Gladesville Bridge Marina Pty Ltd

Gladesville Bridge Marina DA

Air Quality Assessment Report

October 2019

Executive summary

Gladesville Bridge Marina propose to redevelop the existing marina to include additional floating berths, removal of existing swing-moorings and minor additions and alterations to the marina layout. An air quality impact assessment of the existing and proposed operations associated with this redevelopment has been conducted.

A review of the study area was undertaken to identify representative sensitive receptors suitable for modelling. Residential properties are located directly to the south of the marina.

Site specific meteorology and ambient background concentrations of pollutants were sourced from the Rozelle OEH monitoring station. The site specific meteorological data was used along with prognostic TAPM outputs to synthesise a suitable meteorological modelling file in CALMET. The meteorology indicates predominant annual average wind directions from the northwest, northeast and south, with the majority of lower wind speeds (2-4 m/s) from the northwest and south. The average wind speed in the area is low (1.7 m/s), with calm conditions occurring 8.7% of the time.

Operational air quality impacts associated with dust and combustion by-products were modelled and assessed for existing and future operating conditions in the CALPUFF modelling system. CALPUFF is a Gaussian puff model and is a recognised regulatory model in NSW. CALPUFF is especially suited for modelling light to calm wind conditions.

The predicted operational results indicate compliance with the air quality criteria for all pollutants of interest for both the existing and future operating scenarios.

Air quality impacts associated with the construction of the project were not deemed to be significant as the majority of construction works will be undertaken over water. The project is also not associated with significant existing or future sources of odour.

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Glossary of terms and abbreviations

Term/ Abbreviation	Definition
Background levels	Existing concentrations of pollutants in the ambient air.
BoM	Bureau of Meteorology
EPA	NSW Environment Protection Authority
NPI	National Pollutant Inventory
OU	Odour units; indicates concentration of odorous mixtures. The number of odour units is the concentration of a sample divided by the odour threshold or the number of dilutions required for the sample to reach the threshold. This threshold is the numerical value equivalent to when 50% of a testing panel correctly detect an odour. For complex mixtures of odours, odour is specified in OU/m^3 (odour units per cubic metre) as a noise-response-time average.
Pasquill-Gifford	Stability classification used in atmospheric dispersion models to define the turbulent state of the atmosphere
$PM_{2.5}$	Particulate matter (airborne dust) with a size of 2.5 micrograms
PM_{10}	Particulate matter (airborne dust) with a size of 10 micrograms
Sensitive receptor	A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.
TSP	Total Suspended Particles – airborne dust

1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) was commissioned by Gladesville Bridge Marina (GBM) to undertake an air quality impact assessment of the proposed redevelopment of the GBM (‘the project’). The project is located in Gladesville, NSW.

Development consent is required for the development under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and is deemed a Designated Development requiring the preparation of an Environmental Impact Statement (EIS).

This assessment has been prepared to inform an EIS and development application under Part 4 of the EP&A Act. The assessment has been prepared in accordance with relevant statutory considerations.

1.2 Project overview

The proposed development constitutes alterations and additions to the marina berth layout to provide overall storage for 130 vessels comprising 15 swing moorings and 115 floating berths. The works include:

- Removal of 29 existing moorings and retention of 15 existing swing moorings;
- Construction of 65 new floating berth spaces of varying sizes, that increases the number of floating berths from 50 to 115;
- Cessation of slipway activities;
- Demolition of the slipway rails and demolition of the internal office mezzanine structure within the covered slipway area; and
- Provision of 8 new valet car parking spaces within the existing slipway area.

The marina is proposing to:

- Increase storage from 99 to 130 boats in total, with an overall increase of 31 boats.
- Increase storage from 50 to 115 boats as marina floating berths.
- Maintain 15 commercial mooring spaces.

It is understood that dredging is not required for mooring berth deepening as sufficient water depths exist for the proposed facility. Piles into rock (rock-socketed) are envisaged for the new mooring berths.

The Secretary’s Environmental Assessment Requirements (SEARs) assessment (refer SEAR 1268 received from NSW Planning & Environment, dated 15/11/2018) has requested details on any potential air quality impacts from the construction and operation of the project.

The development is located at the centre of Sydney Harbour in Gladesville / Drummoyne, which is ten minutes from Sydney’s central business district by road or water.

The location of the development is shown in Figure 1-1.

BERTH SCHEDULE			
VESSEL LENGTH (m)	QTY	RATIO (%)	LINEAR METRES
8	1	0.9	8
12	18	15.7	216
15	30	26.1	450
17	16	13.9	272
18	4	3.5	72
20	35	30.4	700
25	2	1.7	50
30	5	4.3	150
35	3	2.6	105
45	1	0.9	45
TOTAL	115	100	2068

Figure 1-1 Site location (Source: Drawing No. 21-27558-K101 Rev G, GHD 2019)

1.3 Purpose of the report

This Air Quality Impact Assessment assesses the air quality impacts from the construction and operation of the project and forms part of an EIS.

This report describes the procedures and results of the assessment of air quality impacts from the project. The purpose of this report is to determine if the project would result in adverse air quality impacts above the relevant criteria at sensitive receptors and, if necessary, provide recommendations and mitigation strategies to meet the relevant criteria.

1.4 Structure of the report

The structure of the report is as follows:

- Section 1 provides an introduction to the report
- Section 2 describes the methodology, policy and legislative context for the assessment including the compliance criteria
- Section 3 describes the existing environment and meteorology for the project
- Section 4 identifies and describes the potential air quality emission sources for the project
- Section 5 provides the predicted potential air quality impacts for the project
- Section 6 identifies potential air quality mitigation and management measures
- Section 7 provides a conclusion to the report.

1.5 Limitations

This report: has been prepared by GHD for Gladesville Bridge Marina Pty Ltd and *may only be used and relied on by Gladesville Bridge Marina Pty Ltd for the purpose agreed between GHD and the Gladesville Bridge Marina Pty Ltd as set out in section 1.4 of this report.*

GHD otherwise disclaims responsibility to any person other than Gladesville Bridge Marina Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on a ssumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Gladesville Bridge Marina Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Methodology and legislative context

2.1 Methodology

The following methodology was utilised to assess the potential air quality impacts associated with construction and operation of the project in order to address the legislative requirements:

- Initial desktop review to identify sensitive receptors.
- Review available background air quality data and existing emission sources in the study area.
- Prepare an emissions inventory for the project using client supplied data and relevant emission estimation manuals.
- Outline applicable air quality criteria based on the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016).
- Synthesise a meteorological data file for input to atmospheric dispersion modelling.
- Undertake air dispersion modelling in the NSW EPA approved software CALPUFF to predict construction and operational impacts at nearby receptors. Both existing and future impacts will be assessed.
- Review construction methodology and data to determine if any significant dredging or excavation in the marine environment will be undertaken. Provide a qualitative assessment for emissions and odour from this activity and identify the need for detailed assessment.
- Provide management and mitigation measures for both construction and operation of the project, if required.

2.2 Legislative context

2.2.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements key issues and referenced guidelines are summarised in Table 2-1.

Table 2-1 Environmental Assessment Requirements

Environmental Assessment Requirements
Key issues for air quality *-a description of all potential sources of air and odour emissions;* *-an air quality impact assessment in accordance with relevant Environment Protection Authority guidelines; and* *-a description and appraisal of air quality impact mitigation, management and monitoring measures.*

2.2.2 Agency requirements

The Environment Protection Authority (EPA) requirements with regards to air quality are as follows:

"The EIS must identify all air pollutants of concern and estimate emissions by quantity, size (for particles), source and discharge point. The EIS must also describe the effects and significance of pollutant concentrations on the environment, human health, amenity and regional ambient air quality standards or goals.

The EIS should demonstrate that the facility will operate within the EPA's objectives which are to minimise adverse effects on the amenity of local residents and sensitive land uses and to limit the affects of emissions on local, regional and interregional air quality.

The EIS must describe in detail the measures or controls proposed to mitigate air quality impacts and the extent to which the mitigation measures are likely to be effective in complying with the requirements specified in the POEO Act and the Protection of the Environment Operations (Clean Air) Regulation 2010*."*

2.2.3 State legislation

The POEO Act 1997 establishes, amongst other things, the procedures for issuing licences for environmental protection in relation to aspects such as waste, air, water and noise pollution control. The owner or occupier of premises engaged in scheduled activities is required to hold an EPL and comply with the conditions of that licence. The site is required to be managed in accordance with its existing EPL.

The POEO Act 1997 requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. The operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act 1997).

Odour

Odour 'strength' or concentration is measured in odour units (OU), where 1 OU represents the concentration of a sample that can just be detected by 50% of people in a controlled situation where there is no background 'ambient ' odour.

