Appendix I. Air Quality Impact Assessment

Prospect Hill EfW Plant

Air Quality Impact Assessment

Rev 1

6 October 2020

Prospect Hill International Pty Ltd (Prospect Hill)

Prospect Hill EfW Plant - AQA

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
A	22 July 2020	First draft	M Pickett		T Freeman	
0	25 Sept 2020	Second draft	M. Pickett		R. Winders	
1	6 October 2020	Final	M. Pickett		R. Winders	

Distribution of copies

Revision	Issue approv	Date issued	Issued to	Comments
0	RW	25/09/2020	PHI	
1	RW	6/10/2020	EPA	

Prospect Hill EfW Plant

Project No:	IS305100
Document Title:	Air Quality Impact Assessment
Revision:	1
Date:	6 October 2020
Client Name:	Prospect Hill International Pty Ltd (Prospect Hill)
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File Name:	IS305100_AirQuality_Rev1

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Glossary and Abbreviations

Abbreviation	Expansion	Definition / notes
AG	Australian Government	
APCr	Air Pollution Control residues	
AQCR	Air Quality Control Region	Means a segment of the air environment which, because of its population or density, industrialisation, projected development, or meteorological characteristics, was gazetted (in Victoria) as requiring the regional effects of emissions of wastes to the air environment to be considered in formulating control requirements; source: SEPP(AQM) or VG (2001).
Airshed		For the purpose of this report, the Airshed is the Port Phillip AQCR as defined in the SEPP(AQM). The Prospect Hill site, and therefore the Project, is located within the Airshed.
AQCR	Air Quality Control Region	Source: SEPP(AQM) or VG (2001)
B(a)P	Benzo(a)Pyrene	
BAT	Best Available Techniques	EU (2010) and EC (2019b) terminology
Black start	Black start	Electricity generation without taking supply from any part of the power generation network e.g. following disconnection from the wider network.
BoM	Bureau of Meteorology	
C&IW	Commercial and Industrial Waste	
CO	Carbon monoxide	Molecular formula for carbon monoxide
EC	European Commission	
EETM	Emission Estimation Technique Manual	Source: National Pollutant Inventory
EfW	Energy from Waste	
EPA	Environment Protection Authority (Victoria)	
EU	European Union	
GLC	Ground Level Concentration	
HCl	Hydrogen chloride	Molecular formula for hydrogen chloride
HF	Hydrogen fluoride	Molecular formula for hydrogen fluoride
Jacobs	Jacobs Group (Australia) Pty Ltd.	
kW	kilowatt	
$\mu g/m^3$	microgram (1 x 10^{-6} grams) per cubic metre	
µm	micron (thousandth of a millimetre)	
MSW	Municipal Solid Waste	
MW	MegaWatt	
NEPM	National Environment Protection (Ambient Air Quality) Measure	See also SEPP(AAQ).
NO	Nitric oxide	Molecular formula for nitric oxide
NO_2	Nitrogen dioxide	Molecular formula for nitrogen dioxide
NO_x	Oxides of nitrogen	Molecular formula for oxides of nitrogen

Abbreviation	Expansion	Definition / notes
NPI	National Pollutant Inventory	
O_3	Ozone	Molecular formula for ozone
PAH	Polycyclic Aromatic Hydrocarbons	E.g., B(a)P
PC	PerCentile	E.g., “99.9PC” means “99.9th percentile”
PHI	Prospect Hill International Pty Ltd	
PM_{10}	Particulate Matter 10	Particulate matter comprising particles with aerodynamic diameters less than 10 microns (µm) in size
$PM_{2.5}$	Particulate Matter 2.5	Particulate matter comprising particles with aerodynamic diameters less than 2.5 microns (µm) in size
ppb	Parts per billion	
ppm	Parts per million	
Project		The PHI Prospect Hill EfW proposal
SEPP (AAQ)	State Environment Protection Policy (Ambient Air Quality)	Victorian Government 1999 policy, and 2016 variation, adopting the ambient air quality NEPM as Victoria’s ambient air quality protection policy.
SEPP (AQM)	State Environment Protection Policy (Air Quality Management)	Victorian Government 2001 policy governing how air quality assessments are required to be undertaken in the state, including dispersion modelling methodology.
SO_2	Sulfur dioxide	Molecular formula for sulfur dioxide
TOC	Total Organic Carbon	EU (2010) provides this definition: ‘gaseous and vaporous organic substances, expressed as total organic carbon’. For the purpose of this assessment, TOC is assumed equivalent to total VOC (see ‘VOC’).
USEPA	United States Environmental Protection Agency	
VG	Victoria Government	
VOC	Volatile Organic Compound	The Australian NPI definition for VOC: Total VOC are defined as any chemical compound based on carbon chains or rings with a vapour pressure greater than 0.01 kPa at 293.15 K (i.e. 20°C), that participate in atmospheric photochemical reactions (AG, 2009). For example, VOCs on the NPI list include: benzene, toluene, and xylenes.

Executive Summary

Prospect Hill International Pty Ltd proposes to construct and operate an Energy from Waste (EfW) Plant at its Prospect Hill site, between the small townships of Lara and Corio, north of Geelong. It is proposed the Plant will use modern, moving-grate, boiler technology to recover energy by combusting approximately 400,000 tpa of 80% Municipal Solid Waste (MSW) and 20% MSW-like Commercial and Industrial (C&I) waste. The Plant is expected to provide electricity at a maximum rate of approximately 36 MegaWatt electrical (MW_e).

The Project has two aims: (1) to provide a facility for the improved treatment of MSW and C&I waste compared to landfilling; and (2) to generate electricity for export to the electricity network. The treatment of waste in the Plant will be by combustion using proven and reliable engineering technology and emissions controls, as demonstrated by many similar EfW facilities around the world.

In Europe, emissions to air from EfW plants are regulated by the Industrial Emissions Directive 2010/75/EU (IED). The IED aims to achieve a high level of general protection for human health and the environment by reducing harmful industrial emissions across the European Union through the application of Best Available Techniques (BAT) for air emissions controls. Victoria's Environment Protection Authority (EPA) requires discharges from EfW plants developed and operated in Victoria to comply with IED emission limits as well as Victorian legislative standards.

Air emissions from the proposed Plant were analysed and estimated following EPA's guidelines: *Energy from waste* (EPA, 2017a), and *Demonstrating Best Practice* (EPA, 2017b). An air quality impact assessment was undertaken for the Project in accordance with the *State Environment Protection Policy (Air Quality Management)*, or 'SEPP (AQM)', and the EPA's guidelines for use of the regulatory model, AERMOD. The EPA was consulted about the Project and the proposed air quality assessment methods in March, 2020. EPA's feedback was incorporated in this assessment.

A conservative strategy was applied for the assessment based on testing conservative, high estimates for air pollutant emissions from the proposed EfW, in conjunction with approximately 40,000 hourly meteorological conditions determined specifically for the Project locality between Lara and Corio.

Key components of the air quality impact assessment methodology were:

- A conservative approach was used to estimate emissions for each substance based on a review of the IED air emission limits, and a review of the literature with a primary focus on a European Commission 2019 review of many operating EfW plants in Europe.
- Air pollutant emissions from the proposed, single, tall stack for the Project were modelled as a continuous source; i.e. for all hours in each of five simulated years.
- The modelling included wake and downwash effects associated with the Plant's main buildings and stack.
- The combined effects of the Project emissions plus estimates for background pollution levels based on local measurements represent the expected, cumulative (total), worst-case, air quality impacts.

The assessment concludes that the emissions to air from the proposed EfW Plant are minimal, with no adverse air quality impacts anticipated. Table E.1 shows the key emissions from the EfW Plant and the compliance with relevant legislative requirements. The air quality assessment results for all substances are also summarised in the following table and paragraphs.

Table E.1: Summary of emissions

Parameter	Averaging time	Maximum grid receptor result ($\mu g/m^3$)	Design criterion (or objective) ($\mu g/m^3$)	Fraction of design criterion (or objective)
CO	1-hour average	1602	29,000	5.5%

Parameter	Averaging time	Maximum grid receptor result (μg/m³)	Design criterion (or objective) (μg/m³)	Fraction of design criterion (or objective)
NO_2	1-hour average	68.0	190	35.8%
SO_2	1-hour average	100	450	22.2%
PM_{10}	1-hour average	399	80 (SEPP AQM)	499%
PM_{10}	24-hour average	286	50 (SEPP AAQ)	572%
PM_{10}	Annual average	19.9	20 (SEPP AAQ)	99.5%
$PM_{2.5}$	1-hour average	44.6	50 (SEPP AQM)	89.2%
$PM_{2.5}$	24-hour average	32.7	25 (SEPP AAQ)	1.36%
$PM_{2.5}$	Annual average	8.6	8 (SEPP AAQ)	107.5%
HF	24-hour average	0.14	2.9	4.83%
HF	7-day average	0.05	1.7	2.9%
HF	90-day average	0.01	0.5	2.0%
HCl	3-minute	38.9	250	15.6%
NH_3	3-minute	19.4	600	3.2%
Dioxins & furans[4]	3-minute	7.1E-08	3.7E-06	1.9%
PAH as B(a)P[5]				
TOC as formaldehyde[6]	3-minute	13.1	40 (formaldehyde)[6]	33%
Metals				
Cd	3-minute	0.013	0.033	39.4%
Tl	n/a	0.007	n/a	n/a
Hg	3-minute	0.013	0.33 (organic) 3.3 (inorganic)	3.9% 0.39%
Sb	3-minute	0.020	17	0.1%
As	3-minute	0.039	0.17	22.9%
Pb	1-hour	0.068	3 (1-hour avg)	2.3%
Cr III	3-minute	0.039	17	0.2%
Cr VI	3-minute	0.039	0.17	22.9%
Co	n/a	0.002	No criterion	n/a
Cu	3-minute	0.195	6.7	2.9%
Mn	3-minute	0.039	33	0.1%

Carbon monoxide (CO)

The AERMOD results demonstrated that CO emissions from the Plant will have only a small effect on existing levels of CO and will not cause any exceedances of the SEPP (AQM) design criterion (29 milligram/m³). Several years of CO monitoring by the EPA Geelong South monitoring station show that all CO concentrations in the

Geelong area have been low, with the majority of concentrations less than 10% of the monitoring objective. The conclusion for CO is there is a very low risk of the Project causing air quality impacts due to CO emissions.

Nitrogen dioxide (NO_2) and ozone (O_3)

Most NO_2 in the atmosphere does not originate directly from combustion – oxides of nitrogen (NO_x) from the combustion of fuels (including waste) comprises mostly NO and smaller amounts of NO_2. In the atmosphere, NO may be oxidised to NO_2 by a reaction with ambient ozone (O_3). The EPA's monitoring data show there is always some ambient O_3 available for this reaction. The EPA Geelong South results for NO_2 show that, in general, NO_2 concentrations are low, with the monitoring objective for NO_2 not exceeded at any time over 2014-2019. Maximum hourly averages over the whole period were less than 50% of the monitoring objective.

The AERMOD results for NO_x emissions from the Plant were assessed in two ways: (1) assuming a very high 100% conversion rate of NO_x to NO_2 to determine the maximum possible contributions to existing NO_2 levels; and (2) based on measured, high NO_x concentrations, a NO_2/NO_x conversion ratio of 30% was used and added to the hourly-varying, background NO_2.

The AERMOD results show that there were no model-predicted exceedances of the design criterion for NO_2. Collectively, these results showed that NO_x emissions from the Plant are unlikely to cause exceedances of the SEPP (AQM) design criterion for NO_2.

Sulfur dioxide (SO_2)

The SO_2 monitoring results from EPA Geelong South over 2014-2019 were low, demonstrating a low risk of air quality impact due to existing, local emissions of this substance. The AERMOD results for SO_2, including conservative estimates for background SO_2 for each annual meteorological simulation, did not cause any exceedances of the design criterion for SO_2.

Particulate Matter 10 (PM_{10})

EPA Victoria has air quality monitoring stations around the state, including stations at Geelong South and Footscray. These stations monitor and measure the existing levels of air quality using a range of substances including PM_{10} and $PM_{2.5}$. EPA Geelong South and EPA Footscray monitoring data show existing, high concentrations of PM_{10} for the Project study area due to a variety of sources; e.g., raised dust, and fires. Over a 6-year period to the end of 2019 there were between 3-11 exceedance days per year at Geelong South, and up to 7 exceedance days per year at EPA Footscray. Although, none of the measurements exceeded Victoria's *SEPP (Ambient Air Quality)* or 'SEPP (AAQ)' objective for annual average PM_{10} (20 $\mu g/m^3$).

The AERMOD results for PM_{10} due to emissions from the Plant including the hourly-varying, background PM_{10} levels, showed the results were heavily dominated by high existing background levels. The AERMOD results showed emissions from the Plant are unlikely to cause additional exceedances of the design criterion and the SEPP (AAQ) monitoring objectives. Contributions of PM_{10} from the Plant were small relative to the existing high background PM_{10}. The Plant will employ BAT controls on the particulate emissions from the stack, so the PM_{10} emissions will be low relative to background levels. To conclude, contributions of PM_{10} from the Plant were small relative to the existing high PM_{10} background levels.

Particulate Matter 2.5 ($PM_{2.5}$)

The EPA Geelong South and EPA Footscray monitoring data showed existing, high $PM_{2.5}$ concentrations for the Project study area (the case for $PM_{2.5}$ is similar to PM_{10}). Sources of the high background $PM_{2.5}$ levels include road traffic (i.e., petrol and diesel combustion), domestic wood burning, and, occasionally, controlled burns and bushfires that could be distant from Geelong and Lara. Measurements of $PM_{2.5}$ were obtained at Geelong South over 2016-2019 and 2014-2019 at EPA Footscray. Over these monitoring periods, there were up to 2 exceedance days per year at Geelong South, and up to 4 exceedance days at EPA Footscray. However, none of the annual averages exceeded the SEPP (AAQ) objective for annual average $PM_{2.5}$ (8 $\mu g/m^3$).

The AERMOD results for $PM_{2.5}$ due to emissions from the Plant were similar to those for PM_{10}. The $PM_{2.5}$ results included hourly-varying, background $PM_{2.5}$ concentrations, and again the combined results were heavily dominated by the high existing background levels. The AERMOD results showed emissions from the Plant are unlikely to cause additional exceedances of the design criterion and the SEPP (AAQ) monitoring objectives. To conclude, contributions of $PM_{2.5}$ from the Plant were small relative to the existing high $PM_{2.5}$ background levels.

Hydrogen Fluoride (HF)

The AERMOD results for hydrogen fluoride (HF), using a conservative (high) emissions estimate, did not cause exceedances of the SEPP (AQM) design criteria for maximum 24-hour average, maximum 7-day average, and maximum 90-day average HF concentrations. The modelling shows there is a low risk of air quality impact due to HF emissions from the Plant.

Other substances – general

A suite of other substances was assessed for the Project using emissions estimates based on the substance lists and emissions limits provided in SEPP (AQM), EU (2010) and EC (2019b). These were: hydrogen chloride (HCl), ammonia (NH_3), dioxins and furans, PAHs as B(a)P, and hydrocarbons or TVOCs, and metals such as arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), and nickel (Ni). In general, the background levels of these substances are expected to be small; close to or less than their measurement limits of detection.

Results for other substances – non metals

There were no exceedances of SEPP (AQM) design criteria for HCl, NH_3, dioxins and furans, polycyclic aromatic hydrocarbons (PAHs) as Benzo(a)Pyrene (B(a)P), and hydrocarbons. All the hydrocarbon emissions were assumed to be formaldehyde, a conservative step in the assessment given formaldehyde is a higher risk hydrocarbon in combustion products.

Results for other substances – metals

There were no exceedances of SEPP (AQM) design criteria, (where criteria were available), for all the metals that could be tested. In relation to the first IED metals group total, (Cd+Tl), review of the literature indicated the majority of Cd+Tl emissions from EfW is cadmium (Cd), therefore the assessment was based on all the emission being Cd. There is no design criterion for thallium (Tl), but the assumption of 100% Cd is conservative for the assessment.

The IED emissions limits do not distinguish between organic and inorganic mercury (Hg). The maximum EfW emission was assessed against both the organic and inorganic SEPP (AQM) design criteria for Hg. The risk of air quality impact from mercury emissions expected from the Plant, was found to be low.

In relation to the second IED metals group total: Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V; from a review of the literature, assessment of each of these individual elements was by conservative (high) estimates of fractions of the IED emission limit for the total. None of the AERMOD-predicted concentrations for the individual metals exceeded their SEPP (AQM) design criteria, (where criteria were available). While there were no exceedances of design criteria, the highest risk metals/elements were identified as: highest-risk; cadmium (Cd); equal second-highest risk; arsenic (As) and chromium-6 (Cr VI); and third-highest risk; nickel (Ni).

Conclusion

The air quality modelling assessment demonstrates that there is a low risk of air quality impact from the Project's emissions. The assessment shows that the emissions of all substances from the EfW Plant will meet all IED and SEPP (AQM) emission limits. The assessment also shows that the EfW Plant emissions will meet all ground level concentration design criteria for all substances, as specified in SEPP (AQM).

Emissions of air toxics such as IARC Group 1 carcinogens hexavalent chromium (Cr (VI)), cadmium (Cd) and mercury (Hg) were investigated for this assessment. Model results for all of the carcinogens showed that the GLCs due to the EfW Plant are below the relevant SEPP(AQM) design criteria and most are many times below their criterion.

This air quality impact assessment analysed the air emissions expected from the proposed Plant by using conservative estimates for emissions of the individual substances combined with air dispersion modelling (using AERMOD). AERMOD predicted concentrations of air pollutants from the proposed Plant, added to existing air pollutant concentrations, were found to be minimal in relation to SEPP (AQM) design criteria.

The assessment showed that there are periods when there are high existing levels of PM_{10} and $PM_{2.5}$ in the region and that the SEPP (AQM) design criteria are already exceeded on some occasions due to these existing high background levels. Apart from PM_{10} and $PM_{2.5}$, predicted air emissions from the Plant caused no exceedances of the SEPP (AQM) design criteria, by testing with EPA's regulatory model, AERMOD. The AERMOD results showed that emissions of PM_{10} and $PM_{2.5}$ are unlikely to cause additional exceedances of their design criteria, with the results heavily dominated by high background PM_{10} and $PM_{2.5}$ levels.

Monitoring shows that existing levels of PM_{10} and $PM_{2.5}$ are high due to sources such as raised dust, smoke from fires and wood burning, and road traffic. These background levels are high relative to the small contributions expected from the Plant, which will employ world's best practice, Best Available Techniques emissions controls. Further, the modelling showed that particulate emissions from the Plant are unlikely to cause additional exceedances of the SEPP (AAQ) maximum 24-hour average and annual average monitoring objectives.

1. Introduction

1.1 Purpose

The proposed Project comprises an EfW facility with all air pollutants to be emitted via a single stack with two or three flues at a height of approximately 80 metres above ground level, located on industrial zoned in Lara, Victoria. The EfW plant will have a nominal output of 36 megawatts electrical (MW_e), with the combustion of waste via a moving-grate fired boiler.

The EfW tipping hall, which will receive waste by truck, will be entirely enclosed and operated under negative pressure. For this reason the expectation is there will be no significant fugitive odour emissions from the site. Odorous molecules and hydrocarbons are expected to be destroyed in the EfW's processes as the air from the tipping hall will be used as combustion air in the EfW boiler.

The purpose of the air quality impact assessment described in this report was to assess air quality effects due to emissions from an Energy from Waste (EfW) facility proposed to be constructed and operated near Lara, in Victoria.

1.2 Proposal Overview

Prospect Hill International Pty Ltd (PHI) is proposing the Prospect Hill EfW Plant, ('the Plant'), for a 16-hectare site at 164-200 McManus Road, Lara, just north of Geelong. The aim of the overall Project is to allow PHI to generate electricity for export to the electricity network.

The EfW plant will use moving grate boiler technology to recover energy by combusting approximately 400,000 tonnes per annum (tpa) of Municipal Solid Waste (MSW) and Commercial and Industrial Waste (C&IW). The waste would comprise approximately 80% MSW (~320,000 tpa) and 20% C&IW (~80,000 tpa).

More details about the Project are provided in Section 4 of this report, and further information and details about the Project are provided in the main Works Approval Application report (Jacobs, 2020).

1.3 General Methodology

This assessment was prepared for a Works Approval Application under the *Environment Protection Act (1970)* and a Planning Permit application under the *Planning and Environment Act 1987* (Jacobs, 2020).

The assessment is a cumulative air quality impact assessment conducted in accordance with the Victoria Government (VG) *State Environment Protection Policy (Air Quality Management)*; 'SEPP (AQM)', or VG (2001). Such an assessment addresses the air quality effects from existing and proposed sources. This can be achieved by adding estimates for existing air pollutant concentrations determined by measurements to model-predicted results.

The assessment was based on air dispersion modelling using Victoria's Environment Protection Authority (EPA) regulatory model AERMOD, in accordance with the EPA (2014) and EPA (2015) guidelines for using the model.

Victorian legislation, policy and guidelines relevant to air quality impact assessment are detailed in Section 2 of this report.

1.4 Exclusion

The Project may include a 'black start' diesel generator and emergency shutdown generator. (A definition of 'black start' is provided in the glossary). If this equipment is installed by PHI, it would be used only rarely. Therefore, black start operations may be classified as 'abnormal operations'. On the subject of modelling of emissions to air from stationary sources the SEPP (AQM) states, "*Estimates of emission rates must be based on* *the worst case scenario during normal operations*". Therefore, black start and diesel generator operations were excluded from this assessment.

2. Legislation, Policy and Guidelines

2.1 Overview

This section sets out legislation, policy and guidelines relevant to air quality impact assessment for EfW proposals in Victoria.

- Provision for environmental assessment in the Victorian *Environment Effects Act 1978* is described briefly in Section 2.2.
- The European Union (EU), Industrial Emissions Directive (IED)and relevant documents are described and explained in Section 2.3.
- Victorian requirements for best practice emission control of air emissions are set out in Section 2.4.
- Expectations of Victoria's *Energy from Waste* guideline (EPA, 2017a), are described in Section 2.5.
- Ambient air quality standards (design criteria) for assessment of industrial proposals in Victoria, and national and Victorian air quality monitoring objectives, are detailed in Section 2.6.

2.2 Environment Effects Act 1978

The *Environment Effects Act 1978* provides for the assessment of actions that are capable of having a significant environmental effect. Such actions should be referred to the Victorian Minister for Planning, who decides if an Environment Effects Statement (EES) is required. An EES might be required where:

- There is a likelihood of regionally or state significant adverse environmental effects;
- There is a need for an integrated assessment of social and economic effects of a project or relevant alternatives; and
- Normal statutory processes would not provide a sufficiently comprehensive, integrated and transparent assessment.

The Act also allows an applicant to ask the Secretary of the Department of Environment, Land, Water and Planning if an EES is required.

2.3 European Union Industrial Emissions Directive 2010/75/EU

In Europe, emissions to air from EfW plants are regulated by the European Union (EU) Industrial Emissions Directive (IED) 2010/75/EU (EU, 2010; EC, 2019b). The IED aims to achieve a high level of general protection for human health and the environment by reducing harmful industrial emissions across the EU, in particular through the application of Best Available Techniques (BAT) for air emissions controls. A similar, high level of protection is anticipated for the Australian environment where the IED is applied; e.g., EPA (2017a).

The original BAT reference document on Waste Incineration was adopted by the European Commission (2006); EU (2010) set out BAT-Associated Emissions Limits (AEL); EC (2019a) presents the results of a review and update of BAT reference documents; and EC (2019b) sets out the updated BAT-AEL. The key references are listed here for convenience:

(1) EC (2006): European Commission, *Integrated Pollution Prevention and Control, Reference Document on the Best Available Techniques for Waste Incineration*, August 2006.

(2) EU (2010): The European Parliament and the Council of the European Union, *Directive EC2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) (Recast)*, Official Journal of the European Union, pp. L 334/17-119, 17.12.2010.

(3) EC (2019a): European Commission, JRC Policy for Science Report, *Best Available Techniques (BAT) Reference Document for Waste Incineration*, Industrial Emissions Directive 2010/75/EU, Integrated Pollution Prevention and Control, EUR 29971 EN, 2019.

(4) EC (2019b): European Commission, *Commission Implementing Decision (EU) 2019/2010 of 12 November 2019 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for waste incineration*. Official Journal of the European Union, L 312/55, 3 December 2019.

EU (2010) set out a comprehensive list of emissions limits for EfW facilities. EC (2019a) included a review of emissions measurements and provided recommendations for updates to the emissions limits as data ranges rather than fixed maxima. EC (2019b) adopted the EC (2019a) recommendations for BAT-AEL (Table 2-1).

Emissions limits from EU (2010) and EC (2019b), and the EC (2019a) review of measurements, were analysed and used for this Project. The reason for this was some EU (2010) averaging periods were a better match with the averaging periods of the SEPP (AQM) design criteria used to assess modelling results (Section 2.6.3). A conservative approach was taken in each case for the assessment of each substance. Emissions data used as input in each case are described in Section 5.2.3. The EU (2010) and EC (2019b) emissions limits are listed in Table 2-1.

Table 2-1: European Union EfW emissions limits: EU (2010) and EC (2019b)

Pollutant	IED 2010/75/EU (EC, 2010)			IED 2010/75/EU (EU, 2019b)	
	Emission Limit (mg/Nm^3)	Emission Limit (mg/Nm^3) 97th percentile	Averaging time	BAT-associated emission levels (BAT-AELs) (mg/Nm^3)	Averaging time
Pollutants (general)					
Total dust	10	–	24 hours	< 2-5	24 hours
TVOC	–	–	–	< 3-10	24 hours
Hydrogen chloride (HCl)	10	–	24 hours	< 2-6	24 hours
Hydrogen fluoride (HF)	1	–	24 hours	< 1	24 hour or average over the sampling period
Sulfur dioxide (SO_2)	50	–	24 hours	5 – 30	24 hours
Oxides of nitrogen (NOx) as nitrogen dioxide (NO_2)	200	–	24 hours	50 – 120	24 hours
Carbon monoxide (CO)	50	–	24 hours	10 – 50	24 hours
Total dust	30	10	0.5 hour	–	–
Total organic carbon (TOC)	20	10	0.5 hour	–	–
Hydrogen chloride (HCl)	60	10	0.5 hour	–	–
Hydrogen fluoride (HF)	4	2	0.5 hour	–	–
Sulfur dioxide (SO2)	200	50	0.5 hour	–	–
Oxides of nitrogen (NOx) as nitrogen dioxide (NO2)	400	200	0.5 hour	–	–
Carbon monoxide (CO)	100	–	0.5 hour	–	–
Carbon monoxide (CO)	150	–	10-minute	–	–
Pollutants (heavy metal)					

Pollutant	IED 2010/75/EU (EC, 2010)			IED 2010/75/EU (EU, 2019b)	
	Emission Limit (mg/Nm^3)	Emission Limit (mg/Nm^3) 97th percentile	Averaging time	BAT-associated emission levels (BAT-AELs) (mg/Nm^3)	Averaging time
Cd + Tl	0.05	–	0.5 hours	0.005-0.02	Average over the sampling period$
Hg	0.05	–	0.5 hours	<0.005 - 0.02	24 hour or average over the sampling period$
Hg	–	–	–	0.001 - 0.01	Long term sampling period*
Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V	0.5	–	0.5 hours	0.01-0.3	Average over the sampling period$

* Defined in EC (2019b) as a sampling period of 2 to 4 weeks.

$ Defined in EC (2019b) as average value of three consecutive measurements of at least 30 minutes each, unless a longer period is required due to sampling or analytical limitations.

2.4 Victorian Requirements for Best Practice Emission Control

Under the *Environment Protection Act 1970* (the EP Act), State Environment Protection Policies set out what must be done to protect Victoria's environment concerning potential impacts to air, water and land, and the control of noise. Sources of emissions or discharges to the environment must be managed in accordance with 'best practice'.

With respect to air pollutant emissions, the SEPP (AQM) defines 'best practice' as:

> '*the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity*'.

The SEPP (AQM) requires application of best practice and continuous improvement for all relevant indicators and reductions to the Maximum Extent Achievable (MEA) for the more hazardous air pollutants (class 3 indicators).

In the case of air emissions, best practice can be distinguished from the requirement to reduce emissions of hazardous air pollutants to their MEA. An MEA requirement gives less consideration to cost and places more emphasis on minimising risk to human health than a 'best practice' or 'best practicable measures' requirement.

In contrast, a degree of pragmatism and cost effectiveness is implied in the EPA (2017b) guideline, *Demonstrating Best Practice*, which assists with the assessment of best practice. The EPA's approach to assessing best practice is to use a risk-based approach where the following items are considered:

- Scope – the activity being proposed and its relevant industry sector.
- Options review – a broad summary outlining the range of options available for the proposed works (including the 'do nothing' option), and a brief indication of why they were considered or discarded.
- Best practice analysis – a statement or detailed analysis commensurate to the priorities identified in the environmental risk assessment, describing how the proposal constitutes best practice.

- Best practice assessment – having considered all available evidence, the assessment provides an integrated conclusion to the best practice analysis demonstrating the best combination of eco-efficient techniques, methods, processes or technology (as relevant) and summarising the justification of the preferred approach.

EPA (2017b) outlines suggested evidence or analysis techniques that can be used to demonstrate an assessment of best practice for a Works Approval Application. Types of evidence include: literature review; benchmarking; application of the wastes hierarchy; integration of economic, social and environmental considerations; and integrated environmental assessment. More specifically, EPA (2017b) provides a range of information and best practice requirements relevant to air pollution emissions from EfW facilities.

Section 4 provides details of air pollution emission controls to be applied to the Project.

2.5 Energy from Waste Guideline

EPA Victoria's *Energy from Waste* guideline (EPA, 2017a), provides a range of information and requirements relevant to air pollution emissions from the Plant facilities. The guideline states that proponents of proposals that require a works approval or licence will be expected to demonstrate that the siting, design, construction and operation of the Plant facilities will incorporate best practice measures for the protection of air environments as well as for energy efficiency and greenhouse gas emissions management. The guideline also requires discharges from EfW plants developed and operated in Victoria to meet a European Union (EU), Industrial Emissions Directive (IED). Facilities should be able to provide evidence of how they minimise and manage emissions, including pollutants, odour, and dust, in accordance with relevant statutory requirements.

EPA (2017a) outlines how the EPA assesses the proposed implementation of best practice technology and operations and provides guidance on how to demonstrate compliance with requirements. The guideline states that air emissions associated with processing of waste (for EfW) are consistent with the SEPP (AQM).

More specific guidance is as follows:

Health protection must be an inherent feature during the design, approval process and operation of EfW facilities. In the case of air emissions, EPA currently considers thermal treatment technology as best practice if:

- *Emissions of Class 3 indicators as set out in SEPP(AQM) are reduced to the Maximum Extent Achievable (MEA) which involves the most stringent measures available.*
- *Emission discharges, under both steady and non-steady state operating conditions, meet all the emissions standards set in the European Union's Waste Incineration Directive 2000/76/EC (WID), which was recast into the Industrial Emissions Directive 2010/75/EU (IED). The IED sets stringent emission limits and monitoring requirements which include:*
    - *(1) Continuous emissions monitoring of total particulate matter (TPM); sulfur dioxide (SO_2); oxides of nitrogen (NOx); hydrogen chloride (HCl); carbon monoxide (CO); total organic carbon (TOC); hydrogen fluoride (HF). In addition, there must be at least non-continuous air emission monitoring of other pollutants such as heavy metals, dioxins and furans, a minimum of two measurements per year, which should be more frequent during the initial operation of the plant. This monitoring should capture seasonal variability in waste feedstock and characteristics.*
    - *(2) Additionally, in order to guarantee complete combustion, the IED requires all plants to keep the combustion or co-combustion gases at a temperature of at least 850°C for at least two seconds after the last injection of air. If waste with a content of more than 1 per cent of halogenated organic substances, expressed as chlorine, is combusted, the temperature must be raised to 1,100 °C for at least two seconds after the last injection of air.*

Finally, the combustion of waste or RDF as fuel replacement in an existing facility should have comparable or reduced emissions to atmosphere in comparison to the emissions from the standard fuel it replaces, with appropriate risk controls in place.

Compliance with EC (2019b) was assumed for this assessment although published after EPA (2017a).

2.6 Ambient Air Quality Standards

2.6.1 Overview

Ambient air quality standards are used to assess air quality by monitoring and/or modelling. This section sets out ambient air quality standards relevant to the Project.

2.6.2 National and Victorian Air Quality Monitoring Standards

The National Environment Protection Council (NEPC) of the Department of the Environment, Australian Government (AG), established national ambient air quality standards as part of the *National Environment Protection Measure for Ambient Air Quality*, or the 'AAQ NEPM' (AG, 2016). The Measure aims to improve the health of Australians through improved air quality. The standards relate to six criteria air pollutants: carbon monoxide (CO), nitrogen dioxide (NO_2), photochemical oxidants (O_3), sulfur dioxide (SO_2), lead (Pb) and coarse particulate matter (PM_{10} and $PM_{2.5}$). In the State of Victoria, ambient air monitoring is addressed in the *State Environment Protection Policy (Ambient Air Quality)* or the 'SEPP (AAQ)', (VG, 1999; VG, 2016), which incorporates the standards of the AAQ NEPM except for a more stringent value adopted for annual average PM_{10} (VG, 2016). The AAQ NEPM and the SEPP (AAQ) are compared in Table 2-2 below.

Table 2-2: AAQ NEPM 2016 standards and SEPP AAQ 2016 objectives

Pollutant	AAQ NEPM (NEPC, 2016)			SEPP AAQ (VG, 1999; VG, 2016)		
	Averaging Period	Maximum Concentration Standard	Maximum Allowable Exceedances	Averaging Period	Environmental Quality Objective	Maximum Allowable Exceedances
CO	8 hours	9.0 ppm	1 day a year	8 hours	9.0 ppm	1 day a year
NO_2	1 hour	120 ppb	1 day a year	1 hour	120 ppb	1 day a year
	1 year	30 ppb	None	1 year	30 ppb	None
O_3	1 hour	100 ppb	1 day a year	1 hour	100 ppb	1 day a year
	4 hours	80 ppb	1 day a year	4 hours	80 ppb	1 day a year
SO_2	1 hour	200 ppb	1 day a year	1 hour	200 ppb	1 day a year
	1 day	80 ppb	1 day a year	1 day	80 ppb	1 day a year
	1 year	20 ppb	None	1 year	20 ppb	None
PM_{10}	1 day	50 µg/m^3	None	1 day	50 µg/m^3	None
	1 year	25 µg/m^3	None	1 year	20 µg/m^3	None
$PM_{2.5}$	1 day	25 µg/m^3	None	1 day	25 µg/m^3	None
	1 year	8 µg/m^3	None	1 year	8 µg/m^3	None

Note. A variation in the SEPP (AQM) 2001 deleted the SEPP (AAQ) 1999 8-hour averages for ozone.

