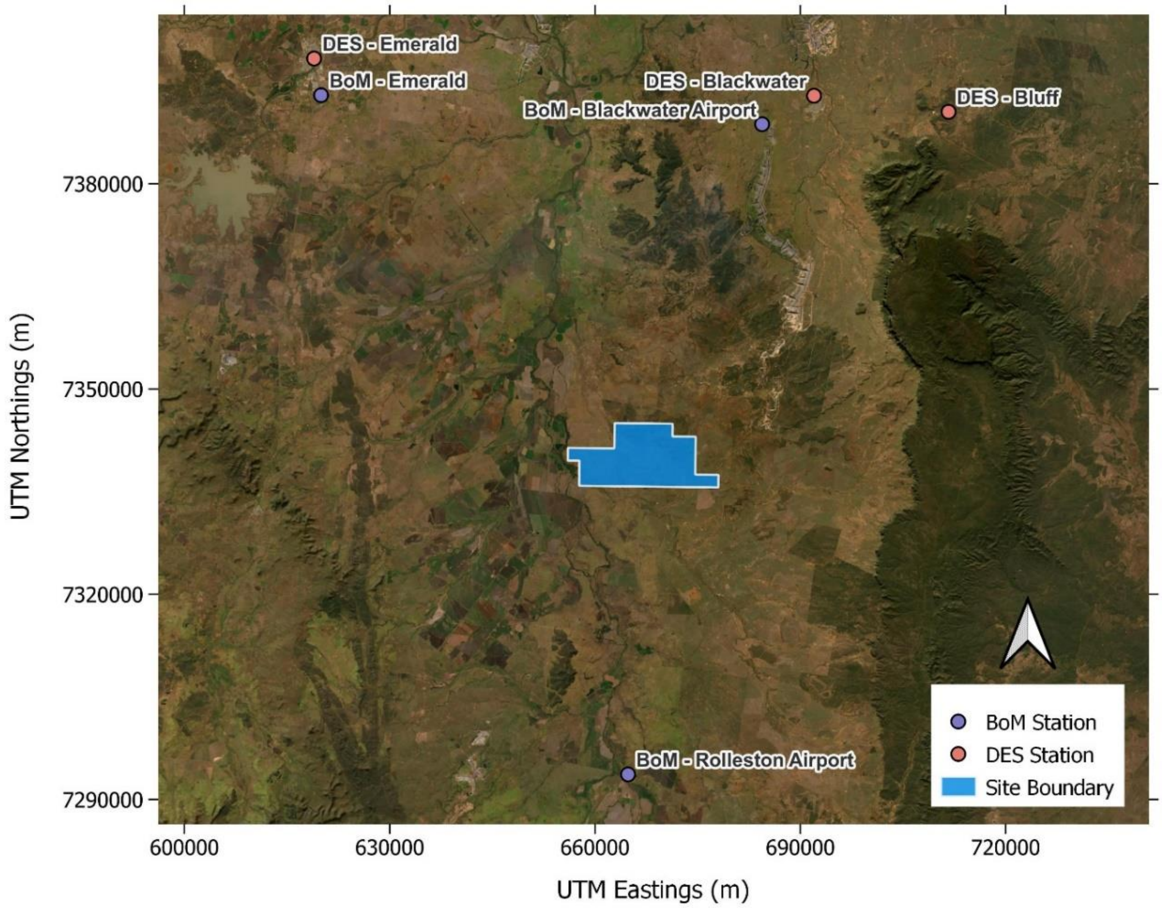


Figure 3 **Air quality monitoring locations**

5.4 Meteorology

Local meteorology is of paramount importance for dispersion of air pollutants generated by the Project's activities; key features are wind speed, wind direction, atmospheric stability, and boundary layer mixing height. Conditions in the local area, as derived from the meteorological modelling carried out for the assessment, are discussed in detail in Section A1.4 of Appendix A, but can be discussed in simple terms based upon the wind rose presented in Figure 4, which summarises the wind speed and direction in 2021.

Predicted annual average wind speed at the Project site in 2021 was 2.91 m/s, with winds most commonly coming from the south-eastern quadrant through the north-eastern quadrant. Winds are rarely from the north-west or south-west. In terms of annual average dispersion of pollutants, this can be expected to follow this general pattern, with the greatest impacts occurring downwind of the Project under the prevailing wind conditions; in this case, to the northwest to west-northwest.

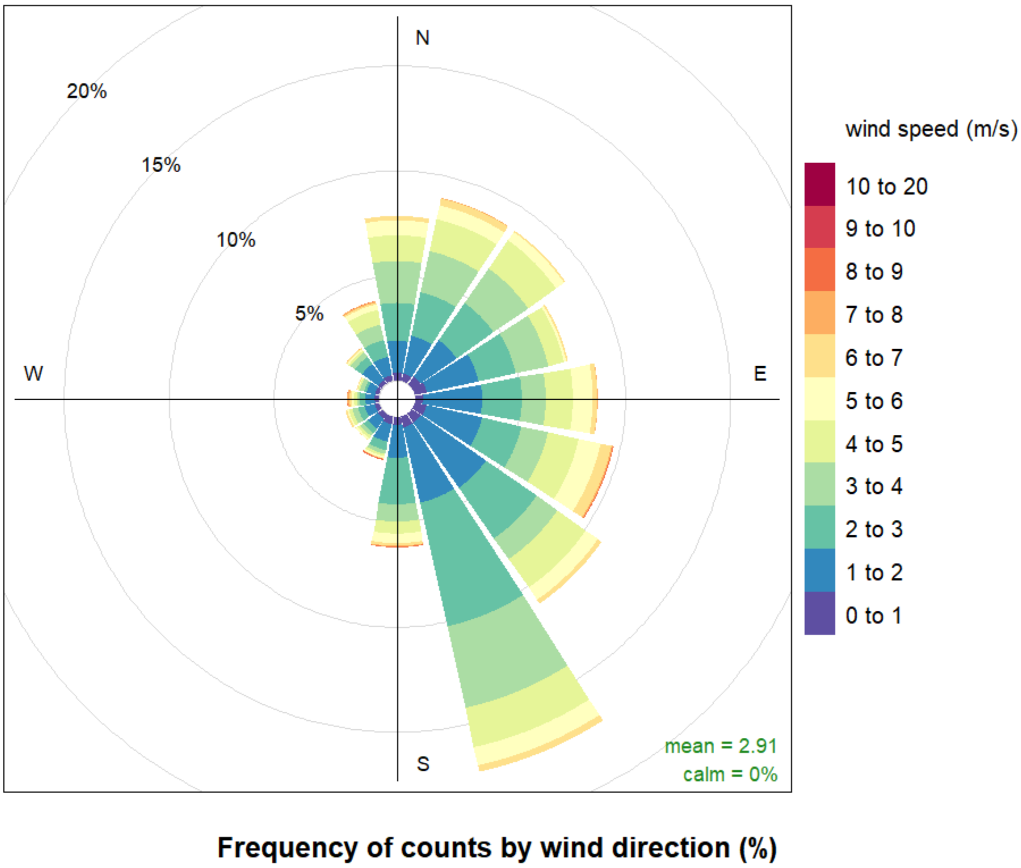


Figure 4 Annual wind rose for the Project site for 2021 (extracted from TAPM and CALMET)

6. EMISSIONS TO THE ATMOSPHERE

6.1 Construction emissions

The construction phase activities can be described broadly as structure and plant erection and installation, drilling and minor site clearance where needed. Emissions from these activities are expected to be minimal and of no significance considering the distances between the activities and nearest sensitive receptors.

Notwithstanding this, adoption of dust mitigation measures such as reducing vehicle speed on unsealed roads, watering of unsealed roads used by construction vehicles, application of sprays on drills, and minimising cleared areas will assist in minimising construction dust.

6.2 Operational emissions

The proponent seeks to drill 34 (vertical) wells over the course of the Project. The wells will be drilled progressively over 10 years, equating to approximately four wells drilled per annum. For each individual production well site, a diesel 20kVA engine (e.g., Staunch Yanmar or similar) will be operational for three to six months at 100% load (to initially de-pressurise the well) and then intermittently as needed. The 20kVA engine will supply power to a well-head pump and a downhole water pump; unlike the engine, neither pump will generate emissions.

Gas will be gathered centrally at the GCF, where two natural gas-powered engines (e.g. Waukesha VHP - L7044GSI S5 or similar) will provide power to gas compression units, gas dehydration and separation units, and other ancillary equipment. The GCF engines will be fitted with a 3-way catalyst and silencer designed to reduce emissions of key pollutants to air. The engines will run at 100% load, 24 hours per day for the lifetime of the Project. A third engine will be added at some point in the next 10 years, however only two engines will ever be used simultaneously (the rotating third engine will be powered down for maintenance). The GCF will also have a flare for emergency purposes only.

While only four engines at wellheads will be operating simultaneously, other engines could potentially be switched on sporadically to maintain well pressure levels and ensure continuous flow. Therefore, all 34 engines at each wellhead have been modelled at 100% load constantly for the year. This is a conservative assumption. The location of each of these engines in relation to the GCF can be seen in Figure 5, along with the layout of the GCF in Figure 6. Each ‘individual well’ will comprise of digging a vertical and horizontal well adjacent to one another. The engines will be located at one of these pairs. The other source of emission will come from the GCF, as shown in Figure 6. This area will host two engines operating at 100% load constantly through the year.

The emission parameters used in the dispersion modelling are described in Table 6 for wellhead engines, and in Table 7 for GCF engines. Emission rates are derived from product specification sheets, which are provided in Appendix B.

A buffer of a 15% increase has been applied to the emission rates of NO_X and CO from the Waukesha units at the GCF. This increase is to allow for any degradation in the equipment over time, including the 3-way catalyst and silencer, to ensure the equipment remains compliant with limits specified in the licence. Actual emissions of NO_X and CO from the Waukesha units will be below the concentrations specified in Table 7.

