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Canberra Town Planning PTY LTD

CTP Mossman Sugar Mill AQ Assessment

Air Quality Assessment

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Executive Summary

CocoNutZ Australia Pty Ltd is planning to construct an R&D (Demonstration) facility for kecap manis production adjacent to an existing plant site at 34 Mill St, Mossman. Vipac Engineers & Scientists (Vipac) have been engaged to provide an air quality assessment for the proposed facility.

An air quality impact assessment has been carried out for the assessment of the proposed kecap manis production facility emissions on the surround environment as follows:

- An emissions inventory of the primary air pollutants ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO and Ethanol) emitted by the demonstration facility was prepared for the maximum operating scenario based on manufacturer supplied source data and fugitive emissions estimated in accordance with the relevant National Pollutant Inventory Emissions Estimation Technique Manual.
- The emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model.
- The atmospheric dispersion modelling results were assessed by comparison with the assessment criteria described in Queensland Environment Protection (Air) Policy 2019.

The results of the modelling assessment may be summarised as follows:

- The predicted concentrations of all of the gases (CO, NO_2, SO_2 and Ethanol) and particulates (PM_{10} and $PM_{2.5}$) are below the criteria at all of the modelled sensitive receptors. In addition, predicted concentrations are well below odour criteria as specified for Ethanol.
- With the exception of NO_2, the contribution of the proposed Demonstration Facility to the air quality levels predicted at the sensitive receptors is much lower than the neighbouring sugar mill.

Overall, the modelling results indicate that the operation of the proposed kecap manis production facility will not adversely impact the amenity of local residential receptors.

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1 INTRODUCTION

CocoNutZ Australia Pty Ltd is planning to construct an R&D (Demonstration) facility (the facility) for kecap manis production adjacent to an existing plant site at 34 Mill St, Mossman. It was recorded at the pre-lodgement meeting with Douglas Shire Council (Council), the proposed activity will include a material change of use to the following environmentally relevant activity (ERA):

- ERA 28 Sugar milling or refining:
  Crushing or grinding 200t or more of sugar cane in a year or manufacturing 200t or more of sugar or other sugarcane products in a year (aggregate environmental score 48).

Council has therefore advised that any future application should be accompanied by an environmental impact assessment including modelling for odour and air quality. In particular, the application will need to be demonstrate through air dispersion modelling that any release of point source air emissions will not result in exceedances of the air quality objectives in the Environmental Protection (Air) Policy. Emissions from the Mossman Mill will also need to be included into the modelling. Furthermore, the application will need to demonstrate how any potential odours from the proposed activity (such as through fermentation) will be managed to ensure there is no impact on the environmental values of sensitive receptors.

Vipac Engineers & Scientists (Vipac) have been engaged to provide an air quality assessment for the proposed facility.

2 PROJECT DESCRIPTION

2.1 PROCESS OVERVIEW

The process uses sugar cane as the raw material. The cane feedstock is cleaned to remove excess leaf matter and dirt. Juice is extracted by milling and dirt is separated from the juice. The leaf matter is collected and returned to the growers' fields. The dirt is added to the site's mill mud pile to be used as a natural fertiliser for cane growers.

The clean cane juice is pasteurised and then fermented to produce the Kecap Manis flavour which is a combination of natural flavours from cane juice altered by the fermentation process. After a sterilisation step, the juice is evaporated into a syrup. The syrup has additional dry ingredients added for flavour. The final product is then cooked, cooled and packed in a sterile environment.

Sugar cane is traditionally harvested from June to November. The Demonstration Facility requires plans to process 10,700 tonnes of cane to produce 3,000 tonnes of Kecap Manis product annually, packed in 220 litre drums.

2.1.1 CANE SUPPLY, CANE CLEANING AND JUICE EXTRACTION

The existing rail network on the mill grounds isn't accessible from the CocoNutZ R&D facility. Instead, green harvested sugar cane will be transported from cane sidings to site by road using a multi-lift, and deposited on a concrete pad at the Eastern side of the facility.

Production rate of the Demonstration Facility is based on a throughput of 3 tonnes per hour of cane billets. This is equivalent to 72 tonnes per day of cane billets, approximately 3 loads on a multi-lift. Based on 70% efficiency and 150 operating days per season, the annual billet consumption is 10,700 tonnes per year.

Billet storage of 12 hours is required for overnight operations which is equivalent to a cane storage requirement of around 100 cubic metres.

Extraneous matter delivered with the cane billets will be removed in two stages of cane cleaning. The material removed will be added to Far Northern Milling's (FNM) biomass stockpile.

Tramp iron will be removed using an electromagnet on a cane conveyor.

Juice will be extracted from the cane using a twin tandem of mills. Exhausted cane fibre will be added to FNM's biomass stockpile.

The cane juice will be filtered, decanted and centrifuged to remove suspended solids. The solids will be added to FNM's mill mud stockpile.

2.1.2 FERMENTATION AND PASTEURISATION

Clean juice is pasteurised to prevent natural microbes in cane juice from impacting the fermentation process.

Four fermenters are used for the biocatalytic transformation of the cane juice. The temperature is controlled using a chiller unit.

To ensure no microbes remain in the juice, a "kill-step" heats the juice up to a temperature high enough to sterilise the juice.

2.1.3 EVAPORATION

The hot juice is thickened into a syrup using 4 evaporation stages. An initial 3-body evaporation uses the vapour generated at each stage to heat the following stage, and evaporates 90% of the required water. A final stirred evaporation stage provides the fine control to get the product to the required water content.

A condenser is used to extract the final vapour from the evaporators, and the energy from this is removed in the cooling tower.

Evaporated syrup has a high sugar content and low water activity, giving it a long shelf life and can be packed and used at a later stage for final processing into Kecap Manis.

The syrup is stored in a heated buffer tank where it is will be processed further during day working hours.

2.1.4 COOKING AND PACKAGING

Dry ingredients are added to the syrup to create the desired flavour profile. It is then cooked at boiling point to finalise the flavour in stirred, heated vessels.

The product then passes through a cooler and is aseptically packed into bags, and stored in plastic drums on pallets.

The product will be loaded onto semis and shipped to The Philippines and Indonesia.

2.2 POTENTIAL AIR EMISSIONS

Primary air emissions associated with the process therefore include the following:

- Products of combustion generated by boilers used to heat and cook the cane juice including CO, NO_2, SO_2, VOCs, PM_{10} and $PM_{2.5}$.
- Particulate matter emissions from the product handling activities (i.e. bagasse carting and crushing) within the sheds which are exhausted to the atmosphere via vents.
- Volatile organic compounds and odour primarily generated by the fermentation processes. However, it is noted that these processes are confined to the enclosed shed such that fugitive emissions would be expected to be minimal.

2.3 SITE LOCATION

The proposed site is on Lot 27 on the grounds of the Mossman Mill, on land owned by Daintree Bio-Precinct, approximately 80km North of Cairns. Figure 2-1 shows an aerial view of the facilities, a third shed is planned below the two existing sheds (left), and the site office and lab will be based in a disused building (right).

The Project Site is on the northeast border of the town of Mossman. As a result, the area to the immediate southwest is primarily commercial and residential. The surrounding area in the other directions is primarily rural, with farming and rainforests. The region is bordered to the west (~3km) by rugged steep mountain ranges and to the east (~3km) by coastal geography. In addition, 800m to the east, the terrain rises to approximately 200m.

Figure 2-1 shows the proposed site plan and Figure 2-2 shows the site location.