Standards are periodically reviewed to consider the latest scientific evidence as new findings emerge. The AAQ NEPM was last varied in February 2016 with the advisory reporting standards for $PM_{2.5}$ set as standards and an annual average standard for PM_{10} was implemented (25 µg/m^3) with the maximum number of allowable exceedances for all particle standards set to zero. Most recently, a proposed variation to the AAQ NEPM was released for public consultation in 2019 in relation to the standards for O_3, NO_2, SO_2, PM_{10} and $PM_{2.5}$. The proposed variations to the standards of these pollutants are summarised in Table 2-3. It is noted the proposed variation removes the 'allowable exceedances', replaced by a requirement for jurisdictions to record and report 'exceptional events', specifically smoke and dust occurrences causing exceedances of the proposed PM_{10}, $PM_{2.5}$ and ozone standards.

Table 2-3: AAQ NEPM 2019 draft - proposed standards

Pollutant	Averaging Period	Proposed Maximum Concentration Standard from 2020	Proposed Maximum Concentration Standard from 2025
CO	8 hours	9.0 ppm	9.0 ppm
NO_2	1 hour	90 ppb	80 ppb
	1 year	19 ppb	15 ppb
O_3	8 hours	65 ppb	65 ppb
SO_2	1 hour	100 ppb	75 ppb
	1 day	20 ppb	20 ppb
PM_{10}	1 day	50 µg/m^3	50 µg/m^3
	1 year	25 µg/m^3	25 µg/m^3
$PM_{2.5}$	1 day	25 µg/m^3	20 µg/m^3
	1 year	8 µg/m^3	7 µg/m^3

2.6.3 Victorian Impact Assessment (Modelling) Standards

The SEPP (AQM) sets the framework for managing emissions to the air environment. The SEPP (AQM) provides a list of 'indicators' (substances) and concentrations for the assessment of model predictions for Ground Level Concentrations (GLCs). The design criteria for class 1, class 2 and class 3 indicators, for the purpose of assessing proposals for new emission sources or modifications to existing emission sources, are established in Schedule A of the SEPP (AQM). The design criteria are used in conjunction with the modelling procedures outlined in Schedule C of SEPP (AQM).

The indicators and their design criteria used for this assessment of the Project are listed in Table 2-4.

Table 2-4: SEPP (AQM) design criteria relevant to the Project

Substance	Reason for classification	Averaging time (99.9 percentiles)	Design criterion (µg/m^3)[1]	Design criterion (ppb)
Carbon monoxide (CO)	Toxicity	1 hour	29,000	25,000
Nitrogen dioxide (NO_2)	Toxicity	1 hour	190	100
Sulfur dioxide (SO_2)	Toxicity	1 hour	450	170
Particulate Matter 10 (PM_{10})	Toxicity	1 hour	80	–
Particulate Matter 2.5 ($PM_{2.5}$)	Toxicity	1 hour	50	–
Hydrogen fluoride (HF) / Fluoride	Bioaccumulation	24 hour[2]	2.9	3.4
		7 day[2]	1.7	2.0
		90 day[2]	0.5	0.59
Hydrogen chloride (HCl)	Toxicity	3 minutes	250	170
Ammonia (NH3)	Toxicity	3 minutes	600	830
Dioxins and Furans (DF) (see SEPP(AQM))	IARC3 Group 1 carcinogen	3 minutes	3.7×10^{-6}	–
Polycyclic Aromatic Hydrocarbons (PAH) as Benzo(a)Pyrene (B(a)P)	IARC3 Group 2A carcinogen	3 minutes	0.73	–
Hexavalent chromium (Cr (VI))[4]	IARC3 Group 1 carcinogen	3 minutes	0.17	–

Substance	Reason for classification	Averaging time (99.9 percentiles)	Design criterion (µg/m³)[1]	Design criterion (ppb)
Cadmium (Cd)[5]	IARC3 Group 1 carcinogen	3 minutes	0.033	–
Mercury (Hg) – Organic	Bioaccumulation	3 minutes	0.33	–

Note 1. Gas volumes are expressed at 25ºC and at an absolute pressure of one atmosphere (101.325 kPa).
Note 2. Averaging periods of greater than 1 hour are maxima; 1 hour and less are 99.9 percentiles.
Note 3. International Agency for Research on Cancer.
Note 4. There are no design criteria for cobalt (Co), thallium (Tl) and vanadium (V) – an assumption was that Cr(VI), which is an IARC Group 1 carcinogen, would be the highest risk element in this group with all Cr assumed Cr(VI).

Ambient air quality monitoring objectives such as those defined in the SEPP (AAQ) are not usually used for the assessment of industrial facilities by modelling. However, the monitoring objectives set out in the 2016 variation to the SEPP (AAQ) were used for the assessment of model-predicted PM_{10} and $PM_{2.5}$ GLCs for this Project (Table 2-5). The reason for this is national and state standards and objectives for PM_{10} and $PM_{2.5}$ for the protection of human health, based on 24-hour and annual averages, are better known than effects over the hourly average periods of the SEPP (AQM) design criteria for PM_{10} and $PM_{2.5}$.

Table 2-5: SEPP (AAQ) objectives adopted as project objectives

Substance	SEPP (AAQ) Monitoring objective	SEPP (AAQ) objective adopted as Project objective (µg/m³)	SEPP (AAQ) 2025 goal (µg/m³)
PM_{10}	Maximum 24-hour average	50	No change
	Maximum annual average	20	No change
$PM_{2.5}$	Maximum 24-hour average	25	20
	Maximum annual average	8	7

2.7 Industrial Residual Air Emissions (IRAE)

The EPA Publication 1518 (March 2013) *Recommended separation distances for Industrial Residual Air Emissions* (IRAEs) sets out separation distances for 'unintended' or non-routine emissions that can be intermittent or episodic and may originate at or near ground level. The purpose of a separation distance is to avoid the potential consequences of IRAEs. An adequate separation distance should allow IRAEs to dissipate without adverse impacts on sensitive land uses.

The EfW Plant is classified as a Waste Management – Advanced Resource Technology Facility, defined as:

> "*Waste treatment facility for the immobilisation, thermal degradation, chemical conversion biological oxidation (aerobic or anaerobic), incineration or gasification or other treatment of solid waste*"

There is no set separation distance for such facilities and rather they are required to be assessed on a 'case by case' basis.

The proposed Prospect Hill EfW Project is suitably located within the Industrial 2 Zone (IN2Z) and the Geelong Ring Road Employment Precinct (GREP) which are areas designated for industrial land uses. Clause 33.02 (Industrial 2 Zone) of the Greater Geelong Planning Scheme identifies that the purpose of the IN2Z is to provide for industry in "*a manner which does not affect the safety and amenity of local communities*." The majority of surrounding land uses are also industrial and potential impacts to the safety and amenity of local communities are largely avoided as a result. Whilst some residential properties exist within the Rural Living Zone (RLZ) to the site's northwest, the Project does not generate emissions that are predicted to affect the safety and amenity of these residents.

The IN2Z also aims to "*keep the core of the zone free of uses which are suitable for location elsewhere so as to be available for manufacturing industries and storage facilities that require a substantial threshold distance*." Given that the Project does not require a substantial threshold distance due to its limited potential for impacts on amenity and safety, it is considered that the Project is appropriately located outside of the core of the IN2Z. This ensures that the core of the IN2Z is reserved for land uses that do require substantial buffers from any sensitive land uses.

Land within the GREP (formerly the Heales Road Industrial Estate) was first identified under the Geelong Industrial Land Study (Geelong Regional Commission, 2001) and set aside as an industrial estate that would be attractive to heavy industry due to its significant buffer from residential development. At this time, a 1000m buffer zone was provided around the Industrial Estate (Figure 2.1). This buffer has limited the southward expansion of residential development within the Lara township. The Lara Structure Plan (City of Greater Geelong, 2011) reaffirmed this buffer by setting a policy direction to "*maintain[ing] a buffer of non-sensitive land uses between the [GREP] and the Lara township to the north*".

The land in the buffer zone is zoned for farming (FZ) and rural residential uses (RRZ). The rural residential properties along the southern side of side of Minyip Road between McManus Road and Bacchus Marsh Road are subject to a Design and Development Overlay – Schedule 7 (Heales Road Industrial Estate Environs) (DDO7). The design objective of the DDO7 is:

> "*To ensure that an effective buffer distance is maintained between dwellings on the south side of Minyip Road, Lara and the Heales Road Industrial Estate [the GREP].*"

Under the DDO7, a planning permit is required to construct or carry out works associated with a dwelling. Additionally, dwellings along Minyip Road and Bacchus Marsh Road should not be set back more than 100 m from the road, to maintain the buffer distance to the Industrial Estate.

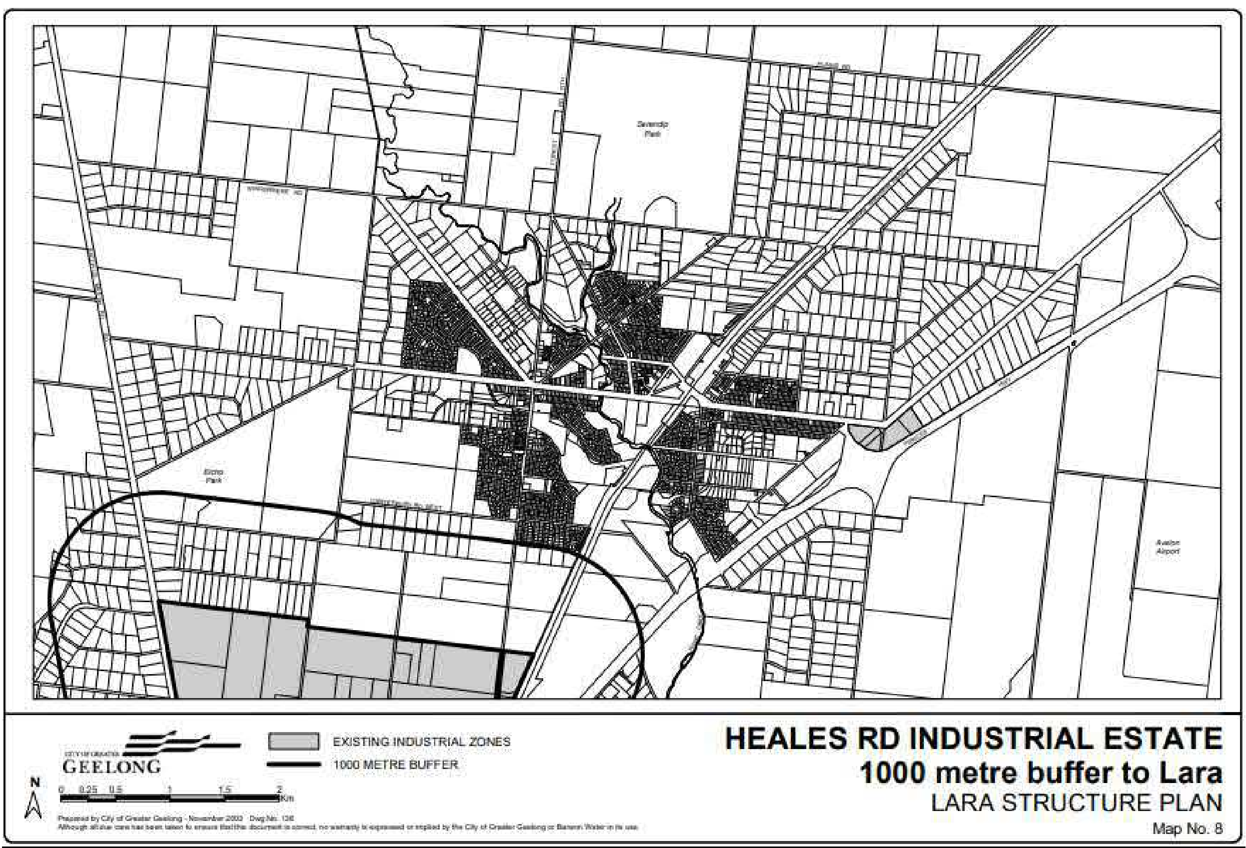


Figure 2.1: Buffer provided between industrial estate and Lara township

3. Existing Environment

3.1 Overview

Air quality impact assessment typically requires a large study area in relation to a source site's boundaries, because air pollutants are transported outside the site boundaries, and air pollutants with sources covering a wide area are transported into the site boundaries. A typical radius of interest around an industrial proposal is approximately 10 kilometres (km). This section describes aspects of the existing environment important for estimating the dispersion of air pollutants from the Plant, including local geography and climatology, and existing air quality.

3.2 Geographical Setting

The Plant is located between the urban areas of Corio and Lara, north of the Geelong urban area, and with Corio Bay lying south to southeast (Figure 3-1).

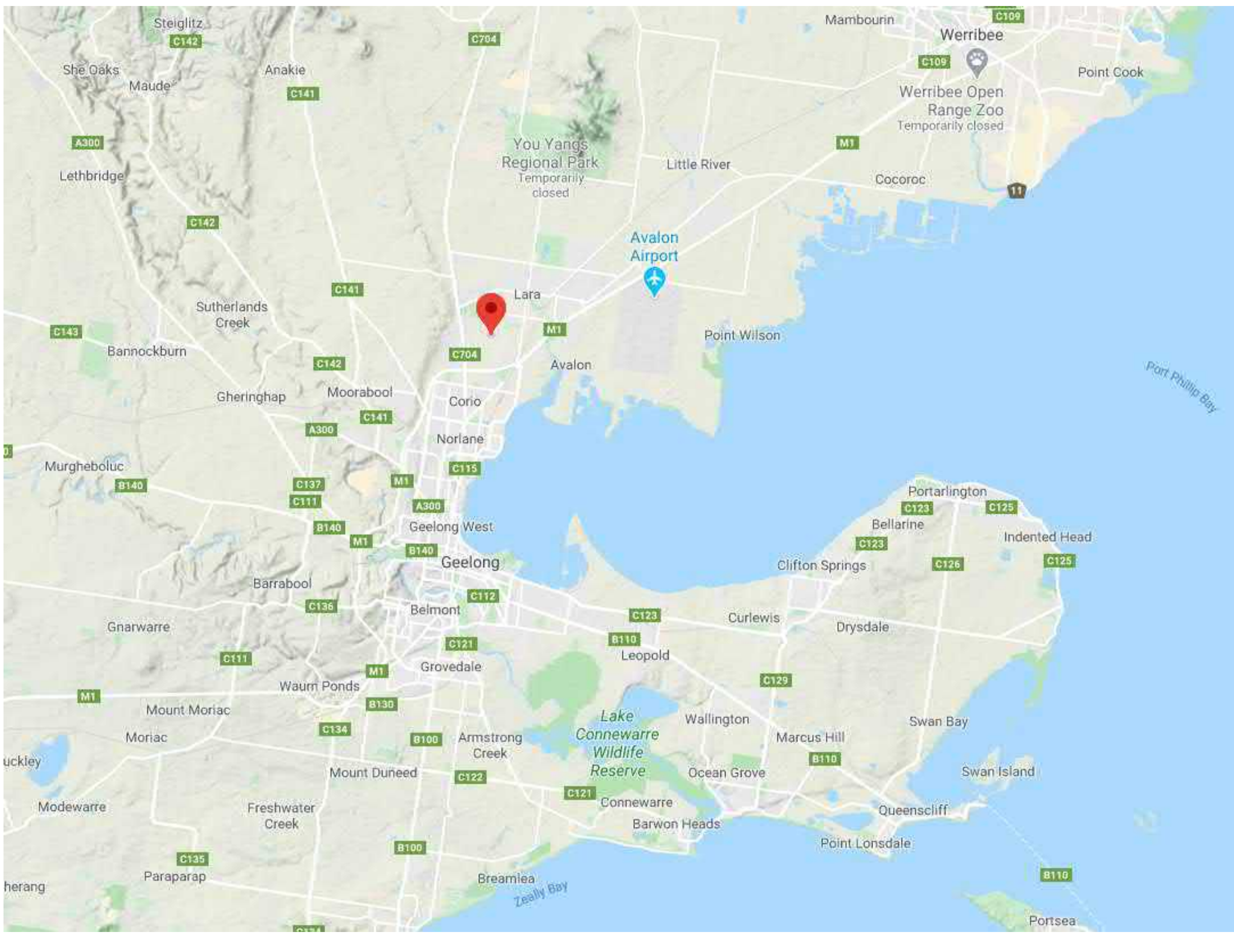


Figure 3-1 Project location; Geelong urban area; and Corio Bay within Port Phillip Bay

The most significant terrain is the You Yangs Regional Park located approximately 10 km north-northeast of the proposed site. The You Yangs rise approximately 300 metres above the surrounding terrain with the highest point Flinders Peak (elevation 347 metres, Victoria Government, 2020). The rising terrain of the You Yangs was too distant from the Project site to be of significance for this air quality assessment.

Sources of air pollution in the Geelong region include road traffic in Geelong and on surrounding roads, industrial sites, shipping, Avalon Airport, and railways. Exposed areas, traffic on unpaved roads, and exposed areas are sources of dust emissions. Sources of smoke particles include controlled burns and bushfires, and domestic wood heaters and open fireplaces; these contribute to the levels of airborne particulate matter levels (see Section 3.5.6 and Section 3.5.7).

The Viva Energy Geelong Refinery, located approximately 4.0 kilometres southeast of the proposed Plant, supplies more than half of Victoria's fuel, and produces aviation fuel, bitumen, and solvents used in mining, paint and adhesives. The refinery provides feedstock for the Lyondell Basell polypropylene plant, located within the refinery boundaries (Viva Energy, 2020).

Other industrial activities described by Geelong Manufacturing Council (GMC) include the shipping of petroleum products into and out of the Port of Geelong, and the manufacture and bulk shipment of fertilisers and timber products (GMC, 2020).

Additionally, there are numerous large scale industrial premises within the Geelong Ring Road Employment Precinct (GREP) Industrial 2 Zone (IN2Z) including:

- Elgas Geelong – Gas storage and supply facility
- Viva Energy Refinery – Fuel refinery and storage facility
- DKSH Group (formerly Axieo) – Specialty chemicals manufacturing facility
- ACCENSI – Agricultural chemical manufacturing facility
- China Scrap Metals Resources – Scrap metal recycling facility
- Wengfu Australia – Agricultural chemical manufacturing facility
- SNF Australia – Chemical manufacturing facility
- Impact Fertilisers – Agricultural chemical manufacturing facility
- Viterra Operations – Proposed grain storage facility

Air pollution monitoring has been undertaken at EPA's monitoring station at Geelong South over many years; some of key results have been summarised in Section 3.5.

3.3 Project Site and Sensitive Receptors

The Plant site is located approximately 5.0 km north of the northernmost urban parts of North Shore, 1.5 km north of the northernmost urban parts of Corio, and 1.4 km south-southwest of the southernmost parts of Lara (Figure 3-2). Nearest sensitive receptors identified as a focus for this assessment are shown in Figure 3-2. A list of the receptor names (for this assessment only), and their Map Grid Australia 1994 (MGA94) co-ordinate locations, are provided in Table 3-1.

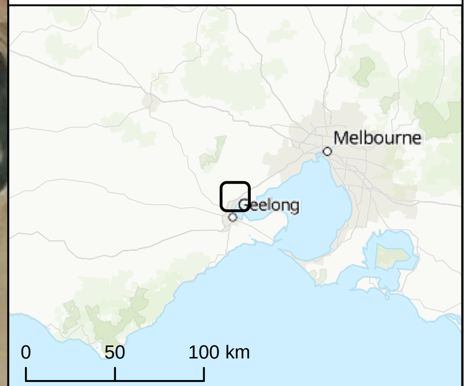
Nearest sensitive receptors (air quality)
Population Centres
Rail Station
Railway
Project site
Major Urban Area

N
A3
1:22,000

IS305100
GDA 1994 MGA Zone 55

0 0.5 1
Kilometres

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) Geodata Topo 250k Series 3; Vicmap Data © State of Victoria; Jacobs.
Earthstar Geographics, Vicmap, Esri, HERE, Garmin, FAO, NOAA, USGS



Jacobs

Path: J:\IE\Projects\03_Southern\IS305100\Spatial\ArcPro\IS305100\IS305100_Environmental.aprx\IS305100-CRTO-000092_Figure_13_1_Nearest_sensitive_receptors_A3_Landscape
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Table 3-1: Discrete receptor co-ordinate locations

Easting (m)	Northing (m)	Map label	Name/description
269400	5786550	Minyip	Nearest sensitive receptor; Minyip Road
268900	5784100	CN	Corio North
271030	5786730	FMP	Flinders Memorial Park
269785	5787300	SR	Stulle Reserve
268800	5787260	EPGC	Elcho Park Golf Course
272300	5785820	MC	Macgregor Court
271110	5784570	RS	Rennie Street
270150	5784330	BP	Beckley Park
268240	5786800	MW	Minyip West
268000	5785850	AD	Apollo Drive
268125	5785000	FR	Frys Road

3.4 Climatology and Local Meteorology

3.4.1 Climatology of Southwest Victoria

Stern (2008) of the Bureau of Meteorology (BoM) classified the climate of Victoria's mountainous regions, the Otways, and the far southwestern coast as 'temperate with no dry season and a mild summer'. Victoria's predominant wind stream is westerly. Hot northerly winds from the Australian interior increase temperatures in the summer, and southerly winds in winter and spring produce cold weather. Easterly, synoptic scale winds are less common, usually associated with high pressure systems over Tasmania and fine weather. Strong coastal winds are a feature of Victoria's climate, occurring most frequently between June and November. Large pressure gradients between high pressure systems over the interior and low pressure systems in the south occasionally produce gale-force and storm-force westerly winds. In winter, these winds can cause blizzards in the alpine regions. The summer months lack the stronger westerlies of winter. Slower moving high pressure systems track along more southerly latitudes (Stern, 2008).

3.4.2 Port Phillip Bay Sea Breezes

Sea breezes on Port Phillip Bay are important during the summer, due to more rapid heating of the land in comparison with over water. There are two main types of sea breeze in Port Phillip Bay: first, initially local heating of the land causes warm air to rise there and 'bay breezes' to be drawn over the shores and inland. Second, Bass Strait produces a stronger, longer-lasting sea breeze from the south, a larger scale phenomenon that takes longer to develop. The overall sea breeze situation becomes complex as the Bass Strait sea breeze interacts with local bay breezes in the early afternoon through to early evening (Batt, 2019).

3.4.3 Dispersion Meteorology in Project Area

Local meteorological conditions are important for determining the direction and dispersion of plumes of air pollutants in a study area. Among other variables used by AERMOD, key meteorological parameters are wind speed, wind direction, temperature, and mixing layer height. For the air quality impact assessment for this Project, at least 90% of five years of hourly meteorological data were required to be tested by modelling; i.e., a minimum of approximately 40,000 hourly records. This meant that almost all possible meteorological conditions, including seasonal and annual variations, were considered in the simulations.

The BoM Avalon Airport weather station was selected as providing the most reliable meteorological dataset representative of Prospect Hill. Meteorological observational data were collected from BoM Avalon Airport monitoring station No. 087113, located 9.2 km east-northeast of the Project site. Hourly wind observations at

BoM Avalon Airport over 2015-2019 are illustrated in Appendix A.1 (annual wind roses), and Appendix A.2 (seasonal wind roses). The wind roses highlight Victoria's dominant westerly winds. However, there is still a high degree of variability in the annual wind patterns, and especially the seasonal wind patterns, demonstrating that wind conditions can be conducive to air quality impacts occurring on any date and at any time of the year.

In Appendix A.1 the Avalon Airport wind roses are shown alongside similar wind roses generated from EPA Geelong South data, showing the EPA's monitoring location within Geelong's urban area is more sheltered, therefore probably not as representative of Prospect Hill as Avalon Airport.

To prepare the suite of meteorological parameters required by the AERMOD model, meteorological observational data from BoM Avalon Airport were first incorporated into the CSIRO's three-dimensional, hourly-varying, prognostic meteorological model, 'TAPM' (Hurley, 2008a; Hurley; 2008b; Hurley et al. 2008). TAPM data were generated specifically for the Prospect Hill Project site while being strongly influenced from the wind observations at Avalon Airport. AERMOD's meteorological data pre-processor, AERMET, then used the TAPM-generated Prospect Hill meteorological data as an input, and also was used to assess land types around Prospect Hill, to generate a meteorological dataset for use with AERMOD. Hourly data availability for each of the Prospect Hill annual datasets was greater than 90% in accordance with EPA (2014). Prospect Hill wind roses were generated using the five years of data used as input to AERMOD; these are shown in Appendix A.3 (annual wind roses), and Appendix A.4 (seasonal wind roses).

Statistical summaries of the wind speeds are illustrated in the following three figures for: EPA Geelong South observations; BoM Avalon Airport observations; and Prospect Hill prognostic simulation. Note the effect of TAPM processing of the Avalon Airport winds was to lower the wind speeds for Prospect Hill slightly, as preferred for Prospect Hill's slightly more sheltered location. Also, the TAPM-AERMET-produced wind speeds for Prospect Hill are slightly higher than the measured wind speeds in the sheltered site of Geelong South; as expected.

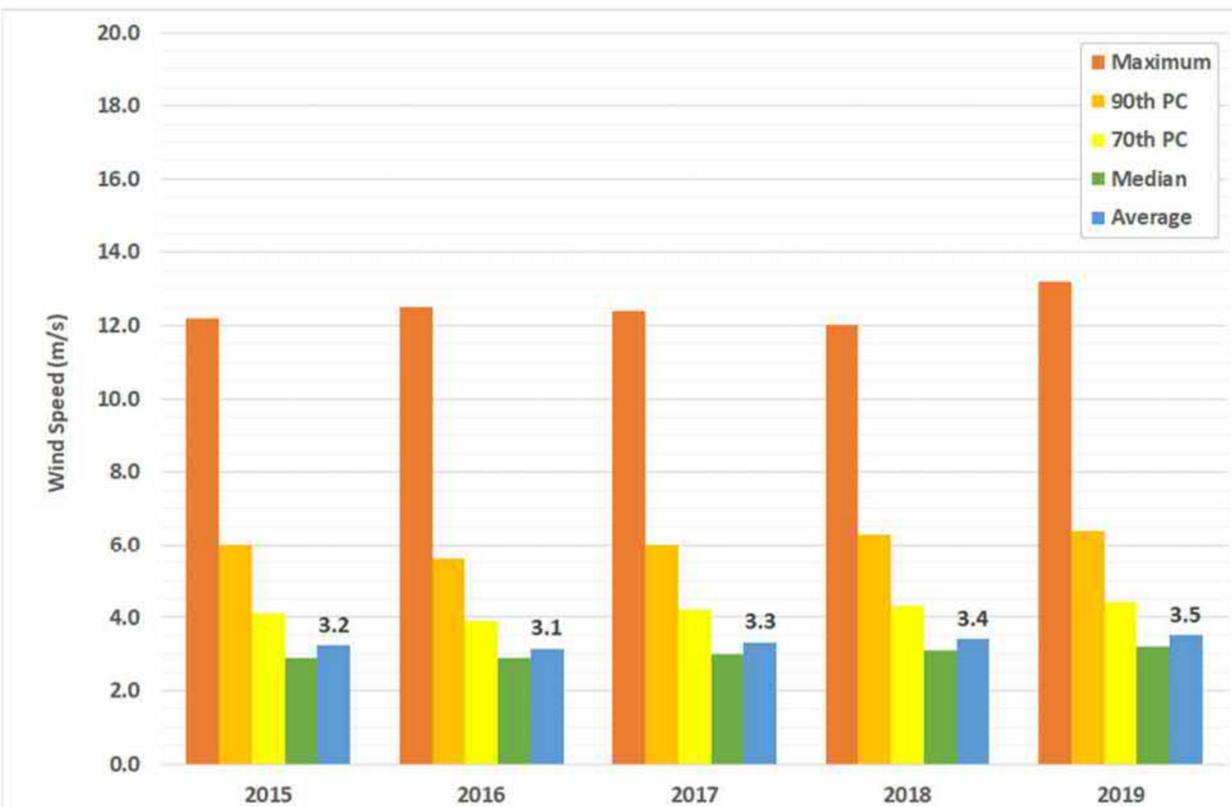


Figure 3-3 Statistical summary of hourly average wind speeds (m/s): EPA Geelong South Obs. Hourly average statistics: maximum, 90th and 70th percentiles, median, and annual average.

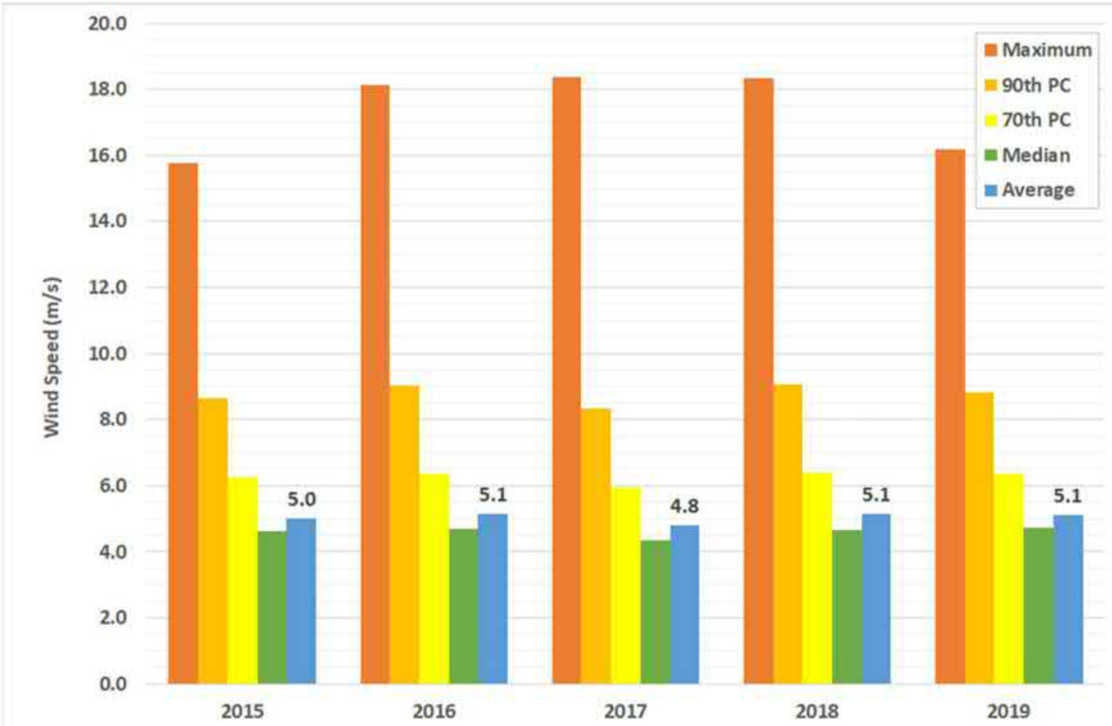


Figure 3-4 Statistical summary of hourly average wind speeds (m/s): BoM Avalon Airport Obs.
Hourly average statistics: maximum, 90th and 70th percentiles, median, and annual average.

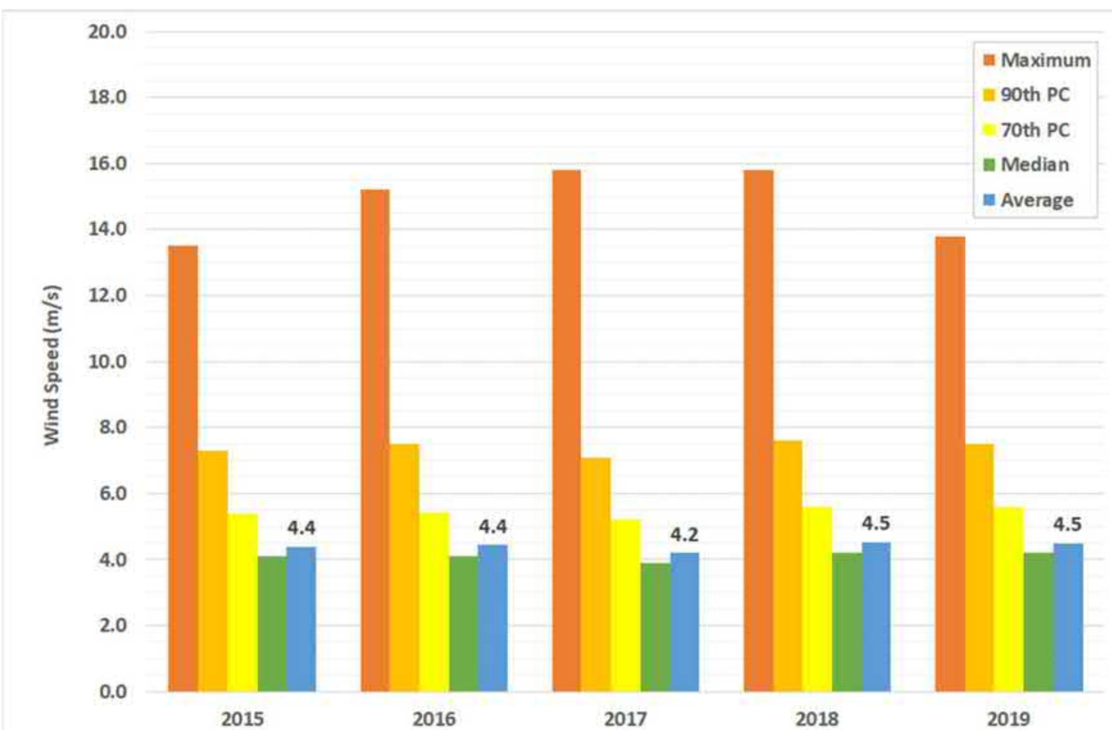


Figure 3-5 Statistical summary of hourly average wind speeds (m/s): Prospect Hill-AERMET
Hourly average statistics: maximum, 90th and 70th percentiles, median, and annual average.

3.5 Existing Air Quality

3.5.1 Overview

Existing air quality in the Prospect Hill study area was determined by a review of the EPA's annual air quality monitoring report for Victoria (EPA, 2019), which included results for the EPA Geelong South air quality monitoring station. EPA (2019) provides annual trends in the concentrations of key air pollutants, increasing our understanding of the concentrations, and whether air quality hazards are increasing or decreasing in their level of risk of impact on the environment, over time.

The EPA has indicated the older results published in EPA (2019) are copied from previous annual reports, but some of the older results have been updated since they were first published. This means there may be some discrepancies between the older results published in EPA (2019) and the results of new analysis of EPA's latest dataset (J. Choi, *direct communication*, 18 May 2020). However, the differences are not expected to have a significant effect on the air quality results, as will be seen from the trends in air pollutant concentrations detailed in this section.