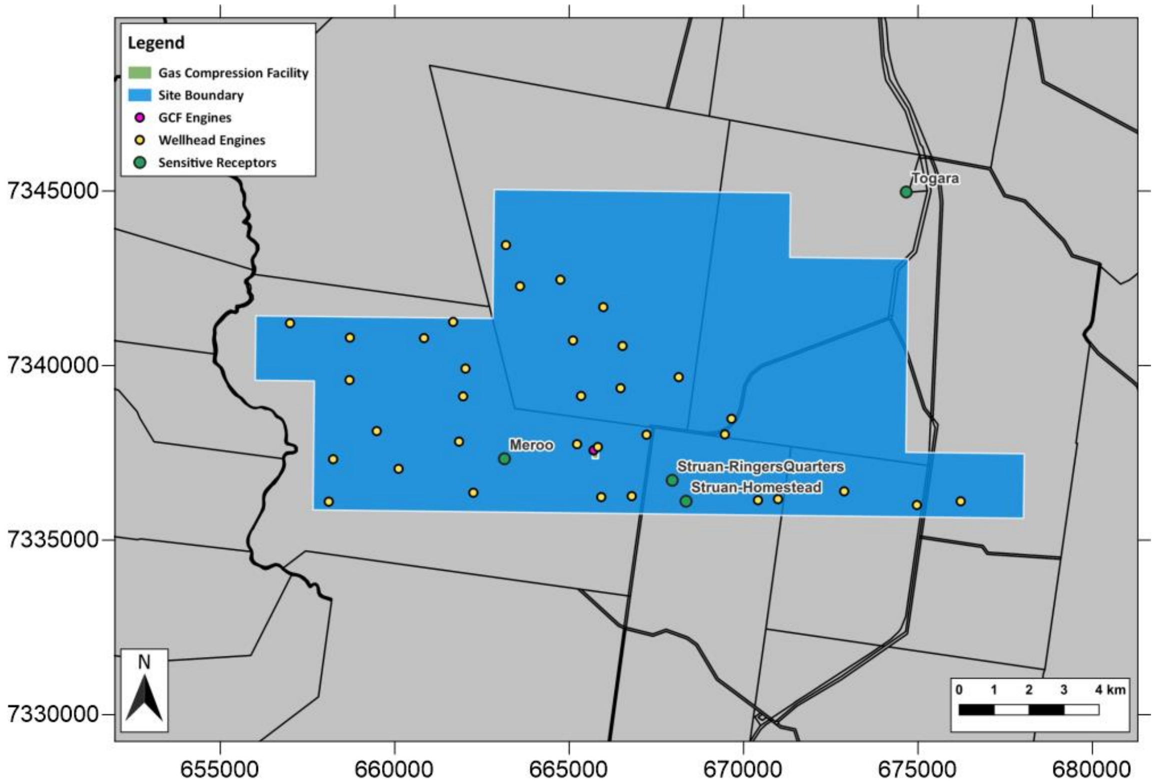


Figure 5 Location of emission sources and gas compressing equipment

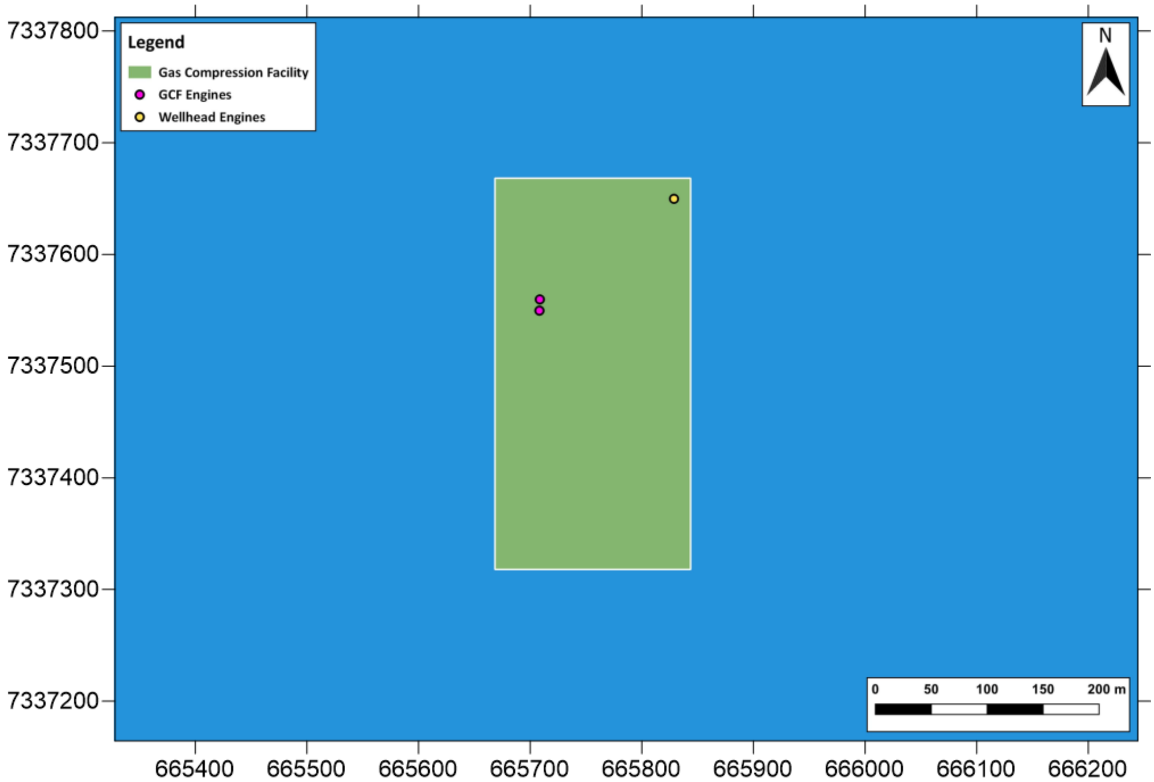


Figure 6 Location of emission sources at Gas Compression Facility

Table 6 Engine parameters for wellhead engines

Parameter	Value[a]	Units
Engine Parameters (at 100% load)		
Fuel type	Diesel	-
Power output	13.9	kW
Fuel consumption	5.0	L/hr
Stack Parameters		
Height	1.2	m
Diameter	0.1	m
Temperature	743	K
Volume flow (actual)	0.07	m^3/s
Exit velocity	8.91	m/s
Emissions		
Oxides of nitrogen (NO_X)	4.7	g/kWh
	0.02	g/s
Carbon monoxide (CO)	5.5	g/kWh
	0.02	g/s

Table notes:
[a] data source Staunch Yanmar 4TNV88, Appendix B

Table 7 Engine parameters for GCF engines

Parameter	Value[(a)]	Units
Engine Parameters (at 100% load)		
Fuel type	Natural gas	-
Power output	1,417	kW
Fuel consumption	405	L/hr
Stack Parameters		
Height	5	m
Diameter	0.35	m
Temperature	858	K
Volume flow (dry @ 7%O2)	1.78	Nm^3/s
Volume flow (actual at stack temperature and 100 kPa)	3.78	m^3/s
Stack oxygen	0	%
Exit velocity	39.3	m/s
Emissions		
Oxides of nitrogen (NO_X)	427.8[(b)]	mg/Nm^3 (dry at 7% O_2)
	0.76[(b)]	g/s
Carbon monoxide (CO)	427.8[(b)]	mg/Nm^3 (dry at 7% O_2)
	0.76[(b)]	g/s

Table notes:
[(a)] data source Waukesha VHP-L7044GSI S5, Appendix B
[(b)] Buffer of 15% increase applied to expected emissions from Waukesha unit at GCF

6.3 Comparison to emission standards

There is no legislation or regulation in force in Queensland that specifies emission concentration limits for plant and equipment; however, DESI commonly considers the emission standards set in other jurisdictions. For example, in NSW the *Protection of the Environment Operations (Clean Air) Regulation 2022* (Clean Air Regulation) provides standards of emission concentrations for premises that are required to be licensed. DESI also consider the European Union (EU) Directive on the limitation of emissions of certain pollutants into the air from medium combustion plants (2015).

Emission standards of NOx are as follows:

- EU Directive – 190 mg/Nm^3 @ 15%O_2 (443 mg/Nm^3 @ 7%O_2)
- Clean Air Regulation – 450 mg/Nm^3 @ 7%O_2

The emission limit of NOx proposed for the Waukesha engines of 428 mg/Nm^3 @ 7%O_2 (including 15% buffer for degradation) satisfies these limits.

The relevant NSW Clean Air Regulation emission standard for CO is 125 mg/Nm^3 @ 7%O_2. Whilst the assessed post treatment CO emission concentration in the exhaust of each of the Waukesha engines of 428 mg/Nm^3 @ 7%O_2 is above this standard, the implementation of the emissions control technology on the units has resulted in a significant reduction in emissions of both NO_X and CO (compared to the units that were assessed in the previous assessment) and NOX, the key pollutant of interest, satisfies the relevant emission standard limits. In addition, the results of the air quality assessment in the following section show that the predicted maximum incremental ground-level concentrations of CO due to the Project are, at most, 0.07% of the EPP (Air) objective and Air NEPM standard.

7. RESULTS

This section presents the results of the dispersion modelling assessment of NO_2 and CO. Table 8 presents the maximum modelled concentrations for all pollutants and averaging periods at all the residential sensitive receptors detailed in Table 3. The conversion of NO_x to NO_2 used is indicated in the footnotes with the relevant averaging period.

All results are presented in isolation and with the ambient background as determined in Section 5.3.2. Pollutant concentrations were also predicted across a Cartesian grid of receptors (at 250 m resolution) to enable the production of contour plots of concentrations across the study area. This grid has been modelled at ground level. The resulting contour plates for cumulative concentrations are shown in Plate 1 to Plate 3.

The results show:

- Predicted 8-hour average ground-level concentrations of CO are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 2.3% the EPP (Air) objective and Air NEPM standard.
- Predicted 1-hour average ground-level concentrations of NO_2 are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 4.1% of the EPP (Air) objective, and less than 6.2% of the Air NEPM standard.
- Predicted annual average ground-level concentrations of NO_2 are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 7.0% of the EPP (Air) objective, and less than 14% of the Air NEPM standard.

The GCF contributes the greatest emissions to overall Project emissions due to the size of the GCF engines compared to the wellhead engines.

Table 8 Maximum modelled concentrations at each receptor

Receptor	NO_2 (µg/m³)				CO (µg/m³)	
	Isolation		Cumulative		Isolation	Cumulative
	1-hour [(a)]	Annual [(b)]	1-hour[(a)]	Annual[(b)]	8-hour	8-hour
Meroo	6.1	0.3	10.2	4.3	7.0	257.0
Struan-Ringers Quarters	2.2	0.1	6.3	4.2	2.1	252.2
Struan Homestead	1.7	0.1	5.8	4.2	3.0	253.1
Togara	2.4	0.02	6.5	4.1	2.0	252.1
Guideline	**-**	**-**	**250[(c)]** **164[(d)]**	**62[(c)]** **31[(d)]**	**-**	**11,000[(c, d)]**

Table notes:
[(a)] NOx to NO_2 conversion assumed to be 30%
[(b)] NOx to NO_2 conversion assumed to be 100%
[(c)] EPP (Air) objective
[(d)] Air NEPM standard

8. ENVIRONMENTAL AUTHORITY RECOMMENDATIONS

The recommended Conditions of Approval in relation to air for the Project informed by the results of the air quality assessment are provided in Table 9 for release points and contamination limits to air.

