Report

Quantem (Terminals Pty Ltd)

Impact Assessment Report

45 Friendship Road, Port Botany NSW 2036

23 November 2020

Environment, Health & Safety, and Sustainability Consultants

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USE OF REPORT

The preparation of this report has been undertaken for the purpose of providing the results of a Level 1 Air Quality Impact Assessment of the emissions from the proposed thermal oxidiser for the bulk liquid storage facility located at 45 Friendship Road, Port Botany NSW.

This report is prepared solely for the benefit of Terminals Pty Ltd (Quantem). This report is provided on the condition that it or any part of it, will not be made available to, or relied upon by any other party for any purpose except with the prior written consent of Peter J Ramsay & Associates Pty Ltd (which consent may or may not be given at its discretion). Peter J Ramsay & Associates Pty Ltd consents to Quantem making this report available to other parties for the purpose of showing the scope of, and the recommendations provided in, this report, however those third parties cannot rely on the contents of this report.

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LIMITATIONS

Peter J Ramsay & Associates Pty Ltd has undertaken this assessment in accordance with New South Wales Environmental Protection Authority and the Approved Method for the Modelling and Assessment of Air Pollutants in New South Wales. The nature of the assessment is influenced by factors such as professional judgement, emission factors from sources from the site and the reliability of the information relating to the site which was obtained by the methodology described in this report. Reasonable care has been taken to verify the accuracy of the data and information available to Peter J Ramsay & Associates Pty Ltd.

The findings presented in this report are based on the information available during this assessment and some of those findings could vary if the information upon which they are based is determined to be false, inaccurate, or incomplete. Peter J Ramsay & Associates Pty Ltd disclaims all liability to any person for events taking place after the time during which the assessment was undertaken.

LIST OF UNITS

°C	degrees Celsius
µg/m3	microgram per metre cubed
g/s	grams/second
m	Metres
m/s	metres per second
m^3/s	metres cubed per second
mg/m3	milligrams per metre cubed

1. INTRODUCTION

Peter J Ramsay & Associates (PJRA) was engaged on 6 November 2020 by Terminals Pty Ltd (Quantem) to conduct a Level 1 Air Quality Impact Assessment for the operation of a proposed thermal oxidiser at Quantem's Port Botany facility.

Quantem operate a bulk liquid storage facility at 45 Friendship Road, Port Botany NSW (the site) and the predominant activity at the site is the storage of petroleum products, liquefied petroleum gas (LPG) and liquid chemicals. It is our understanding that Quantem currently operate an existing oxidiser on the site and is proposing to install an additional unit.

As part of the assessment, dispersion modelling was undertaken to gauge the impacts to air quality surrounding the site when both thermal oxidisers are operating simultaneously.

2. REGULATIONS AND GUIDELINES

2.1 Protection of the Environment Operations Act 1997

The Protection of the Environment Operations Act 1997 (POEO) is a key piece of the environment protection legislation in New South Wales (NSW) administered by the NSW Environmental Protection Authority (NSW EPA).

Within the POEO, air pollution is a term defined as the emission into the air of any air impurity. The POEO provides the statutory framework for managing air emissions in NSW and requires that all necessary practicable means are used to prevent or minimise air pollution (NSW EPA 2014). Also, in accordance with the POEO EPA-licenced activities must not emit offensive odour. Further, there are general provisions that apply to all premises which make it an offence for any person to undertake an activity that emits air pollution (including offensive odour) if the emission is caused by a failure to maintain or operate plant, or deal with materials in a proper and efficient manner.

2.2 Approved Methods for the Modelling and Assessment of Air Pollutants

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2016) ('Approved Methods') lists the statutory methods for modelling and assessing emission of air pollutants from stationary sources. The Approved Methods was released by the New South Wales Environment Protection Authority through the Department of Environment and Conservation. As this is a regulatory document, all stationary sources in NSW must be evaluated in accordance with the methods and criteria set forth in the Approved Methods.

Impact assessment criteria for individual toxic and odorous air pollutants have been extracted from section 7.2 of the Approved Methods. The criteria shown are based on the breakdown of emission estimates from both oxidisers that have been provided to PJRA.

The principal toxic air pollutants are defined on the basis that they are carcinogenic, mutagenic, teratogenic, highly toxic or highly persistent in the environment. Criteria for all pollutants are show in Table 2.

It is stated in the Approved Methods that principal toxic air pollutants must be minimised to the maximum extent achievable through the application of best-practice process design and/or emission controls. Decisions with respect to achievability will have regard to technical, logistical and financial considerations.

2.2.1 Air Quality Impact Assessment

There are two levels of impact assessment outlined in the Approved Methods.

- Level 1 – screening-level dispersion modelling technique using worst case input data
- Level 2 – refined dispersion modelling technique using site specific input data

The impact assessment levels are designed so that the impact estimates from the second level should be more accurate than the first. This means that, for a given facility, the result of a Level 1 impact assessment would be more conservative and less specific than the result of a Level 2 assessment.

3. SITE DESCRIPTION AND OPERATIONS

3.1 Site Location and Surrounding Land Use

The site is located in Port Botany approximately 11 km south of the Sydney's CBD, as shown in Figure F1. The site forms part of the Port Botany industrial area and is surrounded by heavy industrial uses. The nearest residential areas are located approximately 1.4 km south east of the site.

3.2 Zoning

The site is predominantly industrial zoned for Major Development (MD).

3.3 Topography

The topography of the site and the surrounding area is essentially flat and is situated at sea level. The topography of the site was interpreted from the Shuttle Radar Topography Mission, 1-second data file.

3.4 Meteorology

Data were obtained from the Bureau of Meteorology station 066037 (Sydney Airport) as it was the weather station nearest to the site. In accordance with the Approved Methods, the data were for a single year with over 90% of complete data, which in this case was 2017.

Wind roses produced from the meteorological data indicate that the predominant winds in Botany Bay are typically from the north west, north east and south. During winter the winds generally come from the west while summer tends to bring winds from the north east and south. The annual wind rose plot is displayed in Figure 1. The report entitled *AERMOD ready Meteorological data files for Port Botany – NSW* is provided in **Appendix A** and also provides wind rose plots for seasonal variation.

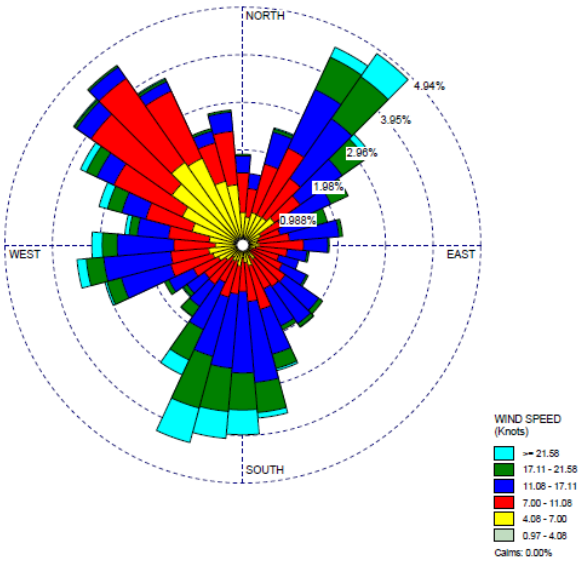


Figure 1 Wind Rose Plot

3.5 Previous Assessments

A previous air dispersion report was available regarding Quantem's facilities at Port Botany. The report was prepared by GHD and was titled *Report for Terminals Australia – Terminals Fuel Project 21/25548* (the GHD Report). An assessment of the cumulative impact of emissions assessed in the GHD Report in addition to the impacts modelled from the operation of the oxidisers is provided in Section 4.3.6.7 of this report.

The data on emissions were provided for the existing and proposed oxidisers by CEC Engineers. It is our understanding that CEC Engineers are the project engineers for the installation of TO-2.

3.6 Description of Operations

The site is used for the bulk storage of petroleum products, liquefied petroleum gas (LPG) and liquid chemicals. The site includes loading and unloading facilities for road tanker trucks. The emissions to be considered are those arising from the operation of two thermal oxidisers for treatment of vapours containing volatile organic compounds (VOCs).

4. AIR QUALITY IMPACT ASSESSMENT

4.1 Sensitive Receptors

Sixteen sensitive receptors were taken into consideration in the modelling. These receptors were the closest existing receptors identified from a review of Nearmap Pty Ltd (Nearmap) aerial photography. The locations of these sensitive receptors are shown in Figure F2.

The nearest sensitive receptor to the site is identified as an existing residence and is located approximately 1.36 km south east. Table 1 displays the type of each receptor and its distance from Quantem's facility.

Table 1 Sensitive Receptors

Receptor Number	Receptor Type	Distance from site (km)	Direction
R01	Existing Residence	1.36	South East
R02	Council Building	1.48	South East
R03	Existing Residence	1.52	South East
R04	Existing Residence	1.52	North East
R05	Existing Residence	1.56	North East
R06	Existing Residence	1.69	North
R07	Existing Residence	1.71	North
R08	Existing Resident	1.79	North East
R09	Existing Residence	2.03	East
R10	Existing Residence	1.91	East
R11	Existing Residence	1.60	North East
R12	Public Sports Facility	1.87	East
R13	Existing Residence	1.88	East
R14	Existing Residence	1.93	East
R15	Existing Residence	2.02	North
R16	Existing Residence	2.29	North

4.2 Emissions to Air

4.2.1 Sources of Air Emissions

The sources of potential pollutants are the stack emissions from the VOC treatment system which consists of the existing thermal oxidiser on the site (TO-1) and the proposed thermal oxidiser (TO-2). For the modelling, it was assumed that both oxidisers are to be operating at the same time, at the highest emission rate provided in the emissions data provided by CEC Engineers.

