



TODOROSKI
AIR SCIENCES

LAKE MACQUARIE – WYONG
REVIEW OF MONTHLY AMBIENT AIR
QUALITY DATA
DECEMBER 2013

NSW Environment Protection Authority

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Lake Macquarie – Wyong

Review of Monthly Ambient Air Quality Data

December 2013

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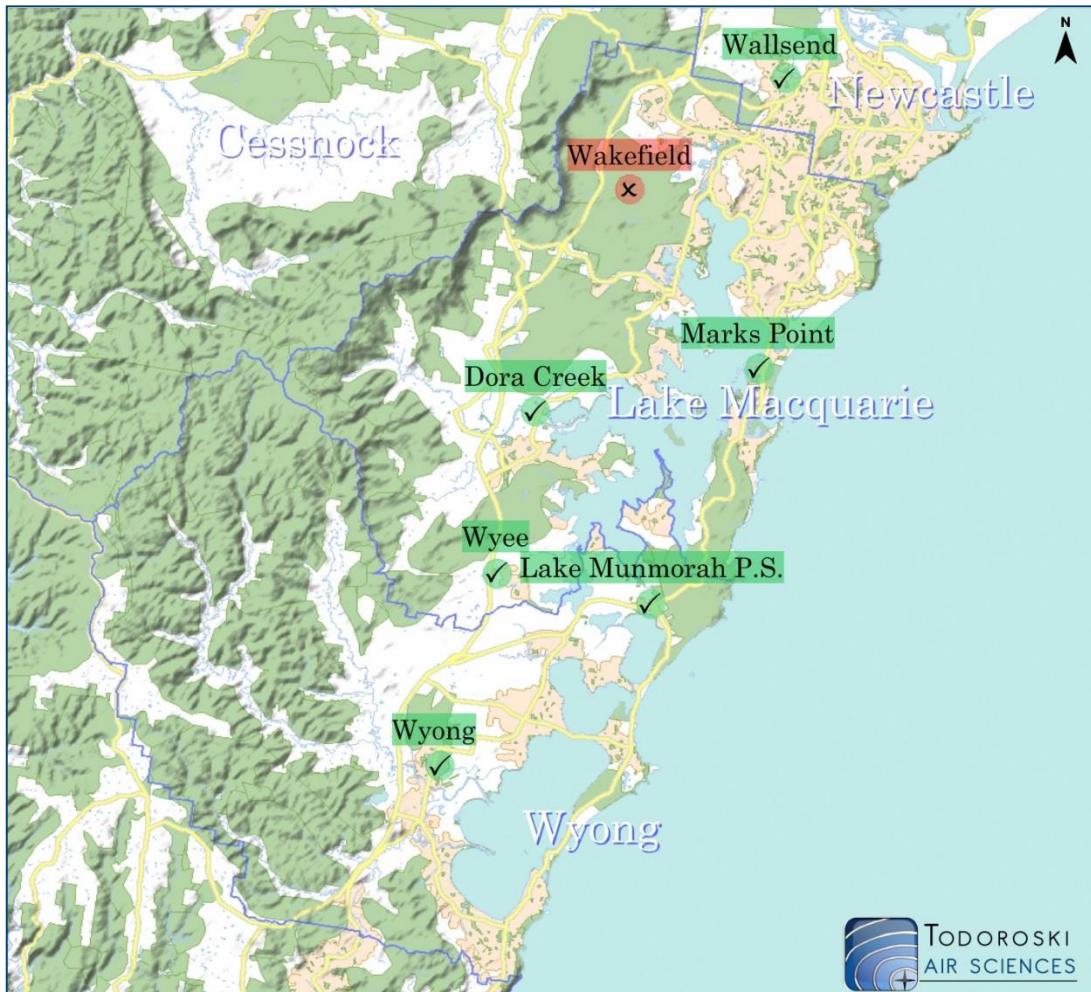
Appendix A – How to read a windrose
Appendix B – Monitoring Data (Graphical)
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EXECUTIVE SUMMARY

This report has been prepared by Todoroski Air Sciences for the NSW Environment Protection Authority (NSW EPA) and presents ambient air quality monitoring data recorded in the Lake Macquarie - Wyong region for the month of December 2013. The results indicate that the air quality was generally very good in the Lake Macquarie - Wyong region during December.