Table 9 Recommendations for Table X of EA (release points and contamination to air)

Release point	Release point and source description	Minimum release height (metres above ground)	Minimum efflux velocity (m/s)	Minimum exit gas temperature (°C)	Contaminant	Maximum concentration release limit	Minimum monitoring frequency
GCF unit 1 and unit 2	GCF engine exhaust stack, exhaust pipe discharge	5.0	39.33	585	NO_X	428 mg/Nm^3 @ 7% O_2 (dry)	Annually for three years from commission

9. CONCLUSIONS

Katestone Environmental Pty Ltd (Katestone) was commissioned by Epic Environmental to conduct an air quality assessment of the Mahalo North Coal Seam Gas Project (the Project) to assist Comet Ridge Mahalo North Pty Ltd (Comet Ridge) with an application for the Environmental Authority (EA).

The assessment was conducted in accordance with the relevant regulatory guidance and legislation and uses recognised techniques for dispersion modelling and emission estimation to determine potential impacts to identified sensitive receptors and the surrounding environment from the following sources at the Project:

- A diesel 20kVA engine at each of the 34 individual production well sites
- Two natural gas-powered engines (Waukesha VHP - L7044GSI S5) fitted with emissions control (in the form of 3-way catalyst and silencers) at the central GCF that will provide power to gas compression units, gas dehydration and separation units, and other ancillary equipment

Incremental and cumulative impacts of NO_X and CO from all sources have been assessed in accordance with the relevant EPP (Air) objectives and Air NEPM standards.

The findings of the cumulative impact for modelling the facility at maximum operations (i.e., all possible engines running continuously at 100% load) are as follows:

- Predicted 8-hour average ground-level concentrations of CO are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 2.3% the EPP (Air) objective and Air NEPM standard.
- Predicted 1-hour average ground-level concentrations of NO_2 are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 4.1% of the EPP (Air) objective, and less than 6.2% of the Air NEPM standard.
- Predicted annual average ground-level concentrations of NO_2 are below the relevant air quality objective at all sensitive receptors in isolation and with an ambient background. The highest cumulative concentration at any sensitive receptor is less than 7.0% of the EPP (Air) objective, and less than 14% of the Air NEPM standard.
- The emission concentration of NOx for the Waukesha units is 428 mg/Nm^3 @ 7%O_2. This is below the emission limit specified in the NSW Protection of the Environment Operations (Clean Air) Regulation 2022 which is 450 mg/Nm^3 @ 7%O_2, therefore meeting best practice requirements.

The assessment has demonstrated that the maximum ground-level concentrations of NO_2 and CO are predicted to be below the air quality objectives at all sensitive receptor locations and across the study area. Thus, it is concluded that the Project will not have a significant impact on local air quality.

10. REFERENCES

Bofinger, N.D, Best P.R., Cliff D.I., and Stumer L.J, (1986). The oxidation of nitric oxide to nitrogen dioxide in power station plumes. Proceedings of the Seventh World Clean Air Congress, 384-392.

Department of Climate Change, Energy, the Environment and Water, 2024, National Pollution Inventory Database, available online: https://www.dcceew.gov.au/environment/protection/npi/data/latest-data

Department of Environment and Science, Queensland Government, 2022, Open Data Portal, available online: https://www.data.qld.gov.au/dataset?q=air+quality

CONTOUR PLATES

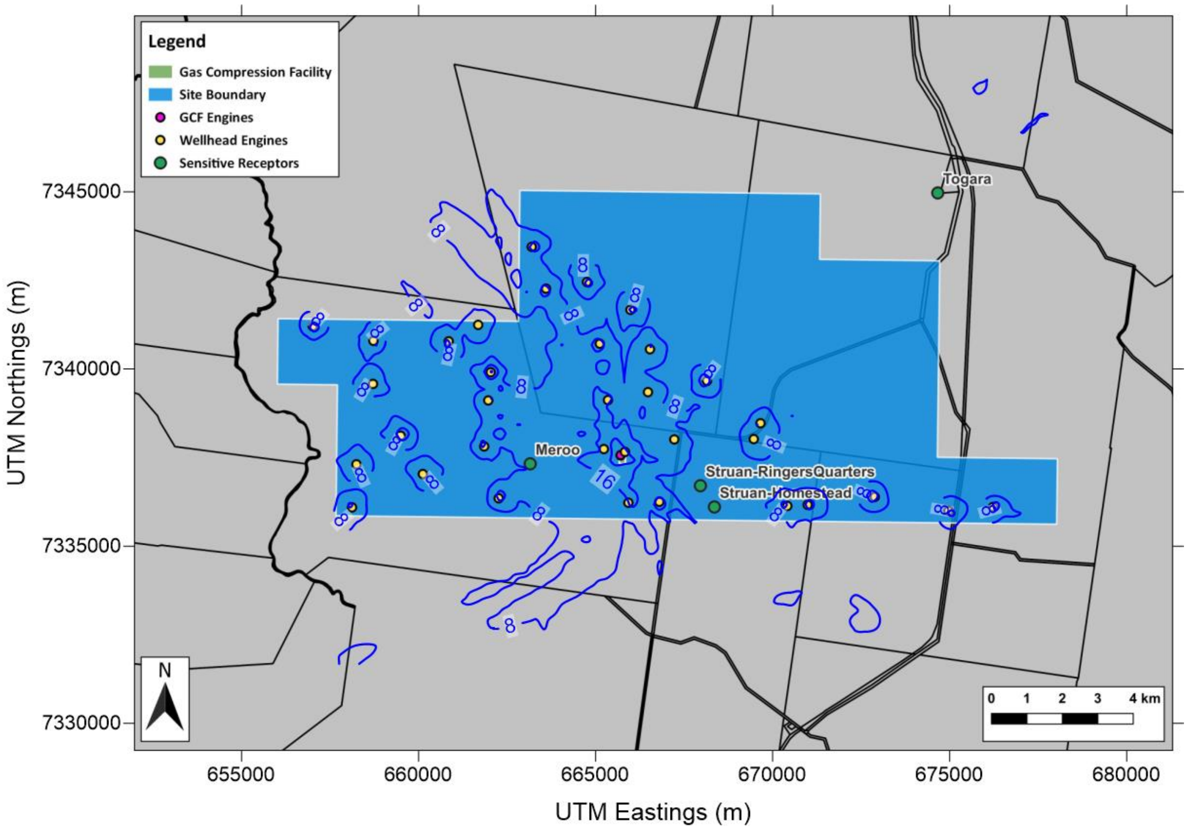


Plate 1 **Predicted 1-hour average ground-level concentrations of NO_2 due to the Project, including ambient background**

Location:	Averaging period:	Data source:	Units:
Mahalo North	1-hour	CALPUFF	µg/m³
Type:	**Criteria:**	**Prepared by:**	**Date:**
Contour plot	164 µg/m³ (Air NEPM) 250 µg/m³ (EPP (Air))	Sarah Richardson	March 2024

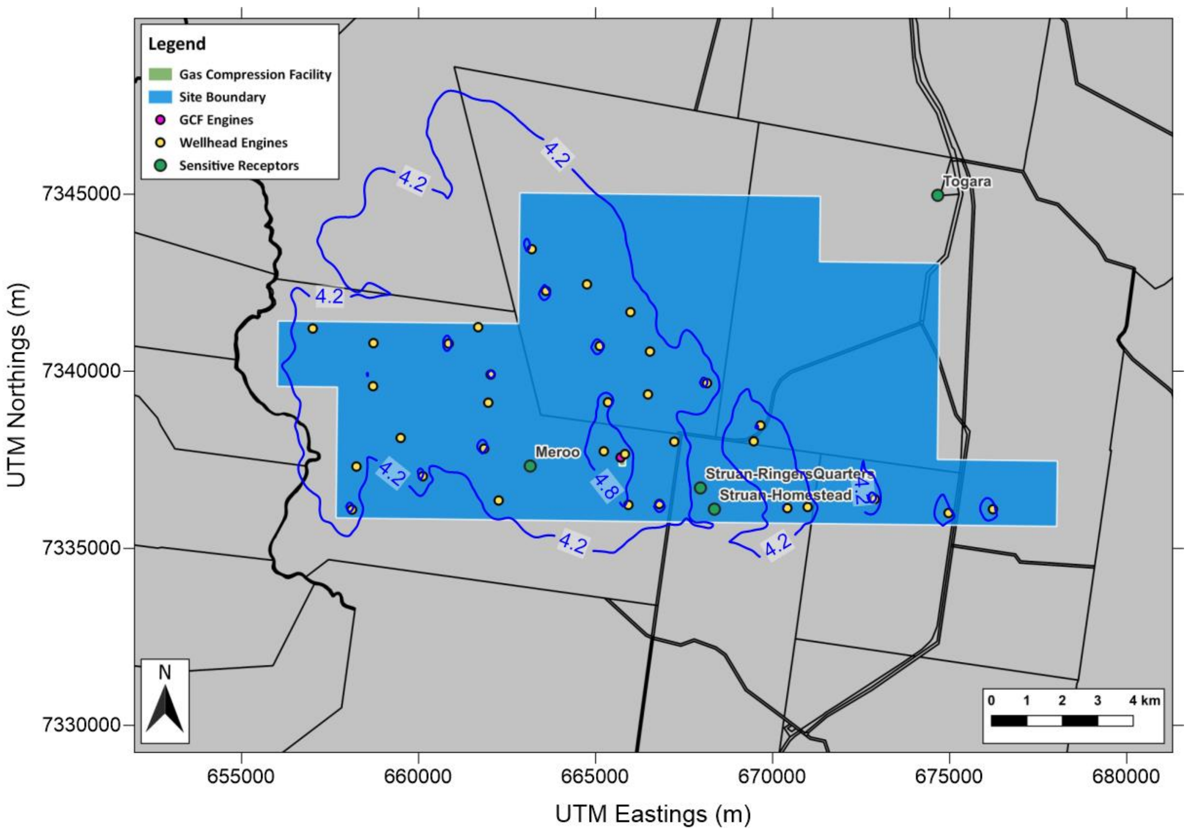


Plate 2 **Predicted annual average ground-level concentrations of NO_2 due to the Project, including ambient background**

Location:	**Averaging period:**	**Data source:**	**Units:**
Mahalo North	Annual	CALPUFF	µg/m^3
Type:	**Criteria:**	**Prepared by:**	**Date:**
Contour plot	31 µg/m^3 (Air NEPM) 62 µg/m^3 (EPP (Air))	Sarah Richardson	March 2024