EPA Geelong South air quality monitoring station is considered to be conservatively representative of the Project site. The data would be conservative (higher) due to Geelong South being more heavily influenced by emissions from road traffic and existing local emission sources; i.e., especially carbon monoxide (CO), oxides of nitrogen (NO_x), and Particulate Matter (PM) as PM_{10} and the smaller particle size fraction, $PM_{2.5}$ (see Glossary for definitions). Therefore, the EPA Geelong South measurements are expected to be slight overestimates for air pollutant concentrations at Prospect Hill.

Measured concentrations of PM_{10} and $PM_{2.5}$ tend to be higher relative to their ambient air quality standards, than other air pollutants. Therefore, the EPA Footscray data were investigated as a check on the results for PM_{10} and $PM_{2.5}$ at Geelong South. The Footscray monitoring station, which is located in Hansen Reserve, is expected to have results approximately equal to those of Geelong South. A summary of the main features of the EPA Geelong South and EPA Footscray air monitoring stations is provided in Table 3-2 (EPA, 2012).

Table 3-2: Features of EPA Geelong South and EPA Footscray air quality monitoring stations

Aspect / feature	EPA Geelong South	EPA Footscray
Address	Breakwater Rd., Breakwater.	Hansen Reserve, Roberts St., Footscray
EPA location category	Residential / Industrial	Industrial / Residential
Sampling heights Above Ground Level (AGL)	Air samplers, 4.7 m AGL Met. (assumed wind) sensors, 15 m AGL	Air samplers, 4.5 m AGL Met. (assumed wind) sensors, 15 m AGL
Site details / Description of surrounding area	In Geelong Racecourse car park, approximately 25 m from railway line and 80 m off the road, on west side of Breakwater Road area used as motorcycle training track.	On mound between two sports areas. Factories at some distance to east and north. Major arterial road 1 km to south.

3.5.2 Summary of EPA Air Quality Monitoring 2014-2019

EPA (2019) assessed Victoria's air quality for 2018 and studied trends based on comparisons of monitoring results with the AAQ NEPM standards. The SEPP AAQ (Victorian) objectives are very similar to the NEPM (National) standards. The purpose of the following sub-sections is to describe existing air quality in the Geelong region using the available, local measurements, and to assess by comparisons with the Victorian air quality objectives.

Annual air pollutant statistics as reported by EPA (2019) are listed and discussed in the following sub-sections. EPA monitoring results for 2019, which were not reported in EPA (2019), were calculated for this assessment from monitoring data provided by the EPA.

3.5.3 Carbon Monoxide

Annual statistical summaries of results for rolling 8-hour average carbon monoxide (CO) concentrations measured at the EPA Geelong South monitoring station over 2014 to 2019 are listed in Table 3-3, and illustrated in Figure 3-6 (EPA, 2019). All the results are substantially lower than the SEPP (AAQ) objective of 9.0 ppm, with the majority of concentrations less than 10% of the objective. As these results are reported in units of ppm, (not ppb), in general only very large, localised emissions of CO have the potential to cause air quality impact. There is a very low risk of air quality impact due to existing CO emissions.

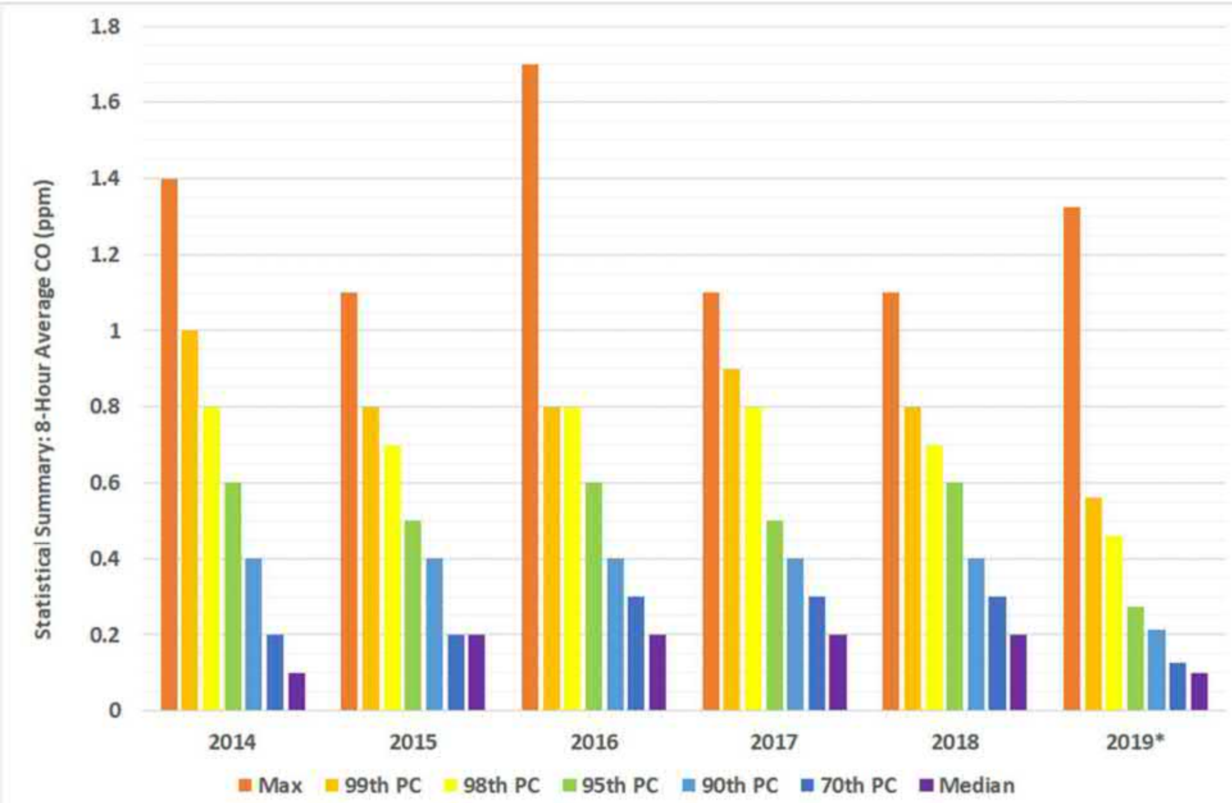


Figure 3-6 Statistical summary of results: 8-hour average CO-EPA Geelong South

*Results for 2014-2018 are from EPA (2019); results for 2019 calculated using EPA hourly data.

Table 3-3: Statistical summary of results: 8-hour average CO–EPA Geelong South

Year	Data avail.	No. exc. (days)	Max. (ppm)	99th PC (ppm)	98th PC (ppm)	95th PC (ppm)	90th PC (ppm)	70th PC (ppm)	50th PC (ppm)
2014	100.0%	0	1.4	1	0.8	0.6	0.4	0.2	0.1
2015	98.4%	0	1.1	0.8	0.7	0.5	0.4	0.2	0.2
2016	92.3%	0	1.7	0.8	0.8	0.6	0.4	0.3	0.2
2017	93.4%	0	1.1	0.9	0.8	0.5	0.4	0.3	0.2
2018	87.7%	0	1.1	0.8	0.7	0.6	0.4	0.3	0.2
2019	91.5%	0	1.3	0.6	0.5	0.3	0.2	0.1	0.1

SEPP(AAQ) 1999: Max. 8-hour average CO, 9.0 ppm; max. exceedances one day per year (equivalent to NEPM).

Key to abbreviations: avail. – availability (or data capture); exc. – exceedance; Max. – maximum; PC – Percentile; ppm – parts per million

3.5.4 Oxides of Nitrogen, Nitrogen Dioxide and Ozone

Oxides of nitrogen (NO_x) emissions are produced by burning fuels; examples of sources are road vehicle traffic in cities and larger towns, bushfires and planned burns, and industry. In emissions from combustion sources, NO_x comprises mostly nitric oxide (NO), and smaller amounts of nitrogen dioxide (NO_2). In the atmosphere, NO may be oxidised to NO_2 by a reaction with ambient ozone (O_3); e.g., Seinfeld and Pandis (2016). There is always some ambient O_3 available for this reaction, which varies strongly on an hourly and daily basis between approximately 20 ppb and 50 ppb in the summer, and exists at steadier concentrations of around 25 ppb by mid-winter. Monitoring results for NO_2, such as those listed in Table 3-4 for the EPA Geelong South monitoring station, and illustrated in Figure 3-7, are strongly dependent on the presence of ambient O_3 and other pollutants.

The statistical summary of results for NO_2 provided in Table 3-4 shows that in general NO_2 concentrations are low, with the SEPP (AAQ) objective for NO_2 (120 ppb), not exceeded over 2014-2019. Maximum hourly averages over the whole period were less than 50% of the monitoring objective.

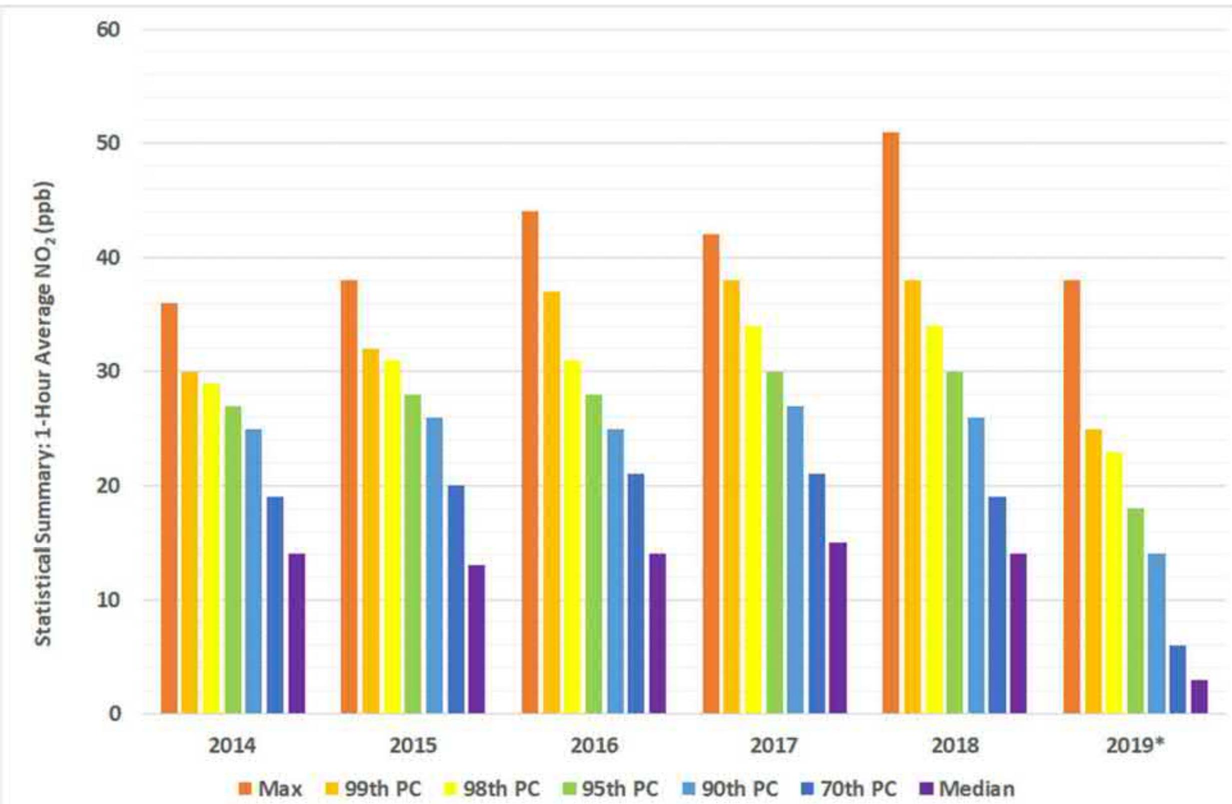


Figure 3-7 Statistical summary of results: 1-hour average NO_2-EPA Geelong South

*Results for 2014-2018 are from EPA (2019); results for 2019 calculated using EPA hourly data.

Table 3-4: Statistical summary of results: 1-hour average NO_2–EPA Geelong South

Year	Data avail. (%)	No. exc. (days)	Max. (ppb)	99th PC (ppb)	98th PC (ppb)	95th PC (ppb)	90th PC (ppb)	70th PC (ppb)	50th PC (ppb)
2014	99.5	0	36	30	29	27	25	19	14
2015	91.0	0	38	32	31	28	26	20	13
2016	90.3	0	44	37	31	28	25	21	14
2017	94.8	0	42	38	34	30	27	21	15

Year	Data avail. (%)	No. exc. (days)	Max. (ppb)	99th PC (ppb)	98th PC (ppb)	95th PC (ppb)	90th PC (ppb)	70th PC (ppb)	50th PC (ppb)
2018	88.3	0	51	38	34	30	26	19	14
2019	92.8	0	38	25	23	18	14	6	3
SEPP(AAQ) 1999: Max. 1-hour average NO_2, 120 ppb; max. exceedances one day per year (equivalent to NEPM).									
Key to abbreviations: avail. – availability (or data capture); exc. – exceedance; Max. – maximum; PC – Percentile; ppb – parts per billion									

Statistical summaries of hourly average O_3 concentrations measured at the EPA Geelong South monitoring station are provided in Table 3-5 and Figure 3-8 (hourly averages), and Table 3-6 and Figure 3-9 (4-hour averages). These results show there is a higher risk of exceedances of the O_3 objectives than exceedances of NO_2 objectives. The importance of these O_3 results is in the management of NO_x. The O_3 results show it is important to cap emissions of NO_x as far as practicable, even though NO_2 objectives are unlikely to be exceeded.

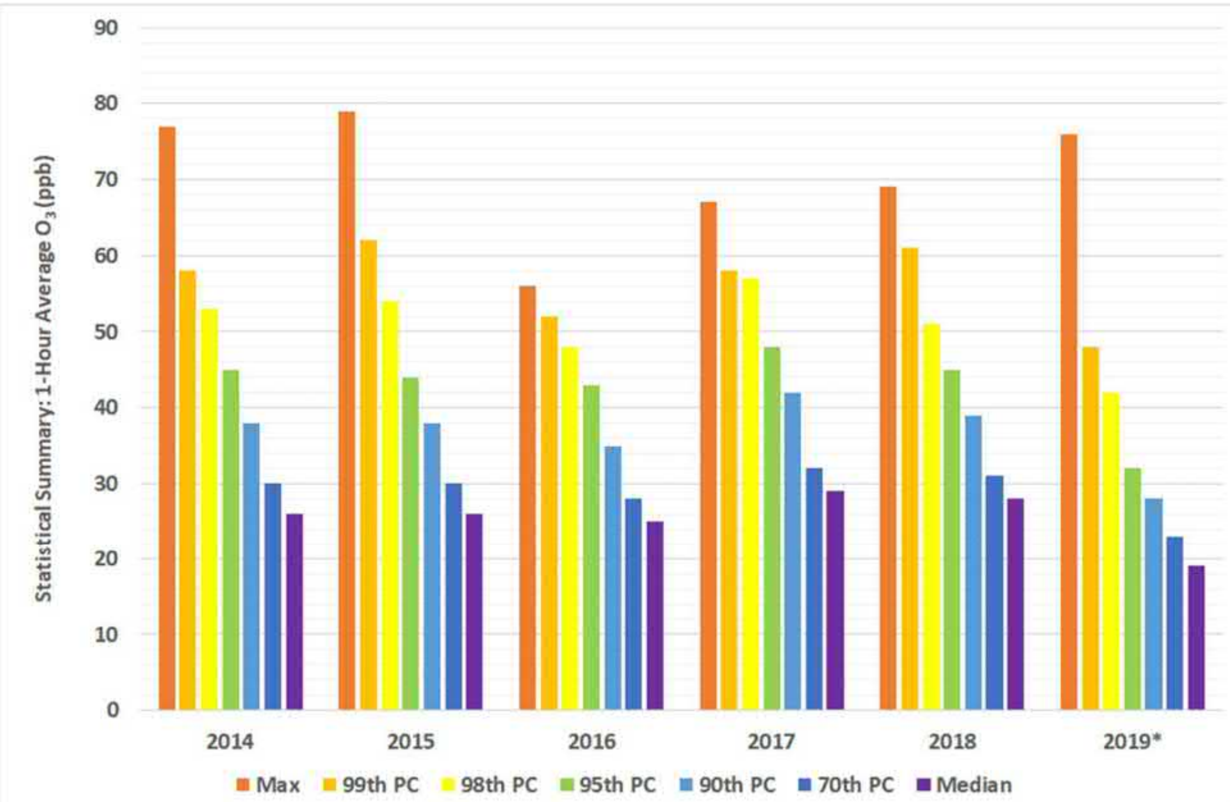


Figure 3-8 Statistical summary of results: 1-hour average O_3-EPA Geelong South

*Results for 2014-2018 are from EPA (2019); results for 2019 calculated using EPA hourly data.

Table 3-5: Statistical summary of results: 1-hour average O_3–EPA Geelong South

Year	Data avail. (%)	No. exc. (days)	Max. (ppb)	99th PC (ppb)	98th PC (ppb)	95th PC (ppb)	90th PC (ppb)	70th PC (ppb)	50th PC (ppb)
2014	98.1	0	77	58	53	45	38	30	26
2015	99.7	0	79	62	54	44	38	30	26
2016	98.1	0	56	52	48	43	35	28	25

Year	Data avail. (%)	No. exc. (days)	Max. (ppb)	99th PC (ppb)	98th PC (ppb)	95th PC (ppb)	90th PC (ppb)	70th PC (ppb)	50th PC (ppb)
2017	97.5	0	67	58	57	48	42	32	29
2018	87.1	0	69	61	51	45	39	31	28
2019	93.2	0	76	48	42	32	28	23	19
SEPP(AAQ) 1999: Max. 1-hour average O_3, 100 ppb; max. exceedances one day per year (equivalent to NEPM)									
Key to abbreviations: avail. – availability (or capture); exc. – exceedance; Max. – maximum; PC – Percentile; ppb – parts per billion									

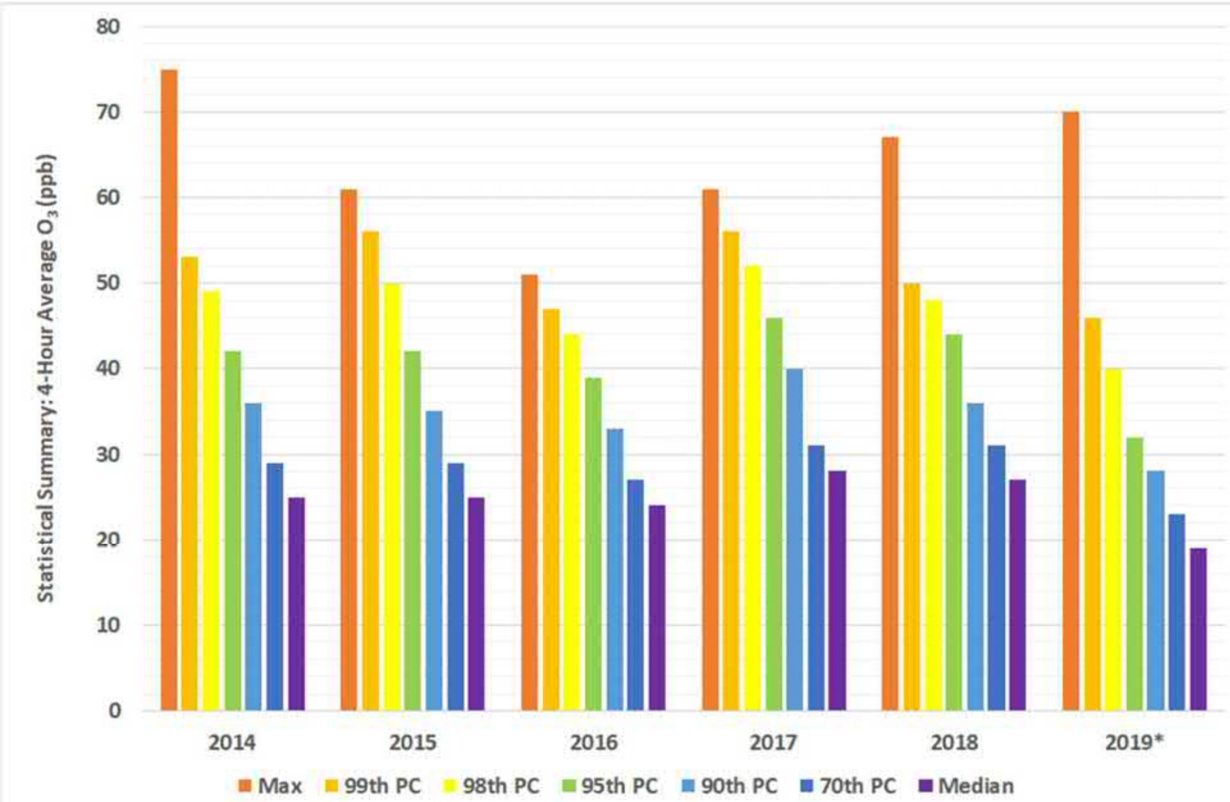


Figure 3-9 Statistical summary of results: 4-hour average O_3-EPA Geelong South

Table 3-6: Statistical summary of results: 4-Hour average O_3–EPA Geelong South

Year	Data avail. (%)	No. exc. (days)	Max. (ppb)	99th PC (ppb)	98th PC (ppb)	95th PC (ppb)	90th PC (ppb)	70th PC (ppb)	50th PC (ppb)
2014	98.4	0	75	53	49	42	36	29	25
2015	99.7	0	61	56	50	42	35	29	25
2016	98.1	0	51	47	44	39	33	27	24
2017	97.3	0	61	56	52	46	40	31	28
2018	86.6	0	67	50	48	44	36	31	27
2019	97.0	0	70	46	40	32	28	23	19
SEPP(AAQ) 1999: Max. 4-hour average O_3, 80 ppb; max. exceedances one day per year (equivalent to NEPM)									
Key to abbreviations: avail. – availability (or capture); exc. – exceedance; Max. – maximum; PC – Percentile; ppb – parts per billion									

3.5.5 Sulfur Dioxide

A statistical summary of results for hourly average SO2 concentrations measured at EPA Geelong South over 2014-2019 is provided in Figure 3-10 Statistical summary of results: 1-hour average SO2-EPA Geelong South

*Results for 2014-2018 are from EPA (2019); results for 2019 calculated using EPA hourly data.

Table 3-7 (including some corrections for 2017 provided by the EPA). The worst-case hour over the 6-year monitoring period is 24% of the objective (200 ppb), demonstrating that SO_2 has a low risk of air quality impact in the Geelong region.

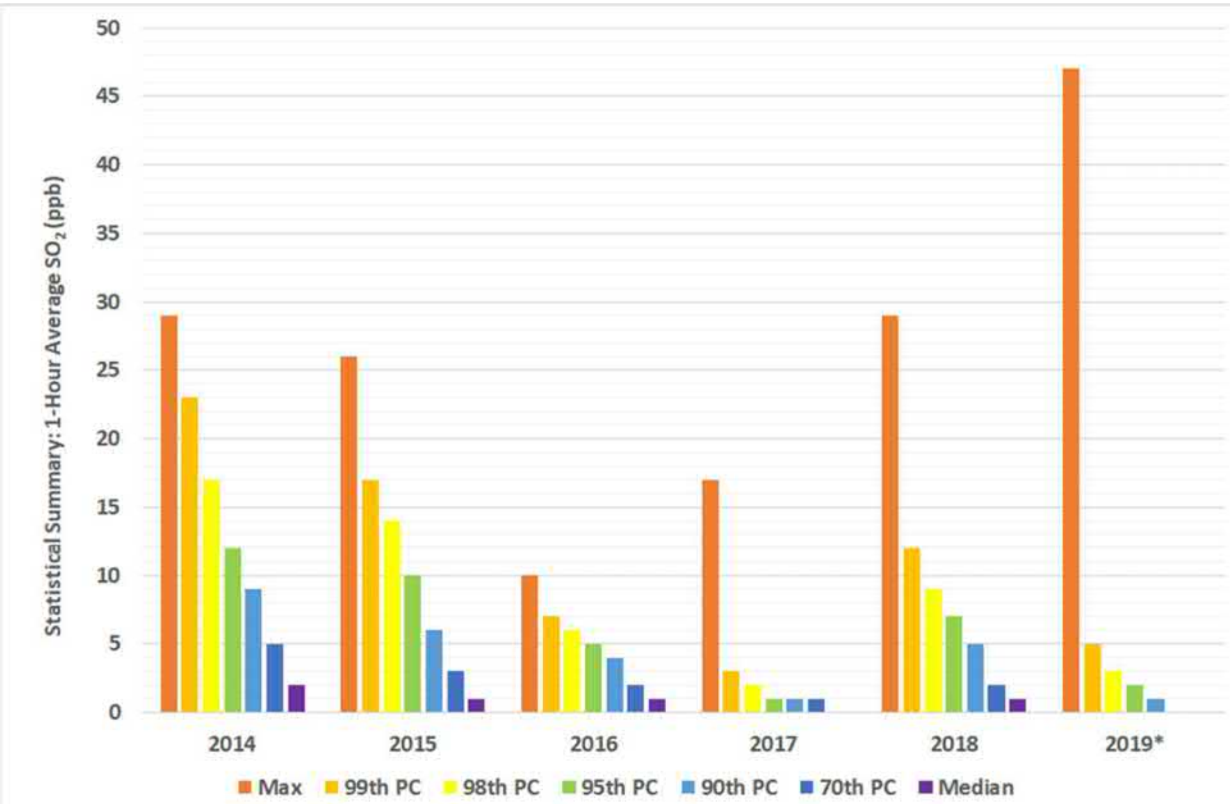


Figure 3-10 Statistical summary of results: 1-hour average SO_2-EPA Geelong South

*Results for 2014-2018 are from EPA (2019); results for 2019 calculated using EPA hourly data.

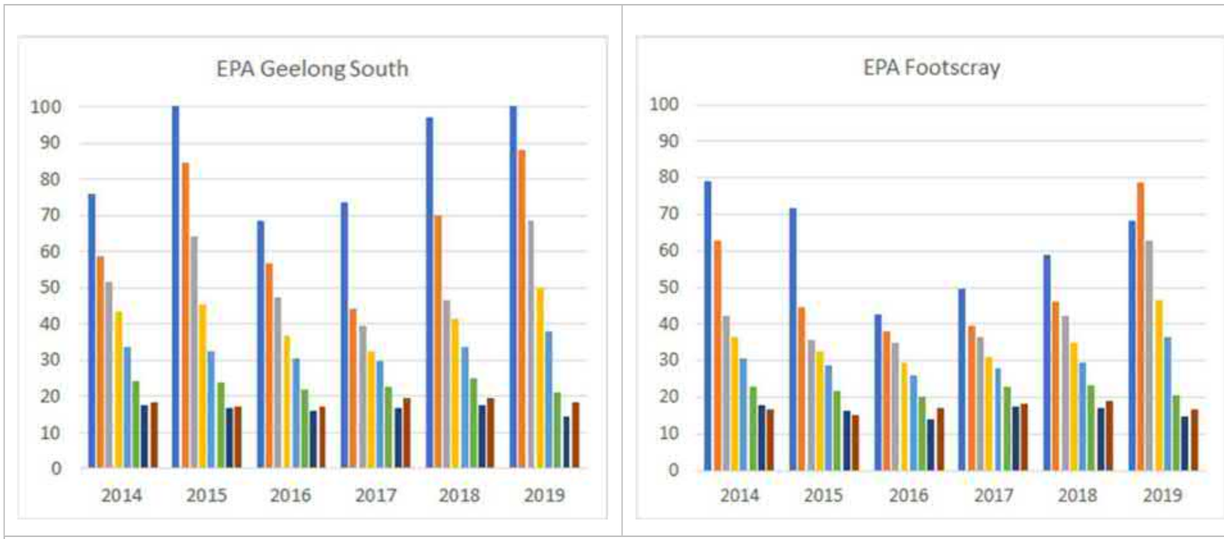
Table 3-7: Statistical summary of results: 1-hour average SO_2–EPA Geelong South

Year	Data avail. (%)	No. exc. (days)	Max. (ppb)	99th PC (ppb)	98th PC (ppb)	95th PC (ppb)	90th PC (ppb)	70th PC (ppb)	50th PC (ppb)
2014	87.4	0	29	23	17	12	9	5	2
2015	98.6	0	26	17	14	10	6	3	1
2016	97.3	0	10	7	6	5	4	2	1
2017	94.8	0	17	3	2	1	1	1	0
2018	95.3	0	29	12	9	7	5	2	1
2019	91.2	0	47	5	3	1	1	0	0

3.5.6 Particulate Matter as PM_{10}

Measurements of small airborne particles or airborne Particulate Matter (PM) in the size range 0-10 microns (μm), tend to be higher than for most other pollutants, in relation to ambient air quality standards and objectives. This is the case for many monitoring stations around Australia, including for EPA Geelong South. The reasons for the higher concentrations are varied, but for PM_{10} include, for example; wind-blown dust from distant, drought-affected regional areas far away from most monitoring stations, and, more locally in the case of Geelong South, salt particles from sea spray, pollen fragments and combustion activities such as motor vehicles and industrial processes. Also, the EPA Geelong South results for PM_{10} may have been affected by a nearby racecourse and motorcycle track (EPA, 2019).

Given that high PM_{10} concentrations are relatively common due to a variety of sources, data from two monitoring stations were studied for this Project. Statistical summaries of results for measured 24-hour average PM_{10} over 2014-2019 are shown in Figure 3-11 and listed in Table 3-8 (EPA Geelong South) and Table 3-9 (EPA Footscray). Over this 6-year period, there were between 3-11 exceedance days per year at Geelong South, and up to 7 exceedance days at EPA Footscray. However, none of the annual averages exceeded the SEPP (AAQ) objective for annual average PM_{10} (20 μg/m^3).



Units μg/m^3; 24h avg. statistics: max., 99th, 98th, 95th, 90th, 70th, 50th percentiles, and averages

Figure 3-11 Statistical summary of results: 24-hour average PM_{10}-EPA Geelong South and EPA Footscray

Table 3-8: Statistical summary of results: 24-hour and annual average PM_{10}–EPA Geelong South

Year	Data avail.	No. exc. (days)	Max. (μg/m^3)	99th PC (μg/m^3)	98th PC (μg/m^3)	95th PC (μg/m^3)	90th PC (μg/m^3)	70th PC (μg/m^3)	50th PC (μg/m^3)	Avg.
2014	99.5	8	75.8	58.8	51.7	43.3	33.8	24.3	17.7	18.4
2015	79.7	10	286.1	84.4	64.1	45.5	32.4	23.8	16.6	17.1
2016	93.7	5	68.3	56.9	47.3	36.8	30.4	21.9	15.9	17.3
2017	79.7	3	73.7	44.3	39.6	32.4	29.6	22.8	16.6	19.5
2018	94.0	6	97.1	70.1	46.7	41.4	33.8	25	17.5	19.6
2019	88.8	11	102	87.9	68.6	50.1	37.9	21.1	14.5	18.4

SEPP (AAQ) 2016: Max. 24-hour average PM_{10}, 50 μg/m^3 (equivalent to NEPM).

SEPP (AAQ) 2016: Annual average PM_{10}, 20 μg/m^3 (equivalent to NEPM).

Key to abbreviations: avail. – availability (or capture); exc. – exceedance; Max. – maximum; PC – Percentile.

Table 3-9: Statistical summary of results: 24-hour and annual average PM_{10}–EPA Footscray

Year	Data avail.	No. exc. (days)	Max. (µg/m³)	99th PC (µg/m³)	98th PC (µg/m³)	95th PC (µg/m³)	90th PC (µg/m³)	70th PC (µg/m³)	50th PC (µg/m³)	Avg.
2014	98.6	6	79.2	63.0	42.2	36.5	30.6	23.0	18.0	16.8
2015	97.0	3	71.8	44.7	35.7	32.5	28.8	21.9	16.4	15.1
2016	94.2	0	42.7	37.9	35.1	29.3	25.9	20.2	14.1	17.1
2017	91.2	0	49.8	39.5	36.6	31.0	28.1	23.0	17.4	18.4
2018	95.6	1	58.8	46.2	42.3	35.0	29.5	23.4	17.2	19.0
2019	79.5	7	68.2	78.7	62.9	46.6	36.5	20.6	14.6	16.8

SEPP(AAQ) 2016: Max. 24-hour average PM_{10}, 50 µg/m³ (equivalent to NEPM).

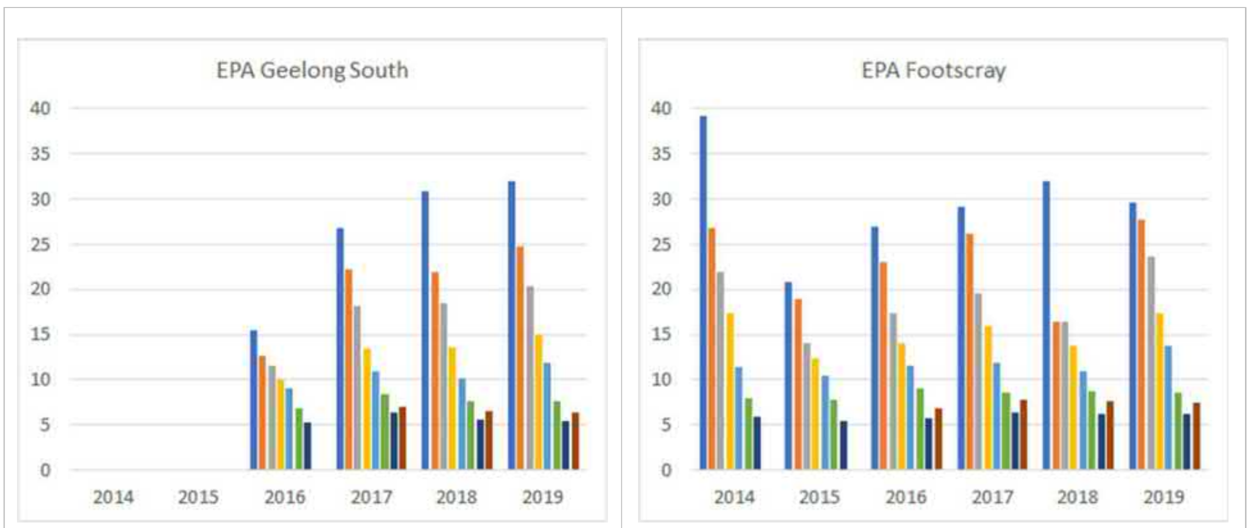
SEPP (AAQ) 2016: Annual average PM_{10}, 20 µg/m³ (equivalent to NEPM).

Key to abbreviations: avail. – availability (or capture); exc. – exceedance; Max. – maximum; PC – Percentile.

3.5.7 Particulate Matter as $PM_{2.5}$

Measurements of smaller particles as $PM_{2.5}$ (size range 0-2.5 µm; see Glossary for definition), also tend to be high relative to $PM_{2.5}$ monitoring standards and objectives. This is the case for many monitoring stations around Australia, including for EPA Geelong South and EPA Footscray. The reasons for the higher concentrations are varied, but for $PM_{2.5}$ include, for example; small smoke particles from the combustion of fossil fuels, extensive use of domestic wood heaters, and, occasionally, from controlled burns and bushfires that can be distant from the monitoring stations. Motor vehicles and power plant emissions are also a major source of $PM_{2.5}$ (EPA, 2019).