The data summary (shown below) indicates that in December 2013, Wakefield recorded data above the PM₁₀ criteria. Further details are provided in the report. The 24-hour average data are provided in the Appendices.

Lake Macquarie - Wyong Air Quality Pictorial Summary - December 2013



Lake Macquarie – Wyong Air Quality Tabular Summary - December 2013

Site	PM ₁₀ ($\mu\text{g}/\text{m}^3$)	PM _{2.5} ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)	NO ₂ ($\mu\text{g}/\text{m}^3$)	SO ₂ ($\mu\text{g}/\text{m}^3$)
	24-hour average	24-hour average	24-hour average	1-hour average	1-hour average
	50	25*	228	246	570
Wallsend	✓	✓	✓	✓	✓
Wyong	✓	✓	✓	✓	✓
Dora Creek	-	-	✓	✓	✓
Marks Point	-	-	✓	✓	✓
Lake Munmorah P.S.	-	-	✓	✓	✓
Wyee	-	✓	✓	✓	✓
Wakefield HVAS	✗	-	-	-	-

✓ - All data below applicable criteria

✗ - At least one elevated level above applicable criteria

- - Not applicable

HVAS - High Volume Air Sampler

* - Advisory reporting standard for PM_{2.5} concentrations (refer to Section 5.1)

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of the NSW EPA. It provides a summary and analysis of the available ambient air quality and meteorological data collected in the Lake Macquarie - Wyong region during December 2013.

2 PROJECT SCOPE

The following outlines the scope of work for this project.

- ◆ Provide a monthly report written in plain English to the NSW EPA summarising and analysing available air quality data and meteorological information.
- ◆ The report will be published on the EPA's website and will assess the available data from monitoring stations operated by the NSW Office of Environment and Heritage (OEH) at Wyong and Wallsend, and by industry at Lake Munmorah public school, Wyee, Marks Point, Dora Creek and Wakefield.
- ◆ The aim is to provide a simplified report that is accessible and contains results that would be clearly understood by the general public.

The work is for the period from September 2013 to June 2015.

3 THE PURPOSE OF AMBIENT MONITORING

It is important to note that the data presented in this report are from both EPA and Industry monitoring sites. The EPA and the industry sites collect data for different purposes and this needs to be understood when comparing the data to the criteria.

EPA monitoring sites are specifically designed to measure the likely levels of pollutants that the general population in the area would experience (i.e. an underlying population exposure level), whereas industry monitoring sites are specifically designed to measure maximum levels in a particular location that may be affected by a particular industry.

Data from EPA sites can be compared with national air quality standards. Where the levels measured at EPA monitoring sites are above the national standards on a prolonged and consistent basis, this indicates that some investigation of the potential cause of the issue may be warranted to determine whether any action on a regional level would reduce or better manage the pollutant levels. In the case of PM₁₀, it is noted that the national standards permit five days annually above the criteria to allow for events such as bushfires and dust storms.

Data from industry monitoring sites can be compared with EPA impact assessment criteria. Where the levels measured at industry monitoring sites are above the impact assessment criteria on a prolonged and consistent basis, this indicates that further investigation is warranted to determine whether industry is responsible, and if so whether action to reduce or better manage the pollutant can be taken.

Whether there is any harmful effect on an individual due to an air pollutant will depend on many additional factors, and not just on the measured level of a pollutant. These factors include the total exposure to the pollutant, individual circumstances (age, health, body mass, levels of pollutants at work), levels of other pollutants in the area, and many other factors.

Where pollutant levels are below the criteria generally, harm would not be expected to occur, but it does not follow that harm automatically occurs when pollutant levels are above the criteria.

The criteria serve to highlight potential issues with the levels of pollutants that may warrant more detailed examination. The criteria may also serve to prioritise action in various areas, for example areas with the highest pollutant levels and highest populations or highest exposure would be expected to receive priority action.