4.2.2 Estimation of Air Emissions

The estimation of air emissions from the combustion system was undertaken by CEC Engineers from process data which were provided by Quantem. It is our understanding that the data were calculated assuming worst case emissions to the thermal oxidisers. Table 2 displays the estimate of stack emission concentrations for both oxidisers and their relative assessment criteria from the Approved Methods.

Table 2 Stack Emission Concentrations and Assessment Criteria

	TO-1 (mg/m^3)	TO-2 (mg/m^3)	Assessment Criteria (mg/m^3)
Benzene	**0.1370**	**0.3809**	0.029
Hexene	0.2080	0.1225	NA
Acetone	0.1167	0.0687	22
Ethanol	0.0288	0.0169	2.1
Methanol	0.1112	0.0655	3
Styrene	0.0005	0.0003	0.12
Vinyl Acetate	0.0376	0.0221	NA
Methyl Methacrylate	0.0000	0.0000	0.12
Butyl Acrylates	0.0004	0.0002	0.1
Methyl Isobutyl Carbinol (MIBC)	0.0000	0.0000	- NA
Hydrogen Sulphide (H_2S)	0.0156	0.0098	1.38
Sulphur Dioxide	**279**	**175**	0.57

* NA – Not available within the Approved Methods

Based on the emission data provided by CEC Engineers, benzene and sulphur dioxide were the only pollutants with concentrations that exceeded the assessment criteria. Other pollutants were below the ambient assessment criteria within the oxidiser emissions. The impact of other pollutants is negligible because the in-stack concentrations are lower than the assessment criteria, therefore the dispersion of emissions of these other compounds were not modelled..

Additionally, carbon monoxide (CO), nitrogen dioxide (NO_2) and PM_{10} were modelled at the request of Quantem. The natural gas maximum usage rate was used to determine the emission rates from the combustion system. Using these peak rates of gas consumption, the National Pollution Inventory (NPI) emission factors were applied to estimate the emission rates of CO, NO_2 and PM_{10}. Table 3 shows the relevant emission factors that we're used for each pollutant.

Table 3 Emission Factors and emission rates for combustion products

Pollutant	Emission Factor (kg/t)	Emission Rates (g/s)	Emission Rates (mg/m^3)	Assessment Criteria*
Carbon Monoxide	1.82	0.242	6.05 mg/m^3	30 mg/m^3
Nitrogen Dioxide	2.16	0.287	7170 $\mu g/m^3$	246 $\mu g/m^3$
PM_{10}	0.16	0.021	525 $\mu g/m^3$	50 $\mu g/m^3$

The emission factors were obtained from the *NPI Emission Estimation Technique Manual for Combustion of Boilers, Version 3.6, 2011* (NPI Manual) for 30 MW or less, wall fired combustion system for natural gas. Using the NPI manual, the predicted stack emissions from TO-1 and TO-2 were then calculated using the following equation.

$$E_{(S)} = A \times EF_{(s)} \times (1 - CE)$$

$$where;$$

4.3 Air Dispersion Modelling

In accordance with the Approved Methods, dispersion modelling was used to predict the impact of discharges to air while TO-1 and TO-2 are operating simultaneously under local meteorological conditions. Dispersion modelling was performed to assess benzene and sulphur dioxide released from the combustion system.

4.3.1 Model Selection

The modelling has been undertaken in accordance with the Approved Methods with the exception that AERMOD was used instead of AUSPLUME. The NSW Environment Protection Authority was consulted regarding the choice of the dispersion model and the advice was that AERMOD can be used in place of AUSPLUME provided the use can be justified as the most appropriate selection.

The modelling prepared using AERMOD is better able to account for terrain factors and is recommended by the United States Environmental Protection Agency (USEPA) in place of the older AUSPLUME model. The AUSPLUME model was developed by the Environment Protection Authority Victoria, however it is no longer supported as the regulatory model in Victoria and the software is no longer updated. The use of AERMOD allows for consideration of terrain effects, and provides a slight improvement over AUSPLUME for assessing potential impacts for small-scale, near-field dispersion modelling such as is the case in this situation.

The site is essentially at sea level and the topography surrounding the site is relatively flat. Examination of meteorological data indicated that calms occur less than 5% of the time. Based on these considerations, it was considered appropriate to use the regulatory approved AERMOD dispersion model version 9.9.0.

4.3.2 Modelling Domain

A 9 km x 9 km grid was used with receptors placed 300 m apart and the centre of the grid located at the centre point of the site. Discrete receptors were also placed at existing residential receptors as described in Section 4.1 of this report.

An additional 600m x 600m grid with receptors placed 30m apart was applied to the same centre point for the site. This was provided to assess whether there would be any impacts in close proximity to the site.

Topography was incorporated into the model using a digital elevation model with approximately 30 m resolution which has been gap filled. Since the terrain is relatively flat surrounding the site, the topographical resolution of the terrain was considered appropriate.

4.3.3 Dispersion

4.3.3.1 Climate Data

The nearest weather station operated by the Bureau of Meteorology (BOM) is at Sydney Airport, site number 066037. The station has been operated by BOM since 1929 and is located approximately 5 km north west of the site.

Daily 9 am and 3 pm weather data from the Sydney Airport BOM station was used to characterise the climate in the vicinity of the subject land. Wind roses produced from the meteorological data used for the dispersion modelling indicate that the winds are typically from the north west and north east.

4.3.3.2 Meteorological Input Files

The data file used for the AERMOD modelling was prepared by pDs Consultancy based on the observational data taken from weather stations operated by the BOM.

4.3.4 Model Input Parameters

In accordance with the Approved Methods the one-hour average concentrations were modelled so the results were consistent with the principle and individual toxic air pollutants assessment criteria.

Table 4 Summary of AERMOD Input Parameters

Model Input Parameters	
Meteorological Data	Obtained from Bureau of Meteorology at station 066037
Pollutant	Benzene, SO_2, CO, NO_2, PM_{10}
Deposition	None
Depletion	None
Dispersion	Rural
Averaging time	Hourly
Terrain	Flat & elevated
Gridded Receptors	9 km x 9km, 300m spacing 600m x 600m, 30m spacing
Discrete Receptors	14 houses located to the north, east and south 1 public sporting facility 1 council building

4.3.5 Source Input Parameters

A full listing of source input parameter used in the AERMOD simulations is provided in Table 5. The estimation of the emission rates utilised in the model was discussed in Section 4.2.2.

Table 5 Summary of Source Input Parameters for Dispersion Modelling Simulations

	Thermal Oxidiser 1 (TO-1)	Thermal Oxidiser 2 (TO-2)
Source Type	Point	Point
Source Height (m)	17.55	17.55
Inside Diameter	1	1.25
X co-ordinate (m)	335242.64	335239.21
Y co-ordinate (m)	6239157.99	6239155.35
Exit Temperature (°C)	980	980
Gas Exit Velocity (m/s)	18.9	20.5
Gas Exit Flow Rate (m^3/s)	14.84	25.16
Emission Rate (g/s) (Benzene)	0.00203	0.00203
Emission Rate (g/s) (SO_2)	4.13333	4.4

4.3.6 Results of AERMOD Simulations and Interpretations

In accordance with the Approved Methods, the emissions must be assessed against the assessment criteria. The impact assessment criteria for a 1-hour average period for both benzene, sulphur dioxide, carbon monoxide and nitrogen dioxide are provided below as per the Approved Methods. The PM_{10} criterion is provided as a 24-hour average period.

- Benzene 0.029 mg/m^3 (Victorian Governments Gazette, 2001)
- Sulphur Dioxide 570 $\mu g/m^3$ (NHMRC, 1996)
- Carbon Monoxide 30 mg/m^3 (WHO, 2000)
- Nitrogen Dioxide 246 $\mu g/m^3$ (NEPC, 1998)
- PM_{10} 50 $\mu g/m^3$ (DoE, 2016)

The predicted 100^{th} percentile peak ground level concentrations at each off-site receptor for benzene and sulphur dioxide are shown in Table 6 and Table 7 and coordinates and elevation of each receptor are displayed. Relevant odour thresholds were also considered.

4.3.6.1 Benzene

Table 6 100th Percentile predicted benzene concentrations at sensitive receptors

Receptor	Ground level concentrations (mg/m³)	Location		Elevation (m)
		Easting	Northing	
R01	0.0000165	336600.77	6238834.97	15.84
R02	0.0000112	336586.90	6238481.55	17.74
R03	0.0000111	336632.12	6238499.78	17.24
R04	0.0000116	336342.33	6240219.80	15.50
R05	0.0000119	336190.89	6240393.45	16.32
R06	0.0000132	336018.25	6240670.08	11.27
R07	0.0000122	335958.68	6240705.42	10.51
R08	0.0000102	336817.93	6240016.59	24.76
R09	0.0000101	336977.39	6240187.57	18.33
R10	0.0000091	337077.67	6239774.93	28.96
R11	0.0000119	336541.84	6240114.49	16.18
R12	0.0000151	337156.16	6239436.87	21.88
R13	0.0000168	337153.68	6239115.58	16.57
R14	0.0000112	337164.39	6238909.43	20.12
R15	0.0000096	334375.19	6240986.80	4.18
R16	0.0000071	334102.67	6241129.35	4.98

Based on the modelling results, there is no exceedance of the impact assessment criterion for benzene at any receptor. The highest concentration of benzene at ground level was 0.000017 mg/m³ at Receptor 13, and this is only 0.06% of the benzene impact assessment criterion of 0.029 mg/m³.