Given that high $PM_{2.5}$ concentrations are relatively common also (as well as for PM_{10}), data from two monitoring stations were studied for this Project. Statistical summaries of results for measured 24-hour average $PM_{2.5}$ over 2016-2019 are shown in Figure 3-12, and listed in Table 3-10 (EPA Geelong South, when data were available) and over 2014-2019 are provided in Table 3-11 (EPA Footscray).



Units µg/m³; 24h avg. statistics: max., 99th, 98th, 95th, 90th, 70th, 50th percentiles, and averages

Figure 3-12 Statistical summary of results: 24-hour average $PM_{2.5}$-EPA Geelong South and EPA Footscray

Table 3-10: Statistical summary of results: 24-hour and annual average $PM_{2.5}$–EPA Geelong South

Year	Data avail.	No. exc. (days)	Max. (µg/m^3)	99th PC (µg/m^3)	98th PC (µg/m^3)	95th PC (µg/m^3)	90th PC (µg/m^3)	70th PC (µg/m^3)	50th PC (µg/m^3)	Avg.
2016	51.4	0	15.5	12.6	11.6	10	9	6.8	5.3	-
2017	82.7	2	26.8	22.3	18.2	13.5	10.9	8.5	6.4	7.0
2018	86.8	1	30.8	21.9	18.4	13.6	10.2	7.7	5.6	6.5
2019	100.0	1	32.7	18.6	17.0	13.6	10.5	7.1	5.6	6.4

$PM_{2.5}$ measurements started at Geelong South in August 2016.

SEPP(AAQ) 2016: Max. 24-hour average $PM_{2.5}$, 25 µg /m^3 (equivalent to NEPM).

SEPP(AAQ) 2016: Annual average $PM_{2.5}$, 8 µg /m^3 (equivalent to NEPM).

Key to abbreviations: avail. – availability (or capture); exc. – exceedance; Max. – maximum; PC – Percentile.

Table 3-11: Statistical summary of results: 24-hour and annual average $PM_{2.5}$–EPA Footscray

Year	Data avail.	No. exc. (days)	Max. (µg/m^3)	99th PC (µg/m^3)	98th PC (µg/m^3)	95th PC (µg/m^3)	90th PC (µg/m^3)	70th PC (µg/m^3)	50th PC (µg/m^3)	Avg.
2014	100.0	2	39.1	26.8	21.9	17.4	11.4	7.9	5.9	-
2015	100.0	0	20.8	19.0	14.0	12.3	10.5	7.8	5.5	-
2016	94.3	2	27.0	23.0	17.4	14.0	11.6	9.0	5.8	6.9
2017	100.0	2	29.2	26.2	19.5	16.0	11.8	8.6	6.4	7.8
2018	92.6	1	32.0	16.5	16.4	13.8	11.0	8.7	6.2	7.6
2019	98.4	4	29.6	27.7	23.6	17.3	13.7	8.6	6.3	7.5

SEPP(AAQ) 1999: Max. 24-hour average $PM_{2.5}$, 25 µg /m^3 (equivalent to NEPM).

SEPP(AAQ) 2016: Annual average $PM_{2.5}$, 8 µg /m^3 (equivalent to NEPM).

Key to abbreviations: avail. – availability (or capture); exc. – exceedance; Max. – maximum; PC – Percentile.

Over the $PM_{2.5}$ monitoring periods, there were up to 2 exceedance days per year at Geelong South, and up to 4 exceedance days at EPA Footscray. However, none of the annual averages exceeded the SEPP (AAQ) objective for annual average PM_{10} (8 µg/m^3). It is noted the SEPP (AAQ) annual average $PM_{2.5}$ objective will be lowered to 7 µg/m^3 in 2025, which will result in a higher likelihood of exceedances in future if the current ambient air quality trends for $PM_{2.5}$ continue.

3.5.8 Hydrogen Fluoride

Measurements of atmospheric hydrogen fluoride (HF) are rare. A Western Australian study of emissions from brickworks found that background 10-minute average and hourly average HF concentrations were below the limit of detection for the equipment used; 11 µg/m^3 (GWA, 2015).

Measured over 24-hour periods, the background HF concentration in the Port Phillip Air Quality Control Region is expected to be approximately 0.1 µg/m^3. Higher concentrations of approximately 1 µg/m^3 may exist on rare occasions; e.g., see U.S. DHHS (2003). Any HF that could be detected in the Geelong region would be due to industrial sources (NICNAS, 2001).

The Safe Work Australia (2020), Time-Weighted Average (TWA; an 8-hour average), is 2.6 mg/m^3, so HF is approximately three times more harmful to human health than hydrogen chloride (TWA 7.5 mg/m^3). However the SEPP (AQM) design criteria for HF are much lower, (see Section 2.6.3), with maxima set for reasons of bioaccumulation: 2.9 µg/m^3 (24 hours), 7 days (1.7 µg/m^3), and 90 days (0.5 µg/m^3).

3.5.9 Ammonia

Ammonia (NH_3) is ranked third by quantity among the nitrogen-containing compounds in the atmosphere, after nitrogen and nitrous oxide. Over land, the main sources are animal waste, emissions from soils, and industrial emissions. Background NH_3 concentrations in continental air (land sources) range from 0.1–10 ppb (Seinfeld and Pandis, 2016).

Cattle feed lots are a significant source of higher NH_3 concentrations within a radius of approximately 7 km from the feed lots (none are known near the Project); recent examples of Australian studies are: Shen et al. (2016) and Hacker et al. (2016). Low-level airborne measurements of NH_3 in Victoria by Hacker et al. (2016) showed background NH_3 levels ranging from approximately 1 ppb near sunrise and sunset to approximately 2 ppb near midday.

3.5.10 Hydrogen Chloride

Measurements of atmospheric hydrogen chloride (HCl) are rare. A Western Australian study of emissions from brickworks found that background 10-minute average and hourly average HCl concentrations were below the limit of detection, 26 $\mu g/m^3$ (GWA, 2015). In the absence of any known HCl sources in the study area, background HCl was assumed to be zero for this assessment.

3.5.11 Hydrocarbons (Organic Compounds)

Road vehicle traffic and combustion processes create many hydrocarbons that are emitted to atmosphere. Of the many substances emitted, the highest risk substances are well known, and monitoring tends to focus on these; especially benzene and formaldehyde. Concentrations are low however, with measurements by EPA indicating typical background levels in the Port Phillip Air Quality Region are:

- Benzene, annual average typically 0.5 ppb, substantially less than the monitoring investigation level of 3 ppb; see EPA, *Benzene levels in Victorian air 2003–07*, https://ref.epa.vic.gov.au/our-work/monitoring-the-environment/monitoring-victorias-air/monitoring-results/benzene-levels-in-victorian-air-2003-07.html, web page accessed 15 July 2020.
- Formaldehyde, 24-hour averages typically 2-3 ppb, substantially less than the monitoring investigation level of 40 ppb; see EPA, *Formaldehyde levels in Victorian air 2005–07*, https://ref.epa.vic.gov.au/our-work/monitoring-the-environment/monitoring-victorias-air/monitoring-results/formaldehyde-levels-in-victorian-air-2005-07.html, web page accessed 15 July 2020.

Often benzene is measured as part of the 'BTEX' suite; i.e., benzene, toluene, ethylbenzene, and toluene, but generally benzene remains as the substance of interest due to its higher toxicity.

3.5.12 Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are by-products of combustion and industry processes. In Victoria, very small quantities of these toxic substances are measured as Benzo(a)Pyrene (B(a)P). Measurements by EPA indicate typical background levels in the Port Phillip Air Quality Region are:

- PAHs as B(a)P, annual average typically 0.1-0.2 nanogram (ng)/m^3, less than the monitoring investigation level of 0.3 ng/m^3; see EPA, *Benzo(a)pyrene levels in Victorian air 2003–08*, https://ref.epa.vic.gov.au/our-work/monitoring-the-environment/monitoring-victorias-air/monitoring-results/benzo-a-pyrene-levels-in-victorian-air-2003-08.html, web page accessed 15 July 2020.

3.5.13 Dioxins and Furans

There are no, known, significant sources of dioxins and furans in the study area. Background levels are expected to be very low.

3.5.14 Metals as components of Particulate Matter

There are no, known, significant sources of airborne metals in the study area; i.e., as components of airborne particulate matter. Concentrations are expected to be very low.

4. Project Description and Air Emissions

4.1 Overview

The Prospect Hill EfW Plant will use moving grate boiler technology to recover energy by combusting approximately 400,000 tpa of MSW and MSW-like C&I waste; i.e., approximately 80% MSW (~320,000 tpa) and 20% C&I (~80,000 tpa). The Plant will utilise a proven combustion grate technology with energy recovery in a steam boiler and turbine, and flue gas emission controls in accordance with European Commission (EC) recommendations for Best Available Techniques (BAT) (EC, 2019b).

The Plant will provide electricity at a maximum rate of approximately 36 MWe (Section 1.2).

The Project may include a 'black start' diesel generator and will include an emergency shutdown generator. This emergency power generation equipment would be used rarely, as such was excluded from assessment (Section 1.4).

A detailed description of the technology, concept design and project implementation processes for the Plant is provided in Jacobs (2020). The remainder of this section sets out information about the Plant relevant to the air quality impact assessment.

4.2 Waste Sources, Composition and Throughput

The Project intends to only use MSW and MSW-like C&I waste as feedstock. The Project has developed Waste Acceptance Criteria for the Plant; examples of waste types that would be rejected include:

- Bulky waste.
- Large electrical equipment e.g. whitegoods.
- Polychlorinated compounds such as PCBs.
- Asbestos and other insulation materials.
- Herbicides, insecticides, and fungicides.
- Paints, solvents and their residues.
- Gas cylinders.
- Vehicle batteries.
- Plasterboard (gypsum).
- Clinical/medical waste.
- E-Waste.

Waste source-separation and householder habits have the potential to change the quantity and composition of the MSW received. The moving grate technology is flexible and will be applicable under a wide range of MSW and C&I waste composition leading to variations in waste energy (calorific) value.

The Plant design will allow safe operation with varying waste compositions within a specified net calorific value firing envelope. The proposed EfW plant should operate satisfactorily within the bounds of a defined envelope indicating safe operational range without auxiliary burner firing, or thermal or mechanical overload of the treatment process.

Further analysis of waste composition is anticipated, which may change assumptions for the Project including waste net calorific value.

The design capacity of the plant is 400,000 tpa of waste assuming waste supply is not a constraint. Based on an estimated plant availability of 90%, the plant will operate for approximately 7,884 hours per annum.

4.3 Plant Layout and Truck Movements

Jacobs was engaged by PHI to undertake a concept design for the Prospect Hill EfW Project. This concept design consisted of developing a plant layout, and determination of some key input and performance parameters, identifying technologies and equipment types, to be used at the Plant. The conceptual layout illustrates site location, plant orientation, road access and existing site interfaces. It is expected this layout will be updated by bidding EPC contractors at the tender and detailed design stages of the project; see Appendix B.

The Plant is laid out with consideration given to simple waste logistics and principal process flows. Waste deliveries to the tipping hall tip directly into the adjacent bunker where waste is mixed by grab cranes. The cranes feed waste into the boiler where waste is incinerated in turn generating heat to create steam to produce power via the steam turbine. The flue gas is filtered in the flue gas treatment area and exits through the flue stack.

The site also contains the ancillary plant such as cooling towers, HV switch-room and electricity grid connection switchyard, water treatment plant and pump house, fire water tanks and pumps as well as wastewater and stormwater detention ponds. Final sizing of equipment and plant areas will be confirmed during detail design (Jacobs, 2020).

Trucks would enter the site from the north-east corner of the site, while site personnel would enter from the south-west entrance and park near the offices. The trucks would be weighed on the site weighbridge and then travel to and from the tipping hall to unload the MSW. Trucks would travel to the bottom ash storage and air pollution control residue silos to pick up by-product/residue and deliver elsewhere. There would be truck deliveries of main consumables and chemicals required for the plant operations.

4.4 Waste Tipping Hall and Bunker

The MSW and C&I waste will be delivered to the facility directly by trucks via waste transfer stations, entering a fully enclosed tipping hall building. Any double configuration trailers will be de-coupled onsite before entering the tipping hall.

The waste transport vehicles will then back up into a tipping bay position and tip their waste into a waste bunker where the waste is mixed and lifted by the overhead waste crane(s) into a waste feed hopper.

There are two combustion grate lines proposed with each boiler output feeding separate steam turbine generators. It is expected that at least two or more cranes operating above the waste bunker will be required to process the waste and deliver to each waste feed hopper system.

4.5 Moving Combustion Grate

The moving grate combustion technology system used in energy from waste plants is an established, reliable technology with many similarities in the offers from equipment vendors (Jacobs, 2020). The combustion technology proposed for the Project is a mass burn combustion grate technology, which is an established and effective method for thermally treating MSW and C&I waste.

As the waste enters the grate it is combusted on the topside of the combustion grate. Primary combustion air is introduced at various controlled points underneath the grate. Also, secondary/tertiary air is introduced above the grate to promote good mixing of the flue gases and to optimise combustion.

The movement of the grate promotes complete burnout of the waste at high temperatures. The plant will be designed such that the flue gas resulting from the combustion of the waste has a flue gas residence time of at least two seconds for the main furnace pass to ensure complete combustion of organic carbon compounds. This is one of the requirements of the IED and EC (2019b).

The primary air is usually drawn from the tipping hall and waste bunker building, typically with the air preheated by a heat exchanger through the use of extracted steam from the steam turbine, to promote better waste drying on the grate. This approach maintains the tipping hall and waste bunker under negative air pressure, thus continuously controlling odour emissions whilst one of the boilers is operational.

Secondary combustion air can be drawn from either the waste bunker or from within the boiler house structure. The optimal source of the secondary air intake will be selected in the detailed design phase, and a common approach is to draw some air from within boiler house to recover some radiation losses and to keep ambient temperature within the boiler house below a safe ambient level for operations and maintenance staff. The secondary air may be pre-heated via heat exchanger(s) using steam extracted from the steam turbine.

4.6 Furnace and Heat Recovery Boiler

The waste is combusted in a furnace which is a fully enclosed membrane with water wall tube cooled chambers. If required, the auxiliary fuel system is used to assist with combustion stability. After the furnace, the boiler has a series of empty passes with water cooled tube walls providing cooling for the flue gases, reducing the risk of ash build up and corrosion.

Heat is recovered from the flue gases and transferred to the feedwater / steam to improve energy recovery efficiency.

Boiler ash will be collected from the various boiler and economiser pass hoppers and ultimately transferred to either the bottom ash treatment system or the air pollution control residue (APCr) system.

Flue gases leaving the boiler will be treated with powdered, activated carbon to absorb toxic volatile organic components such as dioxins and furans and heavy metals such as mercury. A dry or semi-dry lime dosing and reactor system will also be used to neutralise acid gas pollutants such as hydrochloric acid and sulfuric oxides.

Mobile fly ash particulates and flue gas treatment residues entrained in the flue gases will be captured in the bag filter plant. These air pollution control residues will be conveyed to a storage silo ready for disposal to landfill, with some of the residue recirculated back upstream to be re-injected into the ductwork or into the reactor for re-use.

Oxides of nitrogen (NO_x) emissions will be controlled by a Selective Non-Catalytic Reduction (SNCR) system, which injects aqueous ammonia or urea into the flue gases at the top of the furnace. Ammonia or urea can be used with similar performance in terms of NO_x reductions.

The low-pressure conditions maintained in the furnace and boiler prevent the escape of hot combustion gases to atmosphere. Furnace pressure is controlled by an induced draft fan that draws the cleaned flue gases up the chimney. Several sensitivity tests undertaken for this Project led to a chimney (stack) height of 80 metres used as part of the air quality impact assessment described in later sections of this report.

The high pressure and temperature steam generated within each boiler, typically at air pressure 60-70 bar and temperature range 400ºC-450°C, will be piped to separate steam turbine generators. This Project is expected to have one steam turbine per boiler unit. The steam turbine will be rated to accept steam from the boiler when operating at 110% maximum continuous rating. In the turbine, the steam drives turbine blades converting the mechanical energy to electricity in the generator.

4.7 Flue Gas Emissions and BAT Emissions Controls

Legislation, policy and guidelines for EfW air emissions, including emissions limits, were detailed in Section 2. This section provides a summary of the substances expected to exist in combustion products from the Plant, and the emissions control technology to be employed to minimise those emissions to atmosphere. This section represents a summary of the detailed report on the BAT for EfW provided in Jacobs (2020).

The groups of air pollutants found within EfW flue gases from the combustion of MSW and C&I waste, and the BAT for air emissions controls in each case, are detailed in Jacobs (2020) and summarised in the following points:

- Oxides of nitrogen (NO_x) – controlled by combustion control and selective non catalytic reduction (SNCR) with the injection of ammonia or urea into the hot flue gases.
- Oxides of sulfur (SO_x) – controlled by injection of lime (alkaline) reagent into the flue gas to absorb and neutralise the acid gas compounds.
- Halogens e.g. HCl and HF – controlled by lime (alkaline) reagent injection, neutralisation and adsorption.
- Airborne particulate matter as PM_{10} and $PM_{2.5}$ – these boiler ash APCr are filtered out in a bag filter system.
- Heavy metals e.g. lead, mercury, cadmium, chromium – controlled by the injection of activated carbon into the flue gas that is subsequently collected downstream in the bag filter system.
- Volatile Organic Compounds (VOCs) including dioxins and furans – destroyed in the high temperature furnace; reformation of VOCs is inhibited by controlling the flue gas cooling and using activated carbon injection and bag filters to absorb and remove any residuals.

The flue gas treatment systems proposed for this Project will be designed to achieve the IED and EC (2019b) requirements.

Air emissions controls begin with combustion control in the furnace. Secondary combustion air is heated and injected above the grate to promote better mixing maximising destruction of VOCs and minimising carbon monoxide (CO) in the flue gases. The waste is combusted in a reducing environment, which means less air is used than otherwise would be required for full combustion of the waste; this reduces NO_x emissions (NO_x is a precursor for the photochemical air pollutants nitrogen dioxide and ozone).

EfW plants can achieve compliance with NO_x emission limits through the use of a SNCR system. This process injects ammonia (NH_3) or urea ($CO(NH_2)_2$) solutions into the top of the furnace where the temperature is typically around 800ºC to 1000ºC depending on the design of the boiler and the SNCR system. The ammonia or urea reacts with NO_x in the combustion gases producing water and molecular nitrogen (N_2). Molecular nitrogen is a harmless gas – the lower atmosphere comprises of 78% N_2. To avoid overdosing the reagent, NH_3 levels are monitored in the flue gas. This SNCR approach has been specified for this Project.

The flue gas leaving the boiler is expected to be around 170ºC to190ºC and will enter the top of either a dry or semi-dry deacidification (rotary spray reaction tower) system. Lime slurry reacts with the acid gases in the flue gas; e.g., hydrogen chloride (HCl), hydrogen fluoride (HF), and SO_2. Activated carbon powder and dry slaked lime powder are injected directly into the flue gas duct before the flue gas enters bag filters. The effect of the lime powder is to reduce concentrations of acidic gases such as HCl and SO_x. Activated carbon powder will absorb heavy metals in the flue gas such as mercury, and other pollutants such as dioxins and furans. Jacobs (2020) provides more details about each of these processes.

The flue gas enters the bag filters which aim to capture APCr and fly ash to reduce particulate concentrations to below IED limits. In the bag filters, the acidic gases continue to react with the slaked lime, and the activated carbon continues to absorb heavy metals and dioxins and furans. Various particles, including fly ash from the boiler, condensed heavy metals, reaction products, unreacted reagents, and activated carbon, are entrained onto the surface of the bag filters and blown into a dust hopper by compressed air.

A portion of the collected dust will be recirculated back into the duct or the reactor for re-use. Re-circulation of the collected particulate residues, which contain some unspent reagent, allows a reduction in the amount of lime used and thus reduces operating costs. Also, this allows a significant reduction to the volume of APCr generated. This is a requirement of EC (2019b).

The flue gas treatment equipment will comprise of a dry or semi-dry system. Any water that may be used will be fully evaporated within the gas duct, which will typically operate at a temperature of approximately 140ºC at the point of discharge from the stack. No liquid effluent will be produced from the flue gas treatment system.

The activated carbon injection will absorb heavy metals that may exist in small amounts in the waste, and also toxic VOCs such as dioxins and furans. The spent carbon dust containing the absorbed pollutants is also collected in the downstream bag filters.

These approaches for the control of emissions of acid gases, toxic VOCs and heavy metals are considered BAT by EC (2019b).

Typically, the bag filters to be employed for the Project achieve particulate emission levels less than 5 mg/Nm^3, which meets IED requirements, and is a considerably more stringent limit than limits required by other industries in Victoria. The SEPP (AQM) lowest particulate emissions limit for Air Quality Control Regions is 250 mg/Nm^3 (0^oC, 1013.25hPa, gas volume calculated to 12% CO_2).

A Continuous Emissions Monitoring System (CEMS), certified by National Association of Testing Authorities (NATA) Australia, will be provided on each boiler for measuring all pollutant and duct process condition parameters as required for on-line measurement under the IED and SEPP (AQM), as well as NH_3 for SNCR dosing control optimisation. The CEMS will monitor and report emissions in accordance with the IED. The CEMS will provide indication and recording of the following corrected concentrations of gases in the chimney, as a minimum, on a continuous basis: Stack gas flow; temperature; pressure; gas moisture content; oxygen; carbon dioxide; total dust; Total Organic Carbon (TOC); hydrogen chloride (HCl); hydrogen fluoride (HF); sulfur dioxide (SO_2); oxides of nitrogen (NO_x) as nitrogen dioxide (NO_2); carbon monoxide (CO); ammonia (NH3); and mercury.

A 'hot' spare CEMS will also be provided which can be switched into service when the duty CEMS on a combustion line chimney is not operating due to maintenance, calibration or instrument faults.

In summary, for this Project, air emissions control technologies and monitoring equipment will be provided that can achieve the stringent emissions limits of the IED. PHI is proposing emission control technologies that have been proven in many reference plants in Europe and China combusting MSW and C&I waste. The emission limits required for this Project will be included as "make good" performance guarantees under the contract and technical specification, which is standard practice to mitigate the risks of these requirements not being achieved for the project.

4.8 Odour Emissions Controls

The tipping hall and waste bunker will be maintained under negative air pressure, thus continuously controlling odour emissions whilst one of the boilers is operational (Section 4.4).

On rare occasions there may be a short-term boiler outage causing the waste combustion lines to go offline. It is anticipated that systems and procedures will be in place to minimise any odours generated from waste remaining in the bunker. As a minimum, these include:

- a stack ventilation shutdown system to maintain negative pressure in the bunker and tipping hall, and
- an odour filtration system prior to the discharge point located on the facility roof for good dispersion.

Odorous emissions from the waste are expected to be well controlled and contained within the Plant infrastructure. The proposed systems to manage odour emissions will be sufficient to manage the risk of odour emissions from the plant. The provision of a back-up odour filtration system can be considered BAT in accordance with EC (2019b).

4.9 Plant Operating Parameters Summary

A summary of Plant operating parameters is provided in Table 4-1 (Jacobs, 2020).

Table 4-1: Summary of Plant Operating Specifications

Design parameter / input	Value	Comment
Plant design life	25 years / 200,000 hours	
Number of boiler lines	2	
Number of steam turbines	2	
Annual plant fuel consumption	400,000 tonnes/annum	Based on 2 x 200,000 tonnes/annum boiler lines
Plant availability factor	90%	Subject to detailed design and to be agreed contractual guarantees
Typical operating hours per annum	7,884 hours	Based on 90% of 8,760 hours
Operational regime	24 hours/7 days per week	Except for planned and unplanned shutdowns
Design waste throughput per boiler	26.7 tonnes/hour	
Target main steam conditions from boiler	440°C, 64 bar (absolute)	
Target O_2 in flue gas (wet)	7%	At economiser outlet
Fly ash to bottom ash ratio	20 % / 80%	Technology provider assumption
Stack exit temperature	Approximately 140°C	
Stack height	80 metres above ground level	Determined by sensitivity testing with AERMOD using a number of stack heights in combination with building wake effects.
Estimated gross plant power output	40,700 kW	Based on ambient site conditions for two units
Auxiliary load	4,720 kW	Based on ambient site conditions. Estimated to be approximately 11% of gross output.

Estimates for the Plant air emissions parameters used as input for AERMOD, including explanations for the inputs used for modelling, are provided in Section 5.2.3.

5. Assessment Methodology

5.1 Overview

The assessment for the Project was undertaken in accordance with the SEPP (AQM). The assessment methodology was discussed with EPA air quality specialists on 11th March, 2020, including use of the regulatory model AERMOD with a five-year dataset of hourly meteorological data in accordance with EPA (2014) and EPA (2015); see Section 3.4.3 (Dispersion Meteorology), and Section 5.3 (Stakeholder Engagement).

5.2 AERMOD Modelling Methods

5.2.1 Model Description

The latest version of AERMOD (Version 19190; 13/8/2019), was used for predictions of air pollutant concentrations at ground-level (USEPA, 2019). AERMOD is a 'steady-state' plume model: in the stable boundary layer the model assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function. AERMOD is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (USEPA, 2004).

5.2.2 Building Wake Effects

The Plant building wake and stack downwash effects were tested in AERMOD using the Building Profile Input Program (BPIP); the proposed Plant building layout and stack position is illustrated in Figure 5-1.

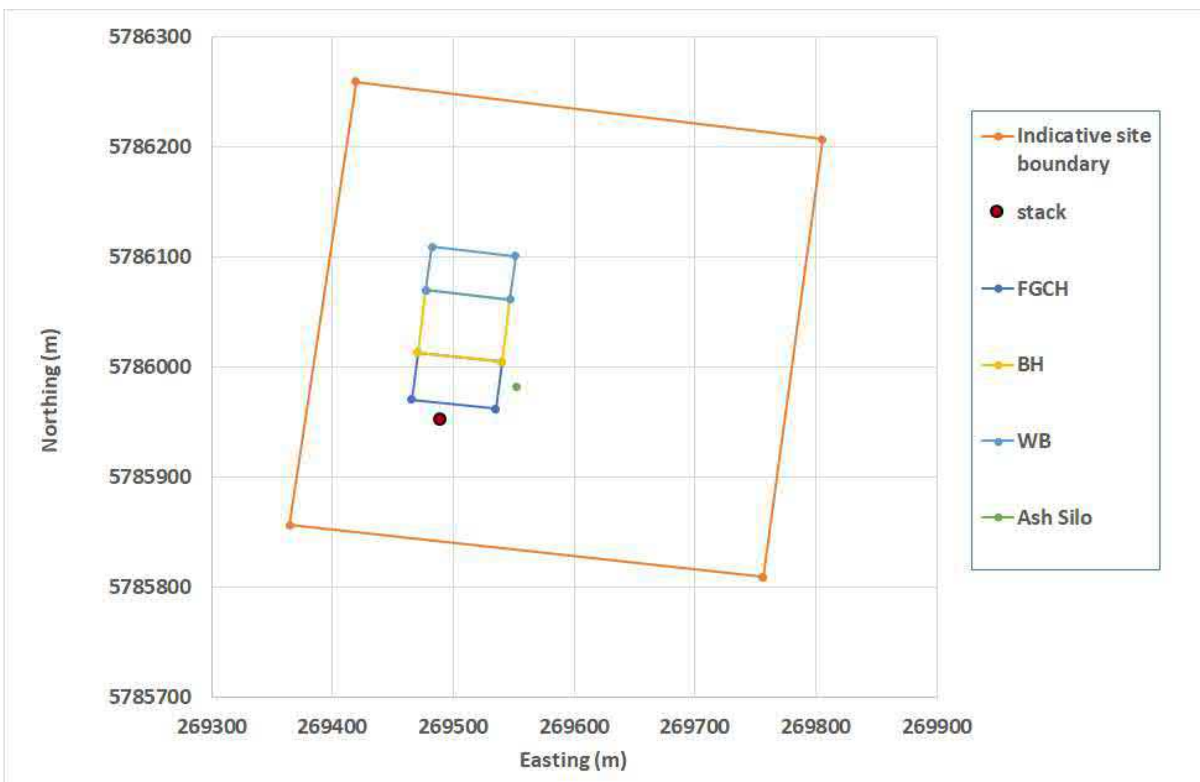


Figure 5-1 Proposed Plant building layout and stack position

Abbreviations: FGCH: Flue Gas Cleaning Hall; BH: Boiler House; WB: Waste Bunker.

Three main Project buildings with heights 40.0 metres, 40.6 metres, and 50.0 metres, (single tier each), were input to the wake effects calculations using the BPIP program. The final stack height included in the calculations was 80 metres, located just to the south of the buildings.

A number of sensitivity tests were undertaken with various combinations of stack height and the layout of the main Project buildings. While the modelled airflow wake effects were found to be small , BPIP calculations were included in all the modelling scenarios to account for the near-field effects of the Project buildings.

5.2.3 Air Emissions Estimates and Ambient Assessment Criteria

The single source of air pollutant emissions identified for assessment is the EfW boiler stack (Section 4). Other potential, more minor sources of air emissions not assessed by modelling were a black start diesel generator (Section 4.1), and fugitive odour emissions (Section 4.8).

The two EfW flues will be ducted to a single common stack, modelled as one exhaust point with the effective cross section area of the stack equal to the area of the two flues. The total exhaust flow from the stack was determined by the sum of the exhaust from the two flues.

The Plant parameters used as input to modelling with AERMOD are listed in Table 5-1.

Table 5-1: Plant boiler stack parameters for modelling

Design parameter / input	Value	Units and notes
Location: MGA Easting & Northing	E 269,490; N 5,785,952	metres Above Ground Level
Height	80.0	metres
Effective stack internal diameter	2.92	metres (two flues with equivalent combined area)
Exhaust temperature	139.7	degrees Celsius
Exit velocity	18.3	m/s
Exhaust flow at stack exhaust temperature	122.8	m^3/s

As mentioned in Section 2.3, the averaging periods of the European emissions limits differ between EU (2010) and EC (2019b), and these differ again from the Victorian SEPP (AQM) criteria and SEPP (AAQ) objectives used for assessment. The air pollutant emission rate estimates for non-metals and explanations for their selections are provided in Table 5-2. Emissions limits were used for assessment by modelling, or a fraction of these emissions limits based on the review of emissions measurements by EC (2019a) and other sources.

Table 5-2: Substances for assessment, emissions estimates, and explanations (non-metals)

Substance	Design Criterion or Objective	Air emission estimates	Explanation for air emission estimate
CO	SEPP (AQM) DC[1] 99.9PC 1h avg, 29 mg/m^3	100 mg/Nm^3 (8.28 g/s)	Highest CO emission limit from EU (2010), a 30-minute average, most closely matching the averaging period of the design criterion. The selection for assessment is conservative (high).
NO_x as NO_2	SEPP (AQM) DC[1] 99.9PC 1h avg, 190 $\mu g/m^3$	400 mg/Nm^3 (33.1 g/s)	Highest NO_x emission limit from EU (2010), a 30-minute average, most closely matching the averaging period of the design criterion. The selection for assessment is conservative (high).
SO_2	SEPP (AQM) DC[1] 99.9PC 1h avg, 450 $\mu g/m^3$	200 mg/Nm^3 (16.6 g/s)	Highest SO_2 emission limit from EU (2010), a 30-minute average, most closely matching the averaging period of the design criterion. The selection for assessment is conservative (high).
'Total dust' as PM_{10}	SEPP (AQM) DC[1] 99.9PC 1h avg, 80 $\mu g/m^3$	30 mg/Nm^3 (2.48 g/s)	EU does not specify particle size distribution; 'total dust' is assumed PM_{10}.

Substance	Design Criterion or Objective	Air emission estimates	Explanation for air emission estimate
			Highest PM_{10} emission limit from EU (2010), a 30-minute average, most closely matching the averaging period of the design criterion. The selection for assessment is conservative (high).
PM_{10}	SEPP (AAQ) objective, max. 24h avg, 50 µg/m^3	5 mg/Nm^3 (0.42 g/s)	Corresponding (24-hour average) emission limit for 'Total dust' (assumed PM_{10}), recommended by EC (2019b).
	SEPP (AAQ) objective, annual avg, 20 µg/m^3	5 mg/Nm^3 (0.42 g/s)	As above for assessment of annual average (conservative, high).
$PM_{2.5}$	SEPP (AQM) DC[1] 99.9PC 1h avg, 50 µg/m^3	15 mg/Nm^3 (1.24 g/s)	EU does not specify an emission limit for a small particle size fraction. A $PM_{2.5}/PM_{10}$ ratio of 50% was used based on review of EC (2019a) and the ENVALL (2017) assessment for the East Rockingham waste power station proposal in Western Australia.
$PM_{2.5}$	SEPP (AAQ) objective, max. 24h avg, 25 µg/m^3	2.5 mg/Nm^3 (0.21 g/s)	Corresponding (24-hour average) emission limit for 'Total dust' (assumed PM_{10}), recommended by EC (2019b), combined with an estimated $PM_{2.5}/PM_{10}$ ratio of 50% (e.g., ENVALL, 2017).
	SEPP (AAQ) objective, annual avg, 8 µg/m^3	2.5 mg/Nm^3 (0.21 g/s)	As above for assessment of annual average (conservative, high).
TVOC	SEPP (AQM) DC 99.9PC 3-min. avg, 40 µg/m^3	20 mg/Nm^3 (1.66 g/s)	EC (2019b) does not specify emissions limits for individual hydrocarbons comprising the Total Volatile Organic Carbons (TVOC). For the purpose of this assessment the TVOC was assumed to be formaldehyde, considered to be a conservative approach as in general formaldehyde is a higher risk VOC in combustion emissions. The highest TOC emission limit selected for modelling from EU (2010), 30-minute average most closely matching the averaging period of the design criterion for formaldehyde. (TOC assumed equivalent to TVOC given similar emissions limits).
NH_3	SEPP (AQM) DC 99.9PC 3-min. avg, 600 µg/m^3	30 mg/Nm^3 (2.48 g/s)	EU (2010) provided no shorter-term average emission limit for ammonia. EC (2019b) provides an upper limit (24-hour average) of 10 mg/Nm^3. The emission estimate for the shorter-term average provided here (30 mg/Nm^3) was based on the review of measurements by EC (2019a).
HCl	SEPP (AQM) DC 99.9PC 3-min. avg, 250 µg/m^3	60 mg/Nm^3 (4.97 g/s)	Highest HCl emission limit from EU (2010), a 30-minute average, most closely matching the averaging period of the design criterion. The selection for assessment is conservative (high).
HF	SEPP (AQM) DC maxima: 24h avg., 2.9 µg/m^3, 7-day avg. 1.7 µg/m^3, 90-day avg., 0.5 µg/m^3	1 mg/Nm^3 (0.08 g/s)	EU (2010) and EC (2019b) 24-hour average emission limit used. Conservative (high) for assessment against design criteria for 7-day and 90-day average GLCs.
Dioxins and furans	SEPP (AQM) DC 99.9PC 3-min. avg, 3.6 x 10^{-6} µg/m^3	10^{-7} mg/Nm^3	As a conservative step in the assessment, the higher of the 6-8h average EU (2010) and EC (2019b) emissions limits was used i.e. 0.1 ng/Nm^3.
PAH as B(a)P	SEPP (AQM) DC 99.9PC 3-min. avg, 0.73 µg/m^3	0.010 mg/Nm^3	EU 2019 shows a typical maximum (emission) across many plants is 10 µg/m^3, also some operational limits are set to this level. A typical average is 1 µg/m^3. Therefore use of 0.01 mg/Nm^3 for modelling is conservative (high).