3.1 More about air quality

More information about air quality can be found via the following links:

- ⊕ The Air Quality Index (AQI) was developed by the NSW EPA as an easily understood means of rating the pollutant level relative to its pollutant.
 - <http://www.environment.nsw.gov.au/AQMS/aboutaqi.htm>
- ⊕ Aqicn.org provides a near real-time AQI values for monitoring locations around the world. It should be noted that the AQI presented on this website is calculated differently to the NSW EPA AQI and is less stringent than those used in Australia, thus a direct comparison may not be valid.
 - <http://aqicn.org/map/world/>
- ⊕ The NSW OEH website air quality page provides hourly updates of the AQI and data readings from the NSW EPA monitoring sites, and can provide daily forecasts for Sydney and alerts for elevated levels at Wallsend and Wyong, for example. The web tool also presents near real-time wind and pollutant data readings overlaid on regional maps for the Upper Hunter and Newcastle.
 - <http://www.environment.nsw.gov.au/aqms/aqi.htm>
- ⊕ The Lower Hunter Particle Characterisation Study aims to determine the composition of particulate samples collected at monitoring sites at Beresfield, Newcastle, Stockton and Mayfield, and to identify the potential major sources of fine particulates in Newcastle and the Lower Hunter. Progress reports are published on the OEH website provided below.
 - <http://www.environment.nsw.gov.au/aqms/lowhunterparticle.htm>
- ⊕ The Air Emissions in My Community web tool presents the estimated emission quantities of various substances and their sources by postcode (and larger) sized areas in an easy to use graphical interface. This is one of the best inventories of emissions that is available, but it is important to appreciate that it cannot include all sources of emissions. It is important to also understand that pollutant emissions are not the same as the pollutant levels that this report presents. Emissions in a given area are one of several important factors that affect pollutant levels in an area, for example the dispersion of the emissions in the atmosphere and how the emissions are released are critical in determining the air quality pollutant levels.
 - <http://www.epa.nsw.gov.au/air/airemissionsapp/airemissionswebtool.aspx>
- ⊕ The NSW Health website provides information on how air pollution affects health and steps for reducing your air pollution and limiting your exposure.
 - <http://www.health.nsw.gov.au/environment/air/Pages/default.aspx>

4 AIR QUALITY MONITORING SITES

Figure 4-1 and **Table 4-1** summarise the locations and recorded parameters of the monitoring sites in the Lake Macquarie - Wyong region in December 2013.