4.3.6.2 Sulphur Dioxide

Table 7 100th Percentile predicted SO_2 concentrations at sensitive receptors

Receptor	Ground level concentrations (µg/m^3)	Location		Elevation (m)
		Easting	Northing	
R01	34.42421	336600.77	6238834.97	15.84
R02	23.51929	336586.90	6238481.55	17.74
R03	23.29747	336632.12	6238499.78	17.24
R04	24.31417	336342.33	6240219.80	15.50
R05	24.97215	336190.89	6240393.45	16.32
R06	27.72382	336018.25	6240670.08	11.27
R07	25.57078	335958.68	6240705.42	10.51
R08	21.31872	336817.93	6240016.59	24.76
R09	21.07394	336977.39	6240187.57	18.33
R10	19.07028	337077.67	6239774.93	28.96
R11	24.82968	336541.84	6240114.49	16.18
R12	31.74728	337156.16	6239436.87	21.88
R13	35.14247	337153.68	6239115.58	16.57
R14	23.50495	337164.39	6238909.43	20.12
R15	20.16503	334375.19	6240986.80	4.18
R16	14.90044	334102.67	6241129.35	4.98

The predicted SO_2 peak concentration levels at each off-site receptor are shown in Table 7. There are no exceedances of the impact assessment criterion of 570 µg/m^3 for sulphur dioxide at any of the receptors.

For a level 1 assessment, the existing background concentration of sulphur dioxide should be included. In accordance with the Approved Methods, the maximum background concentration of the pollutant is to be added to peak concentration levels at the maximum exposed off-site receptor for 100th percentile dispersion model prediction.

Ambient air quality data were obtained to determine the maximum background concentrations of sulphur dioxide. The closest station to the site that records ambient sulphur dioxide is located at Randwick approximately 7.5 km north of Quantem's facility and is operated by NSW EPA. Hourly average data were obtained for the 2017 calendar year and the maximum background concentration was determined to be 75 µg/m^3 for SO_2.

Based on the results of the dispersion modelling, Receptor 13 is predicted to be the maximum exposed off-site receptor. The maximum background concentration was then added to the dispersion model prediction for Receptor 13, to give an impact of 110 µg/m^3, which is only 20% of the impact assessment criterion of 570 µg/m^3.

4.3.6.3 Carbon Monoxide

Based on the modelling results there is no exceedance of the impact assessment criterion for CO at any receptor. As per the Approved Methods, background concentrations of CO must also be reported and included for the maximum exposed off-site receptor. The nearest ambient air quality station that measures background concentrations of CO is located in Chullora, NSW. Analysis of the data determined that the maximum ambient concentration was 2.16 mg/m^3.

Table 8 shows the predicted concentrations of CO at each off-site receptor. Based on the results, Receptor 13 is predicted to be the maximum exposed off-site receptor. The maximum background concentration was then added to the prediction to give an impact of 2.162 mg/m^3 approximately 7.2% of the impact assessment criterion of 30 mg/m^3.

Table 8 100th Percentile predicted CO concentrations at sensitive receptors

Receptor	Ground level concentrations (mg/m^3)	Location		Elevation (m)
		Easting	Northing	
R01	0.00196	336600.77	6238834.97	15.84
R02	0.00133	336586.90	6238481.55	17.74
R03	0.00132	336632.12	6238499.78	17.24
R04	0.00138	336342.33	6240219.80	15.50
R05	0.00142	336190.89	6240393.45	16.32
R06	0.00158	336018.25	6240670.08	11.27
R07	0.00146	335958.68	6240705.42	10.51
R08	0.00121	336817.93	6240016.59	24.76
R09	0.00120	336977.39	6240187.57	18.33
R10	0.00109	337077.67	6239774.93	28.96
R11	0.00141	336541.84	6240114.49	16.18
R12	0.00180	337156.16	6239436.87	21.88
R13	0.00200	337153.68	6239115.58	16.57
R14	0.00133	337164.39	6238909.43	20.12
R15	0.00115	334375.19	6240986.80	4.18
R16	0.00084	334102.67	6241129.35	4.98

4.3.6.4 Nitrogen Dioxide

The predicted concentration levels at each off-site receptor are shown in Table 9. There are no exceedances of the impact assessment criterion of 246 µg/m^3 at any off-site receptor. Based on the modelling results, Receptor 13 is expected to be the maximum exposed off-site receptor with a modelled 100th percentile concentration of 2.4 µg/m^3.

Analysis of background concentrations was undertaken from data measured at Randwick and the maximum ambient concentration of NO_2 was determined to be 84.05 µg/m^3. To predict the total impact at Receptor 13, the highest background concentration was then added to the prediction at Receptor 13 to give an impact of 86.420 µg/m^3, approximately 35% of the impact assessment criterion for NO_2.

Table 9 100th Percentile predicted NO_2 concentrations at sensitive receptors

Receptor	Ground level concentrations (µg/m^3)	Location		Elevation (m)
		Easting	Northing	
R01	2.3311	336600.77	6238834.97	15.84
R02	1.58374	336586.90	6238481.55	17.74
R03	1.5725	336632.12	6238499.78	17.24
R04	1.6419	336342.33	6240219.80	15.50
R05	1.6876	336190.89	6240393.45	16.32
R06	1.87109	336018.25	6240670.08	11.27
R07	1.72744	335958.68	6240705.42	10.51
R08	1.44117	336817.93	6240016.59	24.76
R09	1.42369	336977.39	6240187.57	18.33
R10	1.29087	337077.67	6239774.93	28.96
R11	1.67518	336541.84	6240114.49	16.18
R12	2.14018	337156.16	6239436.87	21.88
R13	2.36963	337153.68	6239115.58	16.57
R14	1.58424	337164.39	6238909.43	20.12
R15	1.36256	334375.19	6240986.80	4.18
R16	1.00255	334102.67	6241129.35	4.98

4.3.6.5 PM_{10}

There are no exceedances of the impact assessment criterion of 50 µg/m^3 for PM_{10} at any of the receptors. The predicted PM_{10} peak concentration levels at each off-site receptor are shown in Table 10. Based on the modelling results, Receptor 13 is expected to be the maximum exposed off-site receptor with a modelled 100th percentile concentration of 0.0215 µg/m^3.

Ambient air quality data were obtained to determine the maximum background concentrations of PM_{10} from Randwick. 24 hour average data were obtained for the 2017 calendar year and the maximum background concentration was determined to be 56.1 µg/m^3 for PM_{10}. The maximum ambient concentration was then added to the highest predicted emission at Receptor 13 to gauge the total impact of PM_{10} emissions. Based on the modelling results, it is considered that the predicted emission from both oxidisers would have negligible impact on the ambient concentrations of PM_{10}.

Table 10 100th Percentile predicted PM_{10} concentrations at sensitive receptors

Receptor	Ground level concentrations (µg/m^3)	Location		Elevation (m)
		Easting	Northing	
R01	0.02137	336600.77	6238834.97	15.84
R02	0.0198	336586.90	6238481.55	17.74
R03	0.01884	336632.12	6238499.78	17.24
R04	0.02112	336342.33	6240219.80	15.50
R05	0.02898	336190.89	6240393.45	16.32
R06	0.03521	336018.25	6240670.08	11.27
R07	0.03643	335958.68	6240705.42	10.51
R08	0.02068	336817.93	6240016.59	24.76
R09	0.0177	336977.39	6240187.57	18.33
R10	0.01884	337077.67	6239774.93	28.96
R11	0.01906	336541.84	6240114.49	16.18
R12	0.02488	337156.16	6239436.87	21.88
R13	0.02153	337153.68	6239115.58	16.57
R14	0.01351	337164.39	6238909.43	20.12
R15	0.01949	334375.19	6240986.80	4.18
R16	0.01618	334102.67	6241129.35	4.98

4.3.6.6 Odour

The emissions from both oxidisers also have the potential to cause odour impacts to surrounding land uses. Based on the emissions estimate from both thermal oxidisers which has been provided by Quantem, the expected ground level concentrations of odorous compounds are not predicted to exceed their impact assessment criteria.

In accordance with the Approved Methods, the following pollutants are considered as individual odorous air pollutants. Their relevant impact assessment criteria are shown in Table 2.

- Butyl acrylate
- Ethanol
- Methanol
- Methyl Methacrylate
- Styrene

These pollutants were below the ambient assessment criteria for odour impact within the oxidiser emissions. The impact of these emission is negligible because the in-stack concentrations are lower than the assessment criteria at ground level, therefore the dispersion of emissions of these compounds were not modelled.

4.3.6.7 Cumulative Impact

The Quantem facility is predominantly used for the bulk storage of liquid fuels. As evident from aerial imagery, nearby industries are used for liquid storage purposes however the contents of the storage may consist of other liquids other than fuels.

The GHD Report identified only two other sites in the Port Botany industrial area that are both sources of emissions. The report estimated that the maximum predicted concentration of benzene beyond the site boundary was only 19% of the impact assessment criterion. It is stated in the report that other sites within the Port Botany industrial area would not be expected to add significant contribution of levels of benzene to the predicted concentrations.