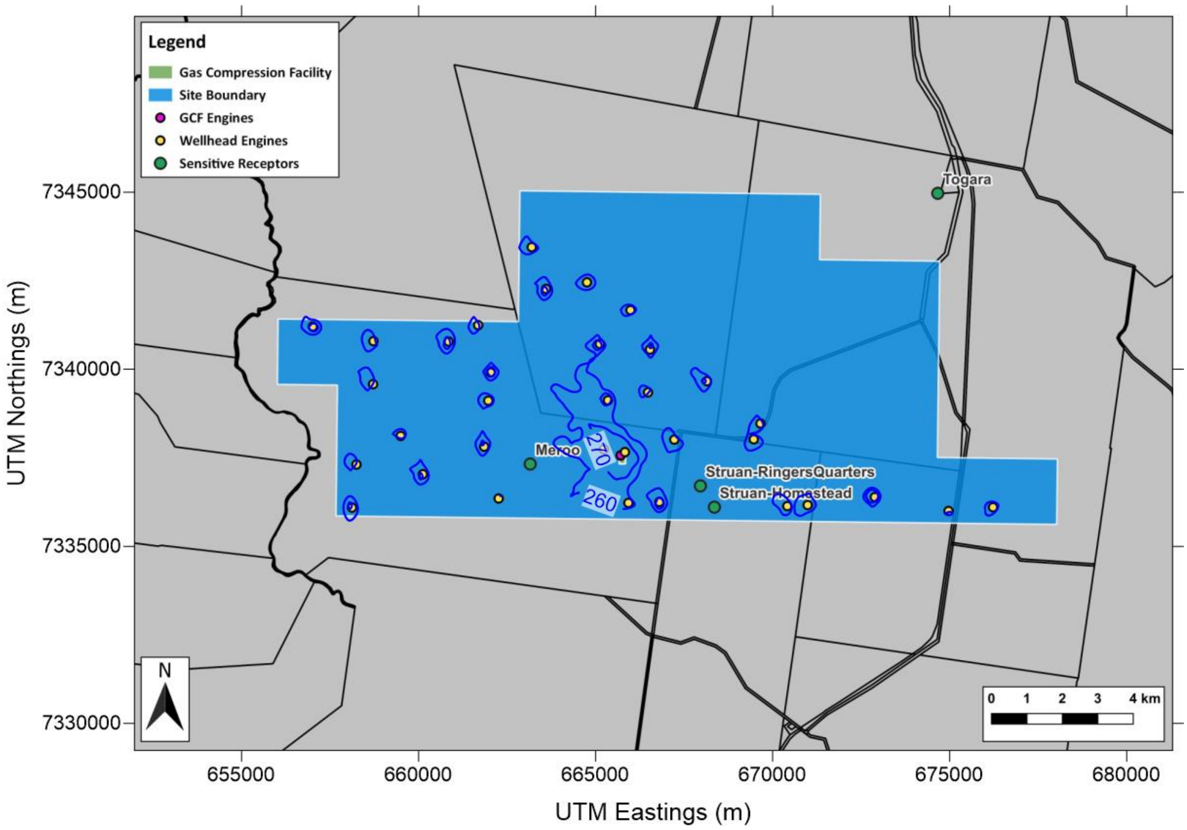


Plate 3	**Predicted 8-hour average ground-level concentrations of CO due to the Project, including ambient background**		
Location: Mahalo North	**Averaging period:** 8-hour (clock average)	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour plot	**Criteria:** 11,000 µg/m³ (Air NEPM and EPP (Air))	**Prepared by:** Sarah Richardson	**Date:** March 2024

APPENDIX A METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

A1 Meteorology

The meteorological modelling methodology for the Project included the following steps:

- Selection of a representative year
- TAPM modelling and validation
- CALMET modelling

The following sections describe each step of the meteorological modelling conducted for the Project. A summary of the meteorological data generated is provided in Section A1.4.

A1.1 Selection of representative year

A representative year is required to be selected at the beginning of the meteorological modelling process. Using a representative year in the air quality assessment ensures that the typical conditions experienced at the Project site are reflected in the model.

Selection of a representative year has been done through statistical analysis of historical meteorological observations at the Bureau of Meteorology automatic weather stations located at Emerald, Blackwater, and Rolleston. The data from three stations were chosen to be used to give a better representation of the typical weather at the site. Meteorological observations from the past six years (2017 to 2022) at each of the three stations were analysed to assess the inter-annual variability. The locations of the BoM stations relative to the site are shown in Figure 3.

For reporting purposes, only results from the Rolleston station are presented. However, for determining the representative year, results from all three stations have been considered. Figure A1 presents annual wind roses for the six years and shows that inter-annual conditions are typically very similar. Figure A2 presents frequency distribution plots for humidity, wind direction, wind speed and temperature, with the year 2021 highlighted, and demonstrates that there is relatively little variation in the distribution of these variables year-on-year. Figure A3 presents Z-Scores for each variable for each year, these being a measure of the variation of values in each individual year against the mean of values across all years.

The calendar year 2021 has been used for the modelling as it is judged to be the year with the least variation from the mean when averaged across all the parameters considered.

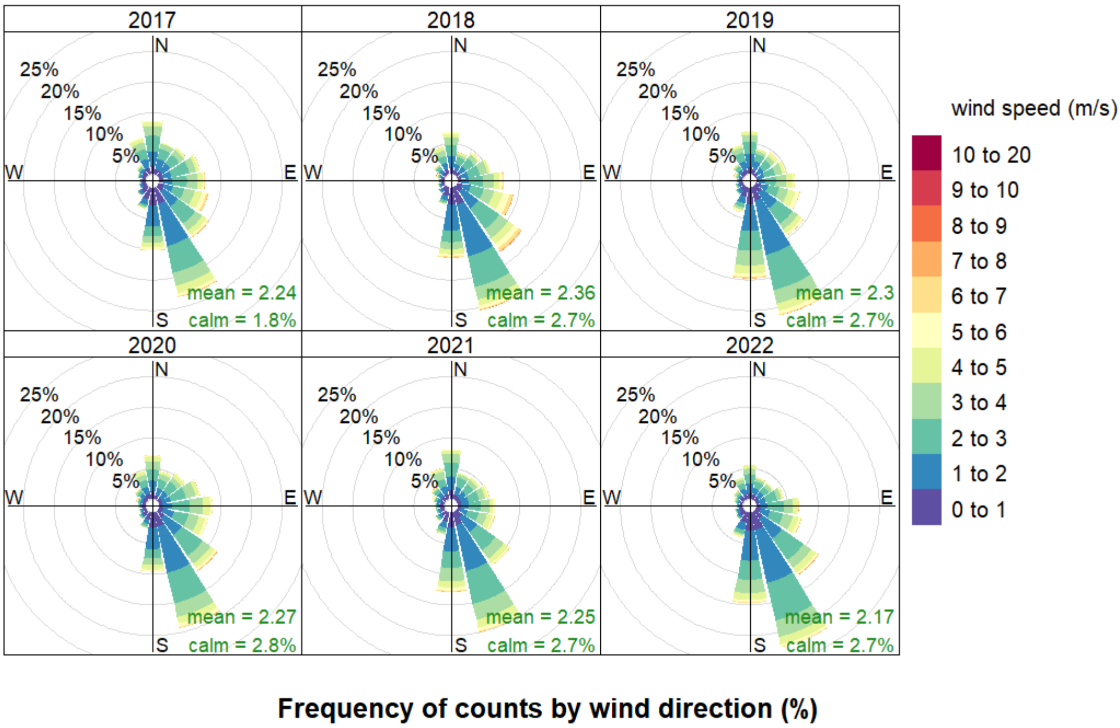


Figure A1 Annual wind roses for Rolleston between 2017 and 2022

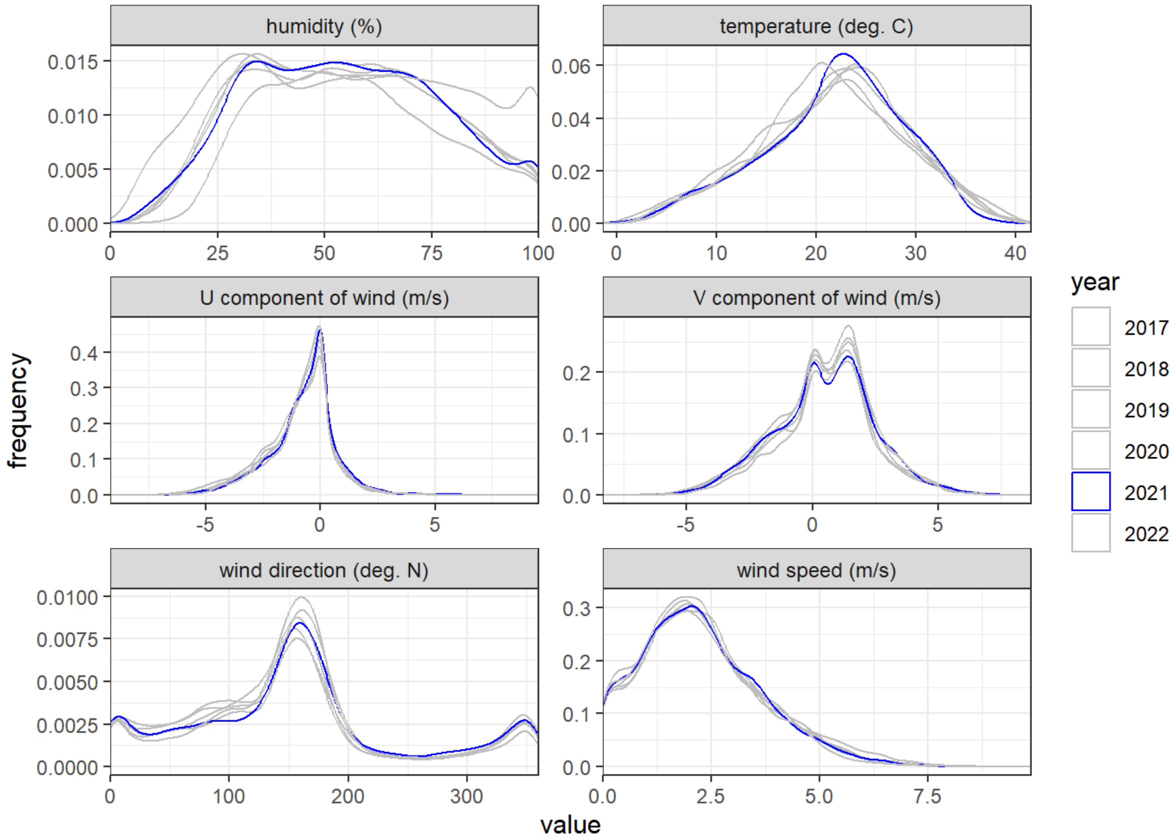


Figure A2 Annual frequency distributions plots for Rolleston between 2017 and 2022 (2021 highlighted)