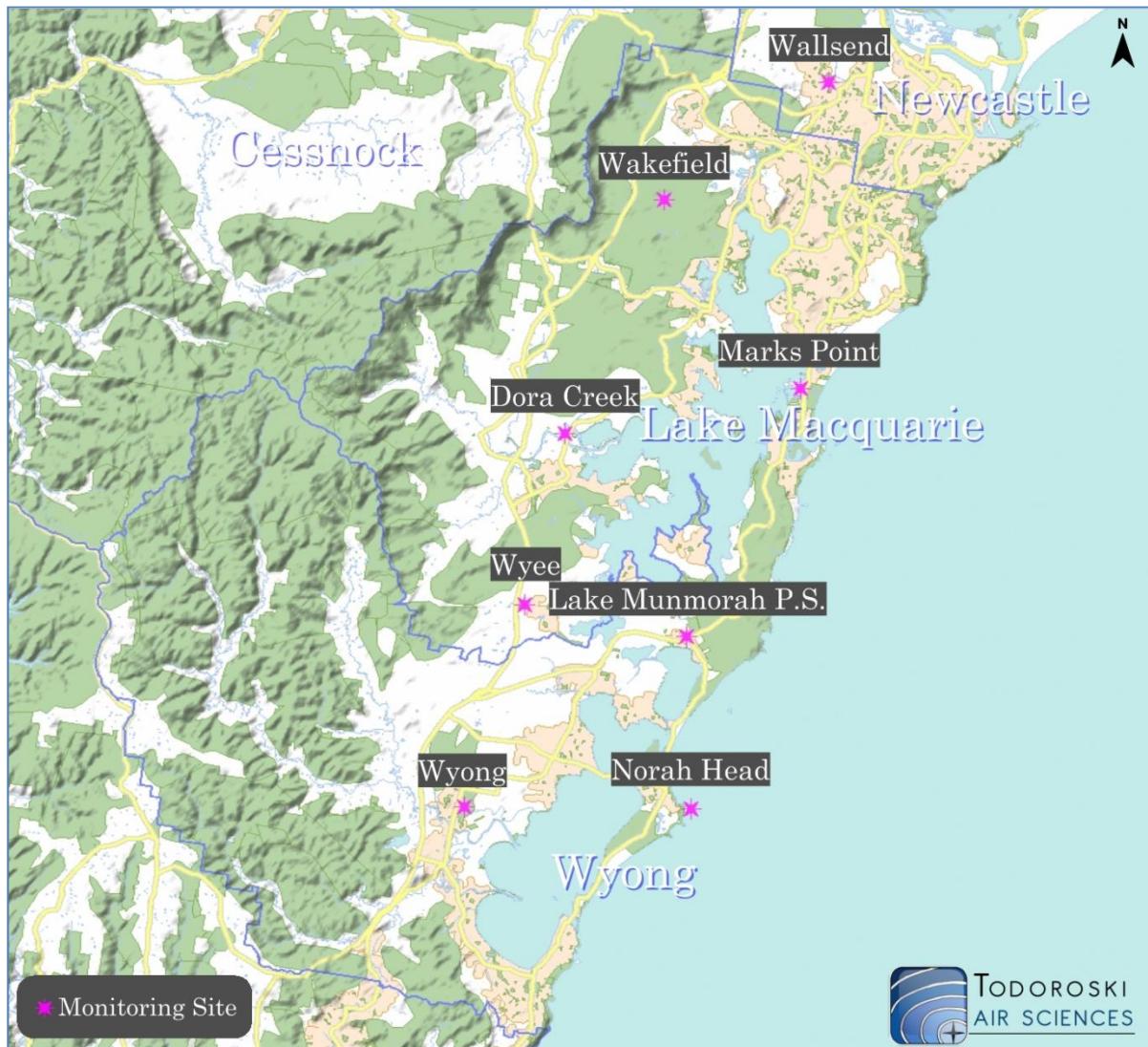


Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW EPA site	PM ₁₀ (TEOM), PM _{2.5} , NO ₂ , SO ₂ , WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM ₁₀ (TEOM), PM _{2.5} , NO ₂ , SO ₂ , WS, WD	Hourly/Daily
Marks Point	Industry site	NO ₂ , SO ₂ , WS, WD	Hourly
Wyee	Industry site	PM _{2.5} , NO ₂ , SO ₂ , WS, WD	Hourly
Dora Creek	Industry site	NO ₂ , SO ₂ , WS, WD	Hourly
Lake Munmorah P.S.	Industry site	NO ₂ , SO ₂	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM ₁₀ (HVAS)	Every 6th Day

PM₁₀ - Particulate matter < 10µm

PM_{2.5} - Particulate matter < 2.5µm

TEOM - Tapered Element Oscillating Microbalance
(which samples air continuously)

NO₂ - Nitrogen dioxide

SO₂ - Sulfur dioxide

HVAS - High volume air sampler (which samples
for a 24-hour period every 6 days)

WS - Wind speed

WD - Wind direction

BOM - Bureau of
Meteorology

5 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Lake Macquarie - Wyong air quality monitoring sites and the applicable air quality criteria.

5.1 Particulate matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (μm) as in practice particles larger than 30 to 50 μm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM₁₀ particles, particulate matter with aerodynamic diameters of 10 μm or less, and PM_{2.5}, particulate matter with aerodynamic diameters of 2.5 μm or less.

Table 5-1 summarises the air quality goals that are relevant to particulate pollutants as outlined in the NSW Environment Protection Agency (EPA) document "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**NSW DEC, 2005**).