The most common method of measuring odour concentration is Dynamic Olfactometry using the 'forced choice' method. Dynamic olfactometry simply dilutes the odour sample in known ratios with odour free air. At each dilution, the diluted odour and a zero odour is presented in turn to six panellists via two 'sniffing' ports. Further, the selection of the port with the diluted odour sample is randomly reassigned at each presentation. Each panellist is required (forced) to nominate the port (left or right) from which the diluted odour emanates. Each panellist's response (i.e. 'guess', 'likely' or 'certain') is recorded. The sequence of presentations generally follows a decreasing dilution ratio, and when half of the panellists have correctly returned a 'certain' response, that dilution ratio is numerically equal to the concentration of the original, undiluted odour sample. Hence, for example, if the dilution needed to get the 50% response was 250:1, then by definition the original sample had an odour concentration of 250 OU.

EPA has defined an odour criterion and the Odour Guideline specifies how it should be applied in dispersion modelling to assess the likelihood of nuisance impact arising from the emission of odour.

Odour impact is a subjective experience and has been found to depend on many factors, the most important of which are:

- The **F**requency of the exposure
- The **I**ntensity of the odour
- The **D**uration of the odour episodes
- The **O**ffensiveness of the odour
- The **L**ocation of the source

These factors are often referred to as the FIDOL factors.

DEC defined the odour criterion to take account of two of these factors (**F** is set at 99 percentile, **I** is set at from 2 to 7 OU). The choice of criterion odour level has also been made to be dependent on the population of the affected area, and to some extent it could be said that population is a surrogate for location – so that the **L** factor has also been considered. The relationship between the criterion odour level **C** to affected population **P** is given below.

$$C = [\log P\text{-}4.5] \div \text{-}0.6 \qquad \text{Equation 1}$$

Table 2-2 lists the values of C for various values of affected populations as obtained using equation 1.

Table 2-2 Odour criterion for the assessment of odour

Population of affected community	Odour performance criteria (nose response odour certainty units at 99th percentile)
Single Residence (≤ ~2)	7
~ 10	6
~ 30	5
~ 125	4
~ 150	3
Urban (~2,000)	2

The NSW Approved Methods specifies a criterion of two odour units at the 99th percentile over a short term averaging nose-response time of one second for a complex mixture of odorous air pollutants in an urban area (population greater than 2000 or with schools and hospitals). The criterion is applied at the location of the nearest sensitive receptor or likely future location of sensitive receptor.

5 OU is commonly taken as a conservative measure of the odour level which can be distinguished against the ambient background level of odour, and which if offensive, could result in complaint. 1 OU generally cannot be detected in a non-laboratory situation (i.e. where the ambient background odour levels reduce the detectability of a given odorant).

Air quality

Potential non-odorous air quality impacts from the project could include dust and products of combustion. The following pollutants have been assessed against relevant criteria:

- Total suspended particles (TSP).
- Fine particulate matter less than 10 micron equivalent aerodynamic diameter PM_{10}.
- Fine particulate matter less than 2.5 micron equivalent aerodynamic diameter $PM_{2.5}$.
- Products of combustion including carbon monoxide, oxides of nitrogen (NOx), sulphur dioxide (SO2), lead and total volatile organic compounds (VOC).

The air quality impact assessment criteria for these pollutants has been sourced from the Approved Methods and is summarised in Table 2-3.

Table 2-3 Air quality impact assessment criteria - other pollutants

Pollutant	Averaging period	Criterion
Particulate Matter PM_{10}	24 hours	50 µg/m^3
	Annual	25 µg/m^3
Particulate Matter $PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
TSP	Annual	90 µg/m^3
Carbon monoxide (CO)	15 minutes	100 mg/m^3
	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Nitrogen dioxide (NO_2)	1 hour	246 µg/m^3
	Annual	62 µg/m^3
Lead	Annual	0.5 µg/m^3
Sulphur dioxide (SO_2)	10 minutes	712 µg/m^3
	1 hour	570 µg/m^3
	24 hours	228 µg/m^3
	Annual	60 µg/m^3

3. Existing environment

3.1 Sensitive receptors

Air quality sensitive receptors are defined based on the type of occupancy and the activities performed in the land use. Sensitive receptors are locations where people are likely to work or reside; this may be any of the following:

- Dwelling
- School
- Hospital
- Office
- Public recreational area.

The project is located in a sub-urban area, with residential receptors lying directly to the south of the marina. The Gladesville Bridge (Victoria Road) lies to the east of the project.

For air dispersion modelling purposes, representative receptors closest to the project site have been selected. It is expected that the closest receptors will experience the worst-case air quality impacts. If potential air quality impacts from the project comply with the adopted assessment criteria at the nearest receptors, then those situated at a greater distance will also comply.

The location of the representative sensitive receptors to the site are presented in Table 3-1 and shown on Figure 3-1.

Table 3-1 Sensitive receptor locations

ID	X Coordinate (m)	Y Coordinate (m)	Description	Address
R01	328401	6253584	Gladesville Bridge Marina	380 Victoria Pl, Drummoyne
R02	328440	6253559	Residential	374 Victoria Pl, Drummoyne
R03	328488	6253538	Residential	356-362 Victoria Pl, Drummoyne
R04	328549	6253544	Residential	348 Victoria Pl, Drummoyne
R05	328615	6253562	Residential	332 Victoria Pl, Drummoyne
R06	328645	6253607	Residential	46 Drummoyne Ave, Drummoyne
R07	328679	6253632	Residential	42B Drummoyne Ave, Drummoyne
R08	328802	6253689	Residential	22 Drummoyne Ave, Drummoyne
R09	328549	6253985	Residential	25 Huntleys Point Rd, Huntleys Point
R10	328454	6253928	Residential	23A Huntleys Point Rd, Huntleys Point
R11	328384	6253927	Residential	17 Huntleys Point Rd, Huntleys Point

Paper Size ISO A4

0 25 50 75 100

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

GLADESVILLE BRIDGE MARINA PTY LTD
GLADESVILLE BRIDGE MARINA DA
AIR QUALITY ASSESSMENT

Project No. 21-27558
Revision No. -
Date 09/08/2019

Sensitive receptor locations

FIGURE 3-1

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Print date: 09 Aug 2019 - 12:08

Data source: GHD . Created by: eibbertson

3.2 Ambient (background) air quality

The NSW OEH operates ambient air quality monitoring stations in selected areas around NSW. The nearest station to the site is the Rozelle OEH monitoring station (located 2.75 km to the southeast of the site).

Pollutant average and maximum ambient concentrations for the modelled year (2017, refer to Section 3.3.2 for a discussion on the selection of 2017 as the representative modelling year) are presented in Table 3-2.

Table 3-2 Ambient air quality concentrations (2017)

Pollutant		Averaging period	Rozelle OEH monitoring station
NO_2	Maximum (µg/m^3)	1 hour	114.7
	Maximum (µg/m^3)	Annual	20.7
CO	Maximum (mg/m^3)	1 hour	1.4
	Maximum (mg/m^3)	8 hour	1.0
SO_2	Maximum (µg/m^3)	1 hour	62.9
	Maximum (µg/m^3)	24 hour	7.9
	Maximum (µg/m^3)	Annual	2.6
O_3	Average (µg/m^3)	1 hour	30.0
	Maximum (µg/m^3)	1 hour	223.4
PM_{10}	Maximum (µg/m^3)	24 hours	54.1
	Maximum (µg/m^3)	Annual	18.1
$PM_{2.5}$	Maximum (µg/m^3)	24 hour	36.3
	Maximum (µg/m^3)	Annual	7.2

A review of the EPA's National Pollutant Inventory (NPI) indicates that there are no sources of industrial emissions in the study area. Local combustion emissions are anticipated from marina operations and vehicles traveling along Victoria Road.

3.3 Local meteorology

3.3.1 Overview

A 12 month site specific meteorological dataset was constructed using the 3D prognostic modelling package, The Air Pollution Model (TAPM) and the diagnostic 3D meteorological model, CALMET.

TAPM was developed by CSIRO and produces a three-dimensional upper air data file of relevant meteorological parameters, including wind speed, wind direction, temperature and pressure.

Prognostic meteorological data from the TAPM model was used alongside observations taken at Rozelle OEH station as inputs into the CALMET model. CALMET is used to refine the wind field in the local study area, taking into account the influences of topography, land uses and surface roughness. The final wind field produced from CALMET is across a finer grid than used in TAPM.

Details of the procedure undertaken to produce the site specific meteorology is outlined in the following sections.

3.3.2 Methodology

The characterisation of local wind patterns generally requires accurate site-representative hourly recordings of wind direction and speed over a period of at least a year.

Existing observational data is available from the Rozelle OEH monitoring station.

In order to produce a representative site-specific meteorological data set encompassing the meteorological data from the observational site, the following methodology was carried out:

- Selection of a representative modelling year based on an analysis of five years of meteorological data from Rozelle OEH monitoring station.
- Production of a 3D gridded dataset with the prognostic model TAPM.
- Utilising the TAPM 3D gridded dataset as an initial guess field for the CALMET meteorological model.
- Utilising data from the observation site (Rozelle OEH station) for surface level observations.

3.3.3 Representative modelling year

An analysis of meteorology from the years from 2014 to 2018 (Rozelle OEH) was undertaken to select a period considered to be most representative of 'normal' conditions.