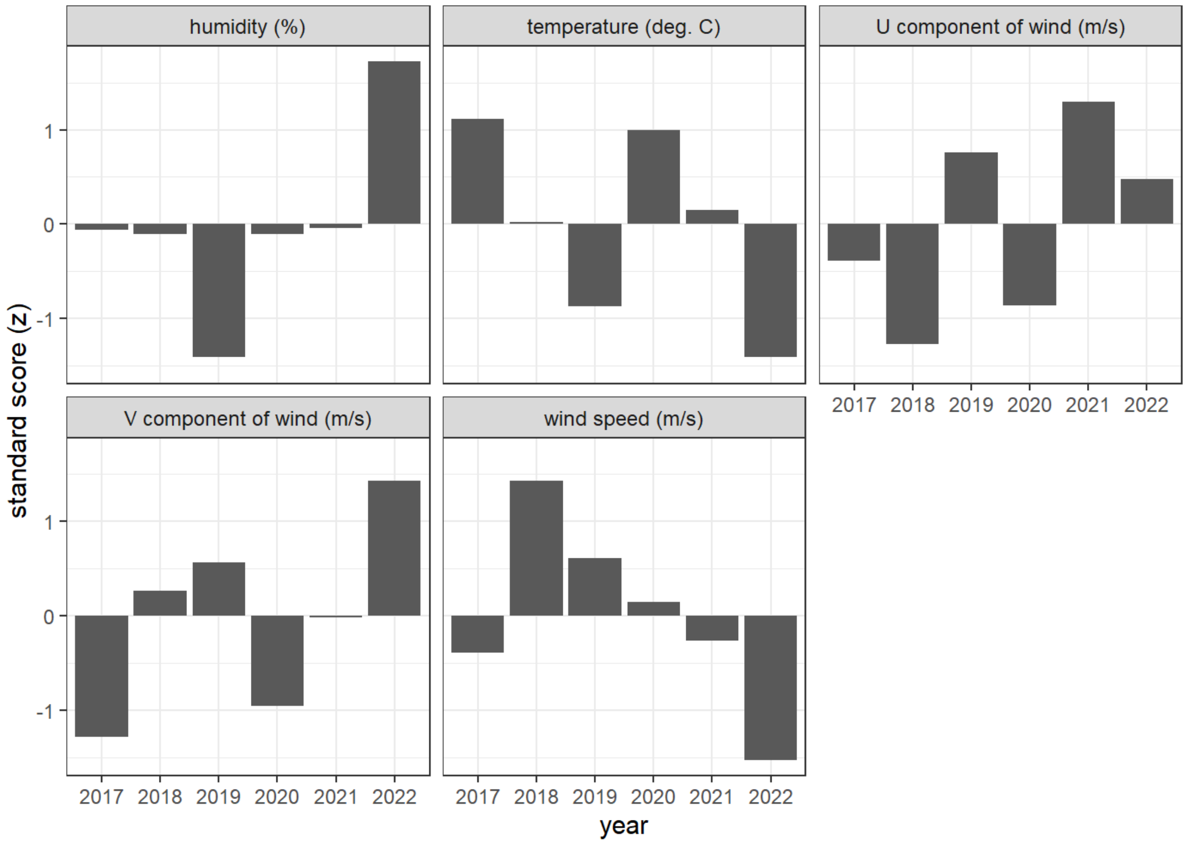


Figure A3 Z-Scores for Rolleston between 2017 and 2022

A1.2 TAPM meteorological modelling configuration

TAPM (The Air Pollution Model) was developed by the CSIRO and has been validated by the CSIRO, Katestone and others for many locations in Australia, in south-east Asia and in North America (CSIRO, 2008). Katestone has extensive experience with TAPM for sites throughout Australia and in parts of America, Bangladesh, New Caledonia and Vietnam. The model performs well in simulating regional wind patterns and has proven to be a useful tool for simulating meteorology in locations where monitoring data is unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy, soil type and radiative fluxes.

TAPM requires synoptic meteorological information for the region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data were supplied on a grid resolution of approximately 75km, and at elevations of 100m to 5km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM version 4.0.5 was configured with the following parameters:

- Modelling period from 1 January to 31 December 2021
- 48 x 48 grid point domain with nesting resolutions of 30 km, 10 km, 3 km, and 1 km
- 25 vertical levels

- Grid centred on latitude -24° 4.0, longitude 148° 38.0’
- Geoscience Australia 9 second DEM terrain data
- TAPM default land cover data edited to be consistent with aerial imagery
- Default options selected for advanced meteorological inputs.

A1.3 CALMET meteorological modelling configuration

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET version 6.5.0 was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 1km grid. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

CALMET was configured in accordance with the requirements of the City Plan Air quality planning scheme policy. This includes default options and parameters, with the following selections:

- Modelling period from 1 January to 31 December 2021
- 50 x 50 grid point domain with 500 m resolution, nested within the TAPM inner domain
- 12 vertical levels at heights of 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600 and 4600 metres
- Prognostic wind fields generated by TAPM input as MM5/3D.DAT at surface and upper air for “initial guess” field (no-observations mode)
- Gridded cloud cover from prognostic relative humidity at all levels
- No extrapolation of surface wind observations to upper layers
- Terrain radius of influence of 3 km.

A1.4 CALMET meteorological outputs

The following sections provide a description of the meteorological parameters that are important for the dispersion of air pollutants in the atmosphere, namely wind speed, wind direction, atmospheric stability, mixing layer height, and temperature. These parameters have been extracted from the TAPM and CALMET dataset at the Project site.

A1.4.1 Wind speed and wind direction

The annual distribution of winds predicted by TAPM and CALMET for 2021 is presented in Figure A4. The seasonal and diurnal distribution of winds is presented in Figure A5 and Figure A6.

Winds across the study area are predominantly light to moderate (up to around 5 m/s) and from the south-southeast through to north direction. Winds from the western sector are less frequent.

The seasonal breakdown of winds shows that the predominant north-northeast to south winds are strongest and most common during the spring and summer months. Autumn shows an increased frequency of winds from the south-southeast, while winds during winter are predominantly from the southwest quadrant.

The diurnal breakdown of winds shows that the strongest winds are predicted during the afternoon (midday to 6pm) when winds are predominantly from the north or southeast. From 6pm there is a shift towards lighter winds from the northeast that occur during the night and into the morning.