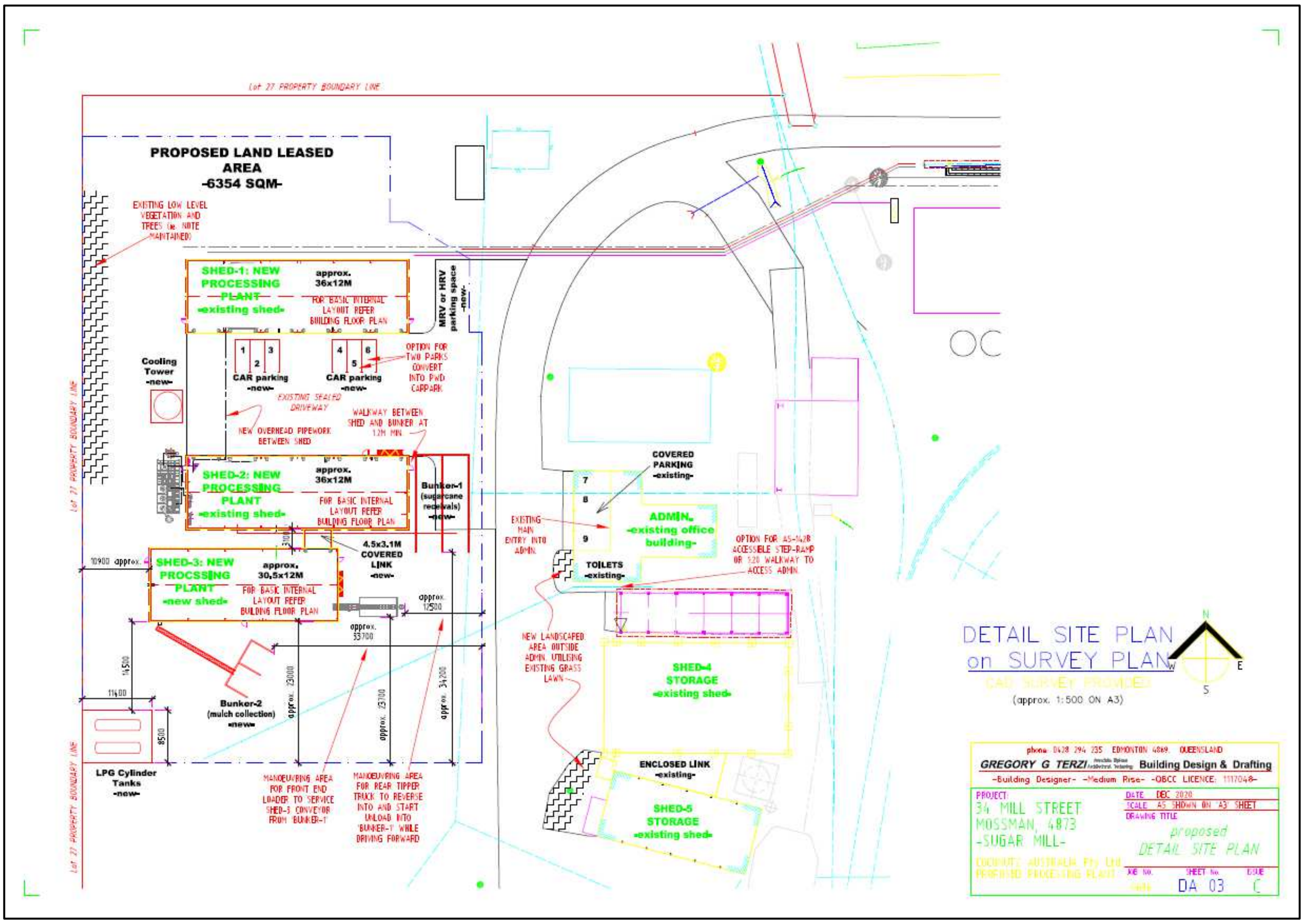


Figure 2-1 - Site Plan

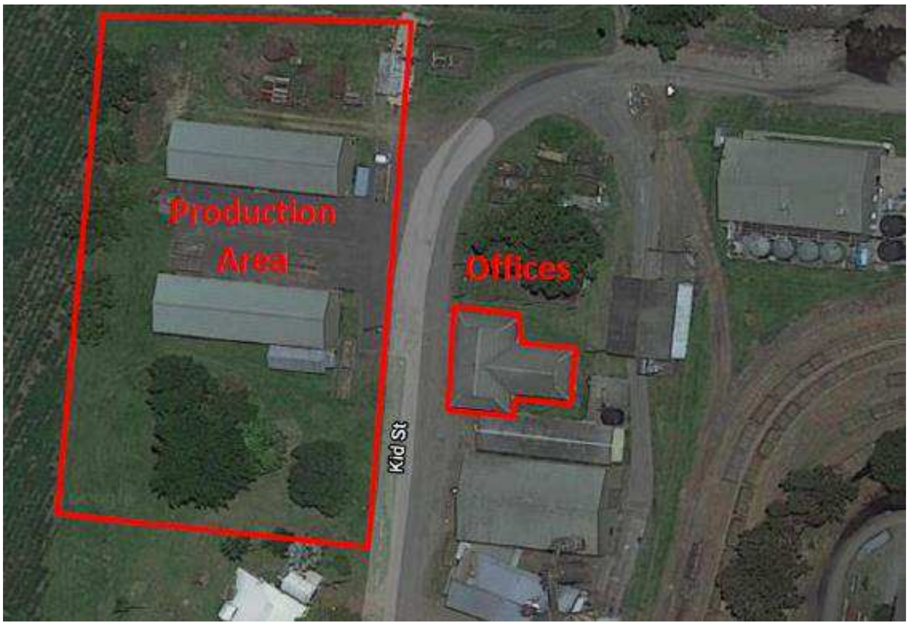


Figure 2-2 - Site Location

3 AMBIENT AIR QUALITY CRITERIA

The Environment Protection (Air) Policy 2019 (EPP (Air)) came into effect on 1 September 2019. The purpose of the policy is to achieve the object of the EP Act in relation to the air environment by: identifying environmental values to be enhanced or protected stating indicators and air quality objectives for enhancing or protecting the environmental values.

The EPP (Air) specifies air quality objectives for a range of pollutants over prescribed averaging times to be achieved and maintained by the policy. The air quality objectives appropriate for the assessment of the impacts from potential pollutants generated by the project activities are outlined in Table 3-1. In the absence of an objective for Ethanol, the Victorian State Environment Protection Policy (Air Quality Management) is adopted. Further details relating to the emissions are provided in Section 5.2.

Table 3-1: Air Quality Objectives

Pollutant	Averaging Time	Maximum Concentration (µg/m³)
PM_{10}	24 hours	50
	annual	25
$PM_{2.5}$	24 hours	25
	annual	8
Nitrogen Dioxide	1 hour	250
	annual	62
Sulphur Dioxide	1 hour	570
	24 hours	229
	annual	57
Carbon Monoxide	8 hours	11,000
Ethanol	3 minutes[1]	3,800
	3 minutes	62,700

1. Odour based criteria

4 EXISTING ENVIRONMENT

4.1 DISPERSION METEOROLOGY

4.1.1 REGIONAL METEOROLOGY

Data recorded by the nearest mainland Bureau of Meteorology (BoM) long term weather station at Cairns Airport (located approximately 62km south of the proposed Project site) was reviewed to describe the meteorological and climatic influences in the region. Long term weather data obtained from the BOM weather station at Cairns Airport is presented in Table 4-1.

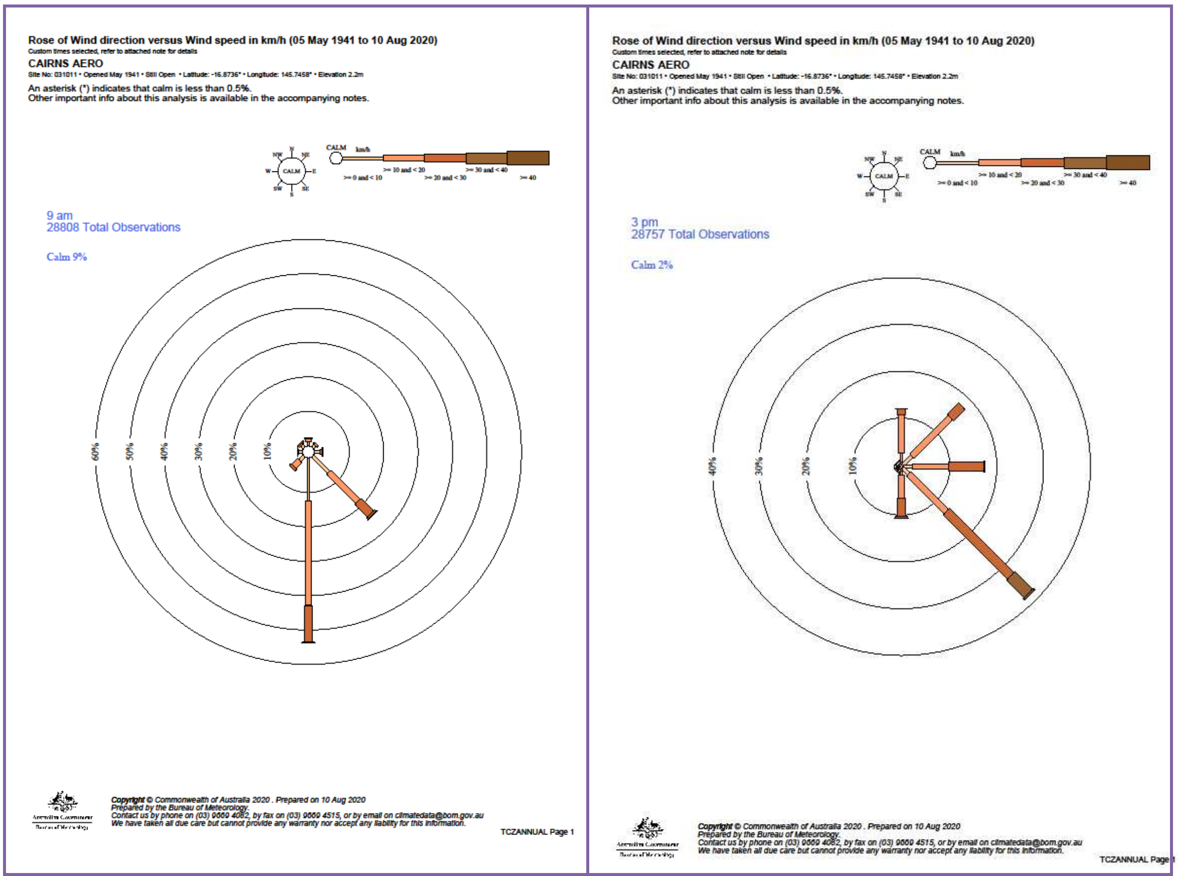
The mean temperature range is between 17.1°C and 31.5°C. The rainfall in the region is variable, with most rainfall in the summer and autumn months. On average, most of the annual rainfall is received between December and April. Rainfall is lowest between May and November. The mean annual rainfall is 1,992mm.

The long term wind roses recorded daily at the BoM station at 9am and 3pm are provided in Figure 4-1. Winds are shown to be primarily from the south at 9am and west and southeast directions at 3pm. Stronger winds (>40km/hr or >11.1m/s) occur infrequently mostly from the southeast direction at 3pm.

The region experiences hot and humid summers and mild, dry winters.

Table 4-1: Mean Long-term Weather Data for Cairns Airport (1941 to 2021)

Month	Mean Temperature		Rainfall (mm)	9 am Conditions			3 pm Conditions		
	Max (°C)	Min (°C)		Temp (°C)	RH (%)	Wind Speed (km/h)	Temp (°C)	Mean RH (%)	Wind Speed (km/h)
Jan	31.5	23.7	402.7	27.6	75	8.8	29.9	66	15.6
Feb	31.3	23.8	441.8	27.2	78	8.9	29.6	69	14.6
Mar	30.6	23.1	417.6	26.5	78	12.2	29.2	67	17.3
Apr	29.3	21.7	191.2	25.1	78	14.5	27.9	65	19
May	27.7	19.9	91.5	23.3	76	14.7	26.4	64	17.9
Jun	26.1	18	47	21.3	74	15.9	24.9	61	18.1
Jul	25.8	17.1	30.7	20.6	72	15.7	24.6	58	18.7
Aug	26.7	17.4	25.9	21.6	70	14.8	25.3	56	19.6
Sep	28.2	18.7	33.5	23.7	66	13.9	26.7	55	20.5
Oct	29.6	20.6	47.5	25.9	65	11.3	28.1	57	19.1
Nov	30.7	22.3	90.3	27.3	68	10	29.2	60	18
Dec	31.5	23.4	182.9	28	70	9.2	29.9	62	17
Annual	29.1	20.8	1991.5	24.8	72	12.5	27.6	62	18



Location: Cairns Airport Station	**Data Period:** 1941 to 2020	**Data Type:** Measured Data

Figure 4-1: Annual Wind Rose for Cairns Airport Weather Station (1941 to 2020)