The analysis shows that the year 2017 is the most representative year based on a review of temperature, wind speed and wind direction. Meteorological characteristics of the 2017 year closely followed the average of all years from 2014 to 2018 suggesting 2017 represents a typical year.

Summary charts of the representative year analysis are provided in Appendix A.

3.3.4 TAPM modelling

The TAPM prognostic model was run to obtain a coarse meteorological 3D gridded dataset for the site for the selected modelling period. This dataset is based on synoptic observations, local terrain and land use information with a resolution of 1,000 metres. The TAPM model parameters are summarised in Table 3-3 and are selected in accordance with the NSW Approved Methods for the Modelling of Air Pollutants in NSW (Approved Methods)[1].

Table 3-3 TAPM model parameters

Parameter	Value
Modelled period	1 December 2016 to 1 January 2018
Domain centre	UTM: 56H 328,057 mE, 6,253,846 mS Latitude = -33° 50.5' Longitude = 151° 8.5'
Number of vertical levels	25
Number of easting grid points	25
Number of northing grid points	25
Outer grid spacing	30,000 m x 30,000 m
Number of grid levels	4
Grid level horizontal resolution	Level 2 – 10,000 m Level 3 – 3,000 m Level 4 – 1,000 m

3.3.5 CALMET modelling

CALMET (Version 5) (previously approved by the US EPA) was used to resolve the wind field around the subject site to a 200 metres spatial resolution. The application of CALMET for this

[1] Environment Protection Authority 2017, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, January 2017.

purpose is an approved modelling approach in NSW as per the Approved Methods with model guidance documentation provided[2].

Upon completion of the broad scale TAPM modelling runs, a CALMET simulation was set up to run for the model period, combining the three dimensional gridded data output from the TAPM model with the site specific surface data from the Rozelle OEH station. This approach is consistent with guidance documentation.

All model settings were selected based on the recommendations provided in the model guidance documentation CALMET was run using the “Hybrid” mode with the TAPM data provided as an initial guess field.

The southwest corner of the CALMET domain, or the origin, was located at UTM Zone 56 coordinates 322.500 kilometre east and 6247.500 kilometre north. The CALMET domain extended 12 kilometre to the east and north. The CALMET domain consisted of 60 grids in both the east and north directions, with a grid resolution of 0.2 kilometre.

The TERRAD, RMAX and R variables were set to the values presented in Table 3-4 based on an inspection of the terrain elevations in the immediate vicinity of the subject site, based on model guidance. The CALMET model parameters are summarised in Table 3-4. All CALMET settings were selected as per the model guidance document for “Hybrid” mode.

Terrain and land use data used for the CALMET modelling are presented in Figure 3-2 and Figure 3-3 (Site location shown with red rectangle).

Table 3-4 Summary of CALMET model parameters

Parameter	Value
Modelled period	1 January 2018 to 31 December 2018
Mode	Hybrid (NOOBS = 1)
UTM zone	56
Domain origin (south-west corner)	Easting: 322.500 km Northing: 6247.500 km
Domain size	60 x 60 at 0.2 km resolution (12.0 km x 12.0 km)
Number of vertical levels	11
Vertical levels (m)	20, 40, 60, 90, 120, 180, 250, 500, 1000, 2000, 3000
CALMET settings for hybrid mode Settings selected in accordance with (OEH, 2011)	TERRAD = 6.0 km RMAX1 = 20.0 km RMAX2 = 20.0 km RMIN = 0.1 km R1 = 8.0 km R2 = 8.0 km
Initial guess field	TAPM .m3d file used as an initial guess field for CALMET.
Surface data	Rozelle OEH station E: 330.033 km N: 6251.200 km
Upper air data	No site specific upper air data is utilised. Upper air data is included within the TAPM .m3d initial guess field.
Land use and terrain data	Land use data was manually developed through assessment of aerial imagery to accurately reflect the land use in the area. High-resolution terrain data was sourced from the STRM 1-second (~30 m) database.

[2] Barclay, J & Scire, J, 2011, 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’, prepared for NSW Office of Environment and Heritage, Sydney, March 2011