The findings of this report support this notion as the maximum predicted off-site concentration of benzene is expected to be only 0.06% of the impact assessment criterion. Therefore, it is predicted that the operation of the thermal oxidisers will have a negligible contribution to off-site benzene concentration.

5. CONCLUSIONS

Benzene and sulphur dioxide were the only two pollutants that were modelled from the emission estimates prepared by CEC Engineers. This was due to both compounds exceeding the assessment criteria in the predicted stack emissions. The impact of other pollutants is considered negligible as their in-stack concentrations are lower than the assessment criteria at ground level.

The predicted ground level concentrations from the dispersion modelling of benzene and sulphur dioxide emissions show that the proposed addition of a second thermal oxidiser (TO-2) will not cause exceedances of the relevant impact assessment criteria at the most impacted off-site receptors. The assessment was undertaken assuming worst case emissions from both thermal oxidisers operating simultaneously, and worst-case ambient concentrations from the nearest monitoring station.

Based on the predicted peak level concentrations, the maximum benzene concentration will be experienced at Receptor 13, approximately 1.88 km east from the site. It was predicted that benzene will peak at 0.000017 mg/m^3 at Receptor 13 which is approximately 0.06% of the impact assessment criteria. The cumulative impact of benzene emissions modelled from the Site was considered including consideration of emissions reported in the GHD Report. The cumulative benzene impact remains well below the assessment criterion at the most impacted receptor.

For sulphur dioxide, the maximum predicted concentration will also be experienced at Receptor 13. It was predicted that sulphur dioxide will peak at 110 µg/m^3 which includes the addition of background concentration which was obtained from NSW EPA ambient air quality data. The expected peak level concentration is approximately 20% of the impact assessment criteria.

In addition, the predicted peak level concentrations for carbon monoxide, nitrogen dioxide and PM_{10} will also be experienced at Receptor 13. As per the Approved Methods, the maximum ambient background concentration was added to the modelling result at Receptor 13 to gauge the overall impact of the emissions from the proposed combustion system. The following conclusions were determined:

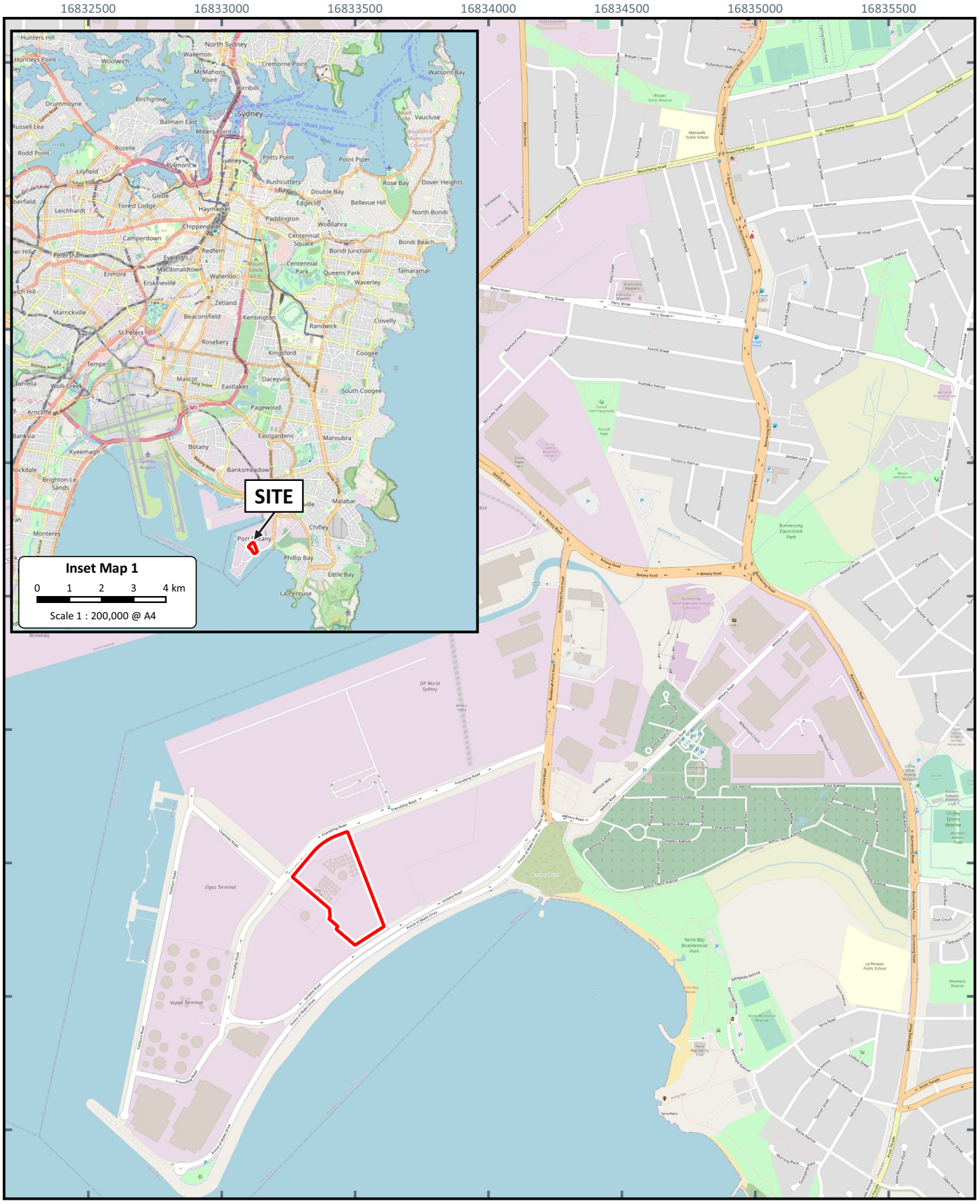
- The maximum carbon monoxide concentration will be experienced at Receptor 13 with a peak of 2.162 mg/m^3 approximately 7.2% of the impact assessment criterion.
- The maximum nitrogen dioxide concentration will be experienced at Receptor 13 with a peak of 86.420 µg/m^3, approximately 35% of the impact assessment criterion for NO_2.
- Based on the modelling results, it was considered that the predicted emission from both oxidisers would have negligible impact on the ambient concentrations of PM_{10}.

Emissions from the operation of the proposed thermal oxidiser, in addition to the existing oxidiser, will not have unacceptable impact on the air quality at the nearest sensitive receptors.

PETER J RAMSAY
& ASSOCIATES

www.pjra.com.au

Figures



PETER J RAMSAY & ASSOCIATES

LEGEND

Site Boundary

LOCALITY MAP

Air Quality Impact Assessment

45 Friednship Road,
Port Botany NSW

Quantem Bulk Liquid Storage & Handling (Terminals Pty Ltd)

Figure **F1**

Project: 1033.1
Date: 17/11/2020
Revision: Rev00
Designed: TA
Drawn: AD
Reviewed: TA

N

0 100 200 300 400 m

Main Map Scale 1: 20,000 @ A4

Coordinates: WGS84 / Pseudo-Mercato

Data Sources

Aerial Imagery - Nearmap Australia Ltd, photograph dated 26/09/2020.

File: P:\Projects\1033_Quantem\01\Maps\Working\F1_Locality Map.qgz

PETER J RAMSAY & ASSOCIATES

Project: 1033.1
Date: 17/11/2020
Revision: Rev00
Designed: TA
Drawn: AD
Reviewed: TA

N

0 100 200 300 m

Main Map Scale 1: 17,000 @ A4

Coordinates: GDA94 / MGA 56

LEGEND

- Site Boudnary
- Sensitive Receptors
- Emission Sources

Data Sources

Aerial Imagery - Nearmap Australia Ltd, photograph dated 26/09/2020

AIR DISPERSION MODELLING SENSITIVE RECEPTORS

Air Quality Impact Assessment

45 Friendship Road,
Port Botany NSW

Quantem Bulk Liquid Storage & Handling (Terminals Pty Ltd)

Figure
F2

File: P:\Projects\1033_Quantem\01\Maps\Working\Working_20201117.qgz

Appendix A

pDs Consultancy REPORT - AERMOD ready Meteorological data files for Port Botany NSW

AERMOD ready Meteorological data files for

Port Botany- NSW

This file was exclusively compiled for **PJRA** By pDs Consultancy.

pDs Consultancy
@1999-2020

INTRODUCTION

New generation regulatory model AERMOD requires hourly averaged meteorological data from a single site that is preferably within the model domain ('on-site' or site-specific data). However, data from the nearest 'off-site' meteorological station can be used when on-site data are not available, and the off-site data are representative of the area of concern (i.e. the meteorological parameters as well as surface characteristics characterise the transport and dispersion conditions of the location in question).