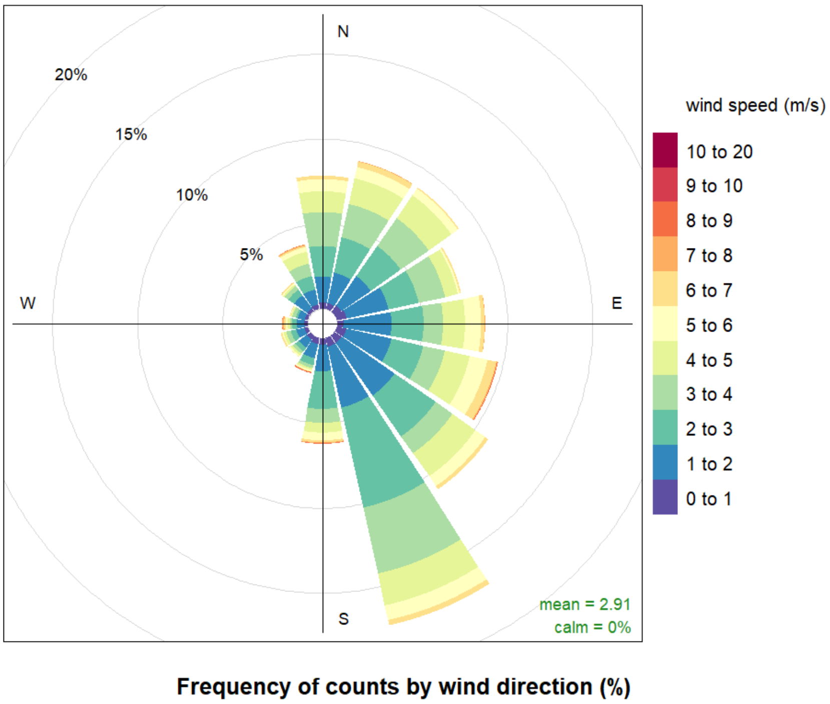


Figure A4 2021 Annual distribution of winds predicted by TAPM and CALMET

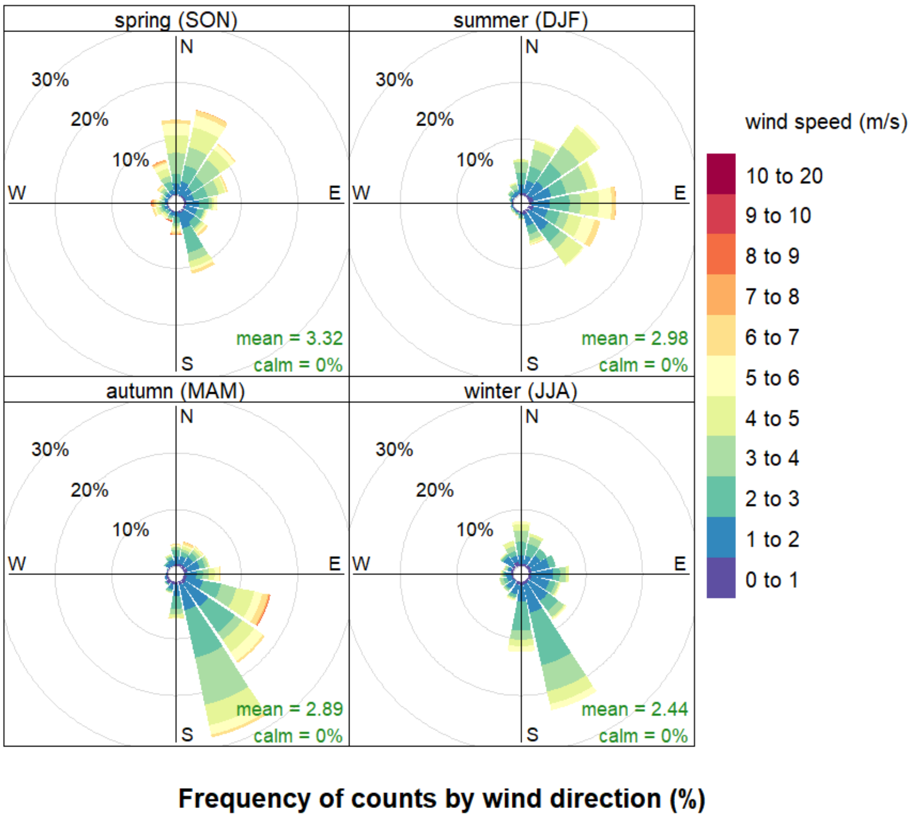


Figure A5 2021 Seasonal distribution of winds predicted by TAPM and CALMET

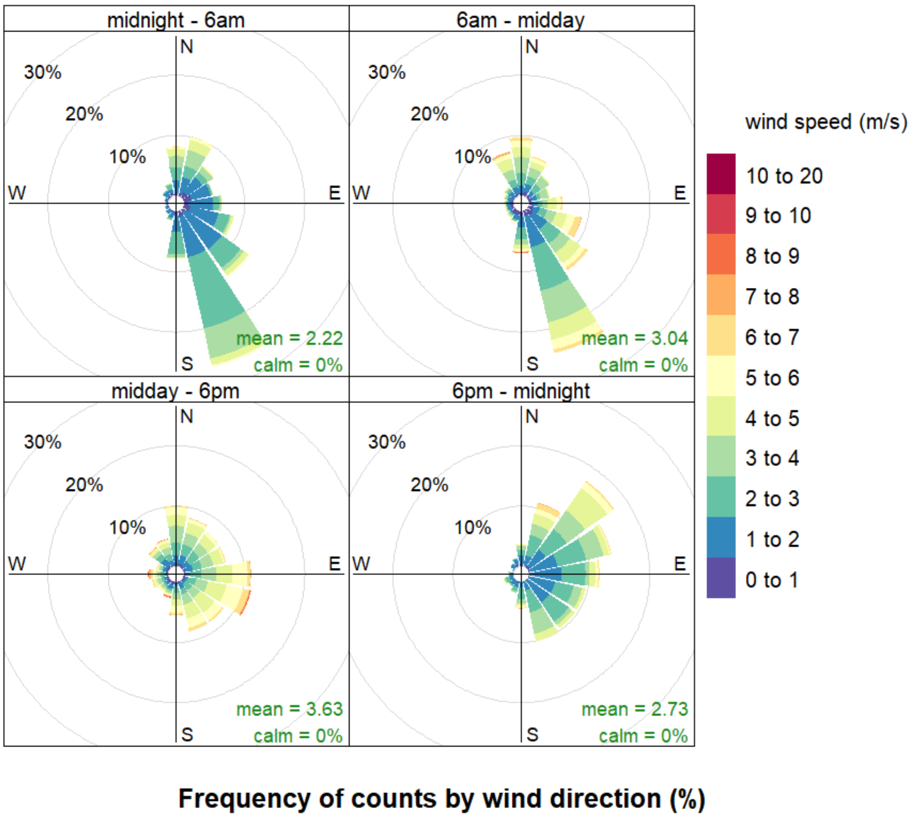


Figure A6 2021 Diurnal distribution of winds predicted by TAPM and CALMET

A1.4.2 Atmospheric stability

Stability classification is a measure of the stability of the atmosphere and can be determined from wind measurements and other atmospheric observations. The stability classes range from A Class, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to F Class, which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (Classes A to C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for Class D conditions are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface. During the night, the atmospheric conditions are generally stable (often Classes E and F).

Figure A7 shows the distribution of stability classes extracted from the TAPM and CALMET dataset, where Class A represents the most unstable conditions and Class F represents the most stable. Neutral (D class) conditions are present throughout the day, comprising 33% of total time. Stable (E class) and very stable (F class) conditions are the next most frequent, comprising 42% of total time, and only occur between 5 pm and 6 am.

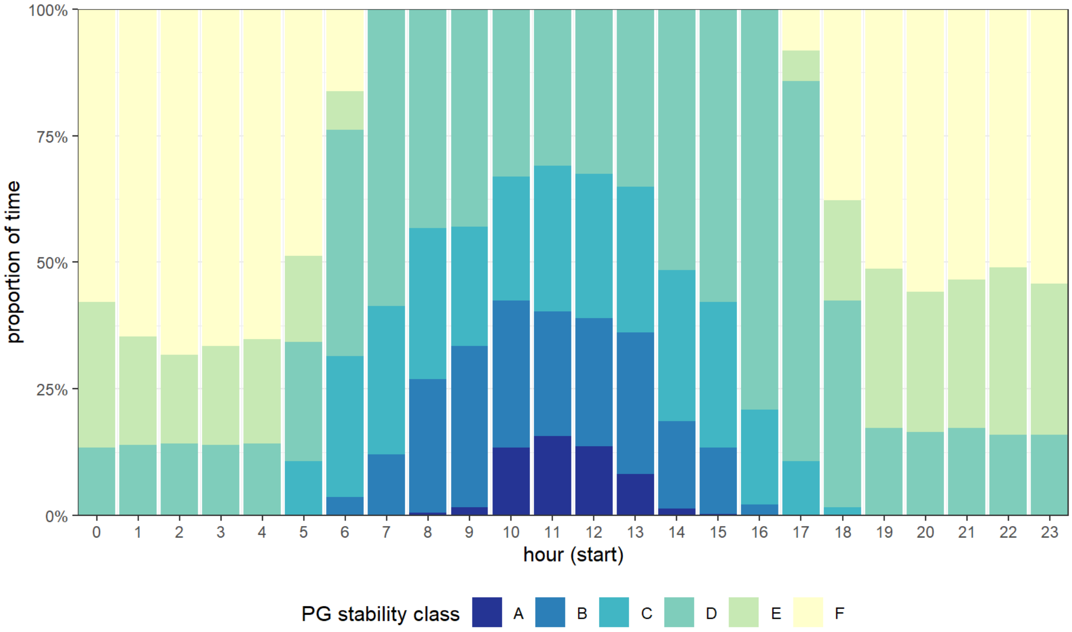


Figure A7 2021 Frequency distribution of atmospheric stability conditions predicted by TAPM and CALMET

A1.4.3 Mixing height

The mixing height defines the height of the mixed atmosphere above the ground (mixed layer), which varies diurnally. Air pollutants released at or near the ground will become dispersed within the mixed layer. During stable atmospheric conditions, the mixing height is often quite low, and dispersion is limited to within this layer. During the day, solar radiation heats the ground and causes the air above it to warm, resulting in convection and an increase to the mixing height. The growth of the mixing height is dependent on how well the warmer air from the ground can mix with the cooler upper-level air and, therefore, depends on meteorological factors such as the intensity of solar radiation and wind speed. Strong winds cause the air to be well mixed, resulting in a high mixing height.

Mixing height information extracted from the TAPM and CALMET dataset are presented as a diurnal frequency (box and whisker) plot in Figure A8. The plot shows that, on average, the mixing height begins to increase around 6am and peaks around 3- 4pm before descending rapidly into the evening.

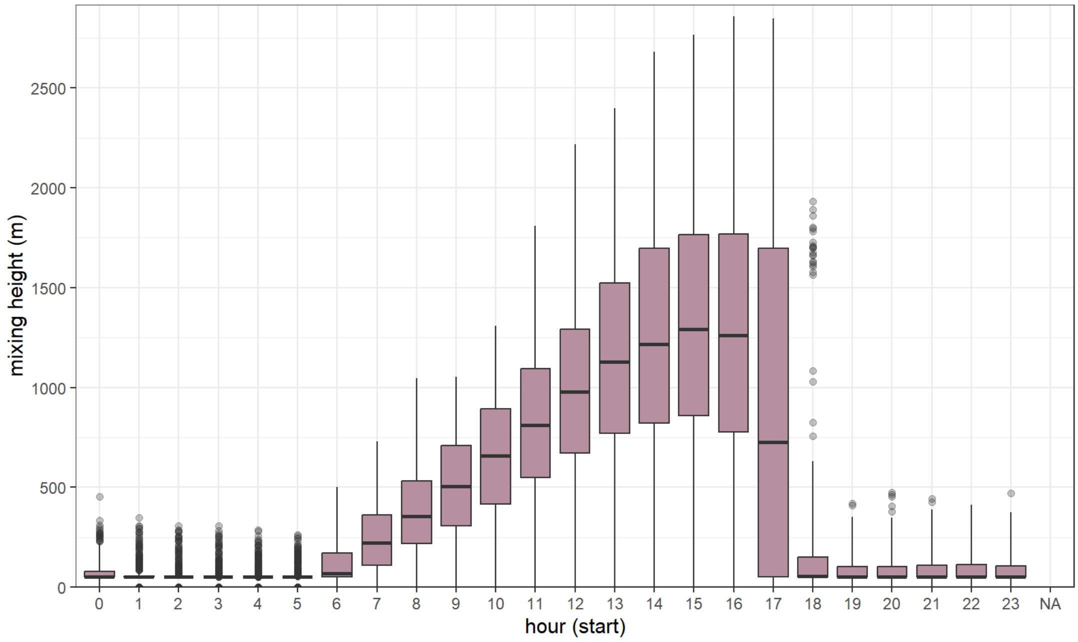


Figure A8 2021 Diurnal profile of mixing height predicted by TAPM and CALMET

A2 Dispersion modelling

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 50 by 50 grids at 0.5 km spacing, equivalent to the domain defined in CALMET
- Sampling grid of 18 km by 25 km at 250 m resolution.
- 365 days modelled (1 January 2021 to 31 December 2021)
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables
- Stack tip downwash, transitional plume rise and PDF used for dispersion under convective conditions.

All other options set to default.

APPENDIX B ENGINE AND COMPRESSOR SPECIFICATION SHEETS

STAUNCH MACHINERY SINCE 1979

20 KVA

POWERED BY: YANMAR

STANDARD SPECIFICATIONS

1. ENGINE

- Diesel engine
- 4 strokes-cycle
- Water-cooled
- 12V Electrical system
- Radiator with blowing fan
- Water separator decanting filter (visible level)
- Mechanical governor
- Dry air cleaner
- Hot components and radiator guards
- Mobile components guards

2. Electrical system

· Control and power electric panel, with measurements devices and controller (according to necessity and configuration)
· Earth leakage protection adjustable (time & sensibility) standard Battery charger 3 poles (standard on automatic control panels)
· Pre-heating resistance (standard on automatic control panels) / water jacket heater· Battery charge alternator with ground connection
· Starting battery/ies installed and connected to the engine (supports included)
· Ground connection electrical installation with connection ready for ground pike (not supplied)Optional :
· Battery isolator switch - DSE Battery charger

3. Open set version

- Emergency stop button
- Steel made chassis
- Antivibration shock absorber
- Chassis with integrated fuel tank
- Fuel level sensor
- Drain cap fuel tank
- Steel made residential silencer -15db(A) attenuation

4. Optional :

- Fuel transfer pump
- Steel made residential silencer -35db(A) attenuation.