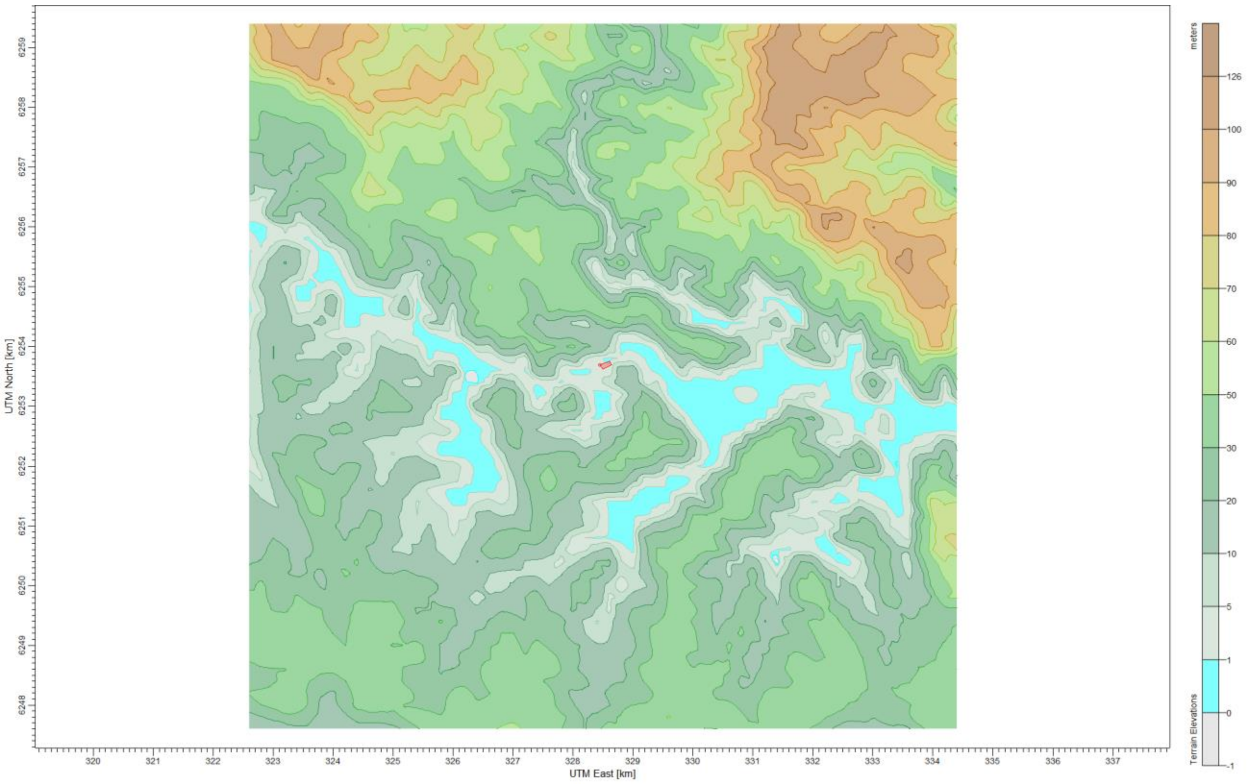


Figure 3-2 Terrain data used for CALMET modelling

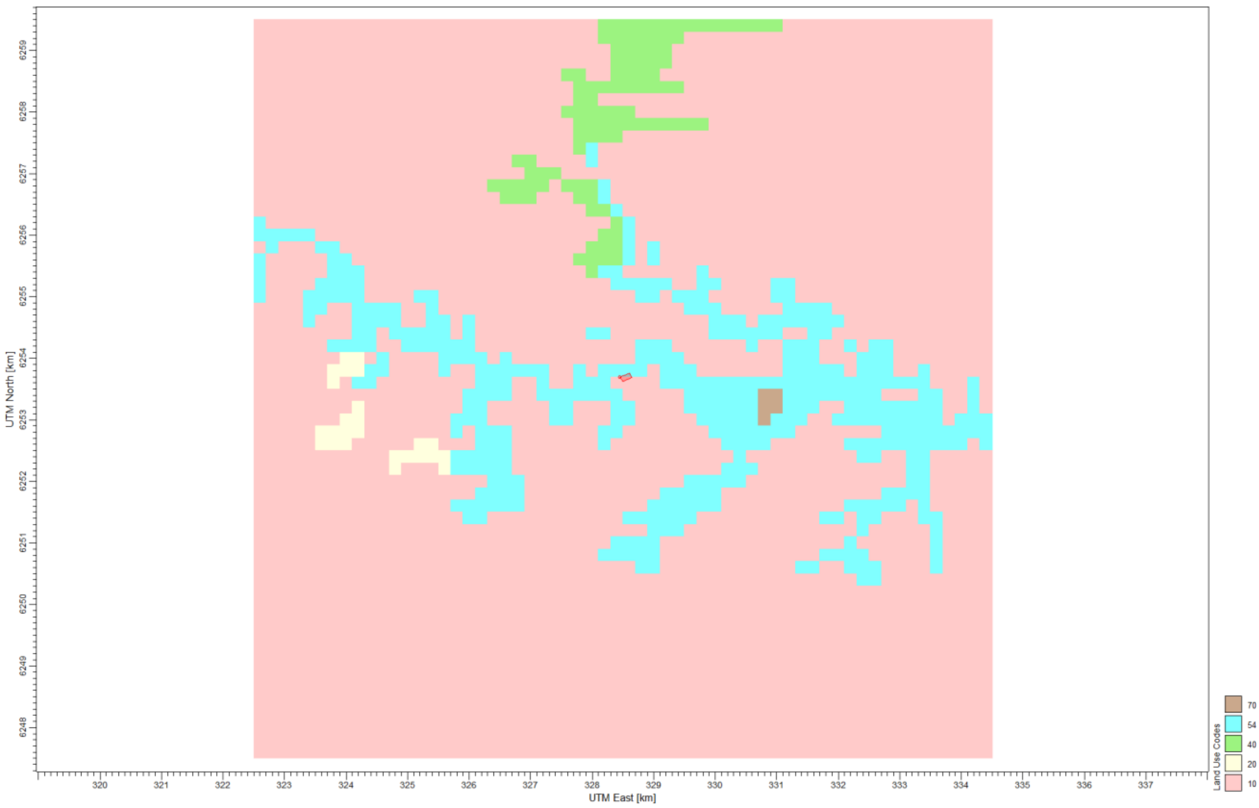


Figure 3-3 Land use data used for CALMET modelling

3.3.1 Wind speed and direction

The local meteorology largely determines the pattern of off-site air quality impact on receptors (houses, businesses and industry). The effect of wind on dispersion patterns can be examined using the wind and stability class distributions at the site from the dataset that is produced by CALMET. The wind pattern at the site is most readily displayed by means of wind rose plots, giving the distribution of winds and the wind speeds from these directions.

The features of particular interest in this assessment are: (i) the dominant wind directions and (ii) the relative incidence of stable light wind conditions that yield minimal mixing (defines peak impacts from ground-based sources).

Annual pattern in wind

The average wind rose for the entire data period at the project site is shown in Figure 3-4 with the following features:

- The predominant annual average wind directions are from the northwest, northeast and south.
- The majority of lower wind speeds (<2 m/s) are from the west-northwest, north sector and south.
- The average wind speed measured was 1.72 metres per second.
- Calms (winds speeds less than 0.5 m/s) occurred 8.7 % of the time.

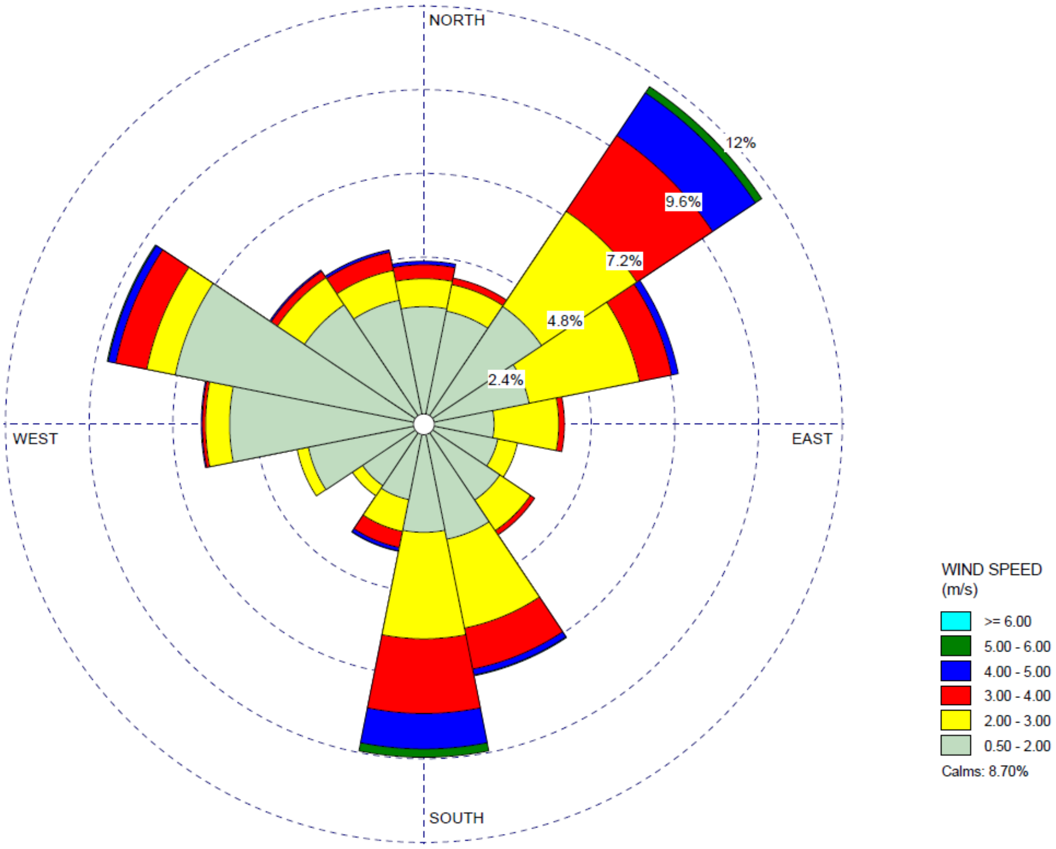
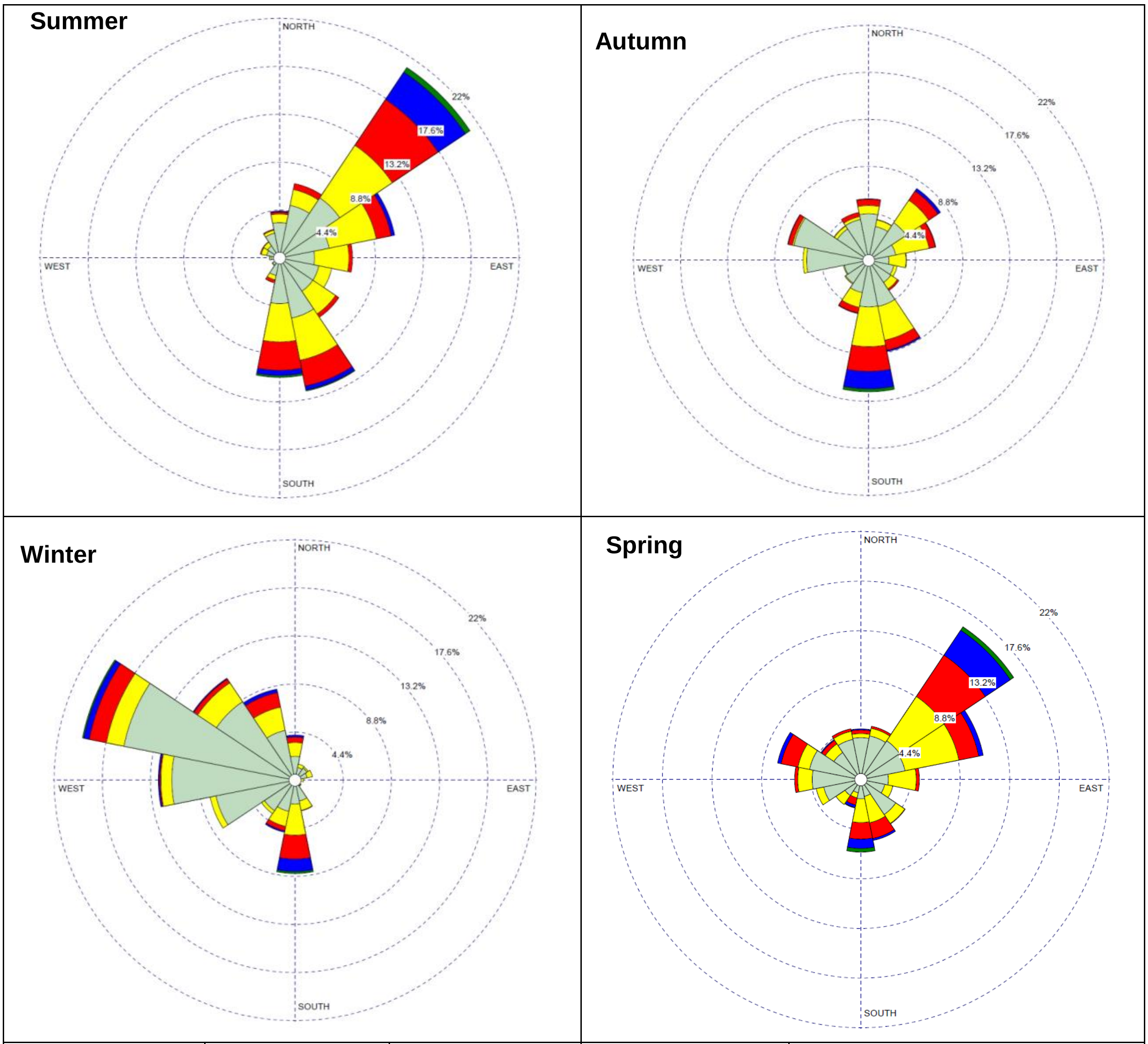


Figure 3-4 Wind rose from CALMET for 2017

Seasonal variation in wind pattern

The seasonal wind roses for 2017 are presented in Figure 3-5 and show that:

- During summer the predominant wind direction is from the northeast and south.
- During winter, west-north westerly and westerly winds are the most dominant.
- Autumn and spring are transitional periods. During these seasons both summer and winter patterns are observed. Autumn wind patterns are characteristically similar to winter, generally consisting of west-north westerly and southerly winds. Spring wind patterns are more similar to summer displaying a higher percentage of northeast winds.