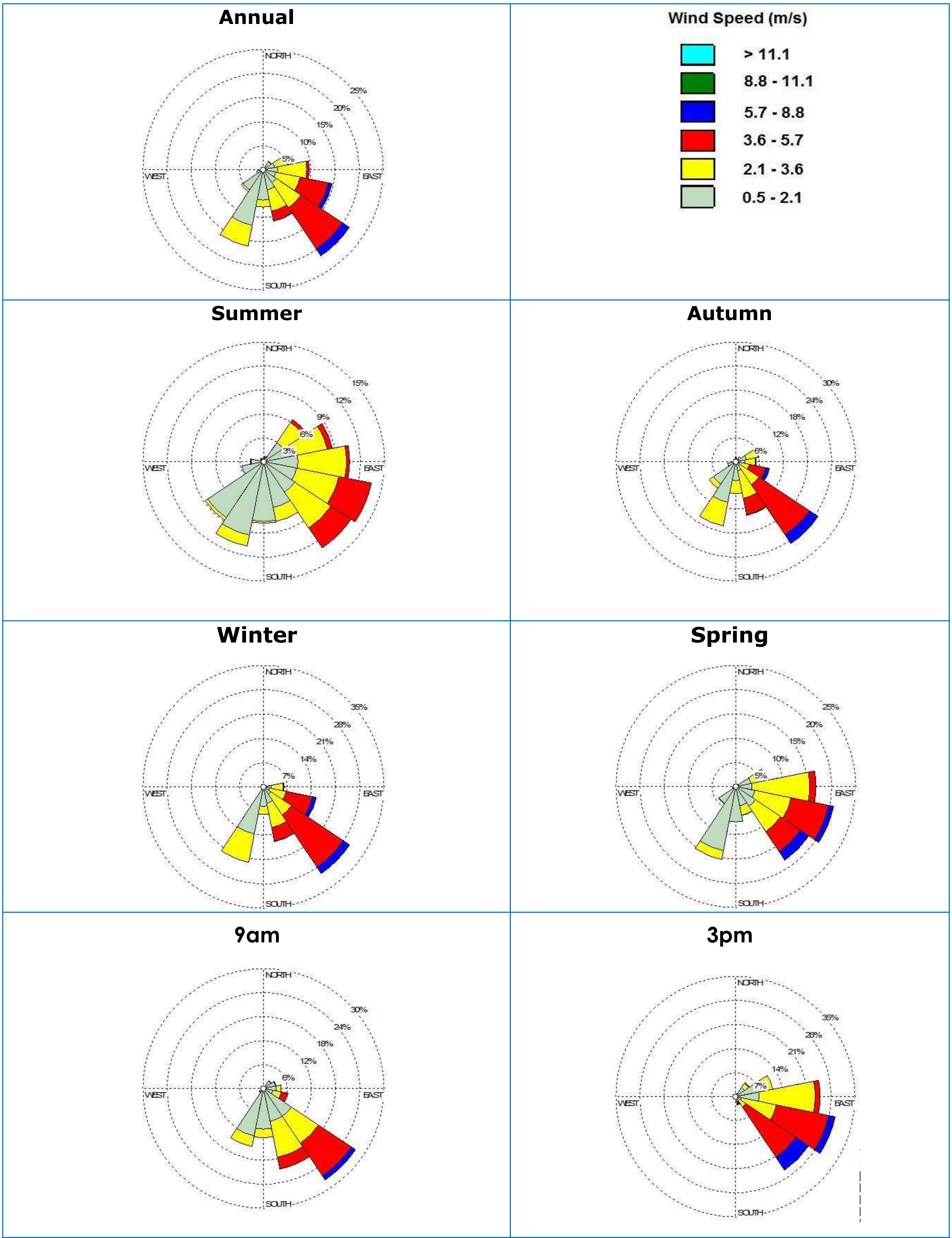
4.1.2 LOCAL METEOROLOGY

A three dimensional meteorological field was required for the air dispersion modelling that includes a wind field generator accounting for slope flows, terrain effects and terrain blocking effects. The Air Pollution Model, or TAPM, is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research and can be used as a precursor to CALMET which produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for each hour of the modelling period. The TAPM-CALMET derived dataset for 12 continuous months of hourly data from the year 2017 and approximately centred at the proposed Project site has been used to provide further information on the local meteorological influences. Details of the modelling approach are provided in Section 5.

4.1.2.1 WIND SPEED AND DIRECTION

Figure 4-2 presents the annual and seasonal wind roses from the TAPM-CALMET derived dataset for the year 2009 at the proposed Project site location. Wind roses from 9am and 3pm for the derived dataset are also provided in Figure 4-2 for comparison with the long term recorded data from the Cairns Airport Weather Station. Key features of the winds are:

- Winds are predominantly from the southeast with average wind speed of 2.5 m/s;
- The winds are largely consistent throughout the seasons with flows following the dominating terrain patterns to the east and west of the site.
- The 9am and 3pm wind roses for the TAPM-CALMET derived dataset are generally consistent with the measured data from the Cairns Airport BoM Weather Station. Winds are shown to be primarily from the south to southeast at 9am and southeast directions at 3pm.



Location: Project Site	**Data Period:** Jan 2017 to Dec 2017	**Data Type:** TAPM- CALMET extract

Figure 4-2: Wind Roses for the TAPM-CALMET Derived Dataset at the Project site, 2017

4.1.2.2 ATMOSPHERIC STABILITY

The Pasquill-Gifford stability classification scheme denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small. Figure 4-3 shows the stability class percentages from the TAPM-CALMET derived meteorological data for the project site. The data identifies that Stability Class F is most common; this stability class is indicative of stable atmospheric conditions.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

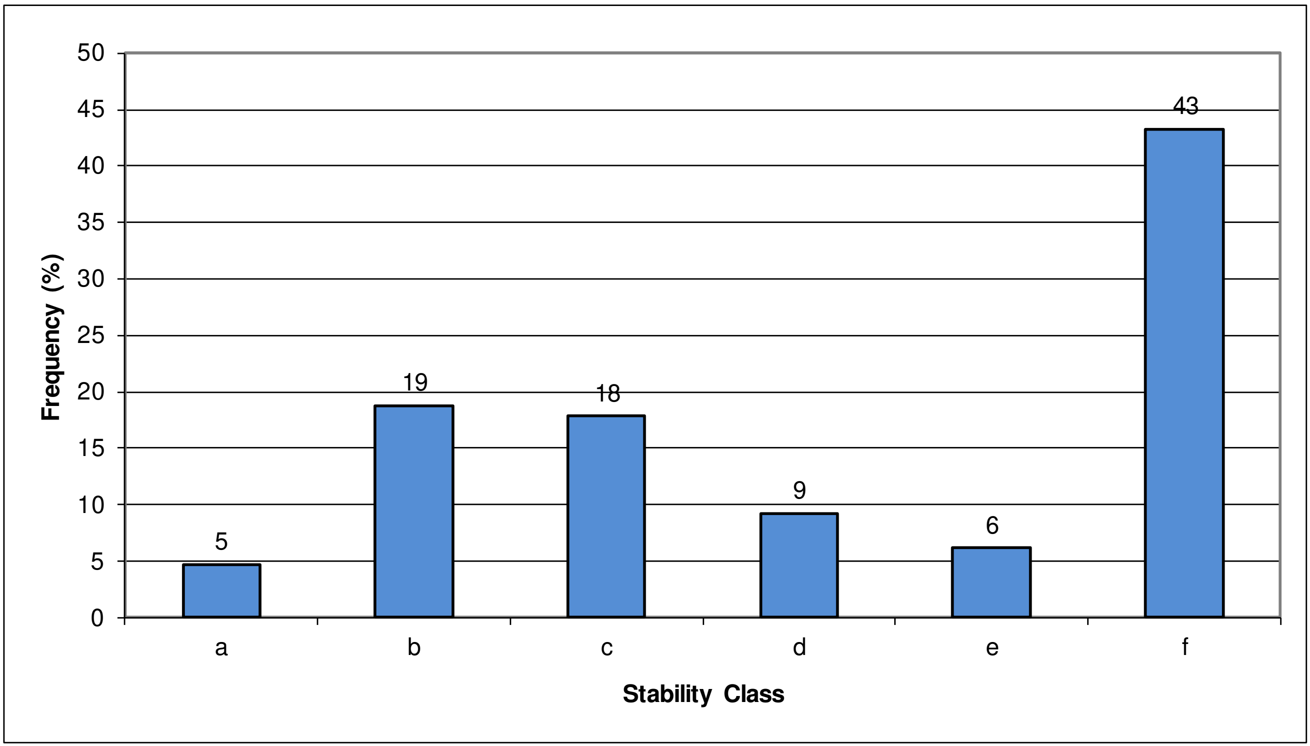


Figure 4-3: Stability Class Percentages for the TAPM-CALMET Derived Data, 2017

4.1.2.3 MIXING HEIGHT

Mixing height is defined as the height of the layer adjacent to the ground over which an emitted or entrained inert non-buoyant tracer will be mixed (by turbulence) within a time scale of about one hour or less.

Diurnal variations in mixing depths are illustrated in Figure 4-4. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