5. CONTROL PANEL

Make	Deep Sea
Model	DSE4510/20

The DSE4510 is an Auto Start Control Module and The DSE4520 Auto Mains(Utility) Failure control Module are suitable for a wide variety of single gen-set applications

- Alternator frequency & CAN speed sensingin one variant
- Largest back-lit icon display in its class
- Fully configurable via the fascia or PC using USB
- 3 Phase generator sensing
- 3 Phase mains(utility) sensing(DSE4520 only)
- Generator/load power monitoring(KW,KVA,KVAR,PF)
- Accumulated power monitoring(KW h, KVA h, KVAr h)
- Generator overload protection(KW)
- Generator/load current monitoring and protection
- Fuel and start outputs(configurable when using CAN)
- Configurable staged loading outputs
- Engine speed protection
- Engine pre-heat
- Engine run-time scheduler
- Battery voltage monitoring
- Comprehensive warning, electrical trip or shutdown protection upon fault condition

Engine Specifications 1.500 r.p.m.

Manufacturer	YANMAR
Engine Model	4TNV88
Engine Type	Diesel 4 strokes-cycle
Injection Type	Direct
Aspiration Type	Natural
Ciylinders Arrangement	4 - L
Bore and Stroke mm	88 x 90
Displacement Liters	2.19
Cooling System	Water Cooled
Lube Oil Specifications	API class CD, SAE grade 10W30
Compression Ratio	19.1
Fuel Consumption StandBy L/h	5.47
Fuel Consumption 100% PRP L/h	4.95
Fuel Consumption 75 % PRP L/h	3.75
Fuel Consumption 50 % PRP L/H	2.72
Lube Oil Consumption Full Load g/kwh	0.27
Total Oil Capacity L	7.4
Total Coolant Capacity L	2.7
Governor	Mechanical
Air Filter	Dry
Inner diameter exhaust pipe mm	51.6
Intake Air Flow m^3/h	88.7
Cooling Air Flow m^3/h	0.8
Alternator fan air flow m^3/s	0.088
Fuel Tank volume L	60
Starting motor KW	1.4
Starting motor CV	1.9
Recommended Battery Capacity Ah	55
Auxiliary voltage Vcc	12
Maximum Exhaust Temperature ºC	470
Exhaust Gas Flow m^3/min	4.24

DIMENSIONS AND WEIGHT*

Lengthmm	Widthmm	Heightmm	Weight* kg (كغ)
1450	620	1286	361

* For skid mounted genset without enclosure — wet weight = with lube oil and coolant

Output Ratings	Prime	Standby
380-415 V, 3 ph, 50 Hz, 1500 rpm	17.38 KVA	19.12 KVA
	13.91 KW	15.29 KW
480 V, 3 ph, 60 Hz, 1800 rpm	17.45 KVA	19.19 KVA
	13.96 KW	15.36 KW

Applicable Voltages: 220/127 V at 60 Hz only (Consult your dealer for more details)
Ratings at 0.8 Power Factor

ALTERNATOR DATA

Make	Stamford
Model	PI144D
KVA	20
KW	16
No. of bearings	1
Insulation class	H
Total Harmonic Content	in linear load <5% , at no load < 1.5%
Winding Leads	12
Ingress Protection	IP23
Excitation System	Self-Excited
Winding Pitch	2/3
AVR Model	AS480
Overspeed	2250 RPM
Voltage Regulation	±1.0 %
Short Circuit Capacity	-

The image shown above might not be the final product

STANDARD SPECIFICATIONS

6. FUEL SYSTEM

On Generating Sets up to 2000 KVA, the base frame design can be incorporated with an integral fuel tankwith a capacity of approx. 8 hours running at Full Load. The tank is supplied complete with fill cap breather fuel feed and return lines to the Engine and drain plug.

7. ALTERNATOR
7.1 INSULATION SYSTEM

• The insulation system is Class H.
• All windings are impregnated in either a triple dipthermosetting liquid, oil and acid resisting polyester varnish or vacuum pressure impregnated with a special polyester resin.

• Heavy coat of antitracking varnish additional protection against moisture.

7.2 AUTOMATIC VOLTAGE REGULATOR (AVR)
The fully sealed Automatic Voltage Regulator maintains the Voltage Regulation at ±1%. Nominal adjustment by means of a trim pot incorporated on the AVR.

7.3 MOTOR STARTING an overload capacity equivalent to 300% of the Full Load impedance at zero Power Factor can be sustained for 10 seconds.

8. MOUNTING ARRANGEMENT

8.1 BASE FRAME
The complete Generating Set is mounted as a whole on a heavy duty fabricated steel Baseframe.

8.2 COUPLINGThe Engine and Alternator are directly coupled by means of an SAE flange. The Engine flywheel is flexibly coupled to the Alternator rotor.

8.3 ANTI-VIBRATION MOUNTING PADS anti-Vibration pads are affixed between the Engine / Alternator feet and the Baseframe thus ensuring complete vibration isolation of the rotating assembly.The Fan & Fan Drive along with the Battery Charging

8.4 SAFETY GUARDS The Fan & Fan Drive along with the Battery Charging Alternator are Safety Guard protected for personal protection.

9. FACTORY TESTS

• The Generating set is load tested before dispatch
• All protective devices control functions and site load conditions are simulated. The generator and it's systems are checked before dispatch.

10.EQUIPMENT FINISHING all mild steel components are fully degreased and painted with powder coated paint to ensure maximum scuff resistance and durability.

RATINGS DEFINITION

Prime Power

These ratings are applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. 10% overload power is available for 1 hour in 12 hours continuous operation.

Standby Power

These ratings are applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings.

STANDARD REFERENCE CONDITIONS

Output ratings are presented at 25°C air inlet temperature, barometric pressure 100 kPa, relative humidity 30%. This generating set is designed to operate at high ambient temperatures (up to 55°C), humidity (up to 99%) and altitudes. De-ration may apply,please consult your dealer for specific site ratings.

STAUNCH Generators are assembled Some of the specifications are not standard on all Genset models. in facilities certified to ISO 9001 All information in this document is substantially correct at time of printing and may be altered subsequently.

Generating Set pictured may include optional accessories.

11. DOCUMENTATIONS a set of Operation & Maintenance manual, Circuit wiring diagrams and Commissioning / Fault Finding instruction leaflets accompany the Generator.

12. QUALITY STANDARDS The equipment meets the following standards: BS4999, BS5000, BS5514 IEC 60034, VDE0530, NEMA MG 1.22 and ISO 8528.

13. WARRANTY All of the Generating Sets are covered under a warranty policy for a period of 12 months. Warranty of the equipment is in line with manufacturers warranty terms & conditions.

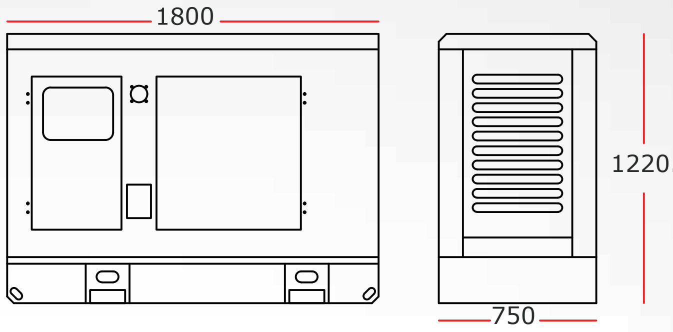
(check warranty statement for more details, as it may vary for different countries)In line with continuous product development, we reserve the right to change specifications without notice.

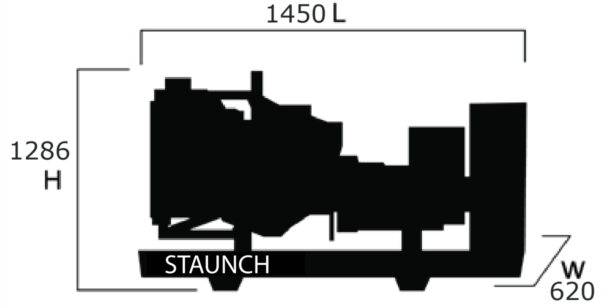
For further information on all of the standard and optional features accompanying this product please contact your local dealer or visit:

WWW.STAUNCHMACHINERY.COM

AVAILABLE OPTIONS & ACCESSORIES

We offer a range of optional features and accessories to tailor our generating sets to meet your power needs.





ACCESSORIES

- *switches*
- *Load banks*
- *Auxiliary fuel tanks*
- *Manual & automatic*
- *Genuine spare partstransfer*

OPTIONS

- *Water jacket heater*
- *A variety of generating set*
- *Additional protection alarms*
- *Water fuel seperator control and synchronizing and shutdowns*
- *panels*
- *Battery charger*

Comet Ridge - Mahalo North Project - Qld, Australia

VHP - L7044GSI S5

Bidell Gas Compression Juan Carlos Marín +61 447 3 Gas Compression

ENGINE SPEED (rpm):	1200	NOx SELECTION (mg/Nm3):	435 NOx 435 CO
DISPLACEMENT (L):	115	COOLING SYSTEM:	JW, IC + OC
COMPRESSION RATIO:	9.7:1	INTERCOOLER WATER INLET (°C):	54.4
IGNITION SYSTEM:	ESM2	JACKET WATER OUTLET (°C):	82.2
EXHAUST MANIFOLD:	Water Cooled	JACKET WATER CAPACITY (L):	379
COMBUSTION:	Rich Burn, Turbocharged	AUXILIARY WATER CAPACITY (L):	42
ENGINE DRY WEIGHT (kg):	11000	LUBE OIL CAPACITY (L):	719
AIR/FUEL RATIO SETTING:	0.38% CO	MAX. EXHAUST BACKPRESSURE (mm H2O):	508
ENGINE SOUND LEVEL (dBA)	105	MAX. AIR INLET RESTRICTION (mm H2O):	381
IGNITION TIMING:	ESM2 Controlled	EXHAUST SOUND LEVEL (dBA)	113

SITE CONDITIONS:

FUEL:	CSG	ALTITUDE (m):	228
FUEL PRESSURE RANGE (barG):	2.76 - 4.14	MAXIMUM INLET AIR TEMPERATURE (°C):	35
FUEL HHV (MJ/Nm3):	37.97	FUEL WKI:	102.0
FUEL LHV (MJ/Nm3):	34.32		