Season	%Complete Record	Average WS (m/s)	Calms Frequency (%)
Summer	100	2.01	4.82
Autumn	100	1.50	12.86
Winter	100	1.47	9.74
Spring	100	1.91	7.28

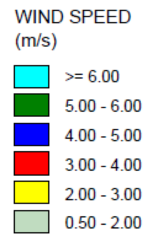


Figure 3-5 Seasonal wind roses for 2017

3.3.2 Pattern of atmospheric stability

Atmospheric stability substantially affects the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere.

There are six Pasquill–Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and solar insolation are used to define the stability category as shown in Table 3-5, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of each stability category.

Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table 3-5 Stability category relationship to wind speed, and stability characteristics

Stability category	Wind speed range (m/s) [a]	Stability characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud;
D	≥6	Neutral atmospheric conditions. Occur during the day or night with stronger winds. Or during periods of total cloud cover, or during the twilight period
E	3.4 – 5.4 [b]	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds
F	0 – 3.3 [b]	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds

a Data sourced from the Turner's Key to the P-G stability Categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am)

b Assumed to only occur at night, during Net Radiation Index categories of –2.

Figure 3-6 shows the frequency of stability class for all hours of the model generated dataset. The following observation were made:

- Stable stability (classes E and F) are the dominant stability state of the atmosphere occurring 51 % of the time.
- Neutral atmosphere conditions (class D) occur about 7 % of the time.
- Unstable atmospheres (classes A, B and C) occur about 43 % of the time.

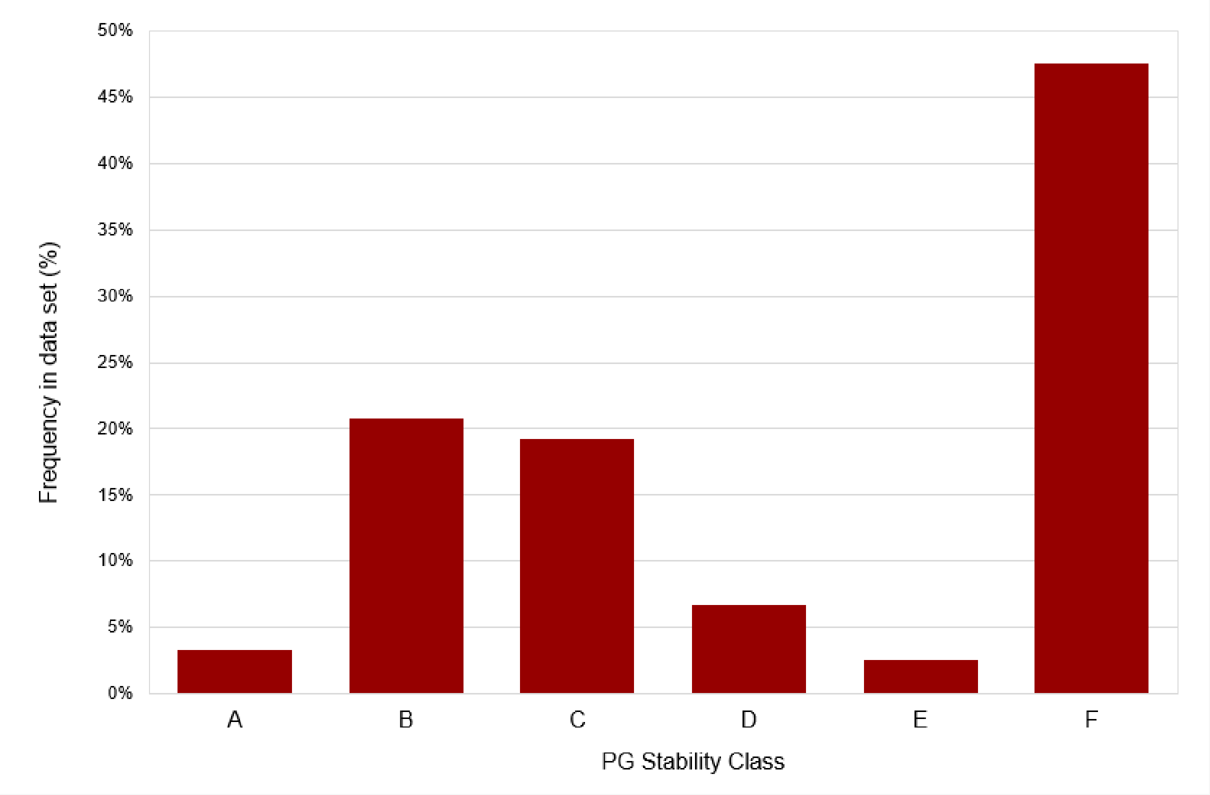


Figure 3-6 Distribution of stability class for the model period

4. Project emissions

4.1 Overview

Air quality may be impacted by a number of pollutants, each of which has different emission sources and effects on human health and the environment. The air quality assessment for the project focuses on the highest-risk impacts with the potential to occur during construction and operation of the project.

4.2 Construction

Information on construction activities has been sourced from *Construction Management Plan Gladesville Bridge Marina Upgrade rev 1* (SMC Marine, 2019).

Construction works will involve the following activities:

- Installation of new piers and floating dock for the increased storage space of vessels.
- Removal of slipway rails
- Demolition of internal office mezzanine structure.

The plant and equipment associated with these activities is likely to include the following:

- Piling crane barge
- Supply barge
- Work boat
- Piling vibrator, Hydraulic impact piling hammer
- Hydraulic power pack.

Construction activities will be undertaken during the hours of 7 am to 5 pm (Monday to Friday) and 8 am to 12 pm (Saturday, where required). No work will be undertaken on Sunday or Public Holidays.

4.2.1 Construction emissions

Significant construction dust generating activities are not proposed as part of the project. A review of the activities listed above indicates that the primary construction activities will involve the installation of over-water infrastructure. This will serve as a natural mitigation measure against potential dust generation. The majority of the demolition and construction materials for the project will be delivered and removed by barge, minimising the potential for dust generation on local roads.

Minor dust generation may occur during the removal of the slipway. These activities will be temporary in duration.

Furthermore, construction activities are proposed during the day time hours when poor dispersion conditions are unlikely.

Therefore, air quality impacts associated with construction activities are not anticipated and not discussed further in this report. All construction activities will be managed in accordance with the construction management plan.

4.3 Operational

Operational emission sources associated with the project will be primarily associated with combustion emissions from idling boats at the marina. Other activities such as fire training, refuelling, major paint repairs or the use of emergency generators/incinerators will not be permitted at the marina.

4.3.1 Emissions inventory

The emissions inventory has been based on the following assumptions:

- Existing number of recreational vessels at berth per year: 50.
- Future number of recreational vessels at berth per year: 115.
- Existing and future number of commercial vessels at berth: 15.
- 50% of vessels will be diesel powered, while 50% of vessels will be petrol powered. This is a conservative assumption for the future scenario as a number of vessels are likely to be electrically powered in the future.
- All vessels at berth conservatively use the marina over a period of 12 hours (7 am to 7 pm) daily. The navigation assessment[3] suggests that this is likely to be conservative and the existing daily movements are approximately 60% of the total vessels at berth, with an increase in vessel movements of 30% for the future scenario.
- The duration of idling is limited to 10 minutes at the marina and has been conservatively modelled at 10 minutes per vessel.
- Fuel consumption during idling has modelled at 0.95 L/hr (corresponding to 0.16 L for a period of 10 minutes). Fuel consumption has been based on a review of available literature[4] data on diesel and petrol engines.
- Emissions have been calculated based on the *NPI Emissions Estimation Technique Manual for Aggregated Emissions from Commercial Ships/Boats and Recreational Boats – Version 1.0* (1999) Table 6: Emissions Factors for Commercial Boats and Table 7: Emission Factors for Recreational Boats. The higher emission factors (of the outboard and inboard petrol engines) have been conservatively adopted.
- Where PM_{10} and $PM_{2.5}$ emission factors are not provided in the NPI, the following assumptions were made:
    - TSP/PM_{10} ratio assumed to be a factor of 2
    - $P_{M2.5}$/P_{M10} ratio assumed to be 0.1.
- VOC assessment criteria exists for individual species. Consequently VOC's were speciated as benzene based on *NPI Emissions Estimation Technique Manual for Aggregated Emissions from Commercial Ships/Boats and Recreational Boats – Version 1.0 (1999)* Table 9: VOC Speciation for Exhaust and Evaporative Emissions from Marine Vessels to assess VOC (as benzene).