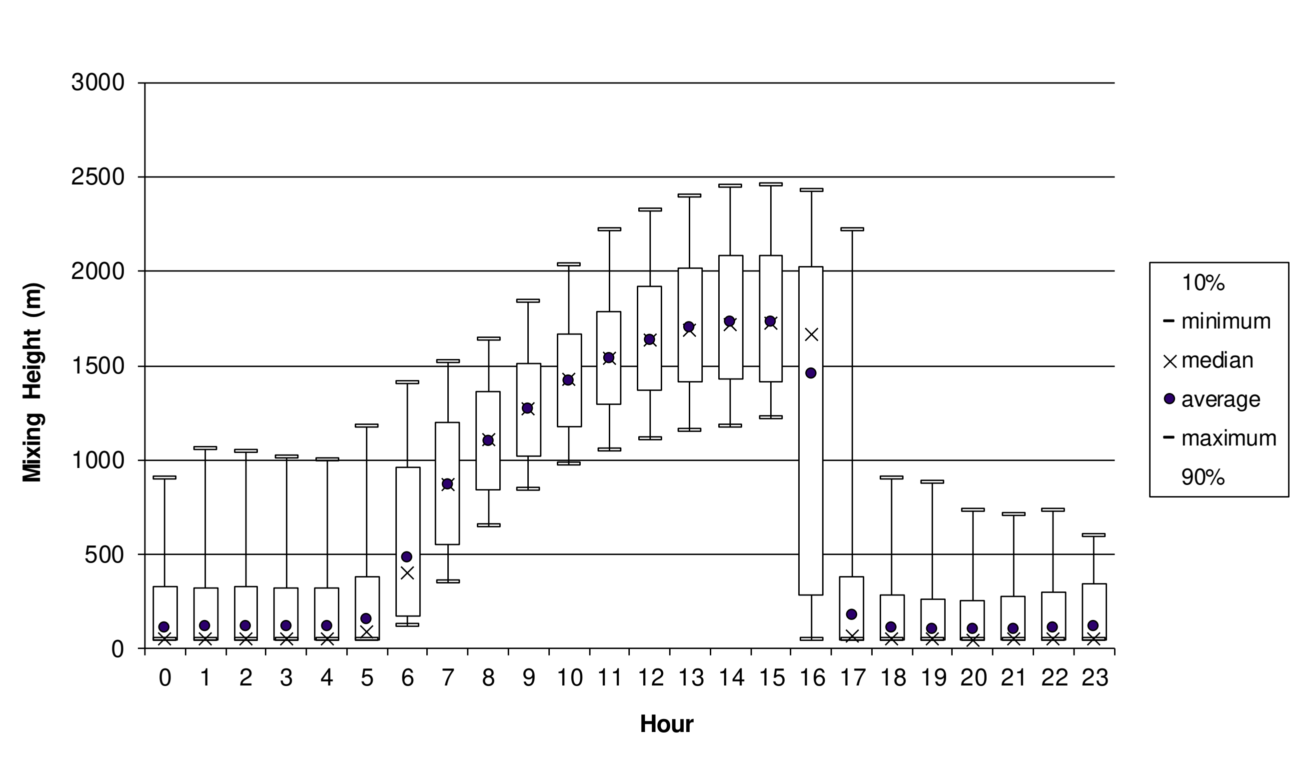


Figure 4-4: Mixing Height of the TAPM-CALMET Derived Data, 2017

4.2 EXISTING AIR QUALITY

The primary sources of air emissions in the region immediately surrounding the Project site are from the adjacent sugar mill activities and wind-blown dust primarily including PM_{10} and $PM_{2.5}$.

Given the remoteness of the location, background levels of pollutants at the Project site are expected to be low except for those affected by the Sugar Mill operations and consequentially, there are no nearby Queensland Department of Environment and Science (DES) air quality monitoring stations currently operating.

In the absence of measured ambient air quality data, background emissions for the Sugar Mill sources were estimated based on the National Pollutant Inventory (NPI) report for the 2018/2019 reporting year (the most recent available data at the time of modelling). Details of the approach are provided in Section 5.2.2.

5 METHODOLOGY

5.1 OVERVIEW

The overall approach to the assessment follows the guidelines outlined in the Generic Guidance and Optimum Model Settings for the CALPUFF modelling system in the 'Approved methods for the Modeling and Assessment of Air Pollutants in NSW' (NSW OEH, 2011). The assessment was conducted as follows:

- An emissions inventory of the primary air pollutants ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO and Ethanol) emitted by the demonstration facility was prepared for the maximum operating scenario based on manufacturer supplied source data and fugitive emissions estimated in accordance with the relevant National Pollutant Inventory Emissions Estimation Technique Manual.
- The emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model (Section 5.3.3).
- The atmospheric dispersion modelling results were assessed by comparison with the assessment criteria described in Section 3.

5.2 EMISSIONS INVENTORY

5.2.1 POINT SOURCE EMISSIONS

The point source emissions input data for the modelled pollutants emitted by the cane handling and processing activities was derived based upon the maximum proposed cane pressing throughput (for bagasse stockpiling and bagasse crushing in two enclosed sheds fitted with exhaust vents and emission factors specified in the National Pollutant Inventory Emissions Estimation Technique Manual for Sugar Milling and Refining for these activities. This is considered a worst-case scenario. Size classified PM emissions (i.e. $PM_{2.5}$) were unavailable so PM_{10} emissions were conservatively adopted as representative of $PM_{2.5}$.

Ethanol emissions (for odour assessment) via the two exhaust vents have also been quantified using the emission factor specified in the National Pollutant Inventory Emissions Estimation Technique Manual for Sugar Milling and Refining. A maximum throughput of 3t/hr sugar cane billets has been used for the estimations.

The point source emissions input data for the modelled pollutants emitted by the combustion boilers was derived based upon the maximum hourly fuel consumption for the two proposed boilers and emission factors specified in the National Pollutant Inventory Emissions Estimation Technique Manual for Combustion Boilers for LPG. This is also considered a worst-case scenario.

Appendix A provides further details of the emissions estimation methodology adopted.

The physical stack modelling parameters were provided by CocoNutZ. *Table 5-1* outlines the emissions data modelled.

5.2.2 BACKGROUND EMISSIONS

Point and fugitive (i.e. VOCs) source emissions for the Sugar Mill were estimated based on the National Pollutant Inventory (NPI) report for the 2018/2019 reporting year (the most recent available data at the time of modelling). Stack parameters are based upon the Sugar Mill's Environmental Authority (EPPR00920713).

Table 5-1 outlines the emissions data modelled.

Table 5-1: Modelled Stack Source Emissions Data

Source ID	UTM Coordinates (km)		Ht (m)	Diam (m)	Vel (m/s)	Temp (K)	Emission Rate (g/s)					
	X	Y					CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	Ethanol
Demonstration Facility Sources												
Boiler1	326.745	8179.811	8	0.15	10	303	0.0321	0.1908	0.0111	0.0034	0.0002	-
Boiler2	326.745	8179.807	8	0.15	10	303	0.0321	0.1908	0.0111	0.0034	0.0002	-
Vent1	326.779	8179.801	8	1.5	11.3	298	-	-	0.00099	0.00099	-	0.054
Vent2	326.779	8179.845	8	1.5	5.7	298	-	-	0.00047	0.00047	-	0.054
Sugar Mill Sources (Background)												
Boiler	326.947	8179.659	46.4	2	15.25	303	22.47	6.54	6.46	3.74	2.15	
Fugitive VOCs	326.922	8179.718	5	-	-	-	-	-	-	-	-	0.34[1]

1. It is conservatively assumed that all fugitive VOC emissions reported for the sugar mill are ethanol.

5.3 MODELLING

5.3.1 TAPM

To generate the meteorological inputs to run CALPUFF, this study has used the model The Air Pollution Model (TAPM), which is a 3-dimensional prognostic model developed and verified for air pollution studies by the CSIRO. TAPM was configured as outlined in Table 5-2.

Table 5-2: TAPM Set Up Data

Parameter	Setting
Centre Coordinates	16^{0}27.5 S; 145^{0}22.5 E
Dates Modelled	30 December 2016 to 31 December 2017 (2 start-up days)
Grid Domains	Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
Vertical Levels	25 vertical levels from 10 m to an altitude of 8000 m above sea level
Data assimilation	Bureau of Meteorology Cairns Airport Weather Station for 2017

5.3.2 CALMET

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system.

The CALMET simulation was run as No-Obs simulation with the gridded TAPM three-dimensional wind field data from the innermost grid. CALMET then adjusts the prognostic data for the kinematic effects of terrain, slope flows, blocking effects and three-dimensional divergence minimisation.

Vipac adopted the no observation approach for this site which uses prognostic data generated using TAPM nudged with observational data for the assessment. The CALMET modelling setup is presented in Table 5-3.

Table 5-3: CALMET setup parameters

Parameter	Setting
Meteorological grid domain	20km x 20km (80 x 80 x 10 grid dimensions)
Meteorological grid resolution	0.25km
Surface meteorological stations	None
Upper air meteorological station	None
3D Wind field	3D wind fields from TAPM (1km resolution) input as an initial guess to CALMET

5.3.3 CALPUFF

CALPUFF is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal.

The emissions have been modelled in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* using CALPUFF using the following key inputs:

- meteorological dataset for 1/1/2017 to 31/12/2017 generated in CALMET.
- 80 x 80 grid with a grid spacing 250m.
- terrain data from NASA SRTM1 - Shuttle Radar Topography Mission 1 arc second
- emission rates and source configurations as presented in Section 5.2.
- partial plume adjustment for terrain influences.
- Building wake effects for structures and building within the Project site.

- a radius of terrain feature set to 2km and minimum radius of influence to 0.1km.

5.3.4 METHOD FOR CONVERSON OF OXIDES OF NITROGEN TO NITROGEN DIOXIDE

Oxides of nitrogen (NOx) emitted from internal combustion engines are composed primarily of nitric oxide (NO) and nitrogen dioxide (NO_2). Although NO and NO_2 are reported together as NOx, they have different characteristics, including different formation mechanisms, measurement techniques, and toxicity (Olsen, et al., 2010). Eventually, all NO emitted is oxidized to NO_2 in the atmosphere in the presence of ozone and sunlight. The reaction takes place over several hours and can result in increased ground level NO_2 concentrations further down-plume (far field) and decreased closer to the source (near field).

The formation of NO_2 from NO is a complex photochemical process depending on a number of factors is that include the total amount of available NOx and ozone. To simplify this reaction two different NOx to NO_2 have been modelled.

The gridded receptors representing impacts from far field combustion sources have been modelled as a 100% conversion ratio given the distances to the site. This is considered to be a conservative estimation of the actual conversion. For the sensitive receptors close to the source (<200m), a ratio of 40% has been used. This is based on the monitoring results presented in the Clean and Healthy Air for Gladstone Final Ambient Air Quality Monitoring Plan (DERM, 2009) where between 20 - 40% of the NOx is present as NO_2.

Given the above, a ratio of 0.4 has been used as a conservative approach for NOx emissions associated with impacts from combustion sources at the proposed facility on local sensitive receptors.

5.4 SENSITIVE RECEPTORS

The Project site and the nearest sensitive receptors (R) are shown in Figure 5-1 and summarised in Table 5-4. It is noted that some receptors, such as R8 to R13, are representative of the closest of multiple dwellings.

Table 5-4: Sensitive Receptor Locations

Sensitive Receptor ID	UTM Coordinates		Description
	East (m)	**South (m)**	
R1	326764	8179748	Kid St Residence
R2	326752	8179729	Kid St Residence
R3	326735	8179693	Kid St Residence
R4	326682	8179654	Mill St Commercial
R5	326655	8179657	Mill St Commercial
R6	326615	8179670	Mill St Commercial
R7	326575	8179668	Mill St Commercial
R8	326468	8179728	Junction Rd Residence
R9	326497	8179785	Junction Rd Residence
R10	326537	8179851	Junction Rd Residence
R11	326572	8179926	Junction Rd Residence
R12	326602	8179978	Junction Rd Residence
R13	326700	8180068	Junction Rd Residence
R14	326907	8179599	Residence
R15	326938	8179606	Residence
R16	326893	8179515	Residence

Figure 5-1: Sensitive Receptor Locations

6 RESULTS AND DISCUSSION

6.1 OVERVIEW

This section presents the results of the air dispersion modelling for the maximum worst case operation inclusive of background (i.e. for assessment of cumulative impacts including the sugar mill operations). The tabulated results are presented for the model predictions at the sensitive receptors for each pollutant and compared with relevant ambient air quality criteria.