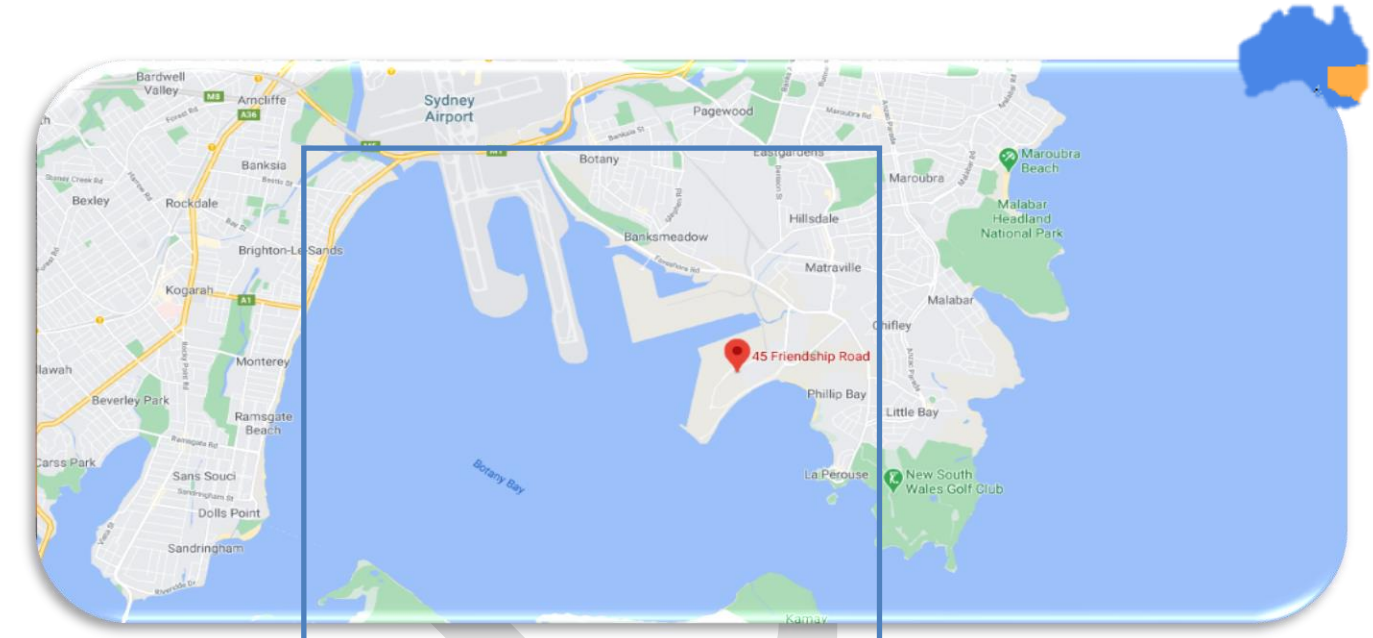
It is also preferable that:

- The compilation of the input meteorological data file is done in accordance with 'best practice', with procedures and algorithms recommended or set by environment regulators/US & VIC EPA.

pDs Consultancy has been engaged by **PJRA** to compile an 'AERMOD-ready' meteorological files for an application site in **Port Botany** in NSW. Sydney Airport (maintained by BoM Australia) data found to be representing this application site.

This input meteorological data files have been compiled basically following the EPA, Victoria's draft guidelines: "Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD) (Publication No.1550)".

LOCATIONS OF THE APPLICATION SITE AND THE DATA SITE: 45, FRIENDSHIP ROAD, PORT BOTANY



Application site is within 10 KM radius of the data site

Data Processing

Input Information

Data Used for the compilation

Meteorological Data

1. Mandatory Data (Site-Representative, Sydney Airport)

    i. 10m Wind Direction and Speed
    ii. Ambient Temperature (Screen Level)

2. Supplementary data (Sydney Airport)

    i. Surface Pressure
    ii. 3 Hourly Cloud observations
    iii. Relative Humidity
    iv. Rainfall Rate

3. Upper air Data (BoM's Sydney Airport)

    i. Pressure Levels
    ii. Geopotential Heights
    iii. Temperature
    iv. Dew Point

Data Source

- National Climate Centre, Bureau of Meteorology, Melbourne for all 3 types of data
- Data Source: **Sydney Airport**, NSW
- Period :1 Jan 2015 to 31 Dec 2019 (5 years)-2017 selected

QA/QC ON RAW DATA

I. Hourly averaged winds both direction and speed and temperature examined for gaps and wind stalls
   - Suspected wind stalls (both wind direction and speed) removed and filled appropriately preserving the temporal consistency.
   - Note that BoM Syncrotec Anemometer's lowest detection limit of wind speed is 2 KM/Hour (Wind Speed Threshold)

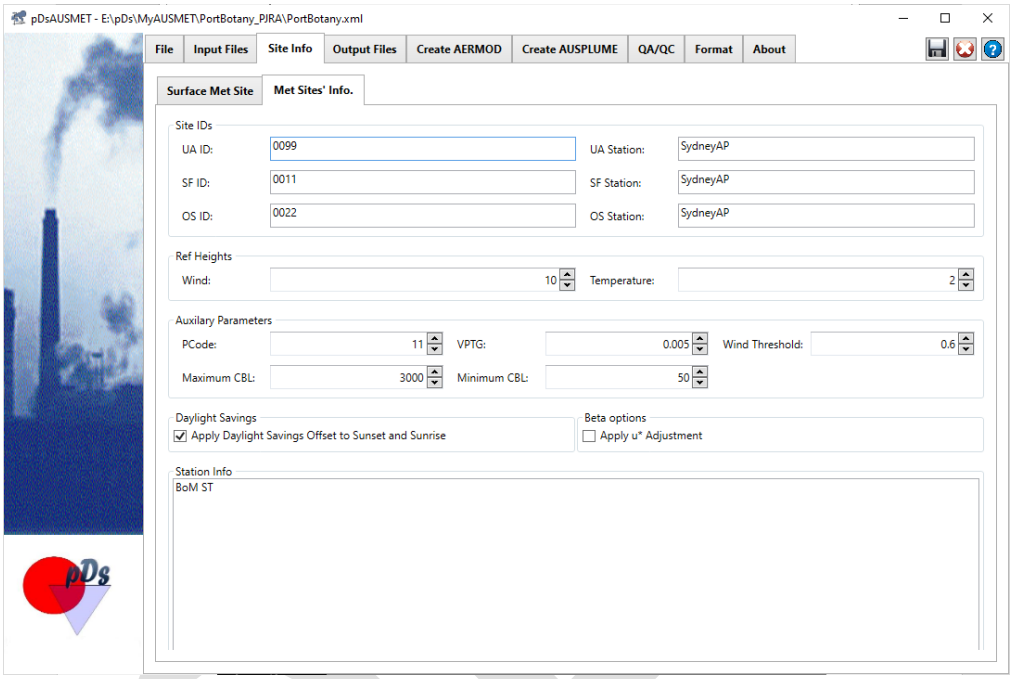
II. Small gaps filled with pervious or following hour records

III. Days with big gaps removed maintaining 90% data recovery

IV. Parameters QA/QCed based on extreme values

V. Gaps in vertical temperature profiles were filled with previous or following day data for the completeness.

METSITE INFORMATION



DATA COVERAGE:

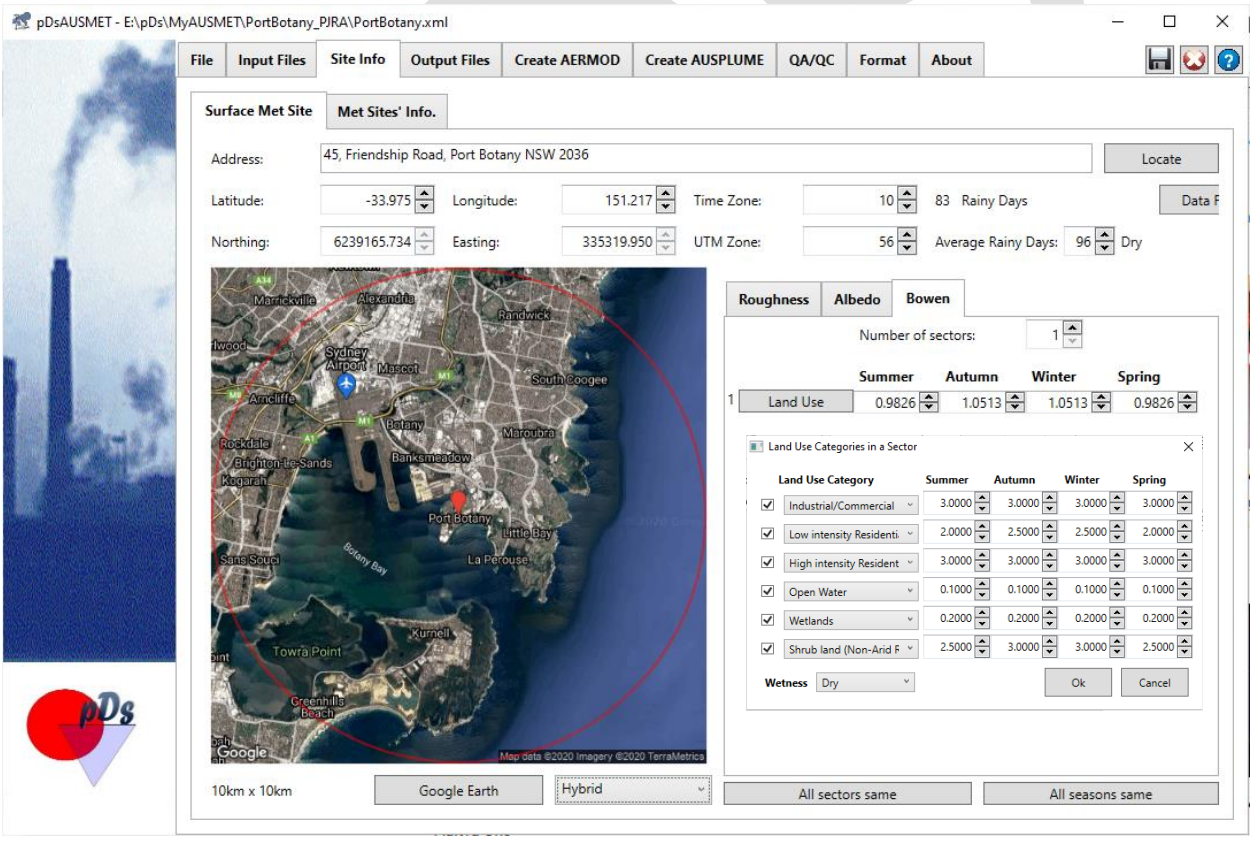
Year	2015	2016	2017	2018	2019
Season					
Summer			100		
Autumn			100		
Winter			100		
Spring			100		
Annual			100		

Annual coverage is 99%. It is meeting regulatory requirement (90% or better). Seasonal coverage is also meeting the requirement.