Notes: 'DC' = design criterion, 'avg'.' = 'average, 'min.' = 'minute', '1h' = '1 hour', '24h' = '24 hour', 'PC'='PerCentile'

BAT-AEL standard conditions are dry gas at 0^{o}C and 1013 hPa (EU, 2019b).

A different approach was needed for the assessment of emissions of the individual metals, to ensure no exceedances of SEPP (AQM) design criteria. The EC (2019b) recommends emissions limits, which are 24-hour averages, were used as inputs for modelling. The selections for modelling and explanations are provided in Table 5-3.

Table 5-3: Metals for assessment, emissions estimates, and explanations

Substance	Design Criterion	Air emission estimate (mg/Nm^3)	Explanation
Hg	99.9PC 3-min. avg. 0.33 $\mu g/m^3$ (organic)	0.02	EC (2019b) emission limit, (24-hour average), was used as an input for Hg-organic. Mercury emission assumed 'organic' for assessment by comparison with the design criterion.
	99.9PC 3-min. avg. 3.3 $\mu g/m^3$ (inorganic)	0.02	EC (2019b) emission limit, (24-hour average), was used as input for Hg-inorganic. Mercury emission assumed 'inorganic' for assessment by comparison with the design criterion.
Cd	99.9PC 3-min. avg. 0.033 $\mu g/m^3$	0.02	EC (2019b) emission limit (24-hour average) used as input. Conservative high 100% of emission limit for Cd+Tl group was assumed to be Cd for assessment by comparison with design criterion for Cd.
Tl	No DC	0.01	A review of literature indicated that most of the Cd and Tl group is Cd. Thus a Tl emission of 50% of EC (2019b) emission limit (24h avg.) is a conservative approach. However there is no design criterion in SEPP (AQM) to use for assessment.
Sb	99.9PC 3-min. avg. 17 $\mu g/m^3$	0.03	Sb: used 10% of EC (2019b) recommended emission limit, (24-hour average), for Cd+Tl group based on EC (2019b) review of emissions data.
As	99.9PC 3-min. avg. 0.17 $\mu g/m^3$	0.06	Arsenic: used 20% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.
Pb	99.9PC 1h avg. 3 $\mu g/m^3$	0.3	Lead (Pb): used 100% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data. Note the design criterion for lead is a 1-hour average; i.e., not a 3-minute average.
Cr III	99.9PC 3-min. avg. 17 $\mu g/m^3$	0.06	Chromium as 100% Chromium-3: used 20% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.
Cr VI	99.9PC 3-min. avg. 0.17 $\mu g/m^3$	0.06	Chromium as 100% Chromium-6: used 20% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.
Co	No DC	0.003	Cobalt (Co): used 1% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data. However no DC to use for assessment.
Cu	99.9PC 3-min. avg. 6.7 $\mu g/m^3$	0.3	Copper (Cu): used 100% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.
Mn	99.9PC 3-min. avg. 33 $\mu g/m^3$	0.06	Manganese (Mn): used 20% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.
Ni	99.9PC 3-min. avg. 0.33 $\mu g/m^3$	0.06	Nickel (Ni): used 20% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.
V	No DC	0.003	Vanadium (V): used 1% of EC (2019b) recommended emission limit, (24-hour average), for metals group based on EC (2019b) review of emissions data.

Notes: 'DC' = design criterion, 'avg'.' = 'average, 'min.' = 'minute', '1h' = '1 hour', '24h' = '24 hour', 'PC'='PerCentile'

BAT-AEL standard conditions are dry gas at 0°C and 1013 hPa (EU, 2019b).

Some further details on assessment methods are provided in the results section for each substance (Section 6).

5.2.4 Hourly Meteorological Data

Development of the hourly meteorological data used as input for AERMOD was described in Section 3.4.3.

5.2.5 Background (Air Quality Monitoring) Data

The air pollutant concentrations due to the Project were added to background air pollutant concentrations determined by monitoring, to form the cumulative air quality impact assessment required by the SEPP (AQM). Background air pollutant concentrations were determined from EPA monitoring data acquired at the EPA Geelong South monitoring station. The description of existing air quality provided in Section 3.5 summarises the EPA's monitoring data used as input to the modelling.

Data files of background, hourly-varying air pollutant concentrations were created from measurements at EPA Geelong South monitoring station, for input to AERMOD. A summary of the hourly-varying background data used is provided in the following points:

- CO EPA Geelong South, 2015–2019 inclusive.
- NO_2 EPA Geelong South, 2015–2019 inclusive.
- PM_{10} EPA Geelong South, 2015–2019 inclusive.
- $PM_{2.5}$ EPA Geelong South, part of 2016 to 2019 inclusive; EPA Footscray, 2015 and part of 2016.

As explained in Section 3.5.5, hourly measurements were not used as background in the assessment of SO_2 due to the low risk of air quality impact from SO_2. Instead, fixed estimates of the background SO_2 were used; these were conservatively high, 99th percentile, one-hour average SO_2 concentrations for each annual simulation.

Background concentrations for the other substances assessed were expected to be low. Also, there is very little information about the small concentrations of these other pollutants, which are expected to be of the order 0.1 $\mu g/m^3$ to 10 $\mu g/m^3$ only, therefore unlikely to contribute to exceedances of design criteria or other monitoring standards; see Section 3.5. Background levels for these remaining substances were assumed to be zero in the modelling.

5.3 NO_x Conversion Method for NO_2

For the assessment of NO_2, AERMOD requires NO_x emissions estimates as input, and produces NO_x GLCs as output. As the substance for assessment is NO_2, a method is needed to convert the NO_x results to NO_2. A review of EPA's NO_2 and NO_x monitoring data measured at Geelong South demonstrated that high NO_2/NO_x ratios are never detected when NO_x concentrations are high. The NO_2/NO_x ratio trends downwards to approximately 20%-30% for the highest NO_x concentrations. As the focus of assessment is on the higher NO_2 concentrations, a conservative, high, fixed NO_2/NO_x ratio of 30% was used to convert the AERMOD predicted NO_x GLCs to NO_2. The second step was to add background NO_2 levels to the AERMOD predictions for NO_2, effectively making the NO_2/NO_x higher than 30%; i.e., more conservative.

Additionally, the total NO_x contributions from the Plant were analysed to investigate the highest possible contributions to existing NO_2 levels, that could occur.

5.4 Stakeholder Engagement

PHI and Jacobs consulted with EPA about the Project on 11th March, 2020. EPA's feedback on the assessment methodology was received on 6th May, 2020. The EPA advised the feedback was relevant to applications submitted and assessed under the Environment Protection Act 1970, given commencement of the Environment

Protection Act 2017 has been deferred until 1st July, 2021. The EPA advised the proposed assessment methodology 'appeared to be appropriate and thorough'; key comments are provided in the following points, with responses given after dashes.

- EPA: Assessment of best practice was to be against the EU (2010) and EC (2019b), including BAT associated emission levels.
  - EU (2010) and EC (2019b) were reviewed in Section 2.3. The assessment used emissions estimates based on the worst case (high) emissions limits, or recommended emissions limits, with consideration given to the averaging periods; see also Jacobs (2020).
- EPA: AERMOD (air) emissions modelling was to include time-varying background for each modelling scenario and consider the impact of emissions in addition to existing ambient air quality.
  - This was incorporated where time-varying data were available except for SO_2; i.e. using monitoring data from EPA Geelong South: CO, NO_2, PM_{10} and $PM_{2.5}$.
  - The hourly-varying SO_2 monitoring data were not used as background in the assessment of SO_2 due to the low risk of air quality impact from emissions of this gas. Instead, the conservatively high, 99th percentile one-hour average SO_2 concentration was used for background for each annual simulation; see results in Section 6.5.
  - EPA Footscray $PM_{2.5}$ monitoring data were used as proxy background data for the 2015 and 2016 meteorological simulations where data were unavailable from EPA Geelong South.
- EPA: Emissions data were to be determined from reference plant(s) using comparable waste as fuel.
  - This was incorporated via a review of EU (2010), EC (2019b), and other sources; see also Jacobs (2020).
- EPA: Waste characterisation for the Project was to be demonstrated to be comparable to waste processed at the reference facilities.
  - Data provided in EU (2010) and EC (2019b) show the full range of emissions expected from the combustion of MSW and C&I waste by best practice EfW techniques (Section 4); see also Jacobs (2020).
- EPA: 'Odour emission modelling' was stated by EPA as a comment.
  - There will be no odour releases from the facility during normal EfW operations because the tipping hall and waste bunker will be maintained under negative air pressure; see Section 4.8. Also, no odorous substances are expected in the products of combustion, which will be well dispersed by the tall stack (see results; Section 6).
- EPA: A human Health Risk Assessment (HRA) was to be prepared.
  - HRA is in progress; an additional statistical set of AERMOD results for this assessment was required and provided to the HRA consultant over 16-29 June, 2020.

5.5 Conservative Assessment Strategy

A conservative strategy was applied for the assessment based on testing air pollutant emissions from the proposed EfW with approximately 40,000 possible meteorological conditions (i.e. 5 consecutive years of hourly average meteorological conditions). Key aspects of the air quality impact assessment undertaken for the Project were:

- A conservative approach was used to estimate emissions for each substance based on a review of the literature, with a focus on the EC (2019a) studies of many operating EfW plants in Europe.
- Air pollutant emissions from the tall stack were modelled as a continuous source; i.e. for all hours in each of the five simulated years, whereas the Plant's capacity factor may be as low as 90% (Section 4.9).
- The combined effects of the Project emissions plus estimates for background based on local measurements represent the expected, cumulative (total), worst-case, air quality impacts.

6. AERMOD Results

6.1 Introduction

The purpose of this section is to set out and assess AERMOD results for the Project in accordance with the SEPP (AQM) and EPA's AERMOD guidelines: EPA (2014) and EPA (2015). AERMOD was used to produce Ground Level Concentrations (GLCs) for each substance assessed. The effects of existing air quality or 'background' air pollutant concentrations were included in the analysis.

6.2 Annual Variability

The annual weather cycle of the four seasons in Victoria is well known, as are annual variations in average temperature and total rainfall. Wind patterns vary annually also, which are particularly important for the dispersion of air pollutants; e.g., annual wind roses are provided in Appendix A.1. To address this annual variability, EPA (2014) and EPA (2015) require that modelling assessments use five years of (hourly) meteorological data, for most circumstances. For this Project, five years of hourly meteorological data were created for the Prospect Hill site using observations from BoM Avalon Airport (Section 3.4.3).

The annual variability in the AERMOD results for air pollutant GLCs is illustrated in the following five figures, using as examples the 99.9th percentile, 1-hour average, carbon monoxide (CO) GLCs (written as '99.9PC 1h CO'). They are shown without background CO levels, which would have dominated the results otherwise; the figures are: Figure 6-1 (2015 meteorological simulation); Figure 6-2 (2016 and 2017 simulations); and Figure 6-3 (2018 and 2019 simulations).

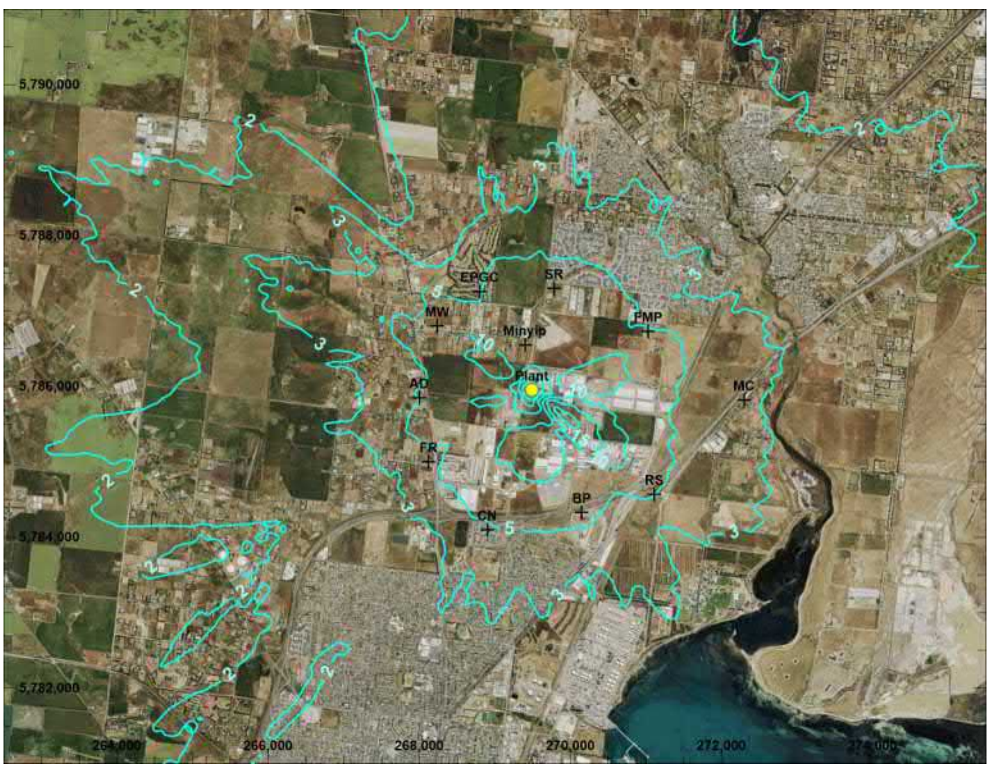


Figure 6-1: AERMOD Results for 99.9PC 1h CO (μg/m^3): Simulation 2015

From inspection of these figures, generally the CO concentrations are approximately the same for each simulation, but details in the spatial patterns can be seen to vary. In terms of the potential for air quality impact these very detailed results are assessed by calculating key statistics and comparing the statistical results with standards. The next sub-sections of results focus on the key statistics for assessment.

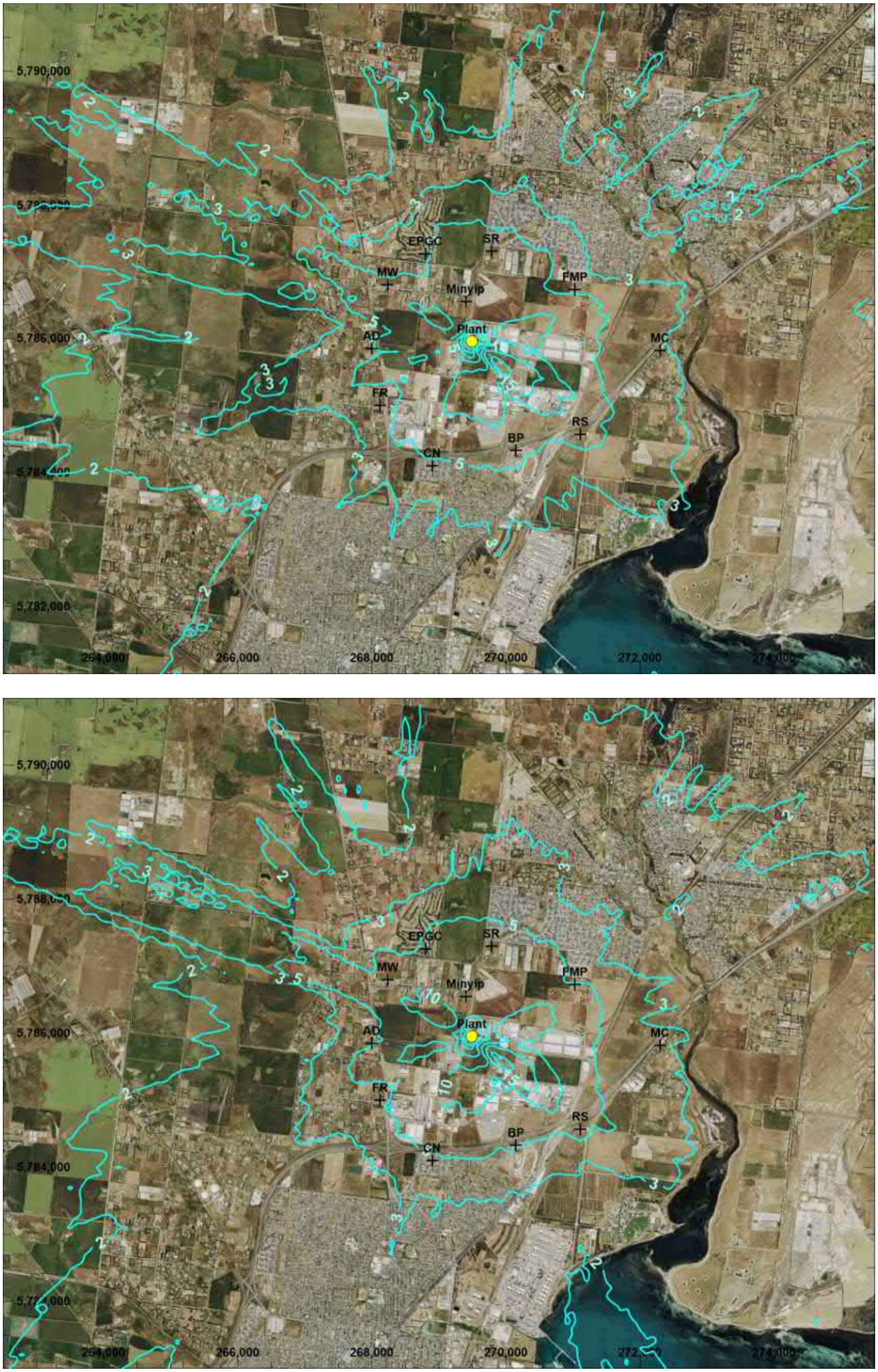


Figure 6-2: AERMOD Results for 99.9PC 1h CO (μg/m³): Simulations 2016 (top) and 2017 (bottom)

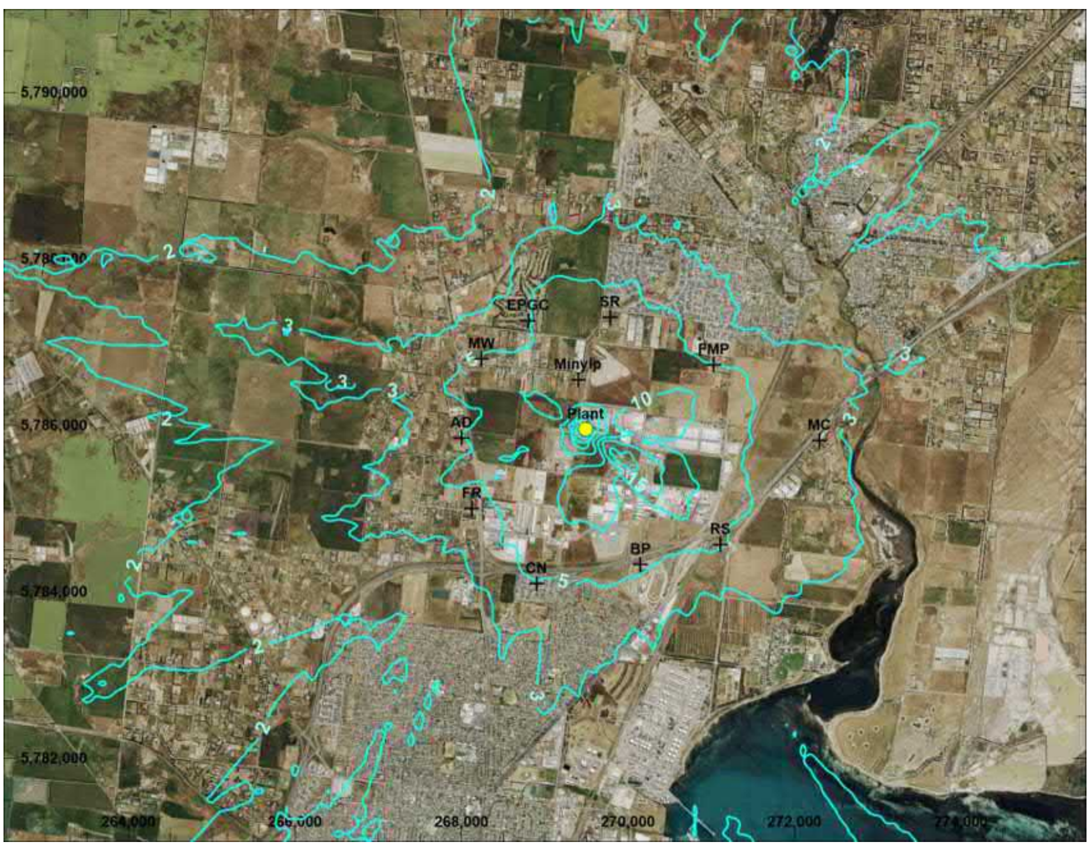


Figure 6-3: AERMOD Results for 99.9PC 1h CO (μg/m^3): Met. Simulations 2018 (top) & 2019 (bottom)

6.3 AERMOD Results: Carbon Monoxide

The maximum AERMOD results for 99.9th Percentile (PC) CO GLCs (μg/m³), for the grid receptors (GR) and discrete receptors (DR) are listed in Table 6-1. AERMOD results including hourly background CO are shown alongside monitoring results at EPA Geelong South in Table 6-2. These results show that CO emissions from the Plant have only a very small effect on existing levels of CO and do not cause any exceedances of the design criterion (29,000 μg/m³).

Table 6-1: AERMOD results for 99.9 PC 1-hour average CO without background

Year	GR maximum without background (μg/m³)	DR maximum without background (μg/m³)
2015	22.1	8.8
2016	22.5	8.8
2017	21.9	8.7
2018	22.5	8.8
2019	22.2	8.2

Table 6-2: Summary of results: 99.9 PC 1-hour average CO

Year	EPA Geelong South meas. (μg/m³)[1]	Model GR max. with background (μg/m³)	Model DR max. with background (μg/m³)
2015	1259	1316	1316
2016	1488	1602	1602
2017	1374	1260*	1258*
2018	1259	1258*	1258*
2019	1374	1258*	1258*
Standard	N/A	SEPP(AQM) design criterion 29,000 μg/m³	

Notes: 1. Units conversion temperature for measurements, 25°C. Modelling included hourly-varying background CO.

The AERMOD grid receptor results for 99.9th percentile 1-hour average CO GLCs (μg/m³), are illustrated by the contour plot provided in Figure 6-4. The 2018 meteorological simulation shown as a worst-case (same as Figure 6-3).

Figure 6-4: AERMOD Results for 99.9PC 1-Hour Average CO (μg/m³)

- Example shown is worst case (2018) met. simulation, excluding background.
- Maximum GR result: 22.5 μg/m³ (0.08% of design criterion)
- 9th-highest result from Top 100 Table: 22.6 μg/m³.
- For results including background see Table 6-2.

6.4 AERMOD Results: Nitrogen Dioxide

The maximum AERMOD results for 99.9PC 1-hour average oxides of nitrogen (NO_x) GLCs (µg/m^3), for the grid receptors (GR) and discrete receptors (DR), are listed in Table 6-3. These results show the worst possible case for NO_2 due to the Plant; i.e., assuming all NO_x emissions are NO_2. AERMOD results using a NO_2/NO_x ratio of 30% plus hourly background NO_2 are shown alongside monitoring results at EPA Geelong South in Table 6-4. The tabled results show that NO_x emissions from the Plant are not predicted to cause any exceedances of the design criterion for NO_2 (190 µg/m^3).

Table 6-3: AERMOD results for 99.9 PC 1-hour average NO_x without background

Year	GR maximum NO_x without background (µg/m^3)	DR maximum NO_x without background (µg/m^3)
2015	89	35
2016	90	35
2017	88	35
2018	90	35
2019	89	33

Table 6-4: Summary of results: 99.9 PC 1-hour average NO_2 with background

Year	EPA Geelong South meas. (µg/m^3)[1]	Model GR max. (µg/m^3)	Model DR max. (µg/m^3)
2015	58	60	60
2016	62	66	62
2017	66	66	66
2018	67	68	68
2019	58	58	58
Standard	N/A	SEPP(AQM) design criterion 190 µg/m^3	

Notes: 1. Units conversion temperature for measurements, 25°C. Modelling included hourly-varying background NO_2.

The AERMOD grid receptor results for 99.9th percentile 1-hour average NO_x GLCs (µg/m^3), (no background), are illustrated by the contour plot provided in Figure 6-5. The NO_x results are shown here without background to illustrate the dispersion pattern, which would not be seen if background was included.

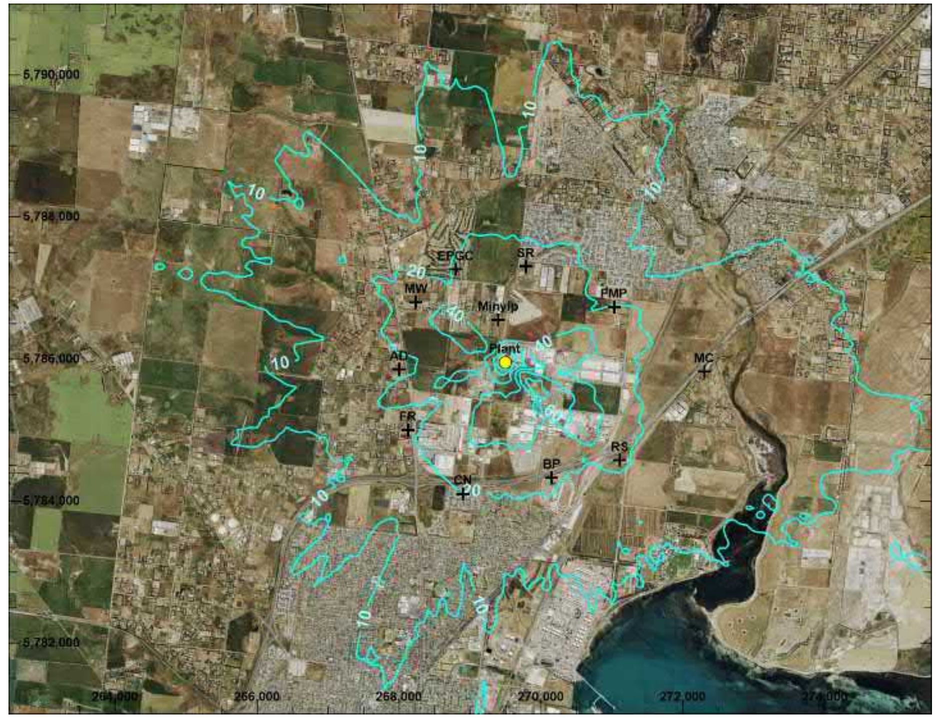


Figure 6-5: AERMOD Results for 99.9PC 1-Hour Average NO_x (µg/m^3)

- Example shown is worst-case (2018) met. simulation, excluding background.
- Maximum from contour plot: 90.0 µg/m^3.
- 9th-highest result from Top 100 Table: 90.4 µg/m^3.
- For results including background see Table 6-4.

6.5 AERMOD Results: Sulfur Dioxide

The maximum AERMOD results for 99.9PC 1-hour average SO_2 GLCs (μg/m³), for the grid receptors (GR) and discrete receptors (DR) are listed in Table 6-5. AERMOD results for SO_2 are shown alongside monitoring results at EPA Geelong South in Table 6-6. These AERMOD results include a conservative, fixed estimate of the background SO_2 (99PC hourly average), given the SO_2 concentrations were low in comparison with the design criterion.

Table 6-5: AERMOD results for 99.9 PC 1-hour average SO_2 without background

Year	GR maximum without background (μg/m³)	DR maximum without background (μg/m³)
2015	44.6	17.7
2016	45.4	17.7
2017	44.3	17.5
2018	45.3	17.7
2019	44.7	16.6

Table 6-6: Summary of results: 99.9 PC 1-hour average SO_2 with background

Year	EPA Geelong South meas. (μg/m³)[1]	Model GR max. (μg/m³)	Model DR max. (μg/m³)
2015	39	84	57
2016	16	61	34
2017	23	68	41
2018	26	72	44
2019	55	100	72
Standard	N/A	SEPP(AQM) design criterion 450 μg/m³	

Notes: 1. Units conversion temp. for meas., 25°C. Model results include fixed estimates for background SO_2; the 99PC 1h background SO_2 were: 2015–39.3 μg/m³; 2016–15.7 μg/m³; 2017–23.4 μg/m³; 2018–26.2 μg/m³; and 2019–55.0 μg/m³.

The tabled results show there is a very low risk of SO_2 emissions from the Plant causing exceedances of the design criterion (450 μg/m³). AERMOD grid receptor results for 99.9th percentile 1-hour average SO_2 GLCs (μg/m³), are illustrated by the contour plot provided in Figure 6-6.

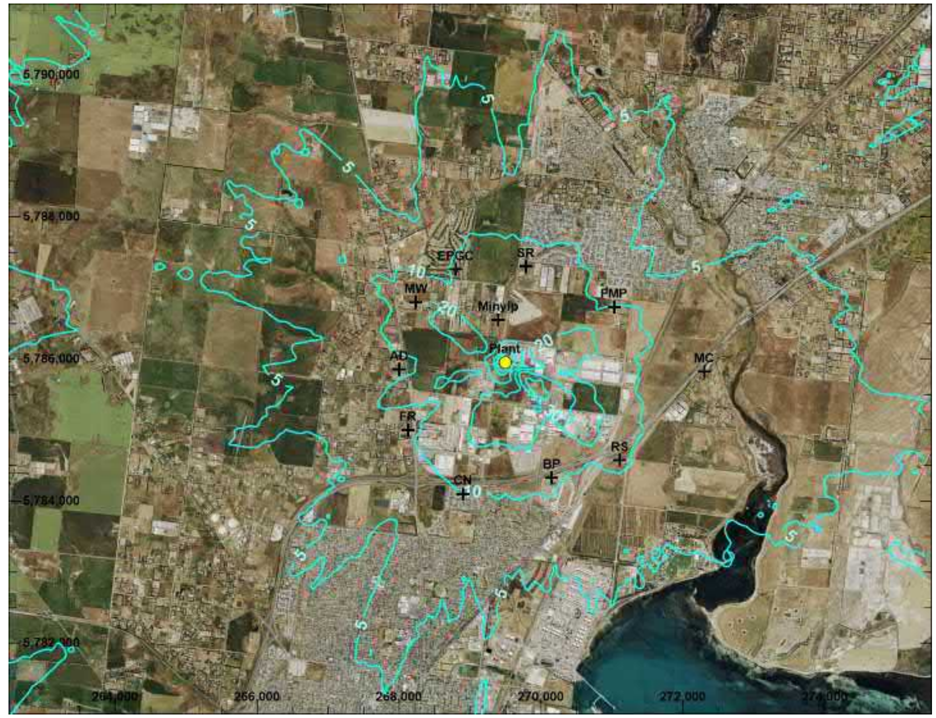


Figure 6-6: AERMOD Results for 99.9PC 1-Hour Average SO_2 (μg/m³)

- Example shown is worst-case (2018) met. simulation, excluding background. Maximum from contour plot: 45.3 μg/m³ (10.1% of design criterion).
- 9th-highest result from Top 100 Table: 45.5 μg/m³.
- For results including background see Table 6-6.

6.6 AERMOD Results: Particulate Matter 10

The maximum AERMOD results for 99.9PC 1-hour average PM_{10} GLCs (μg/m³), for the grid receptors (GR) and discrete receptors (DR) are listed in Table 6-7. AERMOD results including hourly background PM_{10} are shown alongside the monitoring results at EPA Geelong South in Table 6-8.

Table 6-7: AERMOD results: 99.9 PC 1-hour average PM_{10} without background

Year	GR maximum without background (μg/m³)	DR maximum without background (μg/m³)
2015	6.7	2.7
2016	6.8	2.7
2017	6.6	2.6
2018	6.8	2.7
2019	6.7	2.5

Table 6-8: Summary of results: 99.9 PC 1-hour average PM_{10} with background

Year	EPA Geelong South meas. (μg/m³)	Model GR max. (μg/m³)	Model DR max. (μg/m³)
2015	398	399	395
2016	223	226	223
2017	176	173	170
2018	249	253	250
2019	245	248	246
Standard	N/A	SEPP(AQM) design criterion 80 μg/m³	

Notes: Modelling included hourly-varying background PM_{10}.

The tabled results show the predicted PM_{10} concentrations were dominated by high background PM_{10} levels. High levels of measured PM_{10} can be due to raised dust and smoke (EPA, 2019). The EPA Geelong South PM_{10} data, which were used as input background to the modelling, may be affected by dust from a nearby racecourse car park and motorcycle track (EPA, 2012). AERMOD grid receptor results for 99.9th percentile 1-hour average PM_{10} GLCs (μg/m³), without background to highlight the effects of the Project only, are illustrated by the contour plot provided in Figure 6-7.

Figure 6-7: AERMOD Results for 99.9PC 1-Hour Average PM_{10} (μg/m³)

- Example shown is 2018 met. simulation (worst case), excluding background.
- Maximum from contour plot: 6.8 μg/m³ (8.5% of design criterion).
- 9th-highest result from Top 100 Table: 6.8 μg/m³.
- For results including background see Table 6-8.

6.7 AERMOD Results: Additional PM_{10}

The purpose of this section is to compare AERMOD results with SEPP (AAQ) 24-hour average (50 μg/m³) and annual average (20 μg/m³) environmental monitoring objectives for PM_{10}. These monitoring objectives are more widely used therefore better known than the SEPP (AQM) design criteria. The AERMOD results for 24-hour average PM_{10} concentrations are provided in Table 6-9 (without background) and Table 6-10 (with background).

Table 6-9: AERMOD results for max. 24-hour average PM_{10} without background

Year	GR maximum without background (μg/m³)	DR maximum without background (μg/m³)
2015	0.65	0.18
2016	0.65	0.17
2017	0.55	0.15
2018	0.42	0.22
2019	0.68	0.15

Table 6-10: Summary of results for max. 24-hour average PM_{10} without background

Year	EPA Geelong South max. meas. (μg/m³)	Model GR max. (μg/m³)	Model DR max. (μg/m³)
2015	286	286	286
2016	68.4	68.6	68.5
2017	73.7	73.5	73.4
2018	97.1	97.2	97.1
2019	102	102	102
Objective	N/A	SEPP (AAQ) Monitoring Objective 50 μg/m³	

Notes: Modelling included hourly average background PM_{10} from EPA Geelong South.