Contour plots showing the spatial distribution of model predictions inclusive of background in the surrounding environment are shown in Appendix B.

6.2 RESULTS

The model predictions in isolation and including background at the modelled sensitive receptors at the Project site for the worst-case maximum operation running for one full year are shown in Table 6-1 and Table 6-2.

It can be seen from the tables that the predicted concentrations of all of the gases (CO, NO_2, SO_2 and Ethanol) and particulates (PM_{10} and $PM_{2.5}$) are below the criteria at all of the modelled sensitive receptors. In addition, predicted concentrations are well below odour criteria as specified for Ethanol.

It is also worth noting that, with the exception of NO_2, the contribution of the proposed Demonstration Facility to the air quality levels predicted at the sensitive receptors is much lower than the neighbouring sugar mill.

Table 6-1: Model Predictions - Gases

	In isolation (µg/m³)						Cumulative (µg/m³)					
ID	**CO**	**NO_2**		**SO_2**			**CO**	**NO_2**		**SO_2**		
Ave time	**8 Hour**	**1 Hour**	**Annual**	**1 Hour**	**24 Hour**	**Annual**	**8 Hour**	**1 Hour**	**Annual**	**1 Hour**	**24 Hour**	**Annual**
R1	10.4	60.4	0.32	0.14	0.02	0.00	116.0	60.4	2.2	24.3	4.2	1.5
R2	15.1	54.9	0.30	0.13	0.03	0.00	110.2	54.9	2.2	25.3	4.2	1.6
R3	11.4	53.4	0.23	0.12	0.02	0.00	104.1	53.4	2.2	21.4	3.6	1.6
R4	4.8	28.2	0.16	0.06	0.01	0.00	97.8	33.3	1.8	27.3	3.7	1.3
R5	4.5	69.1	0.19	0.16	0.02	0.00	91.0	69.1	1.7	29.2	3.7	1.2
R6	7.5	122.0	0.29	0.28	0.02	0.00	74.6	122.0	1.6	28.6	3.4	1.1
R7	10.2	112.1	0.42	0.26	0.03	0.00	69.3	112.1	1.6	29.2	3.6	1.0
R8	8.4	76.0	1.46	0.17	0.02	0.00	64.5	76.1	2.5	44.7	2.5	0.8
R9	12.7	107.4	2.89	0.25	0.04	0.01	73.4	107.7	3.9	51.9	2.4	0.8
R10	26.0	153.3	4.27	0.35	0.05	0.01	62.2	153.3	5.2	43.7	2.1	0.8
R11	14.0	146.0	3.28	0.34	0.04	0.01	65.1	146.1	4.1	25.6	2.1	0.7
R12	18.0	146.9	2.46	0.34	0.04	0.01	60.9	146.9	3.1	33.4	1.8	0.5
R13	10.4	145.2	1.34	0.33	0.02	0.00	53.4	145.2	1.8	36.7	1.7	0.4
R14	1.5	25.5	0.07	0.06	0.00	0.00	31.4	25.5	0.1	15.9	1.2	0.0
R15	2.3	24.8	0.07	0.06	0.00	0.00	34.5	24.8	0.1	14.6	1.3	0.0
R16	2.1	20.6	0.05	0.05	0.00	0.00	55.4	24.0	0.1	19.5	2.4	0.0
Criteria	**11,000**	**250**	**62**	**570**	**229**	**57**	**11,000**	**250**	**62**	**570**	**229**	**57**
Maximum Conc	26.0	153.3	4.3	0.4	0.0	0.0	116.0	153.3	5.2	51.9	4.2	1.6
Criteria met?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 6-2: Model Predictions - Particulates

	In isolation				Cumulative			
ID	**PM_{10} (µg/m³)**		**$PM_{2.5}$ (µg/m³)**		**PM_{10} (µg/m³)**		**$PM_{2.5}$ (µg/m³)**	
Averaging time	**24 Hour**	**Annual**	**24 Hour**	**Annual**	**24 Hour**	**Annual**	**24 Hour**	**Annual**
R1	1.27	0.05	0.44	0.01	12.45	4.58	7.20	2.64
R2	1.80	0.04	0.59	0.01	12.49	4.80	7.23	2.77
R3	1.37	0.03	0.46	0.01	10.84	4.83	6.27	2.78
R4	0.79	0.02	0.29	0.01	11.13	4.03	6.44	2.32
R5	1.21	0.03	0.42	0.01	11.11	3.73	6.43	2.15
R6	1.65	0.04	0.55	0.01	10.34	3.37	5.96	1.94
R7	1.79	0.06	0.57	0.02	10.98	3.04	6.30	1.74
R8	1.26	0.22	0.41	0.07	8.48	2.67	4.70	1.49
R9	2.33	0.43	0.74	0.14	8.32	2.93	4.52	1.58
R10	3.18	0.63	0.99	0.20	7.01	2.98	3.79	1.56
R11	2.39	0.49	0.74	0.16	7.27	2.43	3.93	1.28
R12	2.80	0.37	0.88	0.12	6.47	2.00	3.45	1.06
R13	1.45	0.20	0.46	0.07	6.09	1.32	3.23	0.71
R14	0.19	0.01	0.08	0.00	3.81	0.11	2.20	0.06
R15	0.24	0.01	0.11	0.00	3.99	0.08	2.30	0.04
R16	0.26	0.01	0.09	0.00	7.12	0.14	4.12	0.08
Criteria	**50**	**25**	**25**	**8**	**50**	**25**	**25**	**8**
Maximum Concentration	3.2	0.6	1.0	0.2	12.5	4.8	7.2	2.8
Criteria met?	✓	✓	✓	✓	✓	✓	✓	✓

Table 6-3: Model Predictions - Ethanol

	In isolation		**Cumulative**	
ID	**Ethanol (µg/m³)**			
Averaging time	**3 minutes**		**3 minutes**	
R1	77		934	
R2	70		790	
R3	68		683	
R4	36		420	
R5	88		422	
R6	155		438	
R7	143		403	
R8	97		326	
R9	137		463	
R10	195		501	
R11	186		474	
R12	187		483	
R13	185		561	
R14	32		604	
R15	32		609	
R16	26		508	
Criteria	**3,800**	**62,700**	**3,800**	**62,700**
Maximum Concentration	187		934	
Criteria met?	✓		✓	

7 CONCLUSIONS

An air quality assessment for the R&D (Demonstration) facility for kecap manis production adjacent to an existing plant site at 34 Mill St, Mossman. The overall approach to the assessment follows the the guidelines outlined in the Generic Guidance and Optimum Model Settings for the CALPUFF modelling system in the 'Approved methods for the Modeling and Assessment of Air Pollutants in NSW'.

The results of the modelling assessment may be summarised as follows:

- The predicted concentrations of all of the gases (CO, NO_2, SO_2 and Ethanol) and particulates (PM_{10} and $PM_{2.5}$) are below the criteria at all of the modelled sensitive receptors. In addition, predicted concentrations are well below odour criteria as specified for Ethanol.
- With the exception of NO_2, the contribution of the proposed Demonstration Facility to the air quality levels predicted at the sensitive receptors is much lower than the neighbouring sugar mill.

Overall, the modelling results indicate that the operation of the proposed kecap manis production facility will not adversely impact the amenity of local residential receptors.

8 REFERENCES

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Scire, J. S., Strimaitis, D. G. & Yamartino, R. J., 2000. A users guide for the CALPUFF Dispersion Model (Version 5), Concord MA: Earth Tech Inc.

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Appendix A EMISSIONS ESTIMATION ASSUMPTIONS

Emission factors can be used to estimate emissions of pollutants to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity.

The National Pollutant Inventory Emission Estimation Technique Manual for Sugar Milling and Refining (January 2001) provides the equations and emission factors to determine the emissions of PM_{10} from dust generating activities. These emission factors incorporate emission factors published by the USEPA in their AP-42 documentation.

Table A-1 and Table A-2 summarises the PM_{10} and Ethanol emission factors adopted from the Manual for the emissions estimations. As discussed in Section 5.2, size classified PM emissions (i.e. $PM_{2.5}$) were unavailable so PM_{10} emissions were conservatively adopted as representative of $PM_{2.5}$.

As the dust generating activities are within the enclosed sheds, the emission factors were applied to a maximum proposed throughput of 626 kg/h with dust extracted through two exhaust vents (one for each shed).

Table A-1: PM_{10} emission factors adopted for the emissions estimations

Source	Emission Factor (kg PM10/t cane crushed)
Bagasse Stockpile (carting)	2.72×10^{-3}
Bagasse Dust (crushing)	5.67×10^{-3}

Table A-2: Ethanol emission factors adopted for the emissions estimations

Pollutant	Emission Factor (kg/t)
Ethanol	0.065

The National Pollutant Inventory Emission Estimation Technique Manual for Combustion in Boilers (December 2011) provides the equations and emission factors to determine the emissions of combustion pollutants from boilers. These emission factors incorporate emission factors published by the USEPA in their AP-42 documentation.