The emissions inventory is summarised in Table 4-1.

[3] Brett Moore, 2019
[4] https://www.energy.gov/eere/vehicles/fact-861-february-23-2015-idle-fuel-consumption-selected-gasoline-and-diesel-vehicles

Table 4-1 Modelled emissions rates for operational activities

Emission source	Pollutant emission rate (g/s)							
	CO	Lead and compounds	NO_X	SO_2	TSP	PM_{10}	$PM_{2.5}$	VOCs (as benzene)
Existing scenario								
Recreational boats	0.038	0.000011	0.005	0.0003	0.0003	0.0002	0.00002	0.00053
Commercial boats	0.011	0.000003	0.001	0.0001	0.0001	0.0001	0.00001	0.00014
Existing scenario total	**0.050**	**0.000014**	**0.007**	**0.0004**	**0.0004**	**0.0002**	**0.00002**	**0.00067**
Future scenario								
Recreational boats	0.088	0.000024	0.012	0.0007	0.0008	0.0004	0.00004	0.0012
Commercial boats	0.011	0.000003	0.001	0.0001	0.0001	0.0001	0.00001	0.00014
Future scenario total	**0.099**	**0.000028**	**0.013**	**0.0007**	**0.0009**	**0.0004**	**0.00004**	**0.0014**

4.1 Odour

Significant dredging or odour generating activities are not proposed as part of the project. Odour impacts are therefore not anticipated and are not discussed further in this report.

5. Predicted impacts

5.1 Dispersion modelling

Air dispersion modelling was conducted using the Gaussian puff model CALPUFF Version 5.8. This model is a recognised regulatory model in NSW. CALPUFF is especially suited for modelling light to calm wind conditions.

The following settings were used in the simulations:

- Model: CALPUFF Version 5.8.
- The nearest receptors from the project are directly to the south. Sensitive receptors were modelled as per Section 3.1.
- Ground level receptor heights have been modelled based on high-resolution terrain data was sourced from the STRM 1-second (~30 m) database.
- A site specific yearly meteorological file was synthesised using CALMET as per Section 3.3 and provided as an input into CALPUFF.
- The emission sources at the marina were modelled as a distributed area source over the vessel area.

5.2 Predicted air quality impacts

5.2.1 Particulates

The impact of dust emissions principally relates to the potential effect on human health of inhalation of particles in the air column, and it is the finer fraction that have the greater potential to cause respiratory health effects.

A summary of the maximum incremental predicted levels at each receptor site is presented in Table 5-1. The incremental levels show that the background levels (refer to Table 3-2) will dominate the dust levels in the area, with negligible contributions from the marina operations.

Table 5-1 Maximum predicted incremental ground level PM10, PM2.5 and TSP concentrations, µg/m³

Receptor	Existing operations					Future operations				
	PM_{10} (24 hr)	PM_{10} (Annual)	$PM_{2.5}$ (24 hr)	$PM_{2.5}$ (Annual)	TSP (Annual)	PM_{10} (24 hr)	PM_{10} (Annual)	$PM_{2.5}$ (24 hr)	$PM_{2.5}$ (Annual)	TSP (Annual)
Criteria µg/m³	50	25	25	8	90	50	25	25	8	90
R01	0.04	0.002	0.004	0.0002	0.004	0.08	0.004	0.008	0.0004	0.008
R02	0.04	0.002	0.004	0.0002	0.004	0.08	0.004	0.008	0.0004	0.008
R03	0.04	0.002	0.004	0.0002	0.003	0.07	0.003	0.007	0.0003	0.007
R04	0.03	0.002	0.003	0.0002	0.004	0.06	0.004	0.006	0.0004	0.007
R05	0.03	0.002	0.003	0.0002	0.004	0.05	0.004	0.005	0.0004	0.008
R06	0.03	0.003	0.003	0.0003	0.005	0.05	0.005	0.005	0.0005	0.011
R07	0.03	0.002	0.003	0.0002	0.005	0.05	0.005	0.005	0.0005	0.009
R08	0.01	0.001	0.001	0.0001	0.001	0.02	0.001	0.002	0.0001	0.003
R09	0.01	0.001	0.001	0.0001	0.002	0.01	0.002	0.001	0.0002	0.004
R10	0.01	0.002	0.001	0.0002	0.003	0.02	0.003	0.002	0.0003	0.007
R11	0.01	0.001	0.001	0.0001	0.002	0.02	0.002	0.002	0.0002	0.003

5.2.1 Products of combustion

The primary pollutants from combustion are oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), lead and VOCs, all formed by incomplete combustion of the fuel. All pollutants have all been assessed against their relevant criteria from the Approved Methods.

Predicted levels for SO_2, NO_2 and carbon monoxide concentrations are provided in Table 5-2 to Table 5-5. The increase in pollutant levels above background is negligible and the predicted levels comply with the relevant criteria at all sensitive receptors for both the existing and future operations.

Table 5-2 Maximum predicted existing ground level sulphur dioxide concentrations

Receptor	Total existing impact (Incremental plus background) (μg/m³)				Total future impact (Incremental plus background) (μg/m³)			
Criteria, μg/m³	712 (10 min[1])	570 (1 hr)	228 (24 hr)	60 (Annual)	712 (10 min[1])	570 (1 hr)	228 (24 hr)	60 (Annual)
Background, μg/m³	No data[2]	62.9	7.9	2.6	No data[2]	62.9	7.9	2.6
R01	64.0	63.7	8.0	2.6	65.1	64.5	8.1	2.6
R02	64.1	63.7	8.0	2.6	65.2	64.5	8.1	2.6
R03	64.0	63.6	8.0	2.6	65.0	64.4	8.1	2.6
R04	64.0	63.6	8.0	2.6	65.0	64.4	8.0	2.6
R05	64.0	63.7	8.0	2.6	65.2	64.5	8.0	2.6
R06	64.0	63.7	8.0	2.6	65.1	64.5	8.0	2.6
R07	64.1	63.8	8.0	2.6	65.3	64.6	8.0	2.6
R08	63.5	63.3	7.9	2.6	64.1	63.8	8.0	2.6
R09	63.1	63.1	7.9	2.6	63.4	63.2	7.9	2.6
R10	63.2	63.1	7.9	2.6	63.5	63.3	8.0	2.6
R11	63.2	63.1	7.9	2.6	63.4	63.3	7.9	2.6

Note 1: The 10 minute concentrations were calculated from the hourly values by applying a peak to mean factor of $(60/10)^{0.2}$.

Note 2: The 10 minute background levels were assumed to be the same as the 1 hour background levels in the absence of monitoring data.

Table 5-3 Maximum predicted ground level nitrogen dioxide concentrations

Receptor	Total existing impact (Incremental plus background) (µg/m³)		Total future impact (Incremental plus background) (µg/m³)	
Criteria, µg/m³	246 (1 hr)	62 (Annual)	246 (1 hr)	62 (Annual)
Background, µg/m³	114.7	20.7	114.7	20.7
R01	128	21	142	21
R02	129	21	144	21
R03	128	21	141	21
R04	128	21	141	21
R05	128	21	143	21
R06	128	21	142	21
R07	129	21	145	21
R08	122	21	130	21
R09	118	21	121	21
R10	118	21	122	21
R11	118	21	121	21

Table 5-4 Maximum predicted ground level carbon monoxide concentrations

Receptor	Total existing impact (Incremental plus background) (mg/m³)			Total future impact (Incremental plus background) (mg/m³)		
Criteria, mg/m³	100 (15 min[1])	30 (1 hr)	10 (8 hr)	100 (15 min[1])	30 (1 hr)	10 (8 hr)
Background, mg/m³	No data[2]	1.4	1	No data[2]	1.4	1
R01	1.5	1.5	1.0	1.7	1.6	1.1
R02	1.6	1.5	1.0	1.7	1.6	1.1
R03	1.5	1.5	1.0	1.7	1.6	1.1
R04	1.5	1.5	1.0	1.7	1.6	1.0
R05	1.5	1.5	1.0	1.7	1.6	1.0
R06	1.5	1.5	1.0	1.7	1.6	1.0
R07	1.6	1.5	1.0	1.7	1.6	1.0
R08	1.5	1.5	1.0	1.6	1.5	1.0
R09	1.4	1.4	1.0	1.5	1.4	1.0
R10	1.4	1.4	1.0	1.5	1.5	1.0
R11	1.4	1.4	1.0	1.5	1.5	1.0

Note 1: The 15 minute concentrations were calculated from the hourly values by applying a peak to mean factor of $(60/15)^{0.2}$.

Receptor	Total existing impact (Incremental plus background) (mg/m^3)			Total future impact (Incremental plus background) (mg/m^3)		
Criteria, mg/m^3	100 (15 min[1])	30 (1 hr)	10 (8 hr)	100 (15 min[1])	30 (1 hr)	10 (8 hr)
Background, mg/m^3	No data[2]	1.4	1	No data[2]	1.4	1
Note 2: The 15 minute background levels were assumed to be the same as the 1 hour background levels in the absence of monitoring data.						