SITE SPECIFIC TECHNICAL DATA

			MAX RATING AT 38 °C AIR TEMP	SITE RATING AT MAXIMUM INLET AIR TEMPERATURE OF 35 °C		
POWER RATING	**UNITS**			**100%**	**95%**	**75%**
CONTINUOUS ENGINE POWER	kWb		1417	1417	1346	1063
OVERLOAD	% 2/24 hr		0	0	-	-
MECHANICAL EFFICIENCY (LHV)	%		36.1	36.1	36.0	35.3
CONTINUOUS POWER AT FLYWHEEL	kWb		1417	1417	1346	1063
based on no auxiliary engine driven equipment						
AVAILABLE TURNDOWN SPEED RANGE	RPM	900 - 1200				
FUEL CONSUMPTION						
FUEL CONSUMPTION (LHV)	kJ/kWh		9984	9974	10001	10192
FUEL CONSUMPTION (HHV)	kJ/kWh		11044	11034	11063	11274
FUEL FLOW *based on fuel analysis LHV*	Nm3/hr		412	412	392	316
HEAT REJECTION						
JACKET WATER (JW)	kW		1068	1061	1015	832
LUBE OIL (OC)	kW		145	146	144	133
INTERCOOLER (IC)	kW		192	186	167	102
EXHAUST	kW		1021	1026	974	776
RADIATION	kW		161	166	165	161
EMISSIONS (CATALYST OUT):						
NOx (NO + NO2) *corr. To 7% O2*	mg/Nm3		372	372	372	372
CO *corr. To 7% O2*	mg/Nm3		372	372	372	372
THC *corr. To 7% O2*	mg/Nm3		143	142	151	190
NMHC *corr. To 7% O2*	mg/Nm3		1	1	1	1
NM,NEHC (VOC) *corr. To 7% O2*	mg/Nm3		1	1	1	1
CO2 *corr. To 7% O2*	g/Nm3		162	162	163	166
CO2e (Methane GWP: 25) *corr. To 7% O2*	g/Nm3		166	166	166	170
CH2O *corr. To 7% O2*	mg/Nm3		0.37	0.37	0.37	0.37
CH4 *corr. To 7% O2*	mg/Nm3		140	139	148	187
AIR INTAKE / EXHAUST GAS						
INDUCTION AIR FLOW	Nm3/hr		3779	3776	3596	2893
EXHAUST GAS MASS FLOW	kg/hr		5291	5287	5035	4051
EXHAUST GAS FLOW *at exhaust temp, 100 kPa*	m3/hr		13618	13624	12944	10329
EXHAUST TEMPERATURE	°C		584	585	583	576

HEAT EXCHANGER SIZING[12]			
TOTAL JACKET WATER CIRCUIT (JW)	kW		1211
TOTAL AUXILIARY WATER CIRCUIT (IC + OC)	kW		383

COOLING SYSTEM WITH ENGINE MOUNTED WATER PUMPS		
JACKET WATER PUMP MIN. DESIGN FLOW	L/min	1703
JACKET WATER PUMP MAX. EXTERNAL RESTRICTION	barG	1.09
AUX WATER PUMP MIN. DESIGN FLOW	L/min	299
AUX WATER PUMP MAX. EXTERNAL RESTRICTION	barG	2.48

All data provided per the condtions listed in the notes section on page three.

Data Generated by EngCalc Program Version 5.0 INNIO Waukesha Gas Engines, Inc.

15/02/2024 9:52 AM

Waukesha

Comet Ridge - Mahalo North Project - Qld, Australia

VHP - L7044GSI S5

Bidell Gas Compression   Juan Carlos Marín   +61 447 3:   Gas Compression

FUEL COMPOSITION

HYDROCARBONS:		Mole or Volume %
Methane	CH4	95.8
Ethane	C2H6	0
Propane	C3H8	0
Iso-Butane	I-C4H10	0
Normal Butane	N-C4H10	0
Iso-Pentane	I-C5H12	0
Normal Pentane	N-C5H12	0
Hexane	C6H14	0
Heptane	C7H16	0
Ethene	C2H4	0
Propene	C3H6	0
	SUM HYDROCARBONS	95.8
NON-HYDROCARBONS:		
Nitrogen	N2	4
Oxygen	O2	0
Helium	He	0
Carbon Dioxide	CO2	0.2
Carbon Monoxide	CO	0
Hydrogen	H2	0
Water Vapor	H2O	0
	TOTAL FUEL	100

FUEL:	CSG
FUEL PRESSURE RANGE (barG):	2.76 - 4.14
FUEL WKI:	102.0
FUEL SLHV (BTU/ft3):	857.67
FUEL SLHV (MJ/Nm3):	33.73
FUEL LHV (BTU/ft3):	872.86
FUEL LHV (MJ/Nm3):	34.32
FUEL HHV (BTU/ft3):	965.55
FUEL HHV (MJ/Nm3):	37.97
FUEL DENSITY (SG):	0.57

Standard Conditions per ASTM D3588-91 [60°F and 14.696psia] and ISO 6976:1996-02-01[25, V(0;101.325)].
Based on the fuel composition, supply pressure and temperature, liquid hydrocarbons may be present in the fuel. No liquid hydrocarbons are allowed in the fuel. The fuel must not contain any liquid water. Waukesha recommends both of the following:
1) Dew point of the fuel gas to be at least 20°F (11°C) below the measured temperature of the gas at the inlet of the engine fuel regulator.
2) A fuel filter separator to be used on all fuels except commercial quality natural gas.
Refer to the 'Fuel and Lubrication' section of 'Technical Data' or contact the Waukesha Application Engineering Department for additional information on fuels, or LHV and WKI* calculations.
* Trademark of INNIO Waukesha Gas Engines Inc.

FUEL CONTAMINANTS

Total Sulfur Compounds	0	% volume
Total Halogen as Chloride	0	% volume
Total Ammonia	0	% volume
Siloxanes		
Tetramethyl silane	0	% volume
Trimethyl silanol	0	% volume
Hexamethyldisiloxane (L2)	0	% volume
Hexamethylcyclotrisiloxane (D3)	0	% volume
Octamethyltrisiloxane (L3)	0	% volume
Octamethylcyclotetrasiloxane (D4)	0	% volume
Decamethyltetrasiloxane (L4)	0	% volume
Decamethylcyclopentasiloxane (D5)	0	% volume
Dodecamethylpentasiloxane (L5)	0	% volume
Dodecamethylcyclohexasiloxane (D6)	0	% volume
Others	0	% volume

Total Sulfur Compound:	0 µg/BTU
Total Halogen as Chlori	0 µg/BTU
Total Ammonia	0 µg/BTU
Total Siloxanes (as Si)	0 µg/BTU

Calculated fuel contaminant analysis will depend on the entered fuel composition and selected engine model.

NOTES

1. All data is based on engines with standard configurations unless noted otherwise.

2. Power rating is adjusted for fuel, site altitude, and site air inlet temperature, in accordance with ISO 3046/1 with tolerance of ± 3%.

3. Fuel consumption is presented in accordance with ISO 3046/1 with a tolerance of -0 / +5% at maximum rating. Fuel flow calculation based on fuel LHV and fuel consumption with a tolerance of -0/+5 %. For sizing piping and fuel equipment, it is recommended to include the 5% tolerance.

4. Heat rejection tolerances are ± 30% for radiation, and ± 8% for jacket water, lube oil, intercooler, and exhaust energy.

5. Emission levels for engines with Waukesha supplied 3-way catalyst are given at catalyst outlet flange. For all other engine models, emission levels are given at engine exhaust outlet flange prior to any after treatment. Values are based on a new engine operating at indicated site conditions, and adjusted to the specified timing and air/fuel ratio at rated load. Catalyst out emission levels represent emission levels the catalyst is sized to achieve. Manual adjustment may be necessary to achieve compliance as catalyst/engine age. Catalyst-out emission levels are valid for the duration of the engine warranty. Emissions are at an absolute humidity of 75 grains H2O/lb (10.71 g H2O/kg) of dry air. Emission levels may vary subject to instrumentation, measurement, ambient conditions, fuel quality, and engine variation. Engine may require adjustment on-site to meet emission values, which may affect engine performance and heat output. NOx, CO, THC, NMHC, CO2, and CO2e emission levels are listed as a not to exceed limit, all other emission levels are estimated. CO2 emissions based on EPA Federal Register/Vol. 74, No. 209/Friday, October 30, 2009 Rules and Regulations 56398, 56399 (3) Tier 3 Calculation Methodology, Equation C-5.

6. Air flow is based on undried air with a tolerance of ± 7%.

7. Exhaust temperature given at engine exhaust outlet flange with a tolerance of ± 50°F (28°C).

8. Exhaust gas mass flow value is based on a "wet basis" with a tolerance of ± 7%.

9. Inlet air restrictions based on full rated engine load. Exhaust backpressure based on 178.1 PSI BMEP and 1200 RPM. Refer to the engine specification section of Waukesha's standard technical data for more information.

10. Cooling circuit capacity, lube oil capacity, and engine dry weight values are typical.

11. Fuel must conform to Waukesha's "Gaseous Fuel Specification" S7884-7 or most current version. Fuel may require treatment to meet current fuel specification.

12. Heat exchanger sizing values given as the maximum heat rejection of the circuit, with applied tolerances and an additional 5% reserve factor.

13. Fuel volume flow calculation in english units is based on 100% relative humidity of the fuel gas at standard conditions of 60°F and 14.696 psia (29.92 inches of mercury; 101.325 kPa).

14. Fuel volume flow calculation in metric units is based on 100% relative humidity of the fuel gas at a combustion temperature of 25°C and metering conditions of 0°C and 101.325 kPa (14.696 psia; 29.92 inches of mercury). This is expressed as [25, V(0;101.325)].

15. Engine sound data taken with the microphone at 1 m (3.3 ft) from the side of the engine at the approximate front-to-back centerline. Microphone height was at intake manifold level. Engine sound pressure data may be different at front, back and opposite side locations. Exhaust sound data taken with microphone 1 meter (3.3 ft) away and 1 meter (3.3 ft) to the side of the exhaust outlet.

16. Due to variation between test conditions and final site conditions, such as exhaust configuration and background sound level, sound pressure levels under site conditions may be different than those tabulated above.

17. Cooling system design flow is based on minimum allowable cooling system flow. Cooling system maximum external restriction is defined as the allowable restriction at the minimum cooling system flow.

18. Continuous Power Rating: The highest load and speed that can be applied 24 hours per day, seven days per week, 365 days per year except for normal maintenance at indicated ambient reference conditions and fuel. No engine overload power rating is available.

19. emPact emission compliance available for entire range of operable fuels; however, fuel system and/or O2 set point may need to be adjusted in order to maintain compliance. VHP emPact particulate emissions measured as condensable PM2.5 per 40 CFR Part 1065 gravimetric reference method.

20. In cold ambient temperatures, heating of the engine jacket water, lube oil and combustion air may be required. See Waukesha Technical Data.

21. Available Turndown Speed Range refers to the constant torque speed range available. Reduced power may be available at speeds outside of this range. Contact application engineering.

SPECIAL REQUIREMENTS

Requires option code 1008A/1008SA for 1 g/bhp-hr NOx 1 g/bhp-hr CO catalyst.