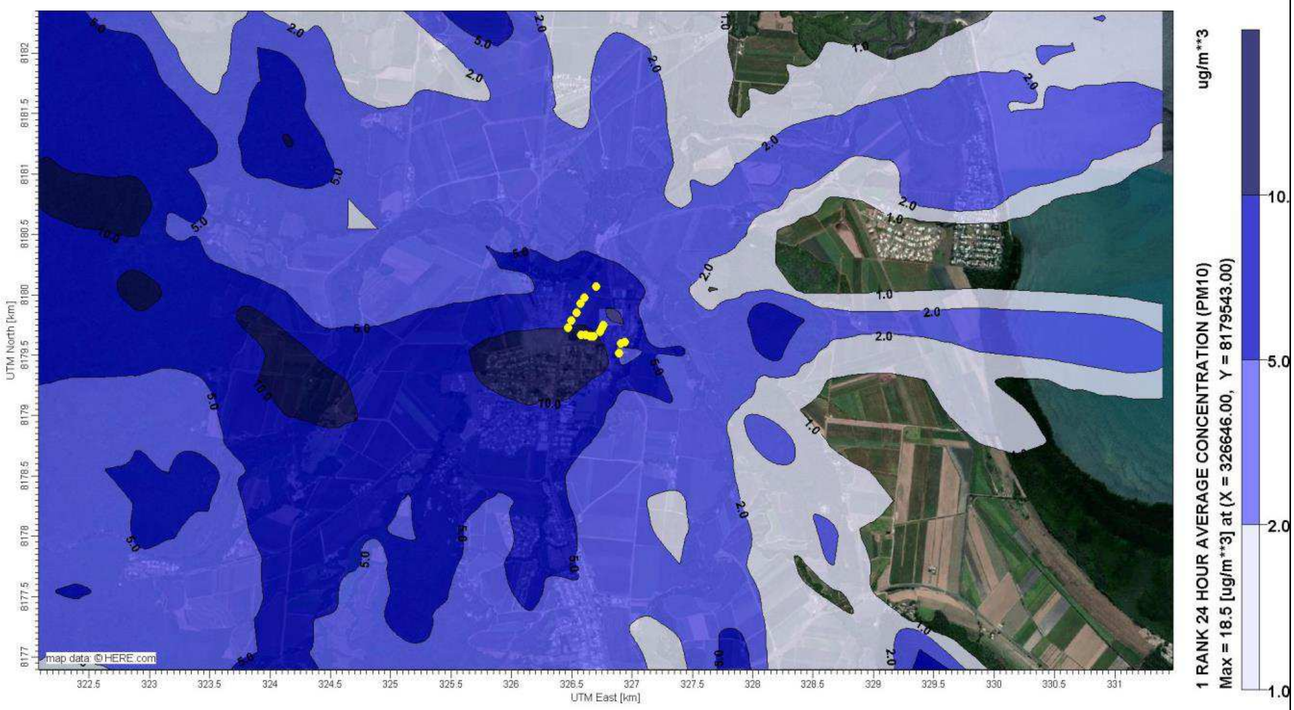
Table A-2 summarises the PM_{10} emission factors adopted from the Manual for the emissions estimations.

Two boiler types are proposed for the Demonstration Facility, a 1.5MW Steamtech D type and a 500Kw East Coast Vertical type. Peak fuel consumption loads are expected to be 154kg/h.

Table B-2: Boiler emission factors adopted

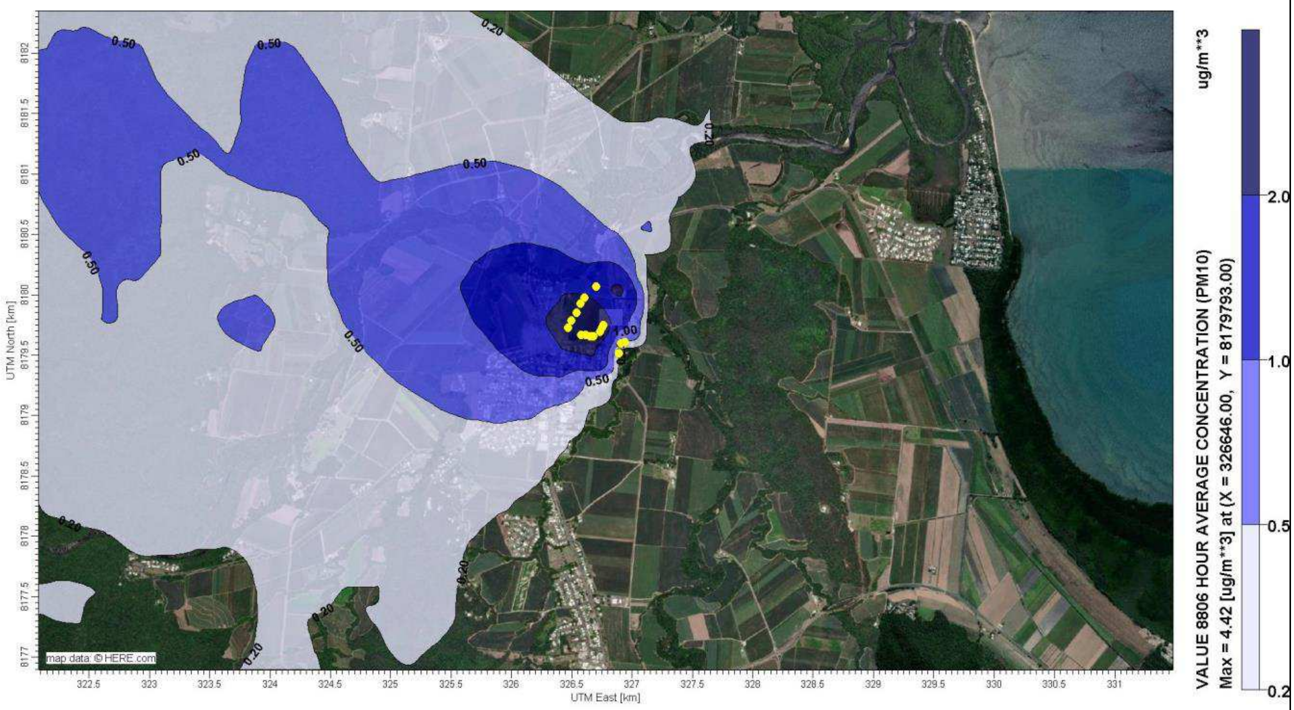
Pollutant	Emission factor (kg/t)
CO	0.75
NOx	4.46
PM_{10}	0.26
$PM_{2.5}$	0.08
SO_2	0.0041
VOC	0.06

Appendix B CONTOUR PLOTS



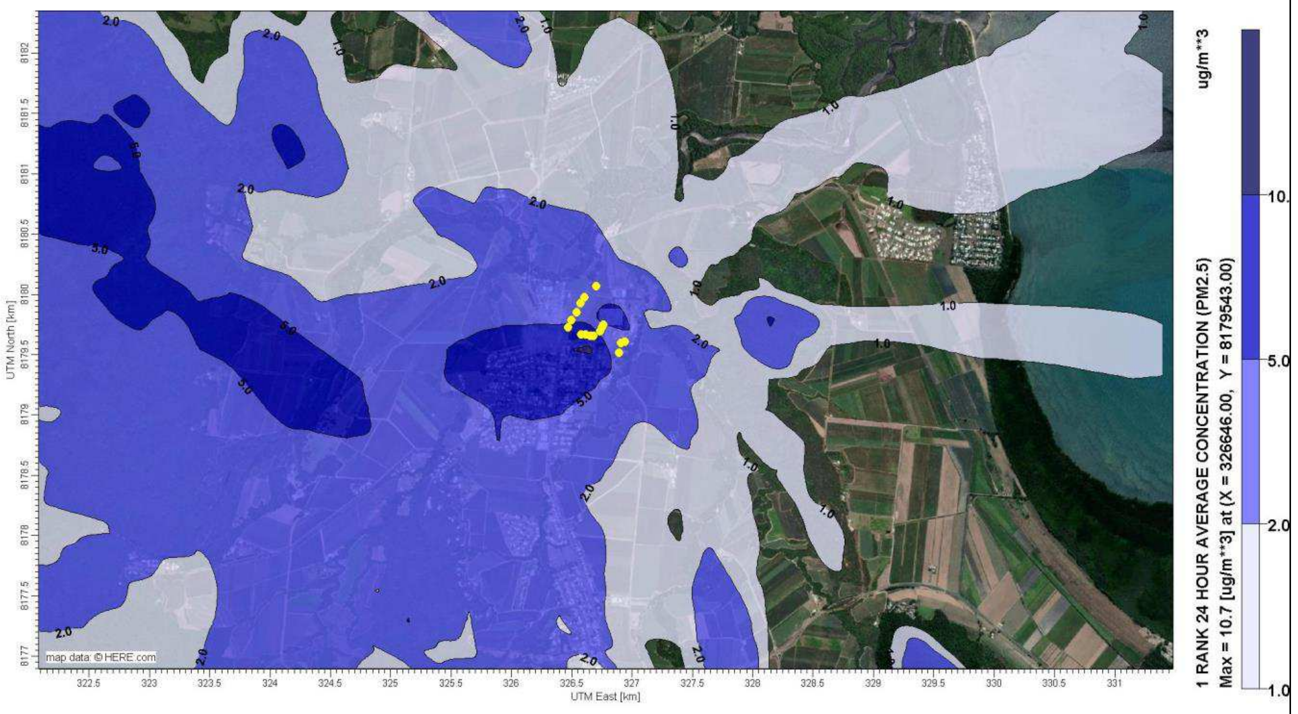
Pollutant: PM10	**Averaging Period:** 24 hour	**Percentile:** MAX	**Criteria:** 50 µg/m^3

Scenario:
Maximum daily operations including background



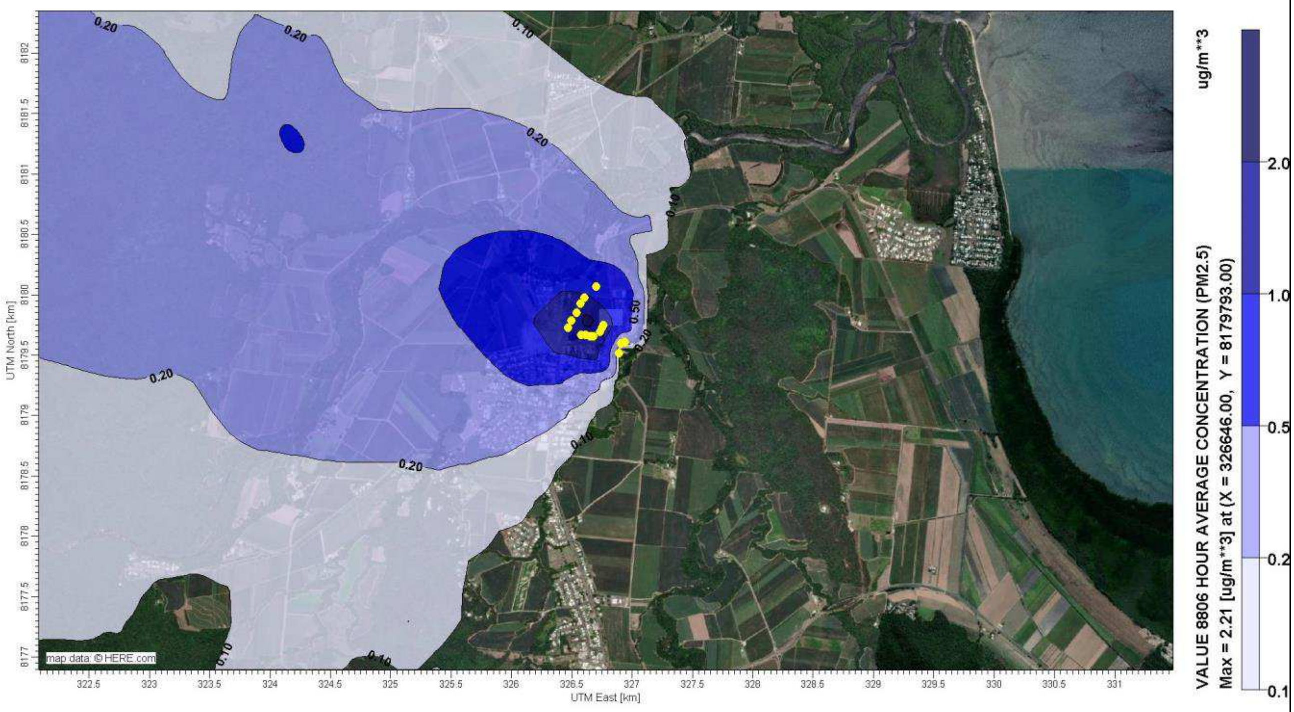
Pollutant: PM$_{10}$	Averaging Period: Annual	Percentile: Average	Criteria: 25 µg/m^3