5.2.2 Lead and VOCs

The maximum predicted (99.9 percentile, 1-hour average) ground level incremental VOC and lead concentration, within and beyond the project boundary is provided in Table 5-5. The predicted levels are significantly lower than the respective EPA principal toxic air pollutant criteria for all substances both within and beyond the project boundary.

Table 5-5 Maximum predicted ground level VOC and lead concentrations

Receptor	Incremental Impact (µg/m^3)			
Pollutant	VOCs[1]		Lead	
Criteria	Individual VOCs, 29 µg/m^3 (1 hour, Benzene)		0.5 µg/m^3 (Annual)	
	Existing	Future	Existing	Future
R01	1.4	2.8	0.0001	0.0003
R02	1.5	2.9	0.0001	0.0002
R03	1.3	2.7	0.0001	0.0002
R04	1.3	2.7	0.0001	0.0002
R05	1.4	2.9	0.0001	0.0002
R06	1.4	2.8	0.0002	0.0003
R07	1.5	3.1	0.0001	0.0003
R08	0.8	1.5	0.0000	0.0001
R09	0.3	0.6	0.0001	0.0001
R10	0.4	0.8	0.0001	0.0002
R11	0.3	0.7	0.0001	0.0001
Maximum level (on site)	2.3	4.7	0.0021	0.0042

Note 1: VOCs have been assessed as Benzene, assuming 4.05 % of total VOCs is composed of Benzene as per *NPI Emissions Estimation Technique Manual for Aggregated Emissions from Commercial Ships/Boats and Recreational Boats – Version 1.0 (1999)* Table 9: VOC Speciation for Exhaust and Evaporative Emissions from Marine Vessels.

6. Mitigation and management

6.1 Construction

A review of the construction methods indicates that significant dust generating activities are not proposed as part of the project. Construction activities over-water such as piling will be naturally mitigated against dust generation.

Similarly, the majority of the demolition and construction materials for the project will be delivered and removed by barge, minimising the potential for dust generation of local roads.

All construction activities are proposed during the day time hours when poor dispersion conditions are unlikely.

Therefore, specific mitigation and management measures are not recommended. General air quality mitigation and management measures for the project are provided below:

- Plant and equipment will be maintained in good condition to minimise spills and air emissions that may cause nuisance
- Dust suppression will be undertaken as required using water sprays, water carts or other media on:
  - Sand, spoil and aggregate stockpiles
  - During the loading and unloading of dust generating materials.
- If the works are creating levels of dust which may significantly impact on residential amenity, the works will be modified or stopped until the dust hazard is reduced to an acceptable level
- Construction vehicles with potential for loss of loads (such as dust or litter) will be covered when using public roads

6.2 Operational

Specific operational air quality mitigation measures are not required. General mitigation measures such as a maximum idling duration of 10 minutes are included as part of the existing marina operations.

7. Conclusion

An air quality impact assessment of the existing and proposed operations associated with the Gladesville Marina has been undertaken.

A review of the project area was undertaken to identify representative sensitive receptors suitable for modelling.

Site specific meteorology and ambient background concentrations of pollutants were sourced from the Rozelle OEH monitoring station. The site specific meteorological data was used in conjunction with prognostic TAPM outputs to synthesise a suitable meteorological modelling file in CALMET.

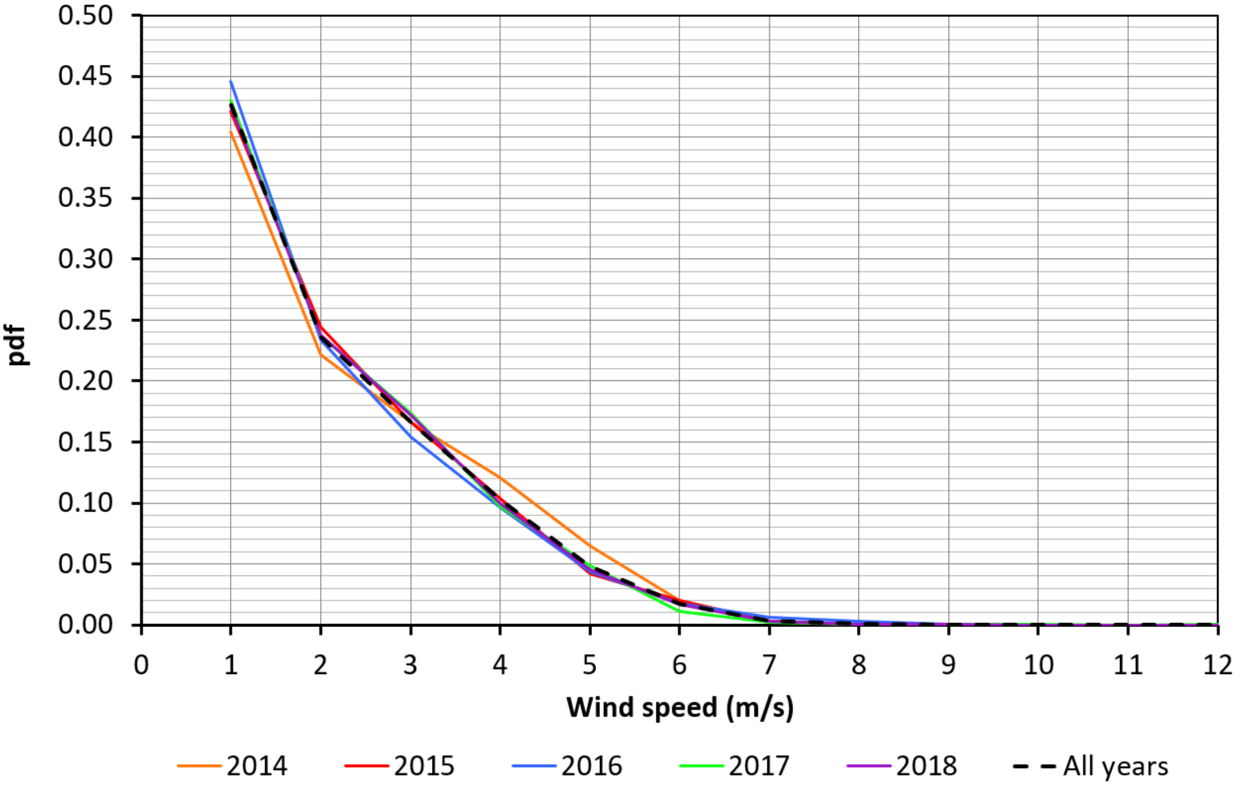
Operational air quality impacts associated with dust and combustion by-products were modelled and assessed for existing and future operating conditions in the CALPUFF modelling system. The predicted operational results indicate compliance with the air quality criteria for all pollutants of interest for both the existing and future operating scenarios.

Air quality impacts associated with the construction of the project were not deemed to be significant. The project is also not associated with existing or future sources of odour.

Overall, the project complies with the relevant air quality criteria and the residual air quality risks associated with the project are considered minor.