The tabled results show PM_{10} emissions from the Plant are very small in relation to the existing, high, background PM_{10} levels. The high PM_{10} levels listed in Table 6-10 are dominated by high background PM_{10}.

AERMOD results for maximum 24-hour average PM_{10} GLCs (μg/m³), without background, are illustrated by the contour plot provided in Figure 6-8.

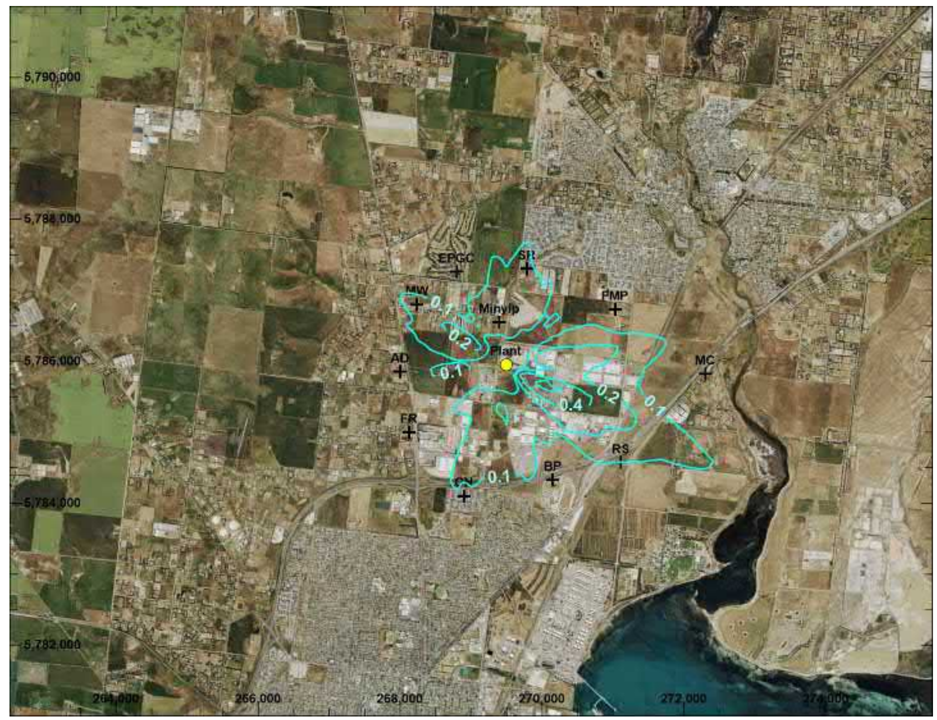


Figure 6-8: AERMOD Results for Max. 24-Hour Average PM_{10} (μg/m³)

- Example is 2019 met. simulation (worst case for 24-hour averages), excluding background; maximum GR result from contour plot: 0.68 μg/m³.
- For results including background see Table 6-12.

AERMOD results for annual average PM_{10} concentrations are provided in Table 6-11 (without background) and Table 6-12 (with background). The tabled results show the model-predicted annual average PM_{10} concentrations due to the plant are very small in relation to existing, high, background PM_{10} levels. Even with the high PM_{10} background levels included, there are no predicted exceedences of the SEPP (AAQ) monitoring objective for PM_{10}.

Table 6-11: AERMOD results for annual average PM_{10} without background

Year	GR maximum without background (µg/m³)	DR maximum without background (µg/m³)
2015	0.026	0.020
2016	0.034	0.021
2017	0.028	0.016
2018	0.030	0.020
2019	0.037	0.018

Table 6-12: Summary of results for annual average PM_{10}

Year	EPA Geelong South max. meas. (µg/m³)	Model GR max. (µg/m³)	Model DR max. (µg/m³)
2015	18.4	18.2	18.2
2016	17.3	17.3	17.3
2017	17.1	17.0	17.0
2018	19.7	19.7	19.7
2019	19.9	19.7	19.8
Objective	N/A	SEPP(AAQ) Monitoring Objective 20 µg/m³	

Notes: Modelling included hourly average background PM_{10} from EPA Geelong South.

AERMOD grid receptor results for annual average PM_{10} GLCs (µg/m³), without background, are illustrated by the contour plot provided in Figure 6-9. These model results are conservative (high) as they assume the Plant will operate all days of the year, whereas the capacity factor is approximately 90% (Section 4.9).

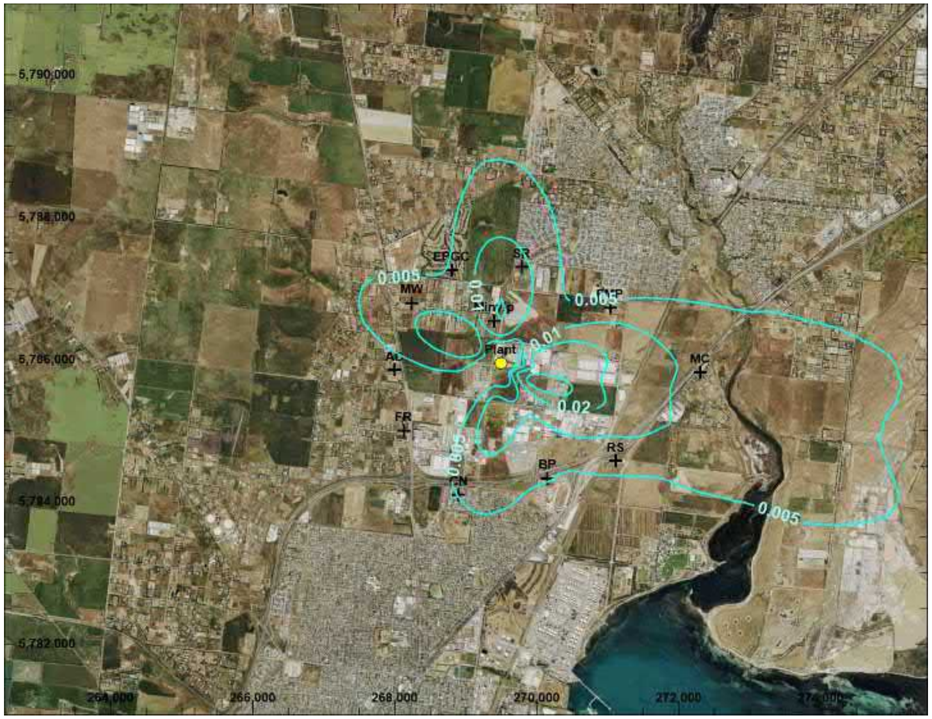


Figure 6-9: AERMOD Results for Annual Average PM_{10} (µg/m³)

- Example is 2019 met. simulation (worst case), excluding background; maximum from contour plot: 0.04 µg/m³.
- For results including background see Table 6-12.

6.8 AERMOD Results: Particulate Matter 2.5

The maximum AERMOD results for 99.9PC 1-hour average $PM_{2.5}$ GLCs (µg/m³), for the grid receptors (GR) and discrete receptors (DR) are listed in Table 6-13. AERMOD results including hourly background $PM_{2.5}$ are shown alongside the monitoring results at EPA Geelong South in Table 6-14.

Table 6-13: AERMOD results for 99.9 PC 1-hour average $PM_{2.5}$ without background

Year	GR maximum without background (µg/m³)	DR maximum without background (µg/m³)
2015	3.3	1.3
2016	3.4	1.3
2017	3.3	1.3
2018	3.4	1.3
2019	3.3	1.2

Table 6-14: Summary of results: 99.9 PC 1-hour average $PM_{2.5}$ with background

Year	EPA Geelong South meas. (µg/m³)	Model GR max. (µg/m³)	Model DR max. (µg/m³)
2015	33.1^F	33.7	33.6
2016	38.1^F	38.1	38.1
2017	43.5	40.2*	40.2*
2018	38.8	39.1	39.1
2019	44.6	44.6	44.6
Standard	N/A	SEPP (AAQ) Monitoring Objective 50 µg/m³	

Notes: Model results include hourly-varying background $PM_{2.5}$. 'F' - EPA Footscray data were included in the background $PM_{2.5}$ file used as input to modelling ($PM_{2.5}$ measurements commenced at Geelong South later in 2016).

The tabled results show the predicted $PM_{2.5}$ GLCs were dominated by high background $PM_{2.5}$; e.g., due to smoke from domestic wood burners (EPA, 2019).

The design criterion of 50 µg/m³ was not exceeded for any of the five annual meteorological simulations. AERMOD grid receptor results for 99.9th percentile 1-hour average $PM_{2.5}$ GLCs (µg/m³), without background to highlight the effects of the Project only, are illustrated by the contour plot provided in Figure 6-10.

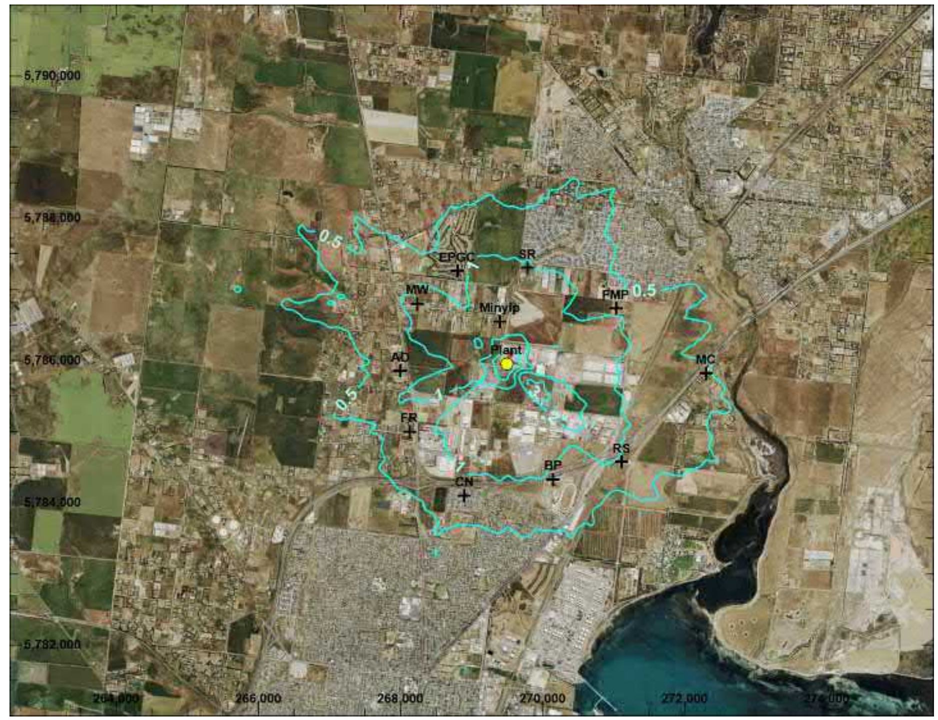


Figure 6-10: AERMOD Results for 99.9PC 1-Hour Average $PM_{2.5}$ (µg/m³)

- Example is 2018 met. simulation (worst case), excluding background. Maximum from contour plot: 3.4 µg/m³ (6.8% of design criterion).
- 9th-highest result from Top 100 Table: 3.4 µg/m³.
- For results including background see Table 6-14.

6.9 AERMOD Results: Additional $PM_{2.5}$

The purpose of this section is to compare AERMOD results with SEPP (AAQ) 24-hour average (25 µg/m^3) and annual average (8 µg/m^3) environmental monitoring objectives for $PM_{2.5}$. These monitoring objectives are more widely used therefore better known than the SEPP (AQM) design criteria. AERMOD results for 24-hour average $PM_{2.5}$ concentrations are provided in Table 6-15 (without background) and Table 6-16 (with background).

Table 6-15: AERMOD results for max. 24-hour average $PM_{2.5}$ without background

Year	GR maximum without background (µg/m^3)	DR maximum without background (µg/m^3)
2015	0.326	0.090
2016	0.323	0.070
2017	0.275	0.075
2018	0.212	0.092
2019	0.339	0.076

Table 6-16: Summary of results for max. 24-hour average $PM_{2.5}$ with background

Year	EPA Geelong South meas. (µg/m^3)	Model GR max. (µg/m^3)	Model DR max. (µg/m^3)
2015	23.3	23.5	23.5
2016	25.9	26.0	25.9
2017	26.8	26.6	26.6
2018	31.0	30.8	30.8
2019	32.7	32.7	32.7
Standard	N/A	SEPP (AAQ) Monitoring Objective 25 µg/m^3	

Notes: Modelling included hourly average background PM_{10} from EPA Geelong South and EPA Footscray. Monitoring data from Footscray were used as background for 2015 and the majority of 2016 in the absence of Geelong South data for those periods.

The tabled results show $PM_{2.5}$ emissions from the Plant are very small in relation to the existing, high, background $PM_{2.5}$ levels. The results for $PM_{2.5}$ listed in Table 6-16 are dominated by high background $PM_{2.5}$.

AERMOD grid receptor results for maximum 24-hour average $PM_{2.5}$ GLCs (µg/m^3), without background, are illustrated by the contour plot provided in Figure 6-11.

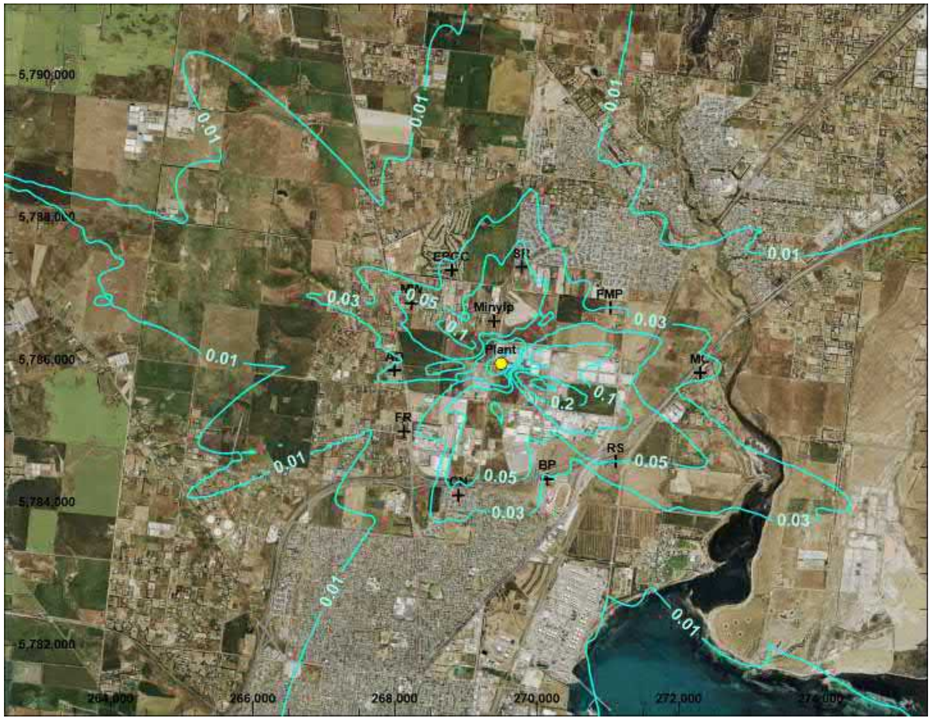


Figure 6-11: AERMOD Results for Max. 24-Hour Average $PM_{2.5}$ (µg/m^3)

- Example is 2019 met. simulation (worst case for 24-hour averages), excluding background; maximum GR result from contour plot: 0.34 µg /m^3.
- For results including background see Table 6-16.

AERMOD results for annual average $PM_{2.5}$ concentrations are provided in Table 6-17 (without background) and Table 6-18 (with background).

Table 6-17: AERMOD results for annual average $PM_{2.5}$ without background

Year	GR maximum without background (µg/m³)	DR maximum without background (µg/m³)
2015	0.013	0.010
2016	0.017	0.010
2017	0.014	0.008
2018	0.015	0.010
2019	0.018	0.009

Table 6-18: Summary of results for annual average $PM_{2.5}$

Year	EPA Geelong South meas. (µg/m³)	Model GR max. (µg/m³)	Model DR max. (µg/m³)
2015	8.6	8.6	8.6
2016	6.8	6.8	6.8
2017	7.9	7.8	7.8
2018	6.6	6.6	6.6
2019	6.4	6.4	6.4
Standard	N/A	SEPP(AAQ) Monitoring Objective 8 µg/m³	

Notes: Modelling included hourly average background PM_{10} from EPA Geelong South and EPA Footscray. Monitoring data from Footscray were used as background for 2015 and the majority of 2016 in the absence of Geelong South data for those periods.

The tabled results show the model-predicted annual average $PM_{2.5}$ concentrations due to the Plant are very small in relation to existing, high, background $PM_{2.5}$. With the high background included there are exceedences of the SEPP (AAQ) monitoring objective for $PM_{2.5}$ (8 µg/m³) for the 2015 simulation, and exceedences of the 2025 monitoring objective (7 µg/m³) for the 2015 and 2017 simulations; again, primarily due to the high background $PM_{2.5}$ levels.

AERMOD grid receptor results for annual average $PM_{2.5}$ GLCs (µg/m³), without background, are illustrated by the contour plot provided in Figure 6-12. These results are conservative (high) as they assume the Plant will operate all days of the year, whereas the capacity factor is approximately 90% (Section 4.9).

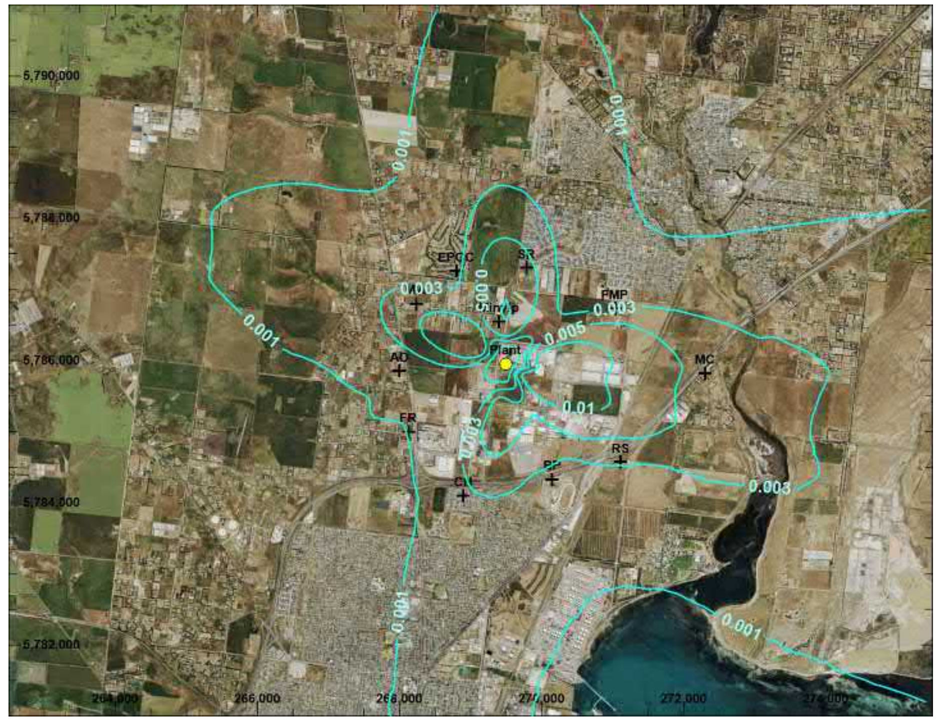


Figure 6-12: AERMOD Results for Annual Average $PM_{2.5}$ (µg/m³)

- Example is 2019 met. simulation (worst case), excluding background
- Maximum from contour plot: 0.018 µg/m³.
- For results including background see Table 6-18.

6.10 AERMOD Results: Hydrogen Fluoride

The AERMOD results for maximum 24-hour average hydrogen fluoride (HF) GLCs (μg/m^3) due to emissions from the Plant, (using the 24-hour average emission limit 1 mg/Nm^3), are listed in Table 6-19. Background HF concentrations are expected to be approximately 0.1 μg/m^3, assuming insignificant influences from other industrial sources (Section 0). Even using a higher background HF concentration of 1 μg/m^3, the design criterion is not exceeded.

Table 6-19: AERMOD results for max. 24-hour average HF (without background)

Simulation	GR maximum (μg/m^3)	DR maximum (μg/m^3)
2015	0.13	0.04
2016	0.13	0.03
2017	0.11	0.03
2018	0.09	0.04
2019	0.14	0.03
Design criterion, max. 24h avg.	2.9	2.9

Note: Results exclude background, worst-case expected to be approximately 1 μg/m^3.

Results for the two other design criteria were estimated based on the AERMOD results for maximum 24-hour average HF and annual average HF. The results without background are shown in Table 6-20 (maximum 7-day average) and Table 6-21 (maximum 90-day average). There were no exceedances of the design criteria, assuming a background HF level of 0.1 μg/m^3 for these longer averaging periods.

The emission estimate used for the assessment of HF, for all averaging periods, was the EC (2019b) emission limit of 1 mg/Nm^3, which is conservative (high) for the 7-day and 90-day averages.

Table 6-20: AERMOD results for maximum 7-day average HF (without background)

Simulation	GR maximum (μg/m^3)	DR maximum (μg/m^3)
2015	0.04	0.017
2016	0.05	0.017
2017	0.04	0.014
2018	0.04	0.020
2019	0.05	0.015
Design criterion, max. 7-day avg.	1.7	1.7

Note: Results exclude background, expected to be approximately 0.1 μg/m^3.

Table 6-21: AERMOD results for maximum 90-day average HF (without background)

Simulation	GR maximum (μg/m^3)	DR maximum (μg/m^3)
2015	0.01	0.007
2016	0.01	0.007
2017	0.01	0.005
2018	0.01	0.007
2019	0.01	0.006
Design criterion, max. 90-day avg.	0.5	0.5

Note: Results exclude background, expected to be approximately 0.1 μg/m^3.

6.11 AERMOD Results: Other Substances (Non-Metals)

A suite of other substances was assessed for the Project based on the substances and emissions limits provided in EU (2010) and EC (2019b). The list includes hydrogen chloride (HCl), ammonia (NH_3), dioxins and furans, Polycyclic Aromatic Hydrocarbons (PAH) as Benzo(a)Pyrene or B(a)P, Total Volatile Organic Compounds (TVOC), and metals such as cadmium (Cd), chromium (Cr), and lead (Pb). In general, the background levels of these substances are small, to the extent they are near or less than their measurement limits of detection. For reasons of brevity, this section provides a summary of results for these remaining substances, focussing on assessment of the maximum AERMOD results in each case.

Most of the SEPP (AQM) design criteria for the substances assessed in this section were 99.9th percentile, 3-minute averages. The corresponding EU (2010) emissions limits with their shorter averaging periods were used to set input emissions. Also, as AERMOD is limited to producing hourly average GLCs, a conservative (high), point source, peak-to-mean ratio was applied to the AERMOD results in each case where hourly averages needed to be converted to 3-minute averages. A conservative (high) peak-to-mean ratio of 2.88 was calculated for a point source using a calculation detailed by Borgas (2000). (The EfW stack is a 'point source' as opposed to a volume source, area source, or other source type).

A summary of the AERMOD results for HCl, NH3, dioxins and furans, PAH as B(a)P and TOC as formaldehyde, and their SEPP (AQM) design criteria, are provided in Table 6-22.

Table 6-22: Summary of results: HCl, NH3, dioxins and furans, PAH and TVOC

Pollutants	Emission estimate for modelling[1] (mg/Nm^3)	GR max. without background[2] (μg/m^3)	DR max. without background (μg/m^3)	SEPP AQM 2001 DC (μg/m^3)[3]	Worst case AERMOD result; fraction of DC
HCl	60	38.9	15.2	250	15.6%
NH_3	30	19.4	7.6	600	3.2%
Dioxins & furans[4]	1.1 x 10^{-7}	7.1E-08	2.8E-08	3.7E-06	1.9%
PAH as B(a)P[5]	0.010	6.5E-03	2.5E-03	0.73	0.9%
TOC as formaldehyde[6]	20	13.1	5.1	40 (formaldehyde)[6]	33%

Notes:
1. Emissions for modelling based on higher emissions limits of EU (2010) and shorter averaging periods.
2. AERMOD results from the 'Top 100 Table' are only 0.3% higher than maximum GR results shown.
3. Design criteria are 99.9th percentile 3-minute averages, except for lead (Pb; 1-hour average).
4. Dioxins and furans emissions estimate based on 6-8h average limit, 0.1 ng/Nm3 (EU, 2010).
5. EC (2019a) Typical maximum PAH emission for many European plants is 10 μg/Nm3; typical average emission 1 μg/Nm3.
6. Hydrocarbon (TOC) emission was assumed 100% formaldehyde (conservative).

6.12 AERMOD Results: Metals

There are three groups of metals for assessment (see Table 2-1); for convenience the groups are repeated here, with the averaging period described as a 24-hour average or 'sampling period':

(1) Combined Cd and Tl total not to exceed 0.02 mg/Nm^3;

(2) Mercury not to exceed 0.02 mg/Nm^3; and

(3) The total, Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V, not to exceed 0.3 mg/Nm^3.

All the metals listed in groups (1) to (3) have SEPP (AQM) design criteria that are 99.9th percentile 3-minute averages, except for lead (Pb), which has a 1-hourly average. The group limits were split into emissions estimates for the individual metals to enable assessment by comparisons with the design criteria. Review of EC (2019b) and a review of the EfW literature was undertaken to ensure the emission estimate for each of the metals was reasonably high and conservative.

A summary assessment of the AERMOD results for the metals, by comparisons with their design criteria, is provided in Table 6-19; for brevity, only the highest AERMOD results are listed. The fractions of the EC (2019b) emissions limits determined for input to the modelling are provided in column 2. All the AERMOD results include a peak-to-mean ratio of 2.88 for the single point source to convert AERMOD's hourly averages to 3-minute averages to enable comparisons with the 3-minute design criteria; except for lead, which has a 1-hour average design criterion.

Table 6-23: Summary assessment of AERMOD results for individual metals

Pollutants	EC (2019b) Emission Limit (mg/Nm^3)	Emission estimate for modelling[1] (mg/Nm^3) and fraction of EU limit	AERMOD result without background[2] (µg/m^3)	SEPP AQM 2001 DC (µg/m^3)	Assessment: fraction of DC
Cd	0.02	0.02 (100%)	0.013	0.033	39.4%
Tl	0.02	0.01 (50%)	0.007	n/a	n/a
Hg	0.02	0.02 (100%)	0.013	0.33 (organic) 3.3 (inorganic)	3.9% 0.39%
Sb	0.3	0.03 (10%)	0.020	17	0.1%
As	0.3	0.06 (20%)	0.039	0.17	22.9%
Pb	0.3	0.3 (100%)	0.068	3 (1-hour avg.)	2.3%
Cr III	0.3	0.06 (20%)	0.039	17	0.2%
Cr VI	0.3	0.06 (20%)	0.039	0.17	22.9%
Co	0.3	0.003 (1%)	0.002	No criterion	n/a
Cu	0.3	0.3 (100%)	0.195	6.7	2.9%
Mn	0.3	0.06 (20%)	0.039	33	0.1%
Ni	0.3	0.06 (20%)	0.039	0.33	11.8%
V	0.3	0.003 (1%)	0.002	No criterion	n/a

Notes: The AERMOD results listed are from the 'Top 100 Table' results in accordance with SEPP (AQM) procedures; as noted previously these results are only 0.3% greater than the maximum GR results (very similar to maximum GR results).

In relation to the first EU metals group, Cd+Tl, with emissions limit 0.02 mg/Nm^3; review of the literature indicated the majority of Cd+Tl emissions from EfW is Cd, therefore the assessment for cadmium was based on 100% of the EC (2019b) emission limit. There is no SEPP (AQM) design criterion for thallium (Tl), therefore no assessment could be made. However, the AERMOD result for Tl is small and the impact from Tl emissions is not expected to be as great as if from 100% Cd, which was assessed.

The EU emissions limits do not distinguish between organic and inorganic Hg. The maximum emission was assessed against both design criteria for Hg.

In relation to the second EU metals group: Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V; from a review of the EfW literature including EC (2019a), assessment of the individual metals was by conservative (high) estimates of fractions of the emission limit of 0.3 mg/Nm^3. The more conservative of the design criteria, 'copper fume', was used for the assessment of copper.

To conclude, AERMOD-predicted GLCs for the individual metals did not exceed design criteria, using the fractions of emissions limits shown. The highest risk metals/elements were identified as cadmium (Cd), arsenic (As), chromium-6 (Cr VI), and nickel (Ni), with their fractions of the design criteria shown in bold in Table 6-19.

7. Summary and Conclusion

PHI proposes to construct and operate an EfW Plant at its Prospect Hill site, between the small townships of Lara and Corio, north of the larger urban area of Geelong. It is proposed the Plant will use modern, moving-grate, boiler technology to recover energy by combusting approximately 400,000 tpa of MSW and C&IW, comprising approximately 80% MSW and 20% MSW-like C&I waste. The Plant will provide electricity at a maximum rate of approximately 36 MWe.

The Project has two aims: (1) to provide a facility for the improved treatment of MSW and C&I waste compared to landfilling; and (2) to generate electricity for export to the electricity network. The treatment of waste in the Plant will be by combustion using proven and reliable engineering technology and emissions controls, as demonstrated by many similar facilities around the world.

In Europe, emissions to air from EfW plants are regulated by the IED (EU, 2019b). EPA (2017a) requires discharges from EfW plants developed and operated in Victoria to meet the IED emission limits under both steady and non-steady state operating conditions. The European IED aims to achieve a high level of general protection for human health and the environment by reducing harmful industrial emissions across the EU through the application of BAT for air emissions controls. A similar, high level of protection is anticipated for the environment in Victoria where the IED will be applied.

The potential air emissions were analysed and estimated following the EPA's guidelines: *Energy from waste* (EPA, 2017a), and *Demonstrating Best Practice* (EPA, 2017b).

An air quality impact assessment was undertaken for the Project in accordance with the SEPP (AQM) and EPA guidelines for use of the regulatory model, AERMOD. A precedent for the assessment methodology was the air quality assessment completed for the Australian Paper Maryvale Energy from Waste proposal (EPA, 2018). The EPA was consulted about the project and the proposed air quality assessment methods in March, 2020. EPA's feedback on the assessment was incorporated in the methods used for this assessment.

A conservative strategy was applied for the assessment based on testing air pollutant emissions from the proposed EfW with approximately 40,000 possible, hourly meteorological conditions. Key aspects of the air quality impact assessment undertaken for the Project were:

- A conservative approach was used to estimate emissions for each substance based on a review of the literature, with a focus on the EC (2019a) studies of many operating EfW plants in Europe.
- Air pollutant emissions from the tall stack were modelled as a continuous source; i.e. for all hours in each of the five simulated years, whereas the Plant's (annual) capacity factor may be as low as 90% (Section 4.9).
- The modelling included wake and downwash effects associated with the Plant's main buildings and stack.
- The combined effects of the Project emissions plus estimates for background based on local measurements represent the expected, cumulative (total), worst-case, air quality impacts.

The assessment concludes that the emissions to air from the proposed EfW Plant are minimal, with no adverse air quality impacts anticipated. Table 7.1 shows the key emissions from the EfW Plant and the compliance with relevant legislative requirements. Emissions from the EfW Plant will meet all IED and SEPP (AQM) emission limits. The air quality assessment results for all substances are also summarised in the following table and paragraphs.

Table 7.1: Summary of emissions

Parameter	Averaging time	Maximum grid receptor result ($\mu g/m^3$)	Design criterion (or objective) ($\mu g/m^3$)	Fraction of design criterion (or objective)
CO	1-hour average	1602	29,000	5.5%

Parameter	Averaging time	Maximum grid receptor result (μg/m³)	Design criterion (or objective) (μg/m³)	Fraction of design criterion (or objective)
NO_2	1-hour average	68.0	190	35.8%
SO_2	1-hour average	100	450	22.2%
PM_{10}	1-hour average	399	80 (SEPP AQM)	499%
PM_{10}	24-hour average	286	50 (SEPP AAQ)	572%
PM_{10}	Annual average	19.9	20 (SEPP AAQ)	99.5%
$PM_{2.5}$	1-hour average	44.6	50 (SEPP AQM)	89.2%
$PM_{2.5}$	24-hour average	32.7	25 (SEPP AAQ)	1.36%
$PM_{2.5}$	Annual average	8.6	8 (SEPP AAQ)	107.5%
HF	24-hour average	0.14	2.9	4.83%
HF	7-day average	0.05	1.7	2.9%
HF	90-day average	0.01	0.5	2.0%
HCl	3-minute	38.9	250	15.6%
NH_3	3-minute	19.4	600	3.2%
Dioxins & furans[4]	3-minute	7.1E-08	3.7E-06	1.9%
PAH as B(a)P[5]				
TOC as formaldehyde[6]	3-minute	13.1	40 (formaldehyde)[6]	33%
Metals				
Cd	3-minute	0.013	0.033	39.4%
Tl	n/a	0.007	n/a	n/a
Hg	3-minute	0.013	0.33 (organic) 3.3 (inorganic)	3.9% 0.39%
Sb	3-minute	0.020	17	0.1%
As	3-minute	0.039	0.17	22.9%
Pb	1-hour	0.068	3 (1-hour avg)	2.3%
Cr III	3-minute	0.039	17	0.2%
Cr VI	3-minute	0.039	0.17	22.9%
Co	n/a	0.002	No criterion	n/a
Cu	3-minute	0.195	6.7	2.9%
Mn	3-minute	0.039	33	0.1%

Carbon monoxide (CO)

The AERMOD results demonstrated that CO emissions from the Plant will have only a small effect on existing levels of CO and will not cause any exceedances of the SEPP (AQM) design criterion (29 milligram/m³). EPA Geelong South monitoring data show that all CO concentrations have been low, with the majority of CO concentrations less than 10% of standards. There is a very low risk of the Project causing air quality impacts due to CO emissions.

Nitrogen dioxide (NO_2) and ozone (O_3)

Most NO_2 in the atmosphere does not originate directly from combustion – NO_x from the combustion of fuels (including waste) comprises mostly NO and smaller amounts of NO_2. In the atmosphere, NO may be oxidised to NO_2 by a reaction with ambient O_3; there is always some ambient O_3 available for this reaction. Monitoring of ambient NO_2 at EPA Geelong South shows that, in general, NO_2 concentrations are low, with the monitoring standard for NO_2 not exceeded at any time over 2014-2019. Maximum hourly averages over the whole period were less than 50% of the monitoring standard.

The AERMOD results for NO_x emissions from the Plant were assessed assuming a NO_2/NO_x conversion ratio of 30% to determine the Plant contributions, which were added to the hourly-varying, background NO_2. Collectively, the AERMOD results showed that NO_x emissions from the Plant are unlikely to cause exceedances of the SEPP (AQM) design criterion. There were no exceedances of the design criterion for NO_2.