DETERMINATION OF SURFACE CHARACTERISTICS

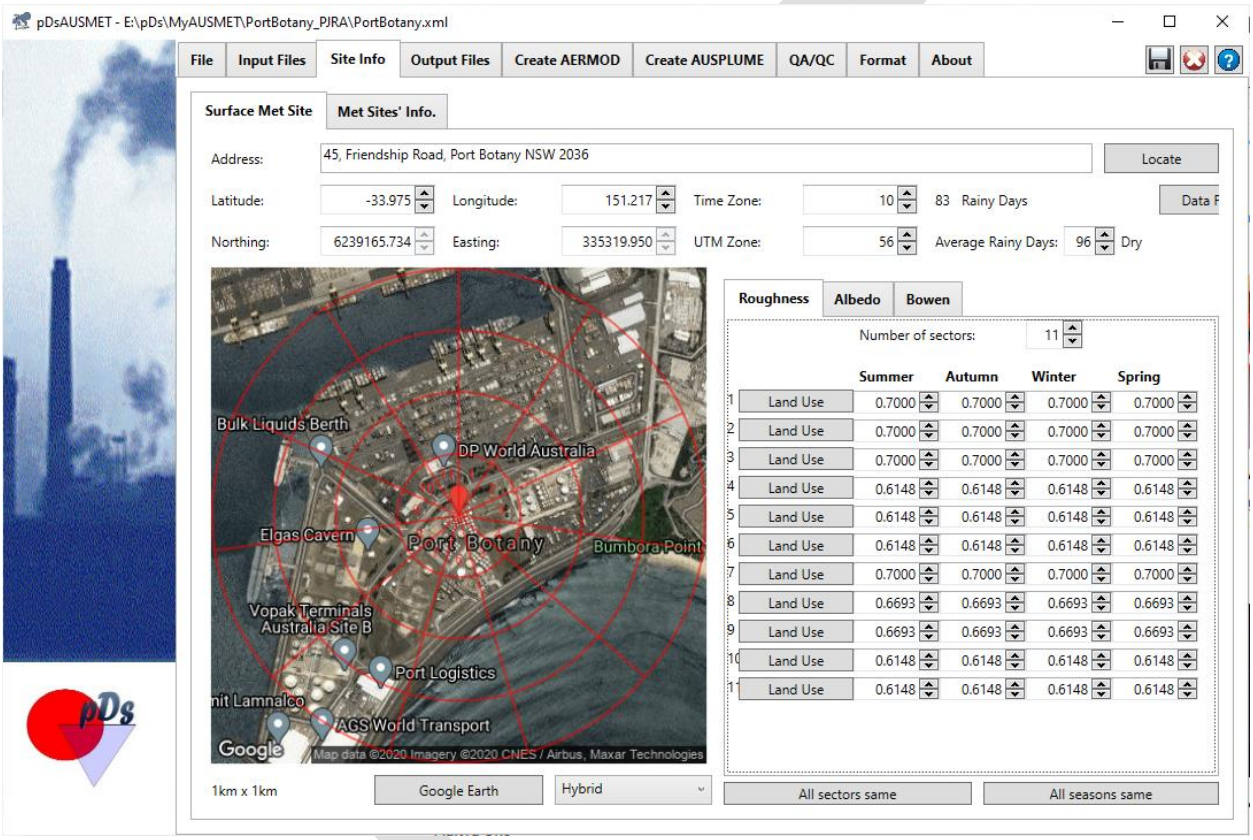
All available surface maps including google maps examined to determine correct land use categories within 10 Km by 10 KM area centring the application site.

Albedo and **Bowen ratio** were determined using land use categories shown below. The year 2017 found to be dry.



SURFACE ROUGHNESS

Sector dependent surface roughness was determined considering 11 sectors. The roughness for each sector was determined professionally examining 4 arc segments (250m).



The following parameters were determined/computed following EPA, VIC and US EPA guidelines.

Sensible Heat flux –Calculated based on cloud observations

I. Friction Velocity (U*)
II. Monin-Obukhov Length (L)
III. Height of the Stable Boundary Layer(SBL)
IV. Vertical Velocity Scale (W*)
V. Height of the Convective Boundary Layer (CBL)

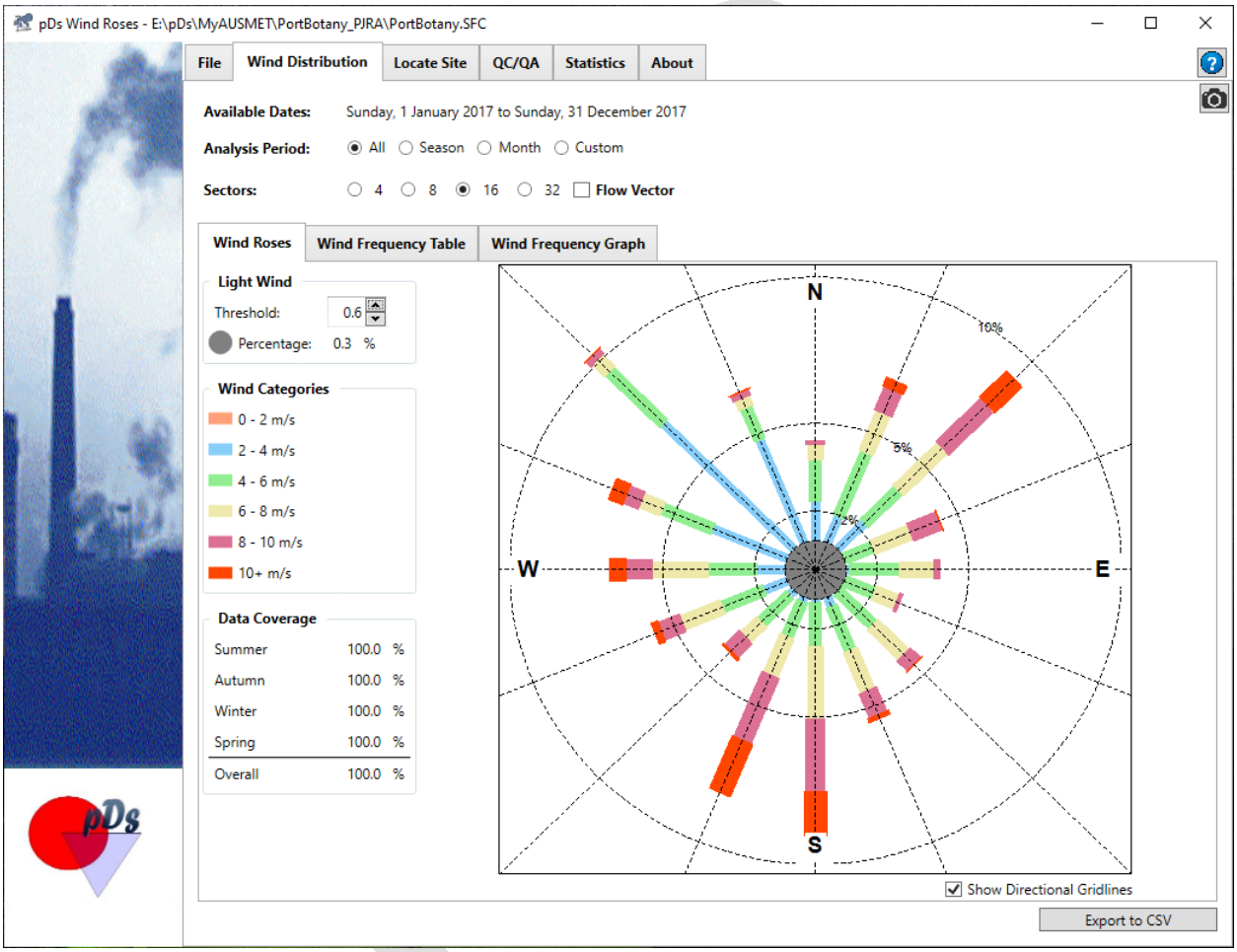
Mixing height (Convective)-CBL

DEFINITION:

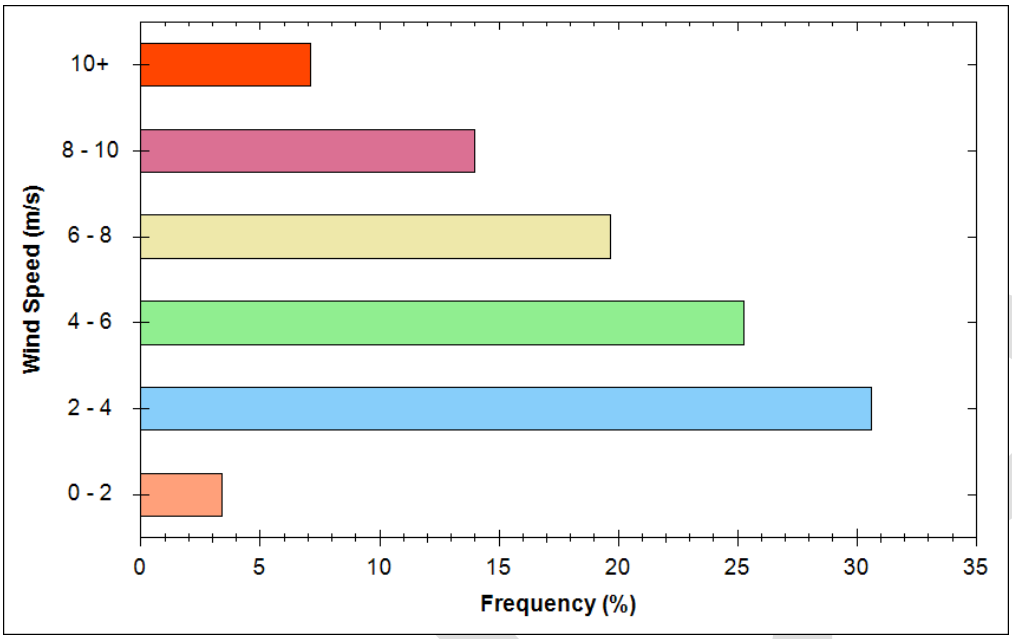
The convective mixing height, the depth of the surface mixed layer is the height of the atmosphere above the ground, which is well mixed due either to mechanical turbulence or convective turbulence. This height was determined by using the methodology of Benkley and Schulman (Journal of Applied Meteorology, Volume 18, 1979,pp 772-780). **Sydney Airport** upper air observation containing temperature and moisture profiles and surface temperature, pressure and relative humidity at **Sydney Airport** were used to determine daytime mixing height.

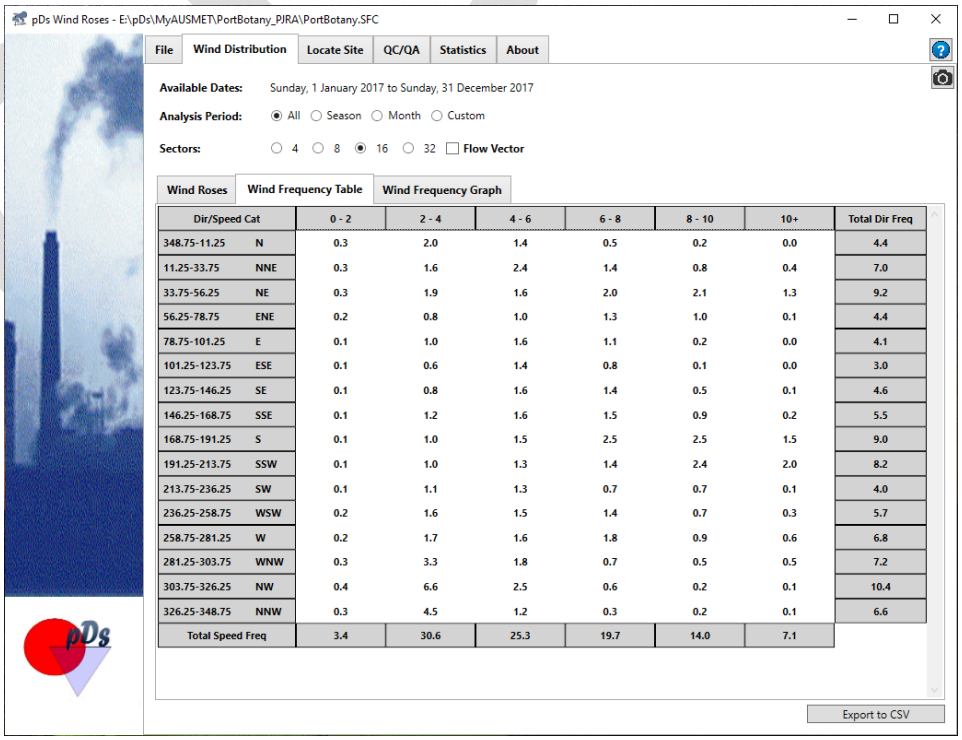
DATA ANALYSIS

ANNUAL WINDROSES FOR SYDNEY AIRPORT



FREQUENCY OF WIND SPEED

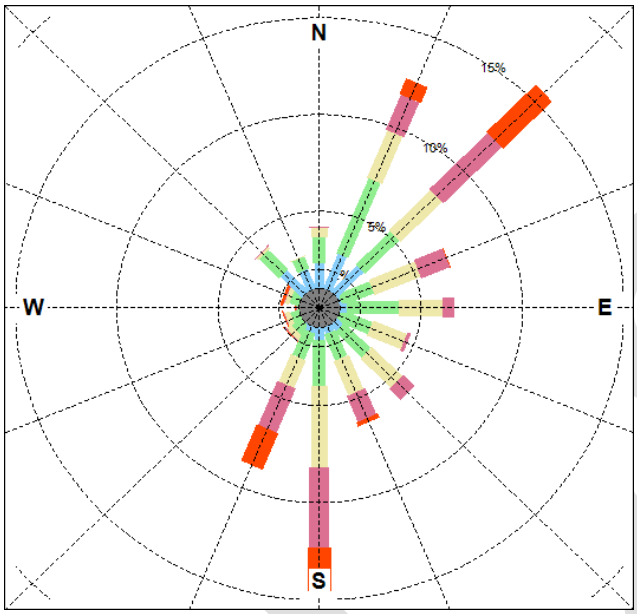


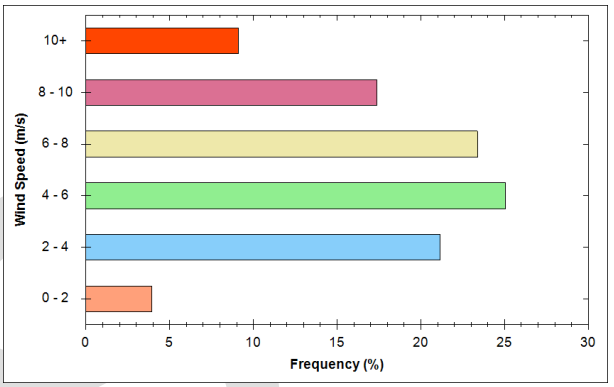


Dir/Speed Cat		0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	10+	Total Dir Freq
348.75-11.25	N	0.3	2.0	1.4	0.5	0.2	0.0	4.4
11.25-33.75	NNE	0.3	1.6	2.4	1.4	0.8	0.4	7.0
33.75-56.25	NE	0.3	1.9	1.6	2.0	2.1	1.3	9.2
56.25-78.75	ENE	0.2	0.8	1.0	1.3	1.0	0.1	4.4
78.75-101.25	E	0.1	1.0	1.6	1.1	0.2	0.0	4.1
101.25-123.75	ESE	0.1	0.6	1.4	0.8	0.1	0.0	3.0
123.75-146.25	SE	0.1	0.8	1.6	1.4	0.5	0.1	4.6
146.25-168.75	SSE	0.1	1.2	1.6	1.5	0.9	0.2	5.5
168.75-191.25	S	0.1	1.0	1.5	2.5	2.5	1.5	9.0
191.25-213.75	SSW	0.1	1.0	1.3	1.4	2.4	2.0	8.2
213.75-236.25	SW	0.1	1.1	1.3	0.7	0.7	0.1	4.0
236.25-258.75	WSW	0.2	1.6	1.5	1.4	0.7	0.3	5.7
258.75-281.25	W	0.2	1.7	1.6	1.8	0.9	0.6	6.8
281.25-303.75	WNW	0.3	3.3	1.8	0.7	0.5	0.5	7.2
303.75-326.25	NW	0.4	6.6	2.5	0.6	0.2	0.1	10.4
326.25-348.75	NNW	0.3	4.5	1.2	0.3	0.2	0.1	6.6
Total Speed Freq		3.4	30.6	25.3	19.7	14.0	7.1	