Appendices

Appendix A – Selection of representative year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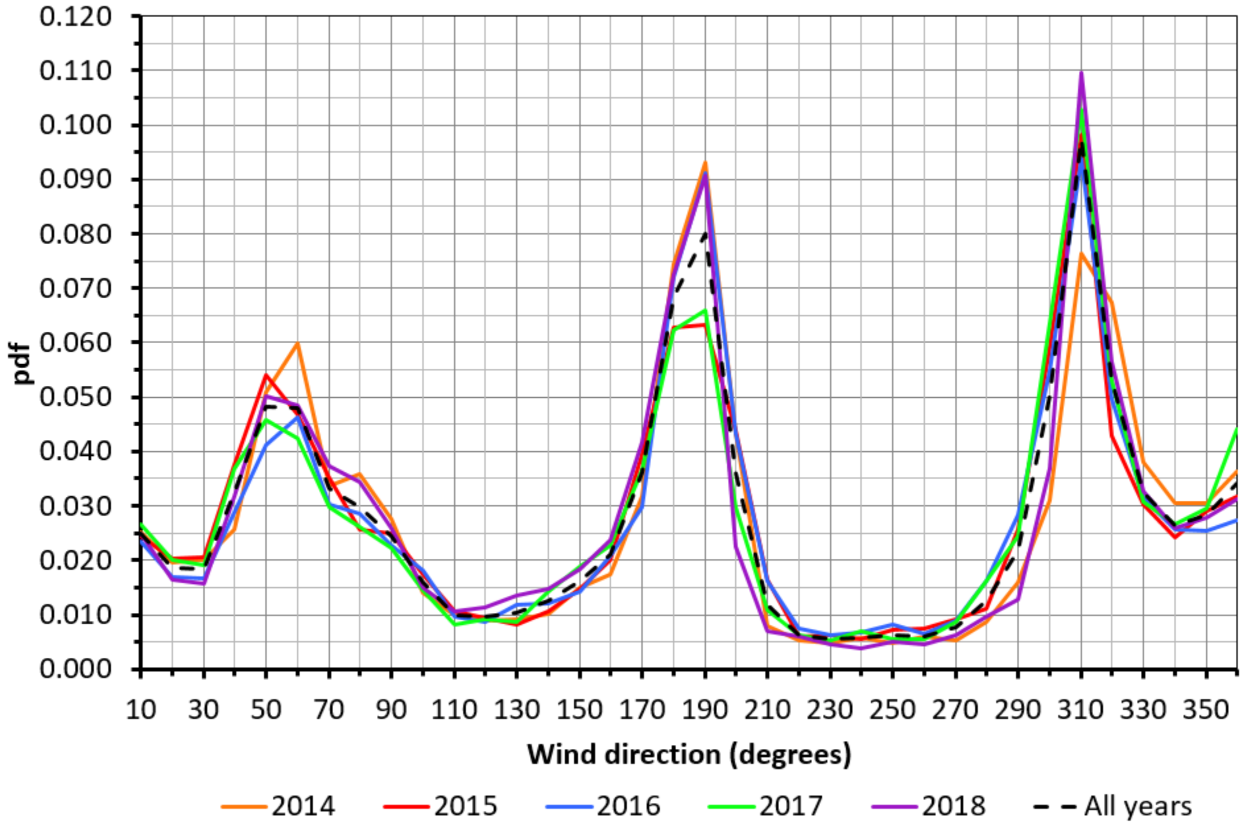
Wind speed (m/s)
2014
2015
2016
2017
2018
All years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110
130
150
170
190
210
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250
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290
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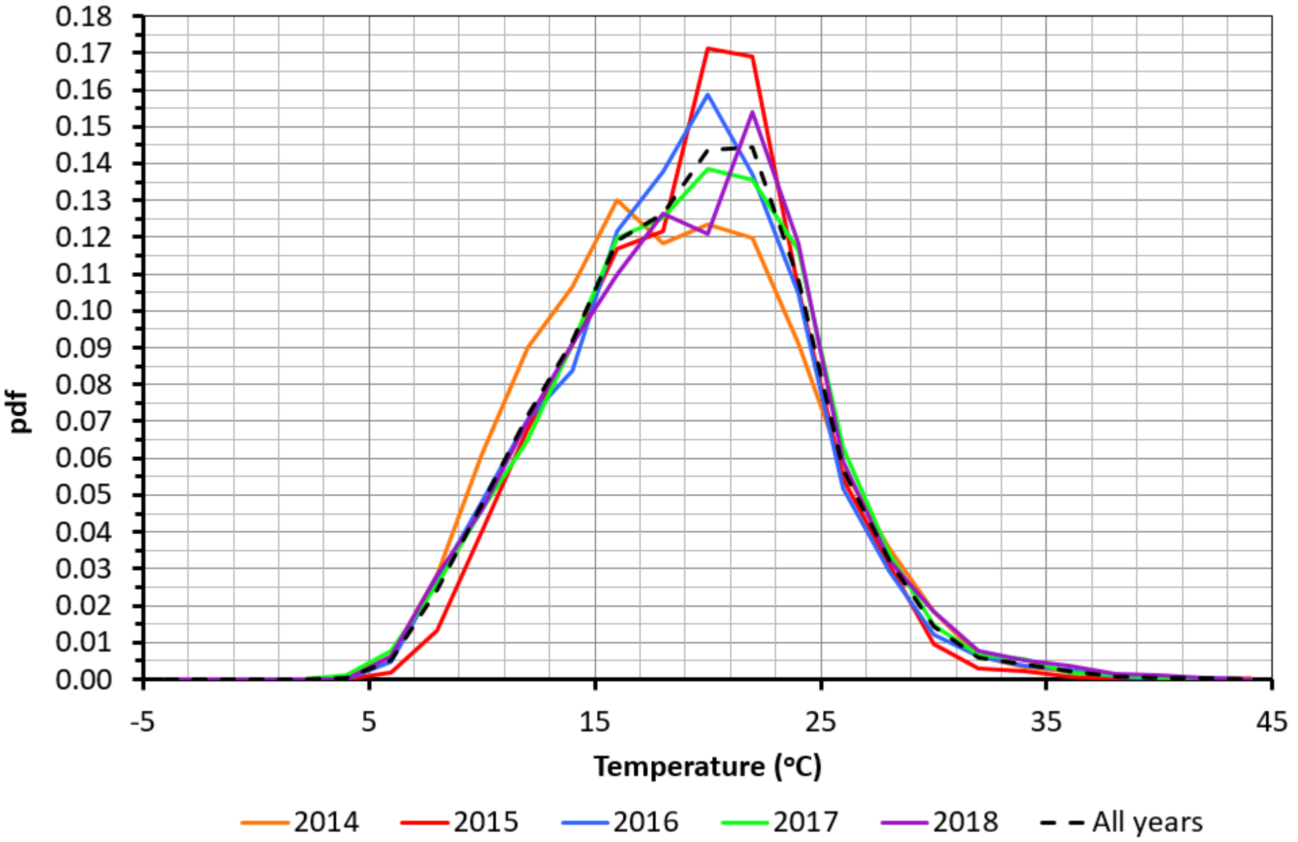
330
350
Wind direction (degrees)
2014
2015
2016
2017
2018
All years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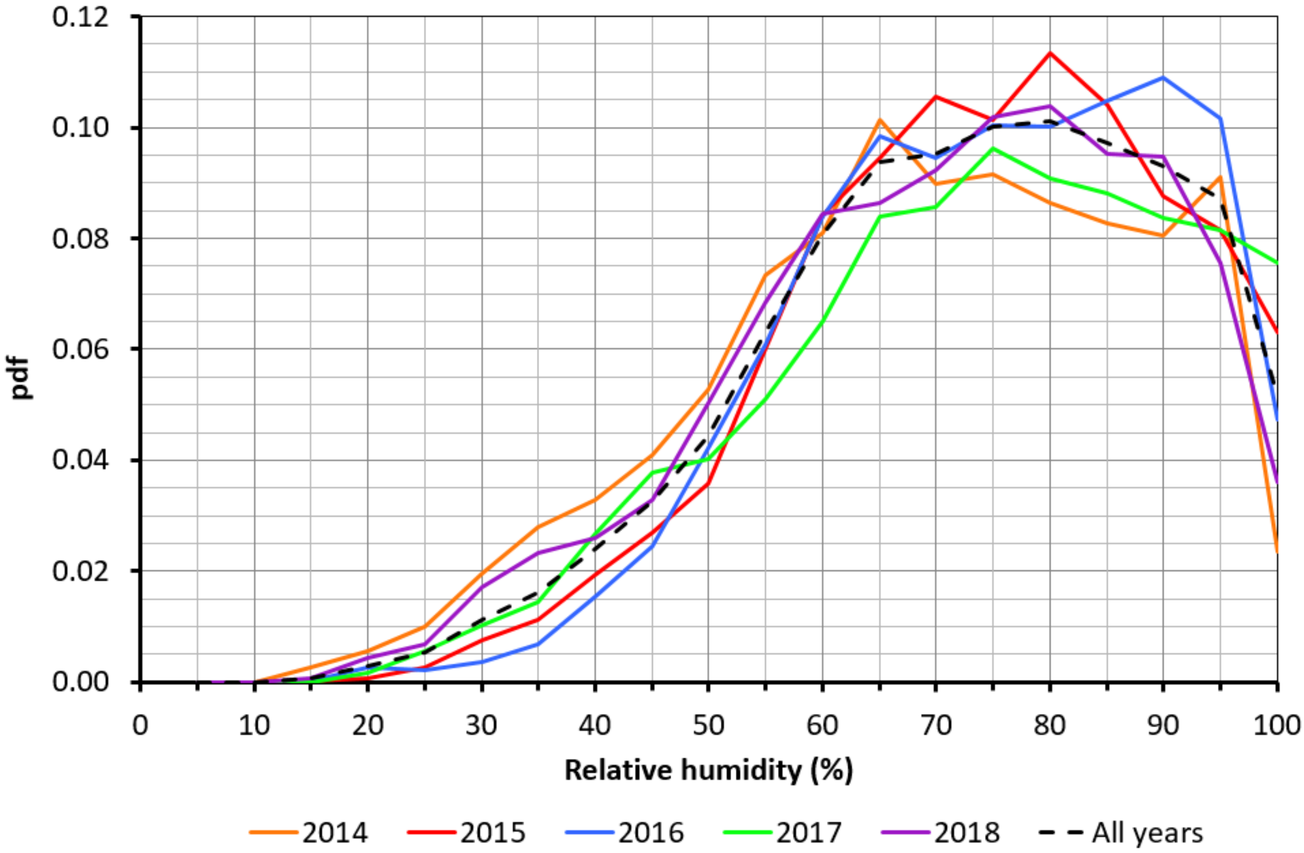
Temperature (°C)
2014
2015
2016
2017
2018
All years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30
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50
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70
80
90
100
Relative humidity (%)
2014
2015
2016
2017
2018
All years

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Revision	Author	Reviewer		Approved for Issue		
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