Scenario:
Maximum daily operations including background



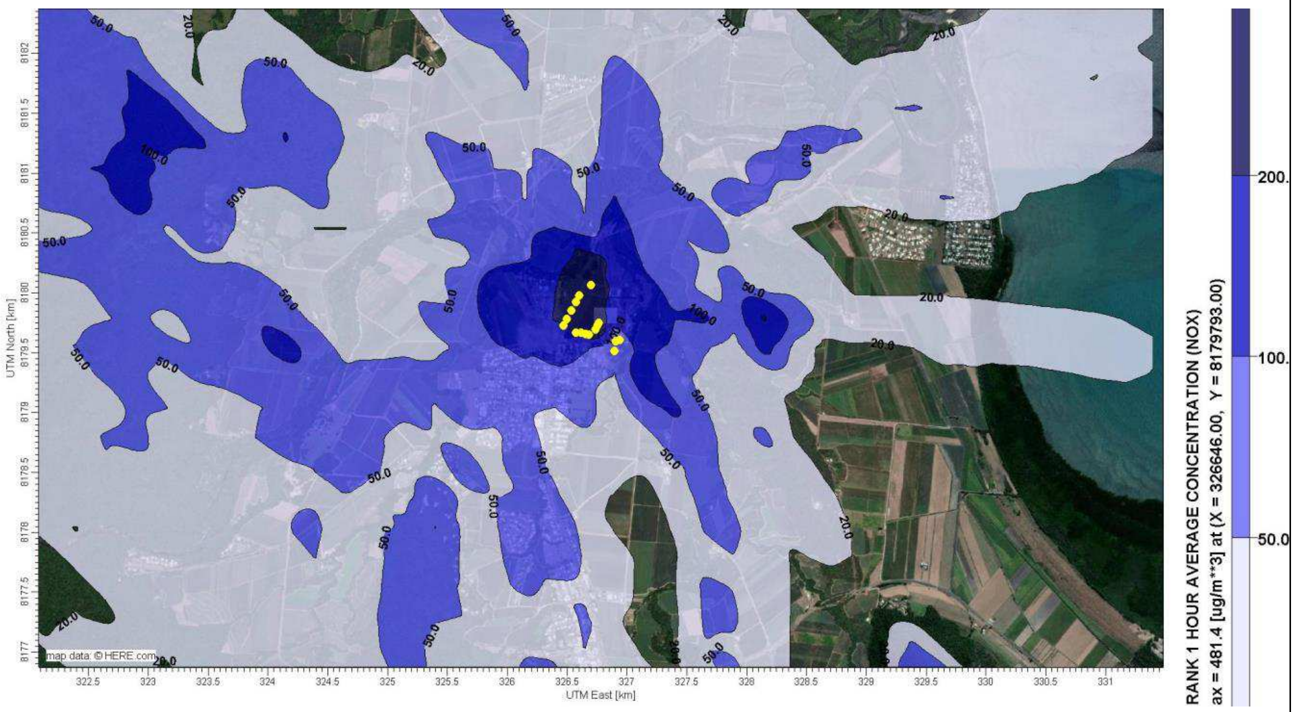
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$	24 hour	MAX	25 µg/m^3

Scenario:
Maximum daily operations including background



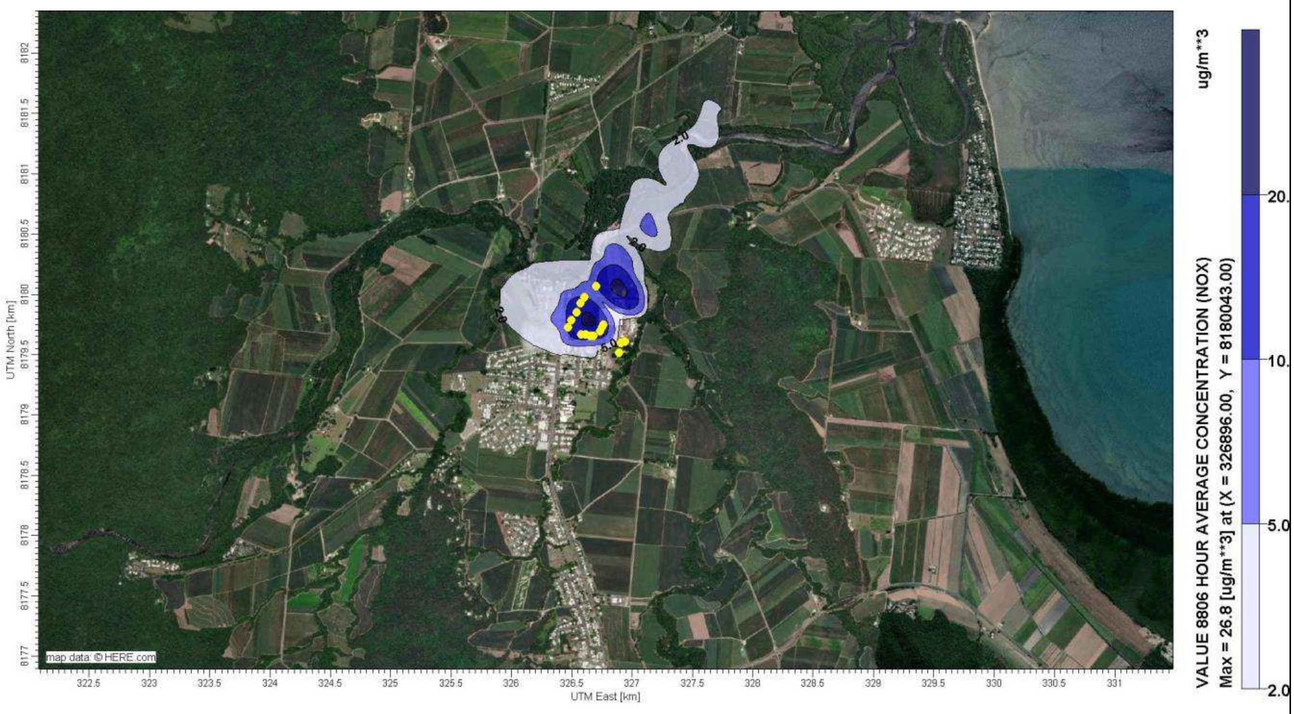
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$	1 year	Average	8 µg/m^3

Scenario:
Maximum daily operations including background



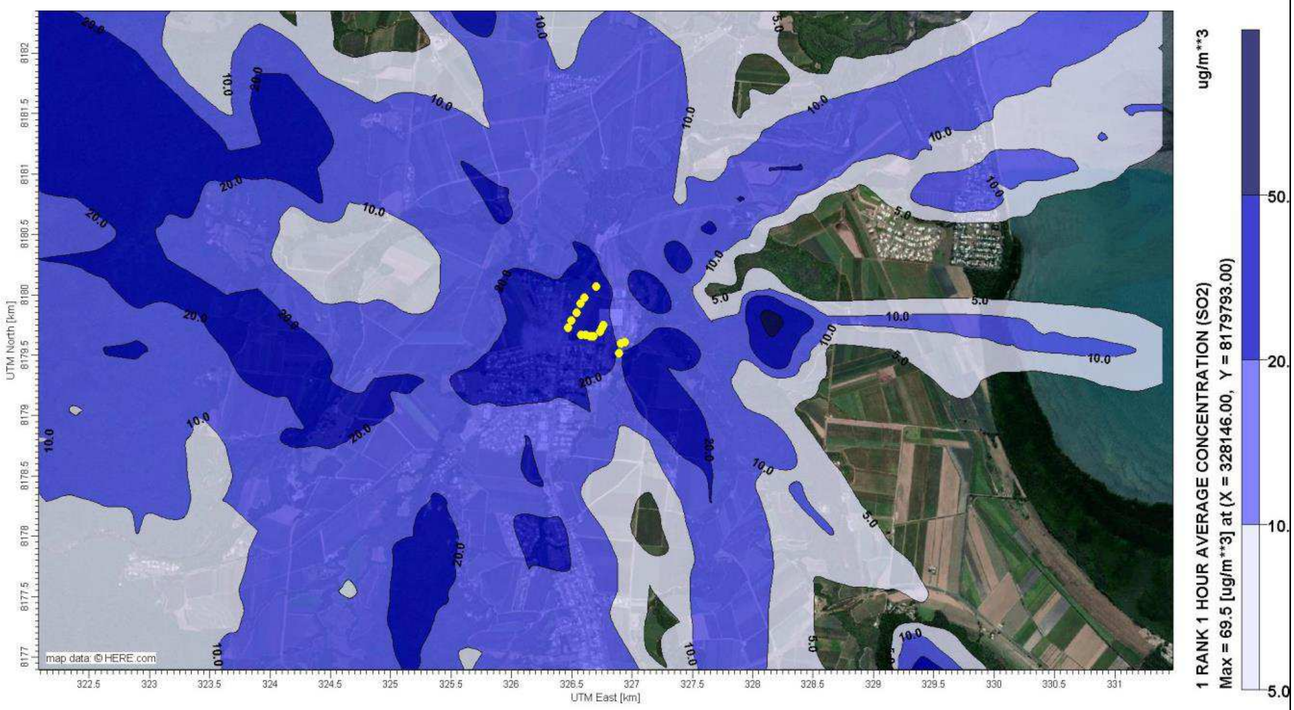
Pollutant: NO_2	Averaging Period: 1-hour	Percentile: MAX	Criteria: 250 µg/m^3