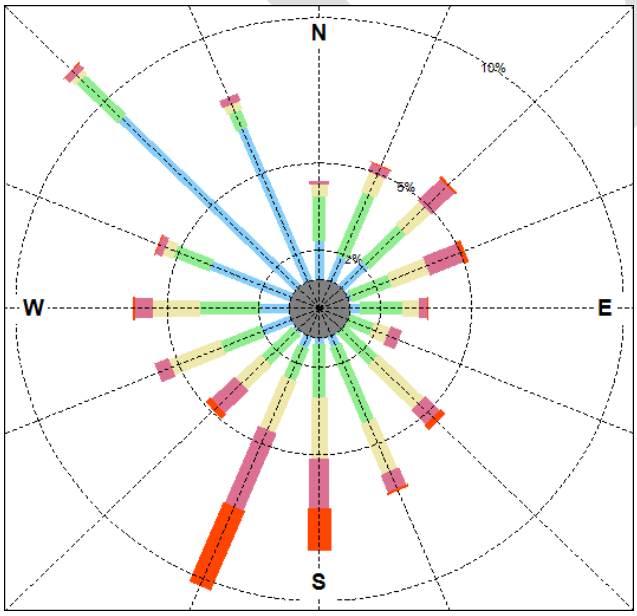
SEASONAL WINDROSES

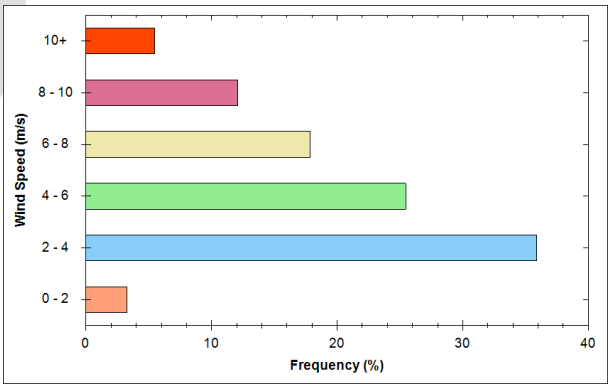
Summer



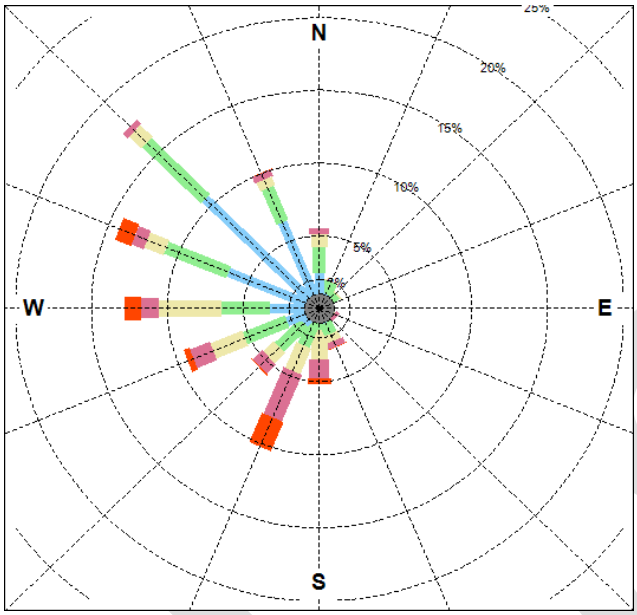


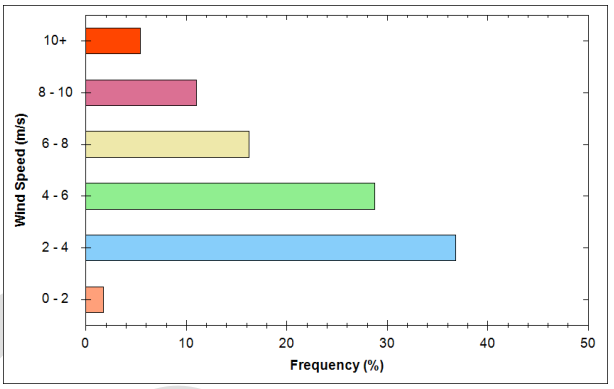
Autumn



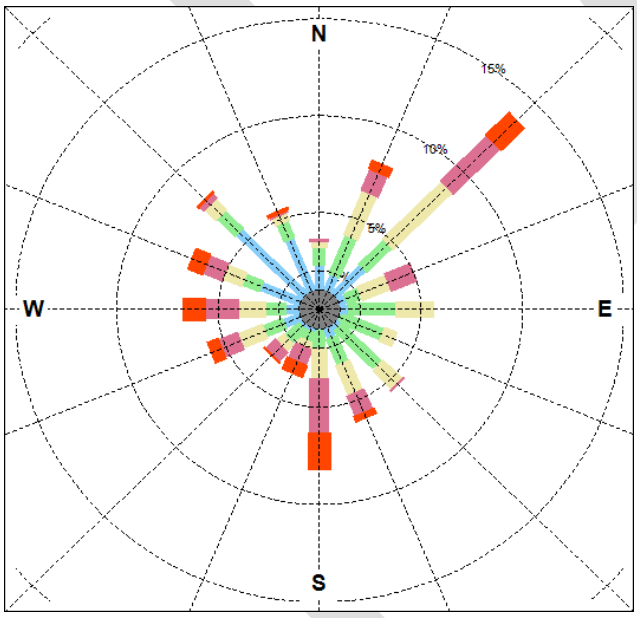


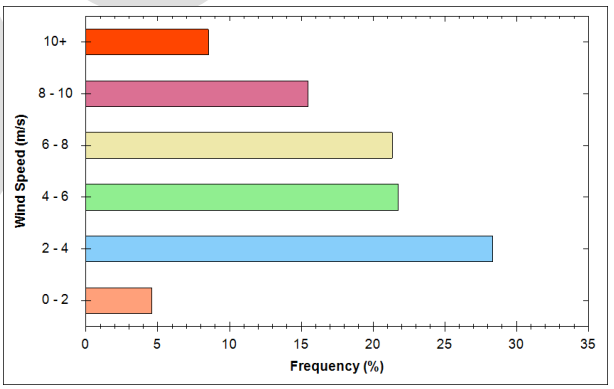
Winter





Spring

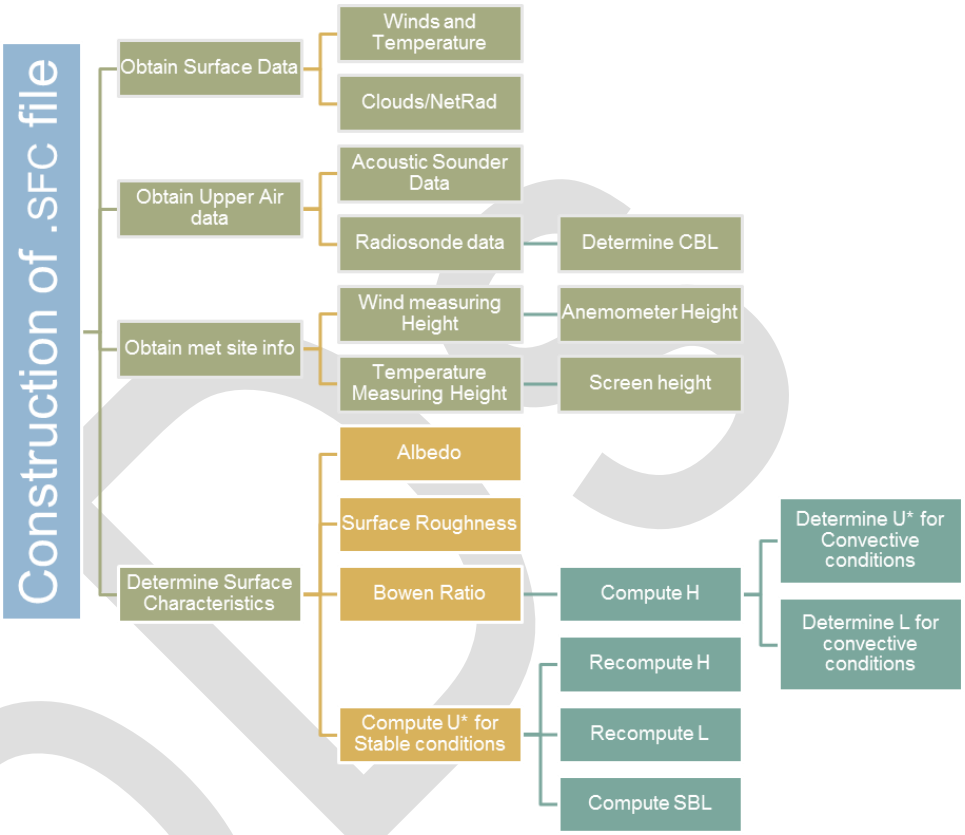


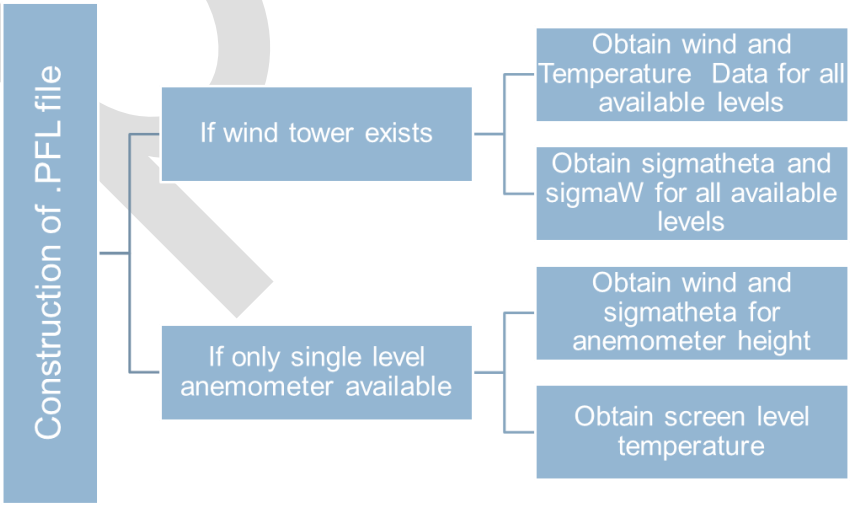


Seasonal variations are clearly depicted.

Appendix

FLOW CHARTS - CONSTRUCTION PROCEDURE





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DISCLAIMER

Compilation of input meteorological data files for AERMOD was done under the supervision of qualified and experienced meteorologists. Although all due care has been taken, we cannot give any warranty, nor accept any liability (except that required by law) in relation to the information given, its completeness or its applicability to a particular problem. These data and other material are supplied on the condition that you agree to indemnify us and hold us harmless from and against all liability, losses, claims, proceedings, damages, costs and expenses, directly or indirectly relating to, or arising from the use of or reliance on the data and material which we have supplied.

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