Sulfur dioxide (SO_2)

The SO_2 monitoring results from EPA Geelong South over 2014-2019 were low, demonstrating a low risk of air quality impact from this substance. The AERMOD results for SO_2, including a conservative, high estimate for background, did not cause any exceedances of the design criterion.

Particulate Matter 10 (PM_{10})

EPA Geelong South and EPA Footscray monitoring data show existing, high concentrations of PM_{10} for the Project study area due to a variety of sources; e.g., raised dust, and fires. Over a 6-year period to the end of 2019 there were between 3-11 exceedance days per year at Geelong South, and up to 7 exceedance days per year at EPA Footscray. None of the annual averages exceeded the SEPP (AAQ) objective for annual average PM_{10} (20 $\mu g/m^3$).

The AERMOD results for PM_{10} due to emissions from the Plant including the hourly-varying, background PM_{10} concentrations, showed the results were heavily dominated by high existing background levels. The Plant will employ BAT controls on the particulate emissions from the stack, so the PM_{10} emissions will be low. The AERMOD results showed emissions from the Plant are unlikely to cause additional exceedances of the design criterion and the SEPP (AAQ) monitoring objectives. Contributions of PM_{10} from the Plant were small relative to the very high PM_{10} background. To conclude, contributions of PM_{10} from the Plant were small relative to the existing high PM_{10} background levels.

Particulate Matter 2.5 ($PM_{2.5}$)

The EPA Geelong South and EPA Footscray monitoring data showed existing, high $PM_{2.5}$ concentrations for the Project study area (the case is similar to PM_{10}). Sources of the high background $PM_{2.5}$ levels include road traffic (i.e., petrol and diesel combustion), domestic wood burning, and, occasionally, controlled burns and bushfires that could be distant from Geelong and Lara. Measurements of $PM_{2.5}$ were obtained at Geelong South over 2016-2019 and 2014-2019 at EPA Footscray. Over these monitoring periods, there were up to 2 exceedance days per year at Geelong South, and up to 4 exceedance days at EPA Footscray. However, none of the annual averages exceeded the SEPP (AAQ) objective for annual average $PM_{2.5}$ (8 $\mu g/m^3$). The annual average objective will be lowered to 7 $\mu g/m^3$ in 2025.

The AERMOD results for $PM_{2.5}$ due to emissions from the Plant were similar to those for PM_{10}. The $PM_{2.5}$ results included hourly-varying, background $PM_{2.5}$ levels; the combined results were heavily dominated by the high existing background levels. The AERMOD results showed emissions from the Plant are unlikely to cause additional exceedances of the design criterion and the SEPP (AAQ) monitoring objectives. To conclude, contributions of $PM_{2.5}$ from the Plant were small relative to the existing very high $PM_{2.5}$ background.

Hydrogen Fluoride (HF)

The AERMOD results for HF, using a conservative (high) emissions estimate, did not cause exceedances of the SEPP (AQM) design criteria for maximum 24-hour average, maximum 7-day average, and maximum 90-day average HF concentrations. The modelling shows there is a low risk of air quality impact due to the HF emissions from the Plant.

Other substances

A suite of other substances was assessed for the Project using emissions estimates based on the substance lists and emissions limits provided in EU (2010) and EC (2019b). These were: hydrogen chloride (HCl), ammonia (NH_3), dioxins and furans, PAHs as B(a)P, and hydrocarbons or TOCs, and metals such as cadmium, chromium, lead, and nickel. In general, the background levels of these substances are small, to the extent they are close to or less than their measurement limits Of detection.

Other substances – non metals

There were no exceedances of SEPP (AQM) design criteria for HCl, NH_3, dioxins and furans, PAHs as B(a)P, and hydrocarbons. In the case of hydrocarbons, 100% of the TOC was assumed to be formaldehyde, a conservative step in the assessment given this is generally a higher risk hydrocarbon in combustion products.

Other substances – metals

There were no exceedances of SEPP (AQM) design criteria, (where criteria were available), for all the metals. In relation to the first IED metals group total, (Cd+Tl), with emissions limit 0.02 mg/Nm^3; review of the literature indicated the majority of Cd+Tl emissions from EfW is Cd, therefore the assessment for Cd was based on 100% of the EC (2019b) emission limit. There is no SEPP (AQM) design criterion for thallium (Tl), therefore no assessment could be made.

The IED emissions limits do not distinguish between organic and inorganic mercury (Hg). The maximum emission was assessed against both SEPP (AQM) design criteria for Hg. The risk of air quality impact from all Hg was found to be low.

In relation to the second IED metals group total: Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V; assessment of the individual metals was by conservative (high) estimates of fractions of the total emission. The more conservative of the design criteria for copper (Cu), 'copper fume', was used for assessment. The different averaging period for lead (Pb), was accounted.

None of the AERMOD-predicted GLCs for the individual metals exceeded their SEPP (AQM) design criteria (where criteria were available), using the emissions estimates described. While there were no exceedances of design criteria, the highest risk metals/elements were identified as: highest-risk – cadmium (Cd); equal second-highest risk – arsenic (As) and chromium-6 (Cr VI); and third-highest risk – nickel (Ni).

Conclusion

The air quality modelling assessment demonstrates that there is a low risk of air quality impact from the Project's emissions. The assessment shows that the emissions of all substances from the EfW Plant will meet all IED and SEPP (AQM) emission limits. The assessment also shows that the EfW Plant emissions will meet all ground level concentration Design Criteria for all substances, as specified in SEPP (AQM).

Emissions of air toxics such as IARC Group 1 carcinogens hexavalent chromium (Cr(VI)), cadmium (Cd) and mercury (Hg) were investigated for this assessment. Model results for all of the carcinogens showed that the GLCs due to the EfW Plant are below the relevant SEPP(AQM) design criteria and most are many times below their criterion.

This air quality impact assessment analysed a large number of air pollutants by using conservative (high) estimates of emissions by individual substances, combined with air dispersion modelling. Emissions of air pollutants from the proposed Plant are minimal in relation to existing air quality impacts and air quality standards. Emissions from the EfW Plant will meet all IED and SEPP (AQM) emission limits.

The assessment showed that there are periods when there are high existing levels of PM_{10} and $PM_{2.5}$ in the region and that the SEPP (AQM) design criteria are already exceeded on some occasions due to these existing high background levels. Apart from PM_{10} and $PM_{2.5}$, predicted air emissions from the Plant caused no exceedances of the SEPP (AQM) design criteria, as tested by AERMOD. The AERMOD results showed that emissions of PM_{10} and $PM_{2.5}$ are unlikely to cause additional exceedances of their design criteria, with the results heavily dominated by the high background levels.

Monitoring shows that existing levels of PM_{10} and $PM_{2.5}$ are high due to sources such as raised dust, smoke from fires and wood burning, and road traffic. These background levels are very high relative to the small contributions expected from the Plant, which will employ world's best practice, Best Available Techniques emissions controls. Further, the modelling showed that particulate emissions from the Plant are unlikely to cause additional exceedances of the SEPP (AAQ) maximum 24-hour average and annual average monitoring objectives.

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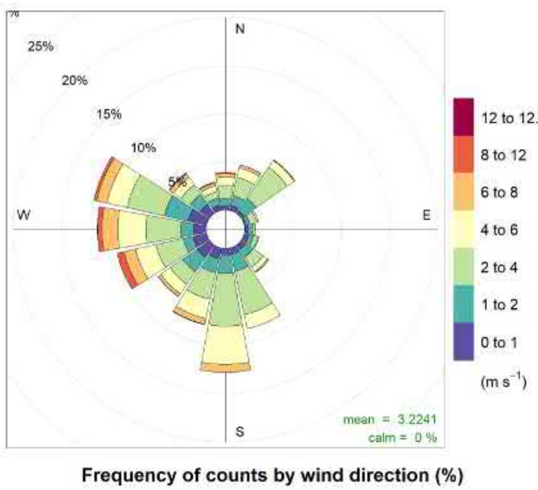
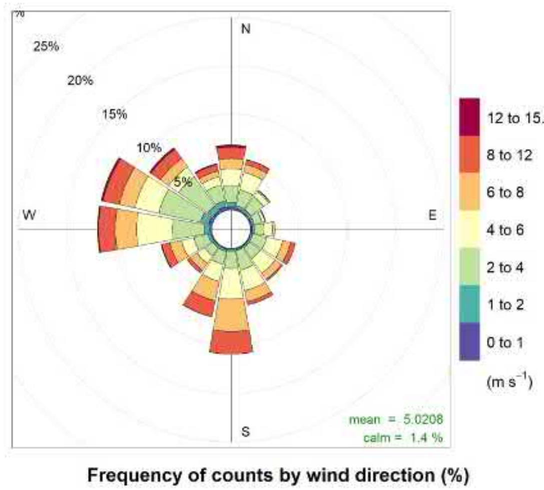
Appendix A. Wind Roses

A.1 BoM Avalon Airport and EPA Geelong South – Annual Wind Roses

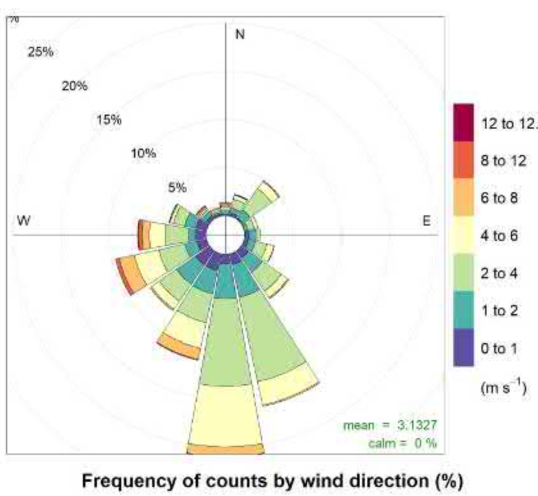
This sub-section provides annual wind rose results for EPA Geelong South (left) and BoM Avalon Airport (right).



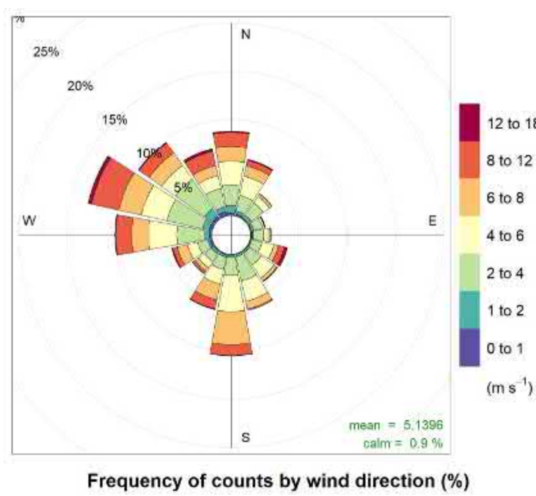
EPA Geelong South 2015; ws_{avg} = 3.2 m/s



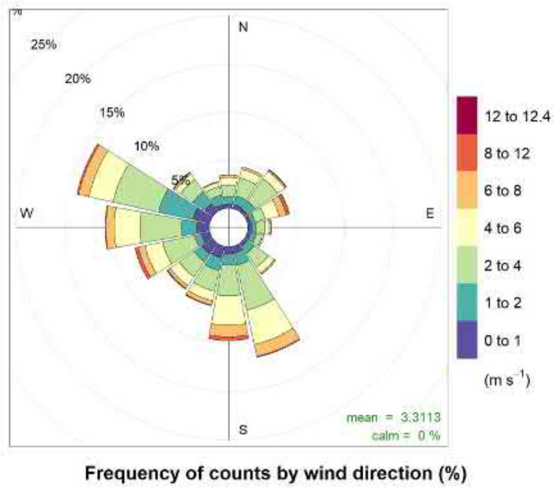
BoM Avalon Airport 2015; ws_{avg} = 5.0 m/s



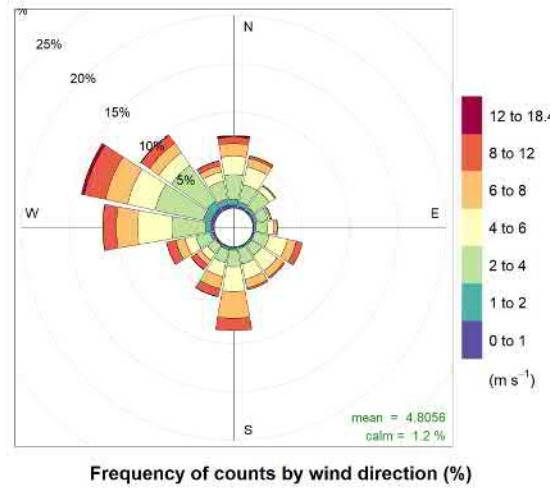
EPA Geelong South 2016; ws_{avg} = 3.1 m/s



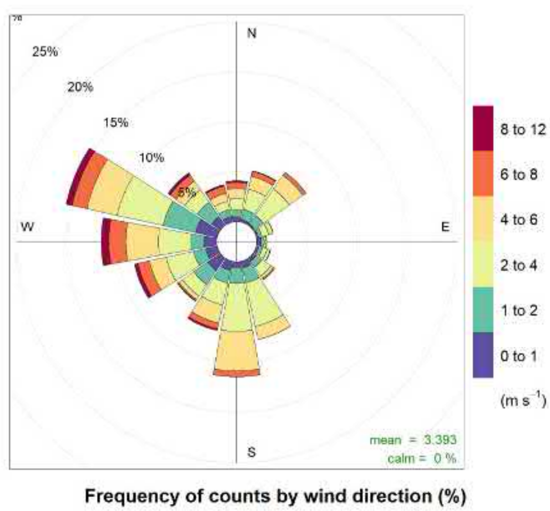
BoM Avalon Airport 2016; ws_{avg} = 5.1 m/s



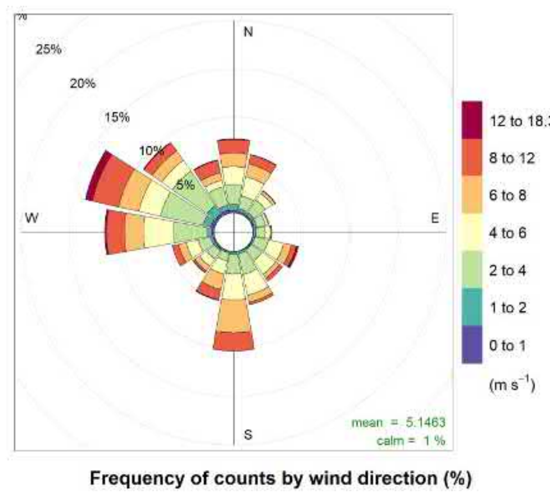
EPA Geelong South 2017; ws_{avg} = 3.3 m/s



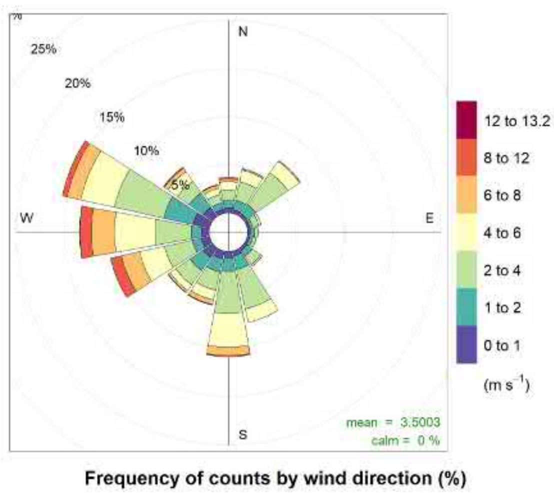
BoM Avalon Airport 2017; ws_{avg} = 4.8 m/s



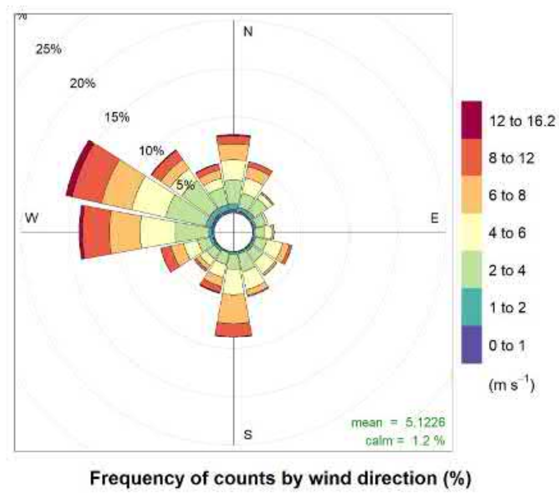
EPA Geelong South 2018; ws_{avg} = 3.4 m/s



BoM Avalon Airport 2018; ws_{avg} = 5.1 m/s



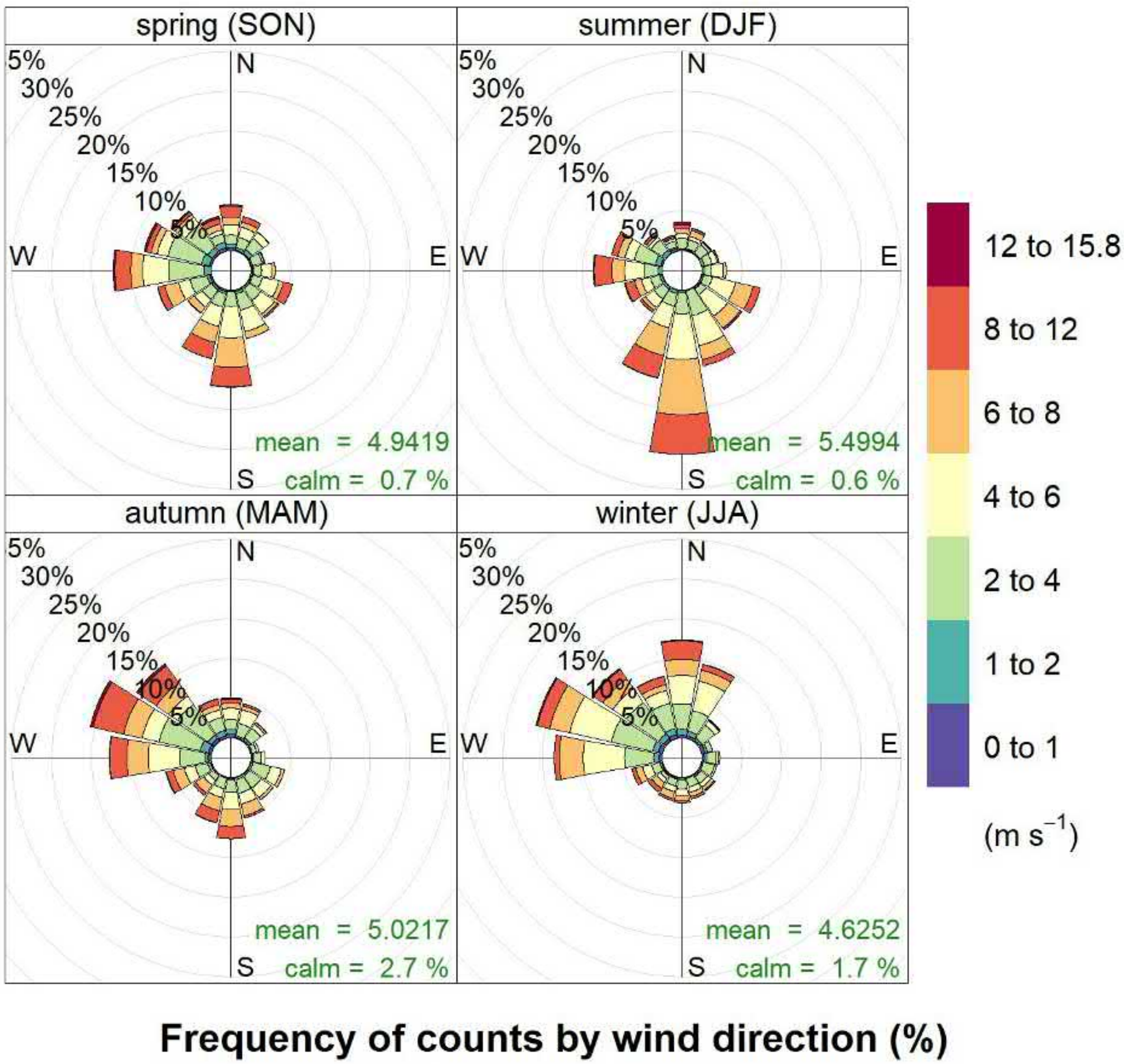
EPA Geelong South 2019; ws_{avg} = 3.5 m/s



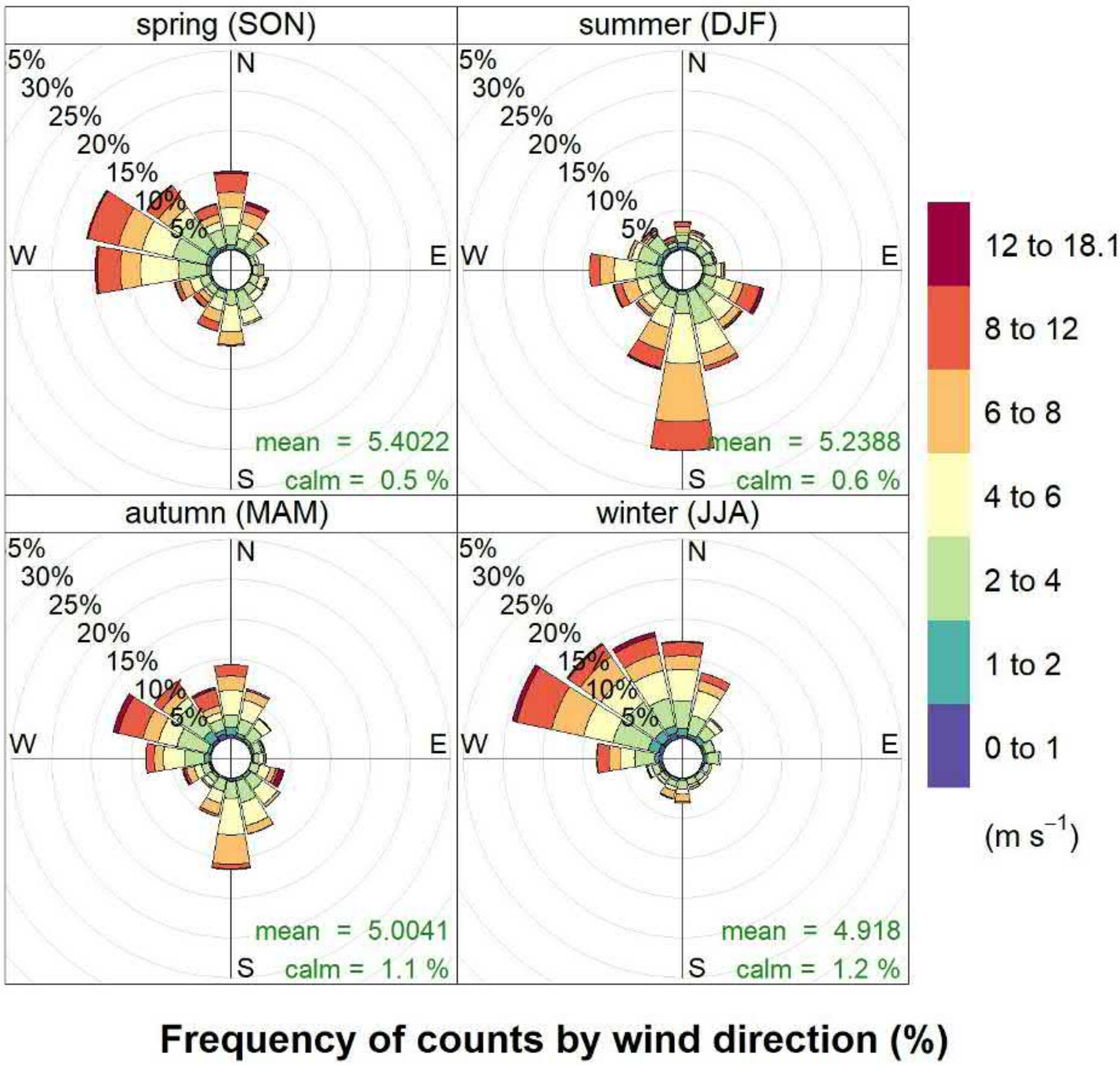
BoM Avalon Airport 2019; ws_{avg} = 5.1 m/s

A.2 BoM Avalon Airport – Seasonal Wind Roses

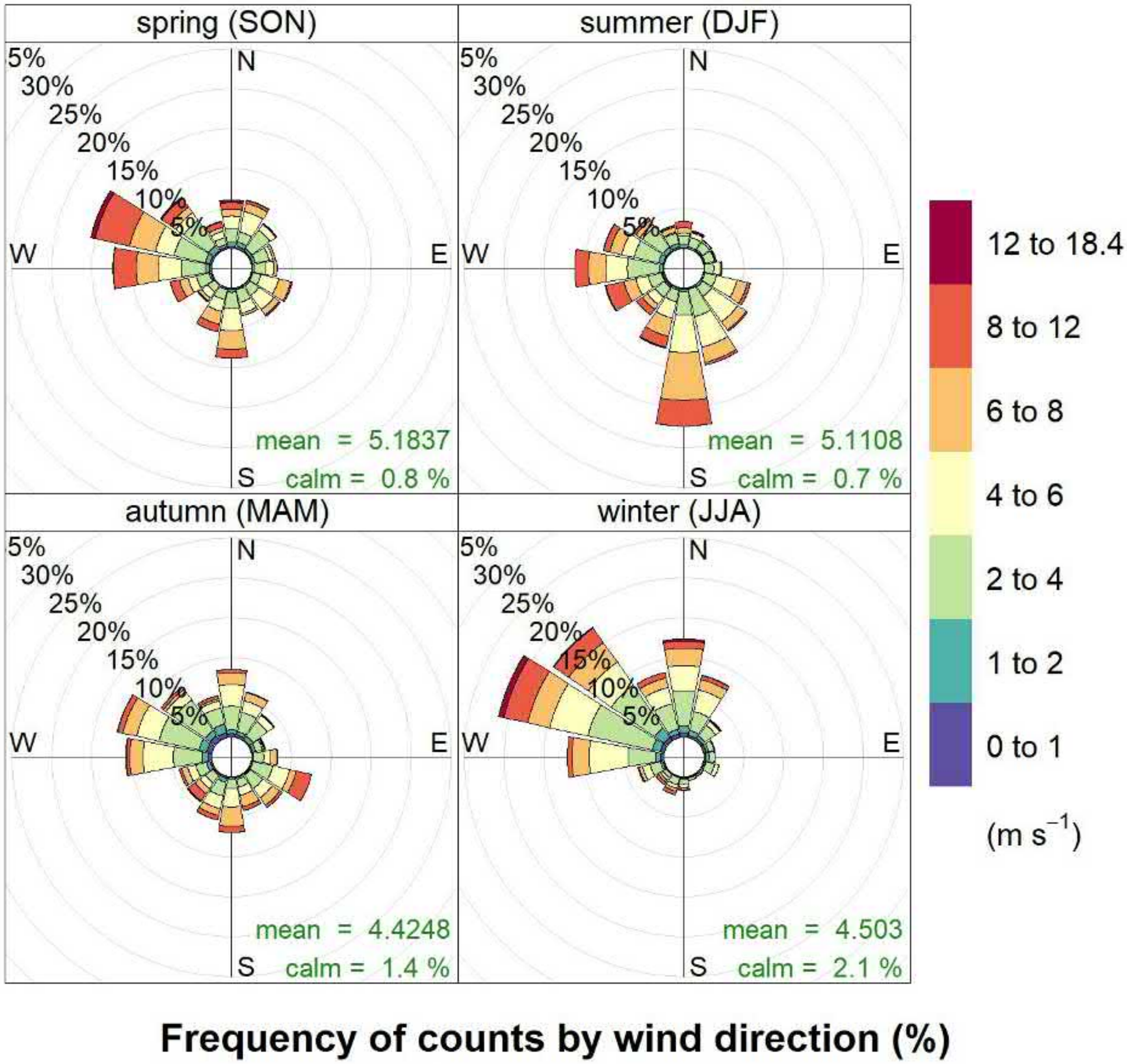
This sub-section provides seasonal wind rose results for BoM Avalon Airport.



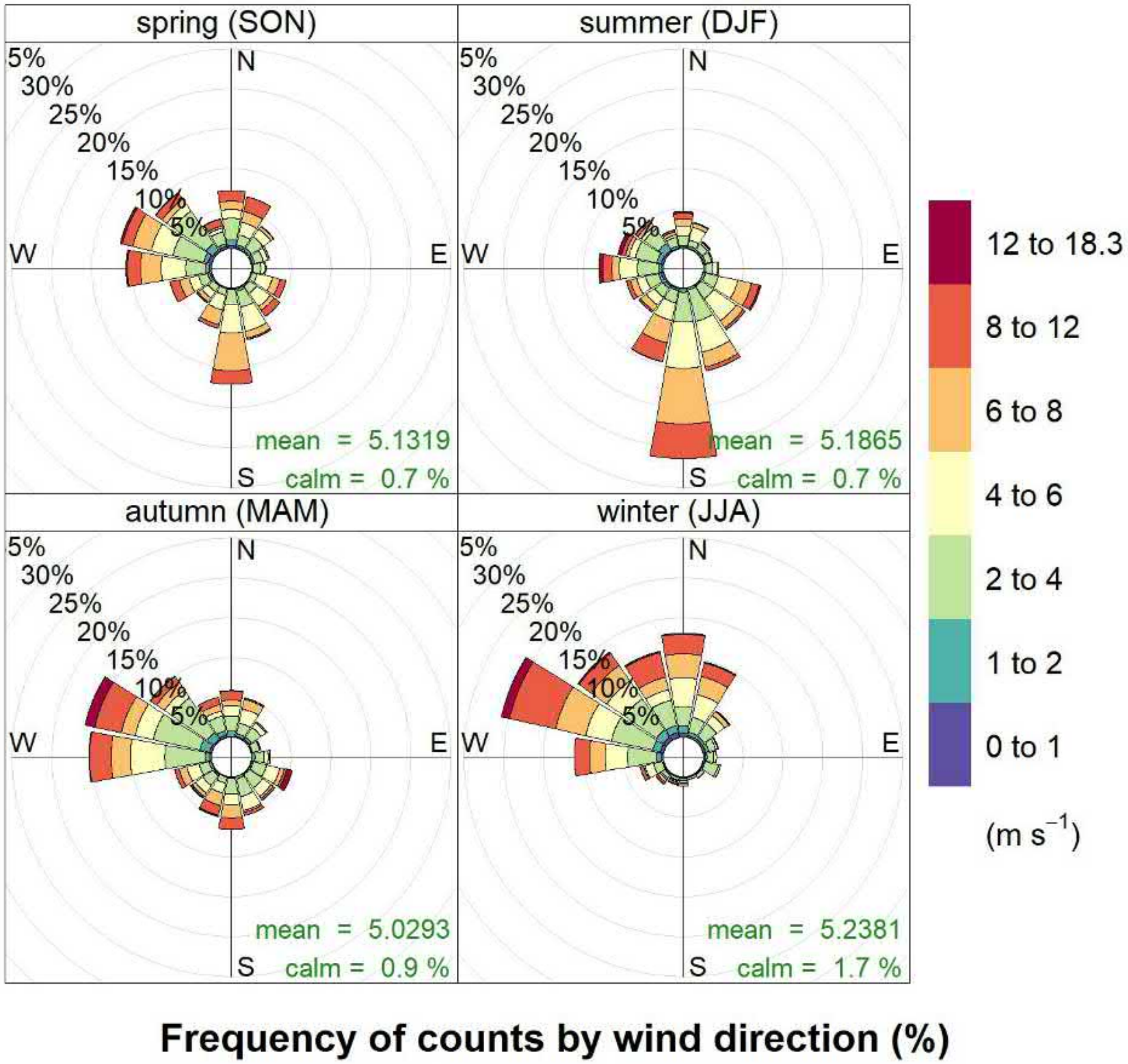
BoM Avalon Airport Seasonal Windroses 2015



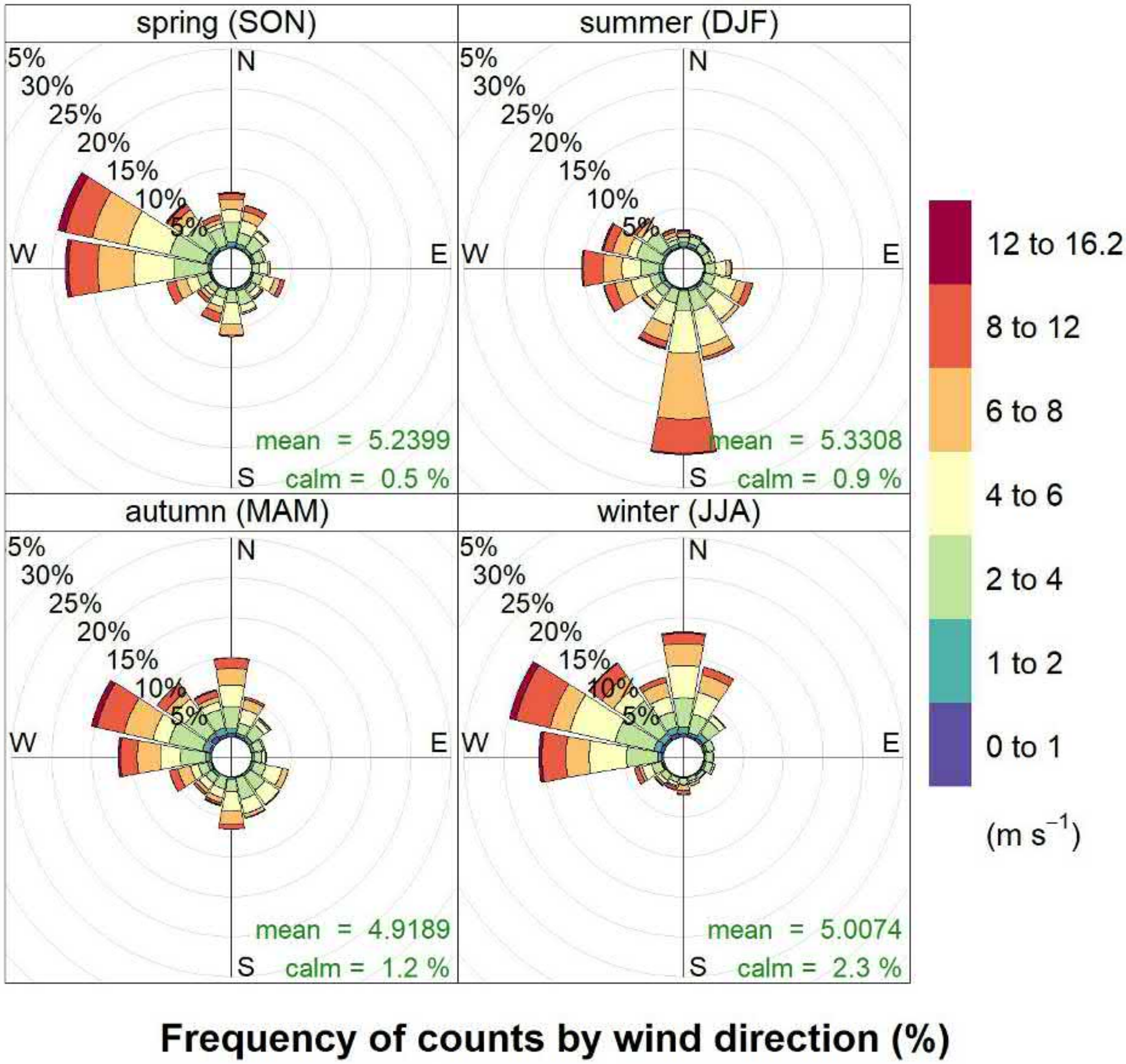
BoM Avalon Airport Seasonal Windroses 2016



BoM Avalon Airport Seasonal Windroses 2017



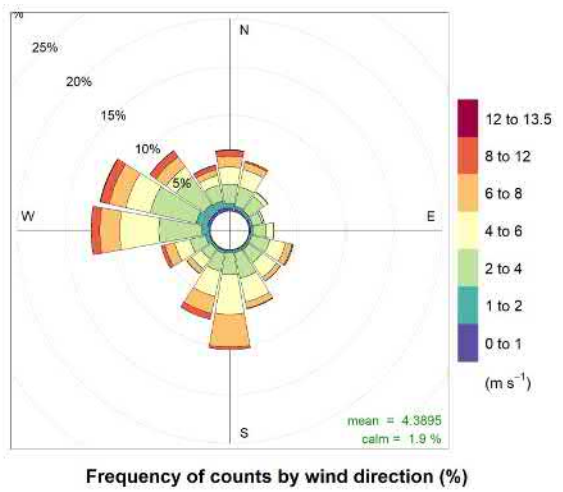
BoM Avalon Airport Seasonal Windroses 2018



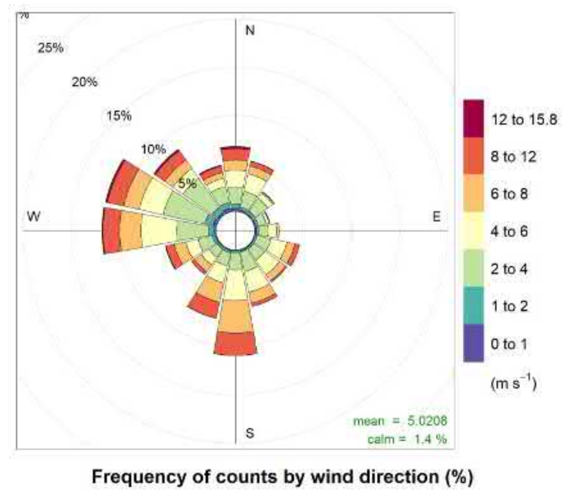
BoM Avalon Airport Seasonal Windroses 2019

A.3 Prospect Hill AERMOD Meteorological Data – Annual Wind Roses

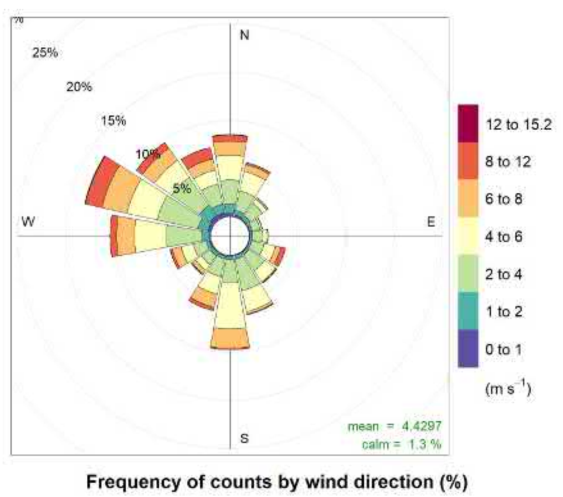
This section provides annual wind rose results created from the hourly average wind data used in the AERMOD modelling (left column); corresponding wind roses for BoM Avalon Airport are shown at right.