Scenario:
Maximum daily operations including background



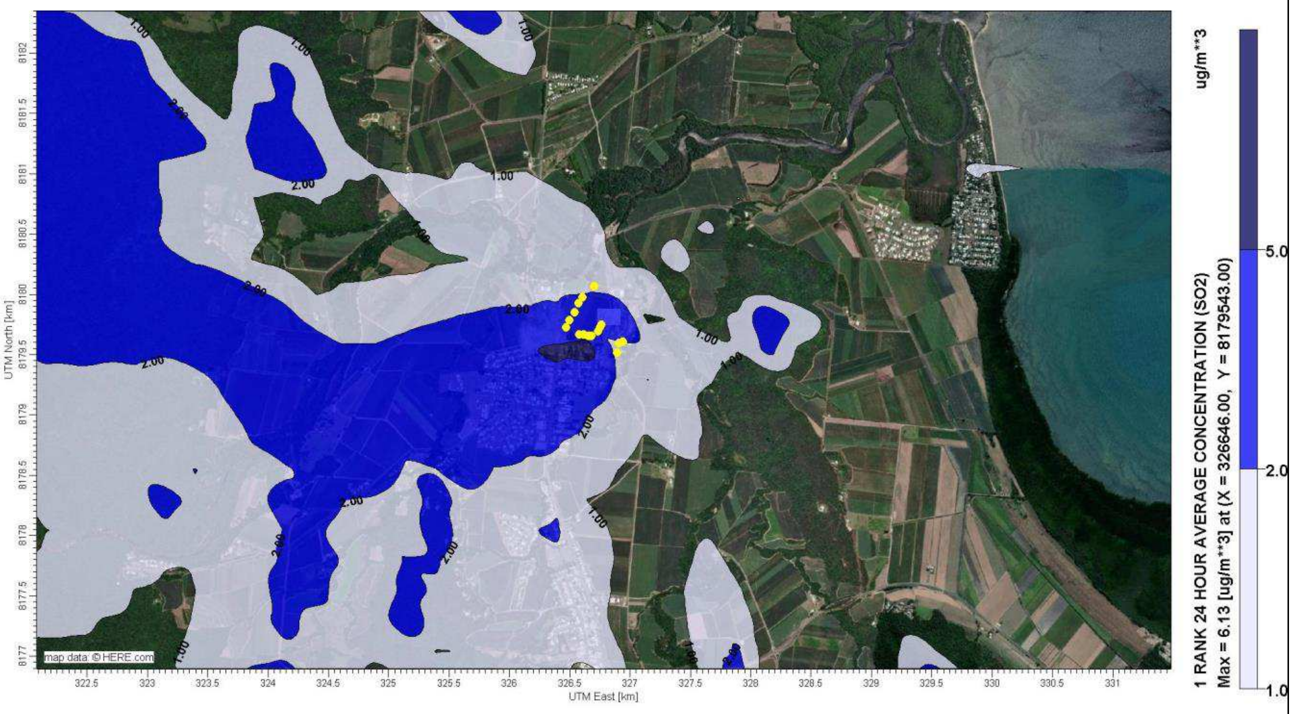
Pollutant:	Averaging Period:	Percentile:	Criteria:
NO_2	Annual	Average	62 µg/m^3

Scenario:
Maximum daily operations including background



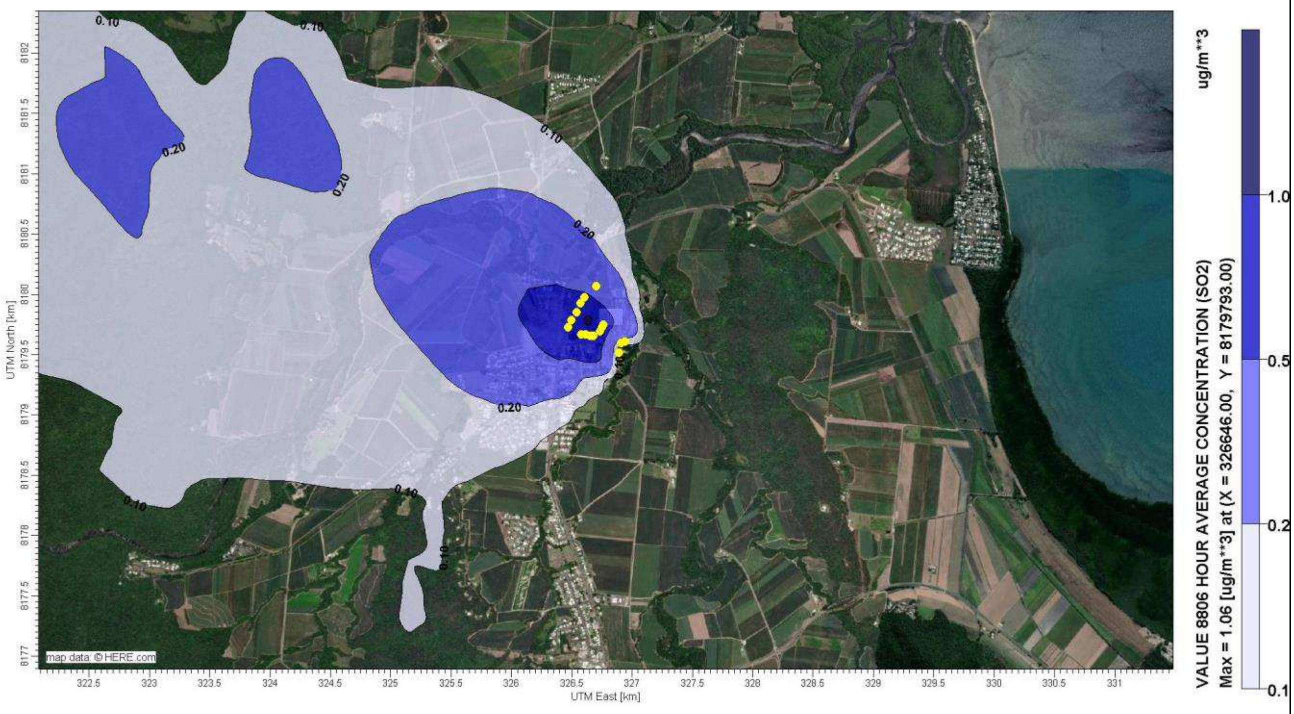
Pollutant:	Averaging Period:	Percentile:	Criteria:
SO_2	1 hour	max	570 µg/m^3

Scenario:
Maximum daily operations including background



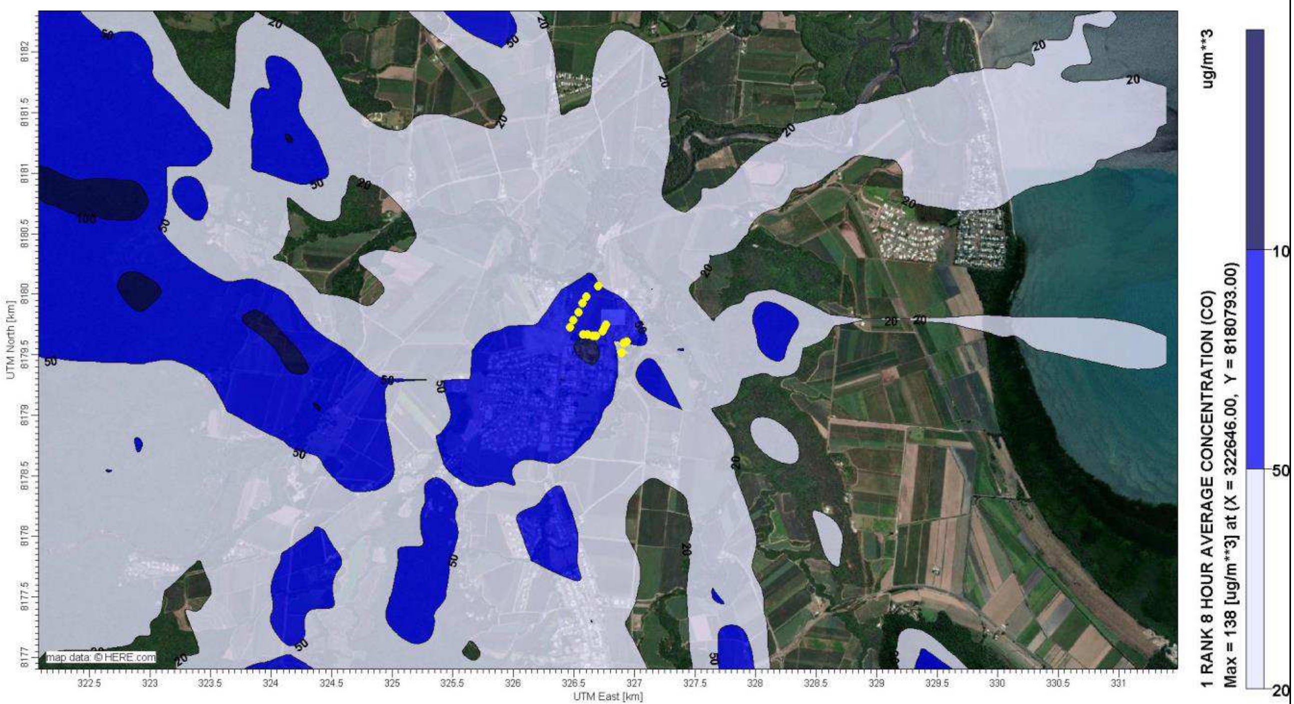
Pollutant:	Averaging Period:	Percentile:	Criteria:
SO_2	24 hour	MAX	229 µg/m^3

Scenario:
Maximum daily operations including background



Pollutant:	Averaging Period:	Percentile:	Criteria:
SO_2	Annual	Average	57 µg/m^3

Scenario:
Maximum daily operations including background



Pollutant:	Averaging Period:	Percentile:	Criteria:
CO	8 hours	MAX	11,000 μg/m^3

Scenario:
Maximum daily operations including background