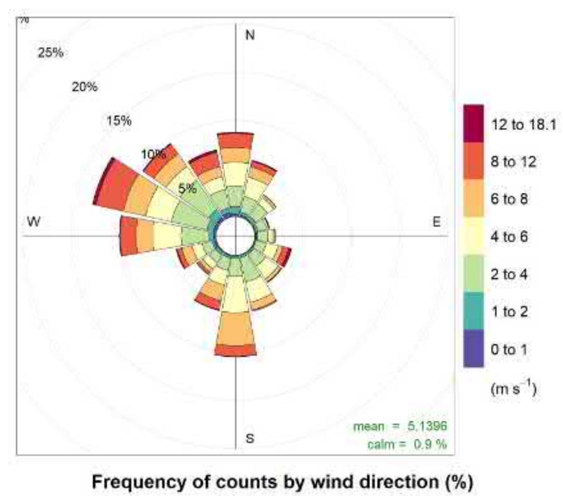
AERMOD Prospect Hill 2015; ws_{avg} = 4.4 m/s



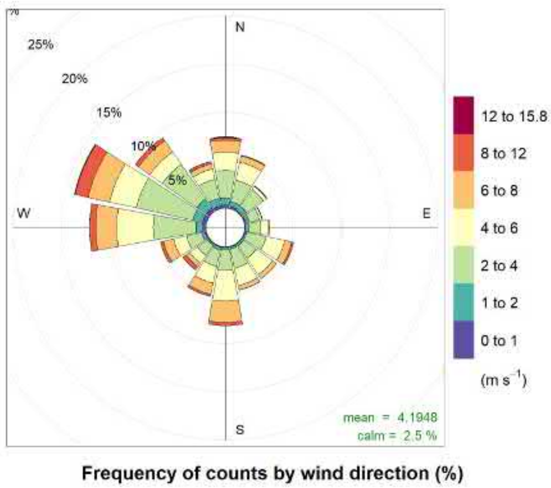
BoM Avalon Airport 2015; ws_{avg} = 5 m/s



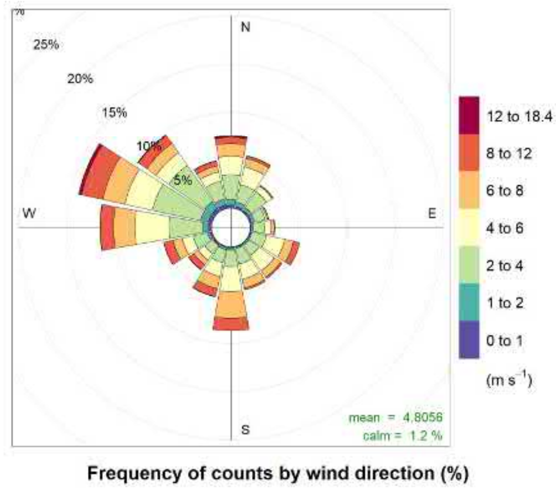
AERMOD Prospect Hill 2016; ws_{avg} = 4.4 m/s



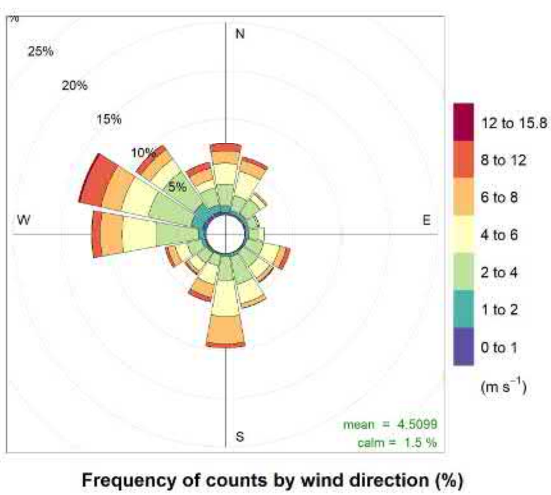
BoM Avalon Airport 2016; ws_{avg} = 5.1 m/s



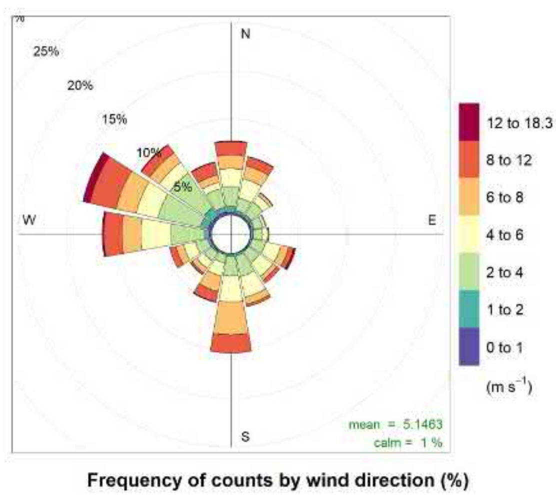
AERMOD Prospect Hill 2017; ws_{avg} = 4.2 m/s



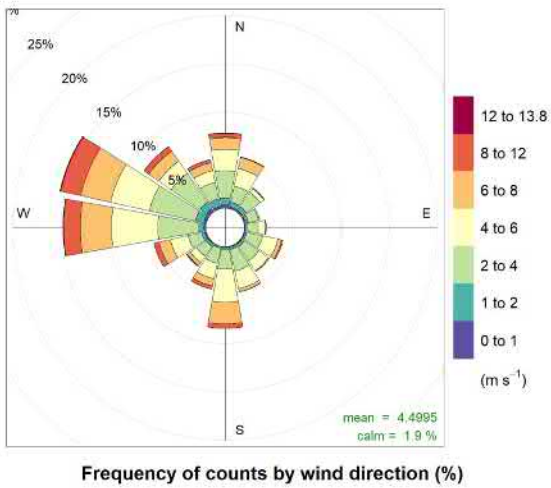
BoM Avalon Airport 2017; ws_{avg} = 4.8 m/s



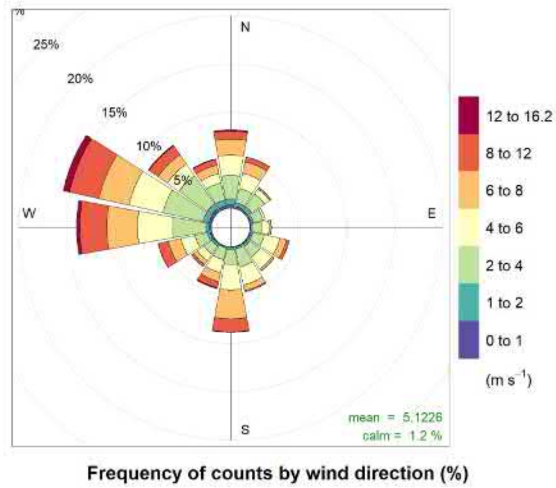
AERMOD Prospect Hill 2018; ws_{avg} = 4.5 m/s



BoM Avalon Airport 2018; ws_{avg} = 5.1 m/s



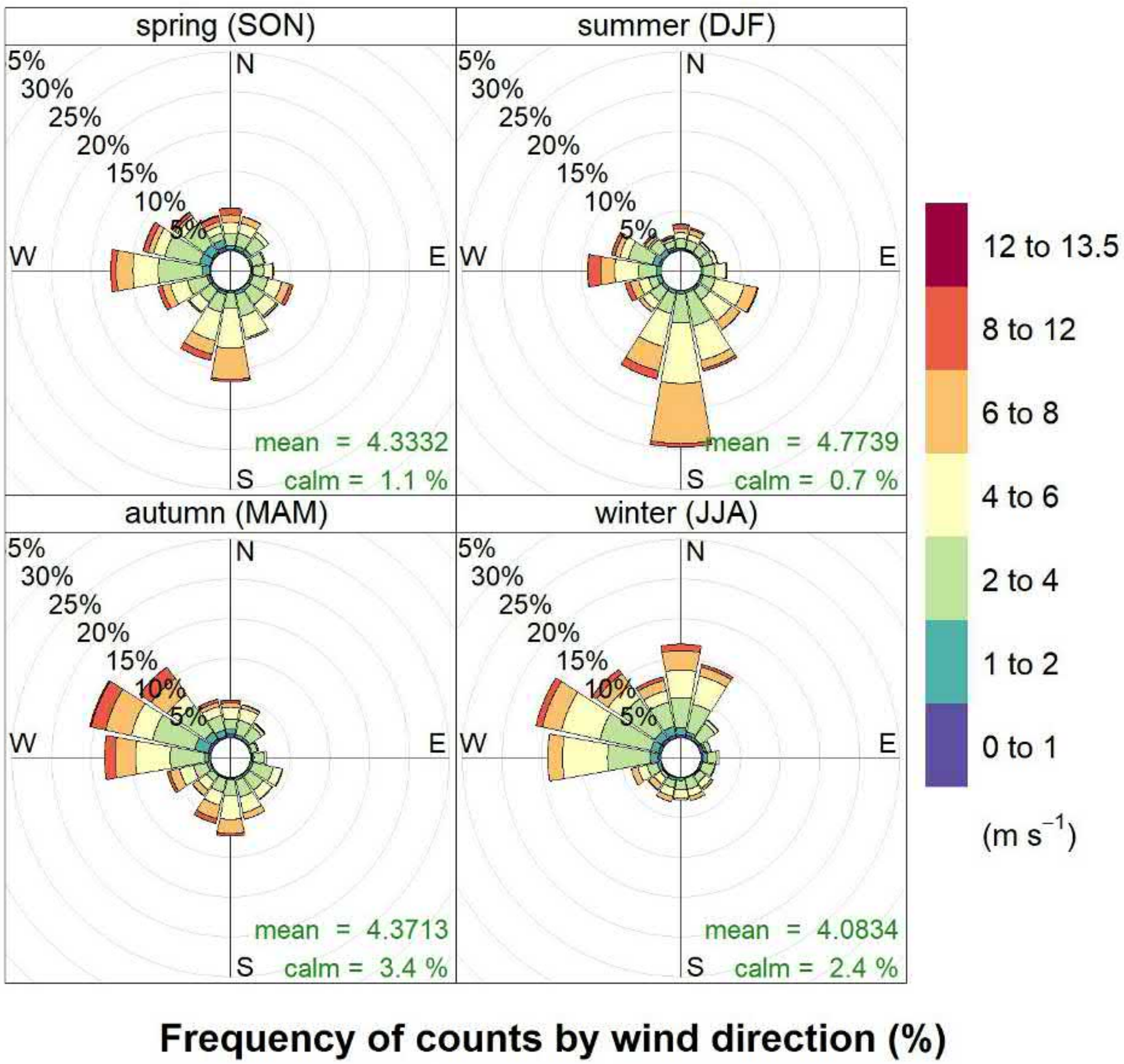
AERMOD Prospect Hill 2019; ws_{avg} = 4.5 m/s



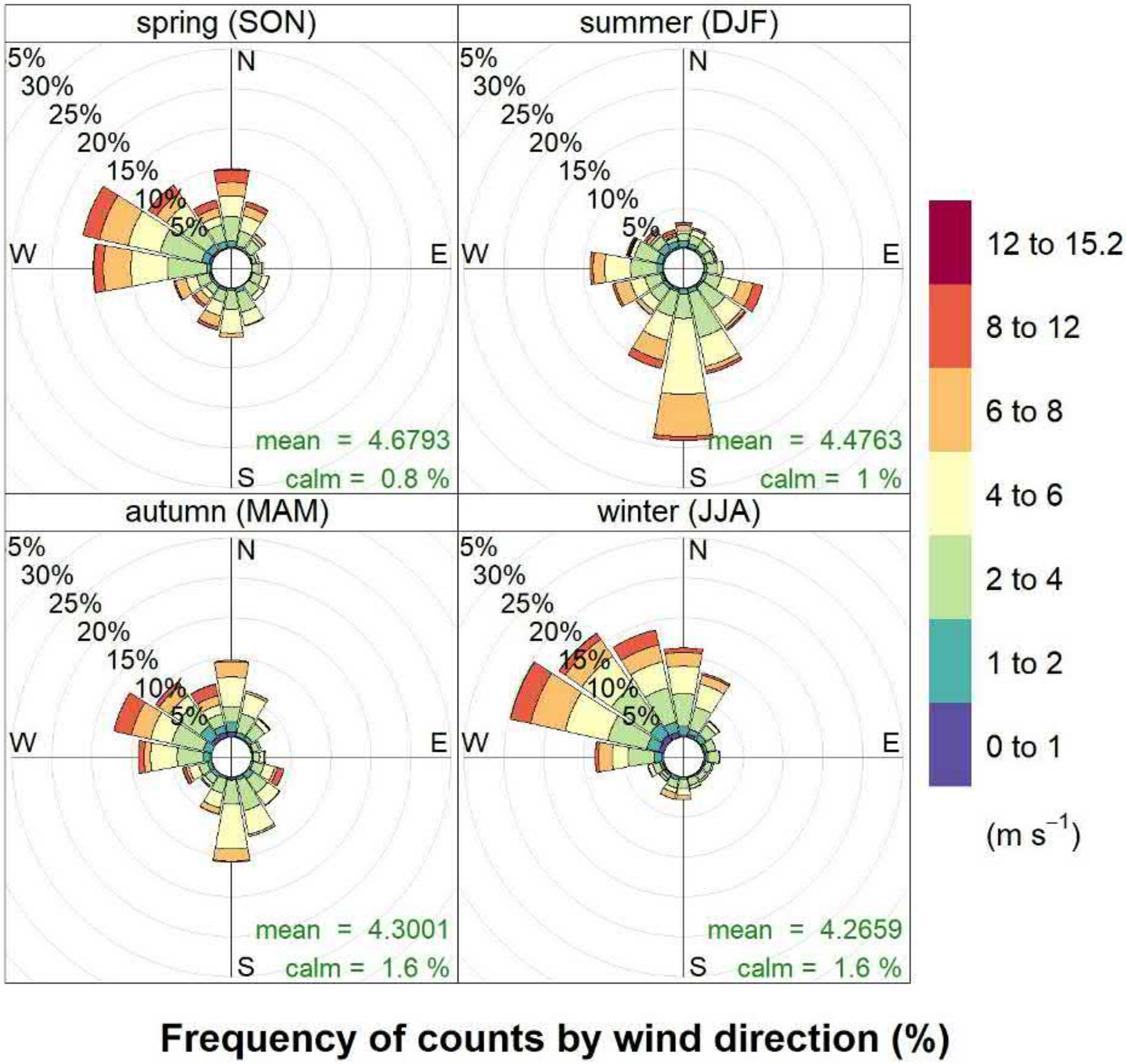
BoM Avalon Airport 2019; ws_{avg} = 5.1 m/s

A.4 Prospect Hill AERMOD Meteorological Data – Seasonal Wind Roses

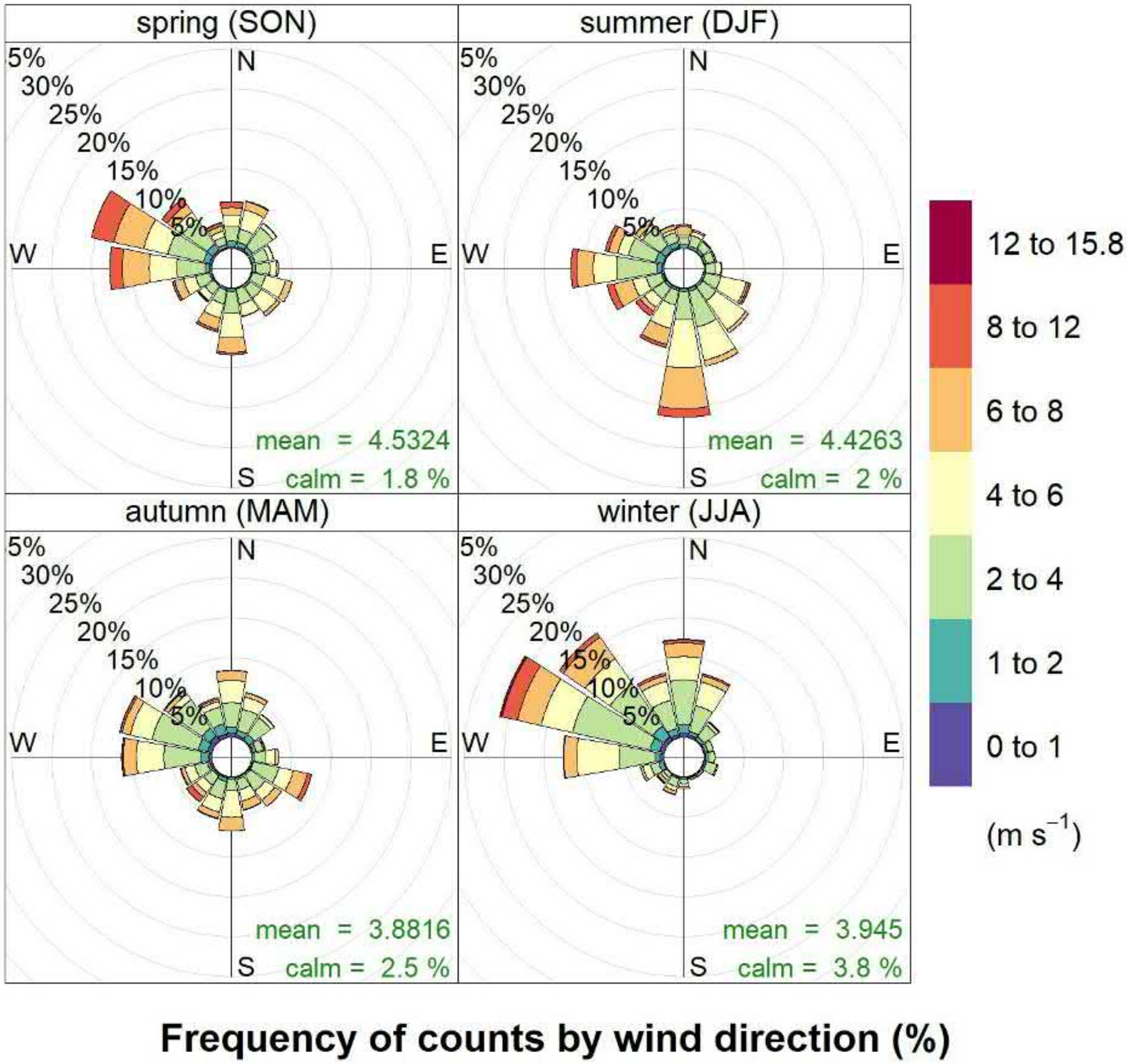
This section provides seasonal wind rose results for the Prospect Hill site using model data generated from observations at BoM Avalon Airport.



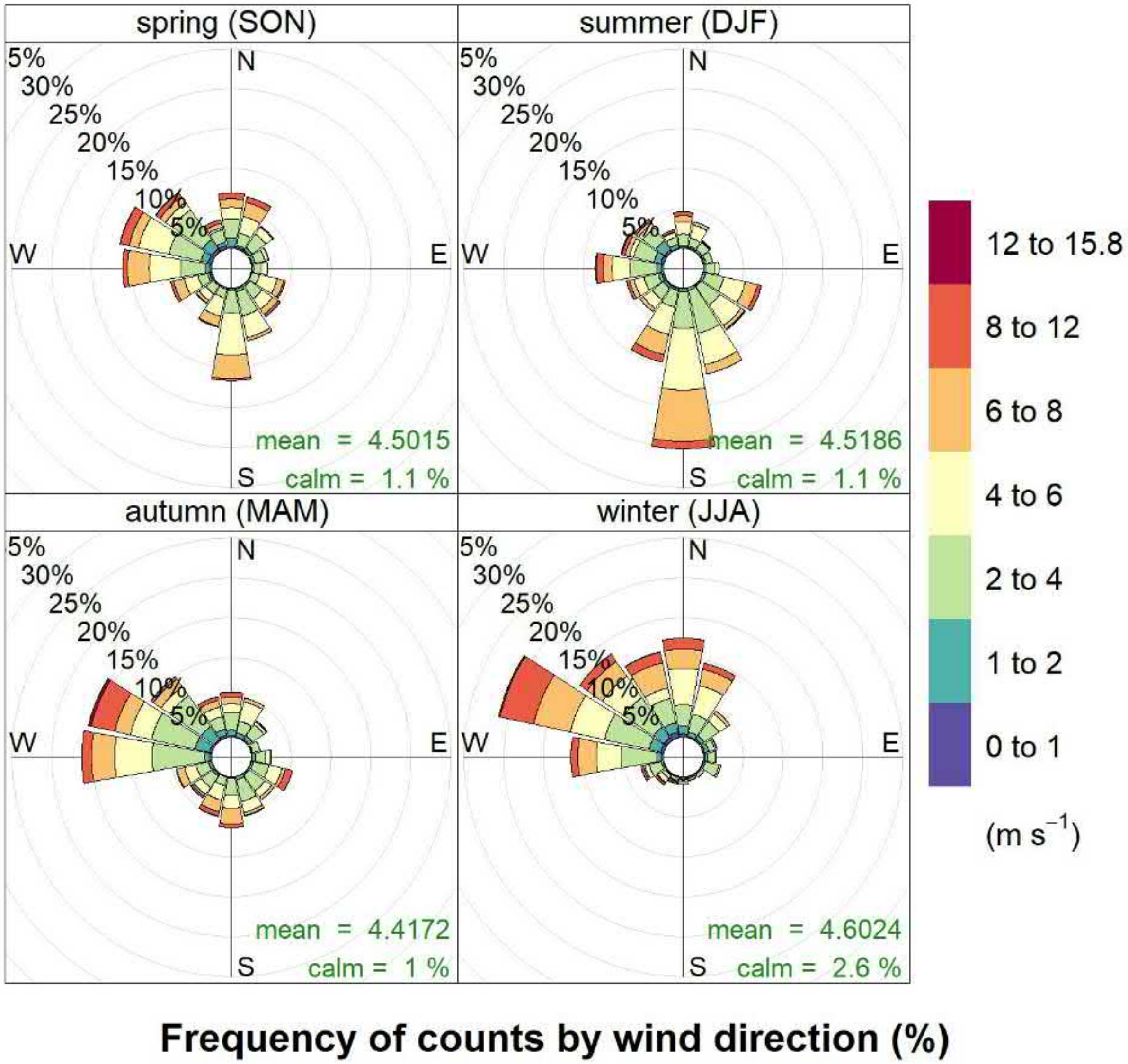
AERMOD Prospect Hill Seasonal Windroses 2015



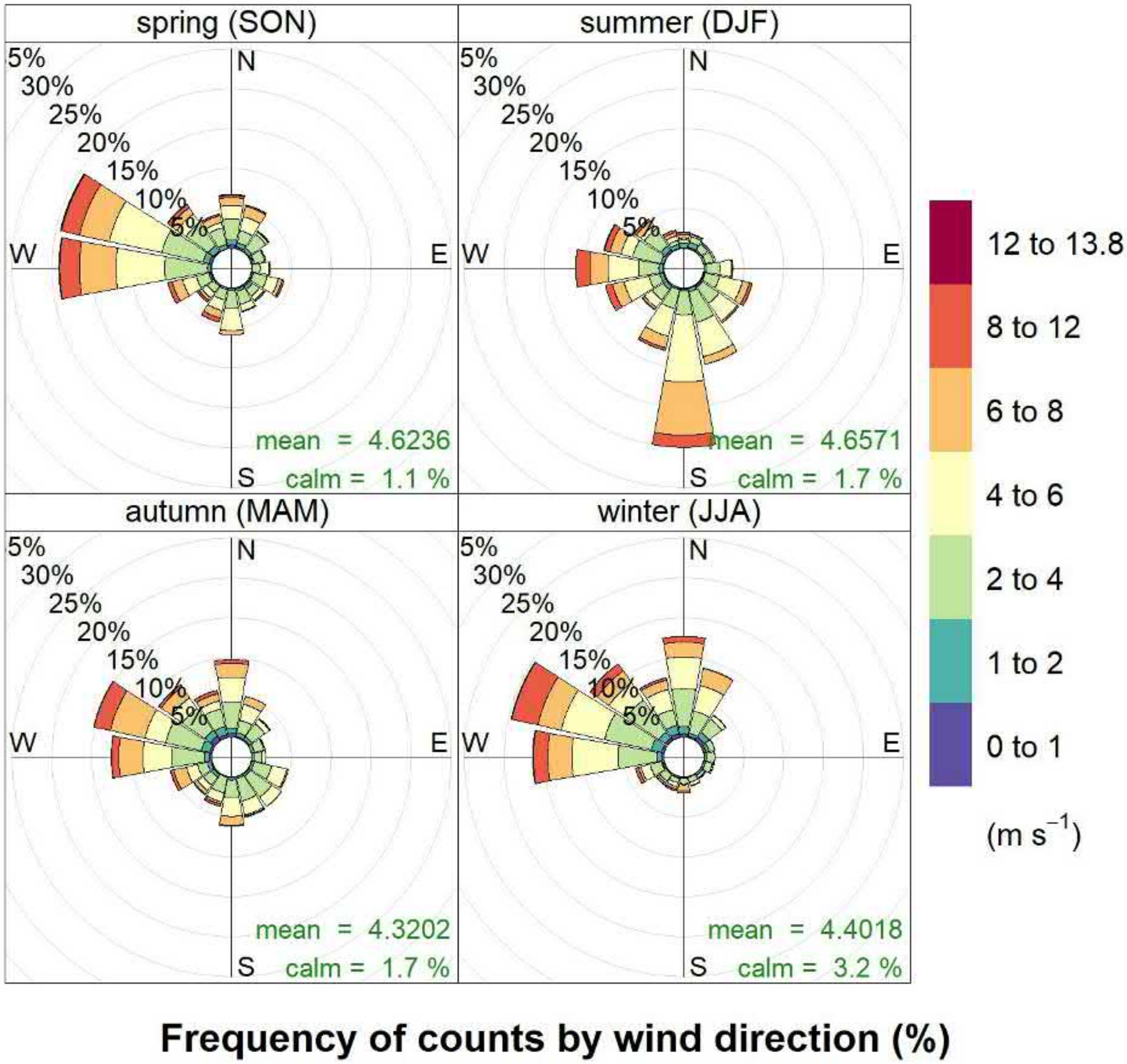
AERMOD Prospect Hill Seasonal Windroses 2016



AERMOD Prospect Hill Seasonal Windroses 2017



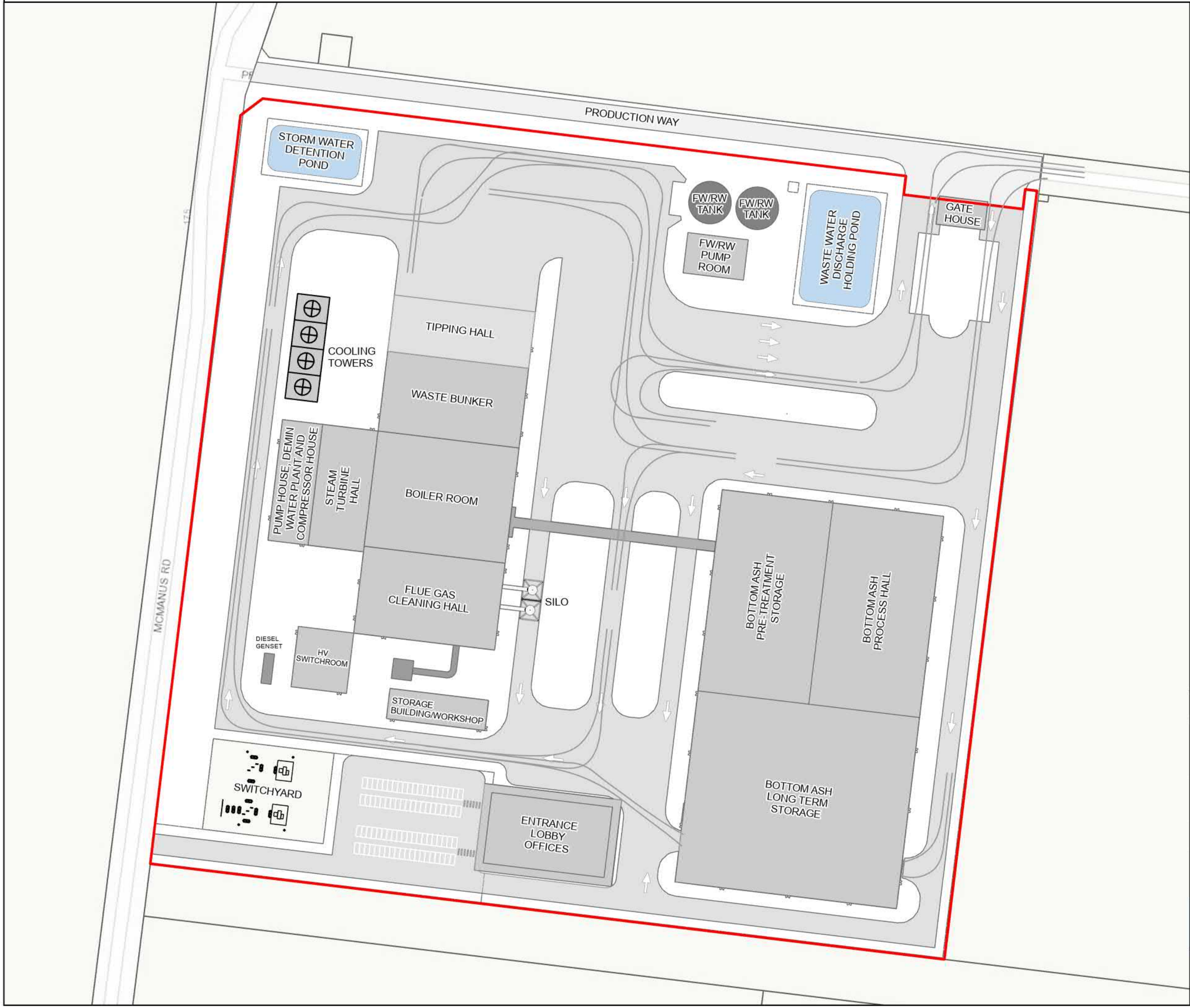
AERMOD Prospect Hill Seasonal Windroses 2018



AERMOD Prospect Hill Seasonal Windroses 2019

Appendix B. Proposed Plant Layout

Figure 7.1: Site layout



Project site

N

A3

1:1,800

0 25 50 m

IS305100

GDA 1994 MGA Zone 55

DATA SOURCES

© Commonwealth of Australia (Geoscience Australia) Geodata Topo 250k Series 3; Vicmap Data © State of Victoria; Jacobs.

Vicmap, Esri, HERE, Garmin, USGS, Vicmap, Esri, HERE, Garmin, FAO, NOAA, USGS

Jacobs