Table 5-1: EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90 $\mu\text{g}/\text{m}^3$
Particulate Matter < 10 μm (PM ₁₀)	Annual	30 $\mu\text{g}/\text{m}^3$
	24-hour	50 $\mu\text{g}/\text{m}^3$

Source: **NSW DEC, 2005**

5.1.1 PM_{2.5} concentrations

The NSW EPA currently do not have impact assessment criteria for PM_{2.5} concentrations, however the National Environment Protection Council (NEPC) has released a variation to the National Environment Protection Measure (NEPM) (**NEPC, 2003**) to include advisory reporting standards for PM_{2.5} (see **Table 5-2**). As with the NEPM goals, the advisory reporting standards apply to the average, or general exposure of a population, rather than to "hot spot" locations such as industry monitoring sites.

Table 5-2: Advisory standard for PM_{2.5} concentrations

Pollutant	Averaging Period	Concentration
Particulate Matter < 2.5 μm (PM _{2.5})	24-hour	25 $\mu\text{g}/\text{m}^3$
	Annual	8 $\mu\text{g}/\text{m}^3$

Source: **NEPC, 2003**

5.2 Other air pollutants

Nitrogen dioxide (NO₂) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO₂ belongs to a family of reactive gases called nitrogen oxides (NO_x). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (**USEPA, 2013**). NO_x may also be generated by blasting activities. It is important to note that when formed, NO₂ is generally a small fraction of the total NO_x generated.

Sulfur dioxide (SO_2) is a colourless, toxic gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to be an issue in NSW.

Table 5-3 summarises the air quality goals for NO_2 and SO_2 .

Table 5-3: Air quality impact assessment criteria for air pollutants

Pollutant	Averaging period	Criterion
NO_2	1-hour	246 $\mu\text{g}/\text{m}^3$
	Annual	62 $\mu\text{g}/\text{m}^3$
SO_2	10-minute	712 $\mu\text{g}/\text{m}^3$
	1-hour	570 $\mu\text{g}/\text{m}^3$
	24-hour	228 $\mu\text{g}/\text{m}^3$
	Annual	60 $\mu\text{g}/\text{m}^3$

Source: NSW DEC, 2005

5.3 Summary of applicable criteria for this assessment

The particulate and gaseous pollutants monitored in the Lake Macquarie – Wyong region have air quality criteria which are averaged over short and long time periods. Annual average criteria require a full year of data.

As this report only looks at one month of ambient air quality data, the annual average criteria are not applicable. The SO_2 10-minute average criterion was not included as 10-minute monitoring data are not available. Therefore the criteria relevant to this assessment are those averaged over the shorter time periods (1-hour and 24-hours).

Table 5-4 summarises the applicable air quality criteria for this assessment.

Table 5-4: Air quality impact assessment criteria used in this assessment

Pollutant	Averaging Period	Type	Concentration
Particulate Matter < 10 μm (PM_{10})	24-hour	Criterion	50 $\mu\text{g}/\text{m}^3$
Particulate Matter < 2.5 μm ($\text{PM}_{2.5}$)	24-hour	Advisory Reporting Standard	25 $\mu\text{g}/\text{m}^3$
Nitrogen Dioxide (NO_2)	1-hour	Criterion	246 $\mu\text{g}/\text{m}^3$
Sulfur Dioxide (SO_2)	1-hour	Criterion	570 $\mu\text{g}/\text{m}^3$
	24-hour	Criterion	228 $\mu\text{g}/\text{m}^3$

6 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Lake Macquarie - Wyong air quality monitoring stations. The data are presented as a series windroses. For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 6-1 presents the December 2013 windroses for Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong.

The figure shows that the meteorological stations recorded winds which varied depending on the local influence of environmental features such as terrain, vegetation and buildings. Overall the stations

recorded a similar underlying trend of winds which originated from the north north-east to east south-east directions.

The Norah Head weather station recorded wind speeds which were generally higher than those recorded at the other stations. This is expected as the Norah Head weather station is located in an unsheltered coastal location that would be largely influenced by sea breezes.

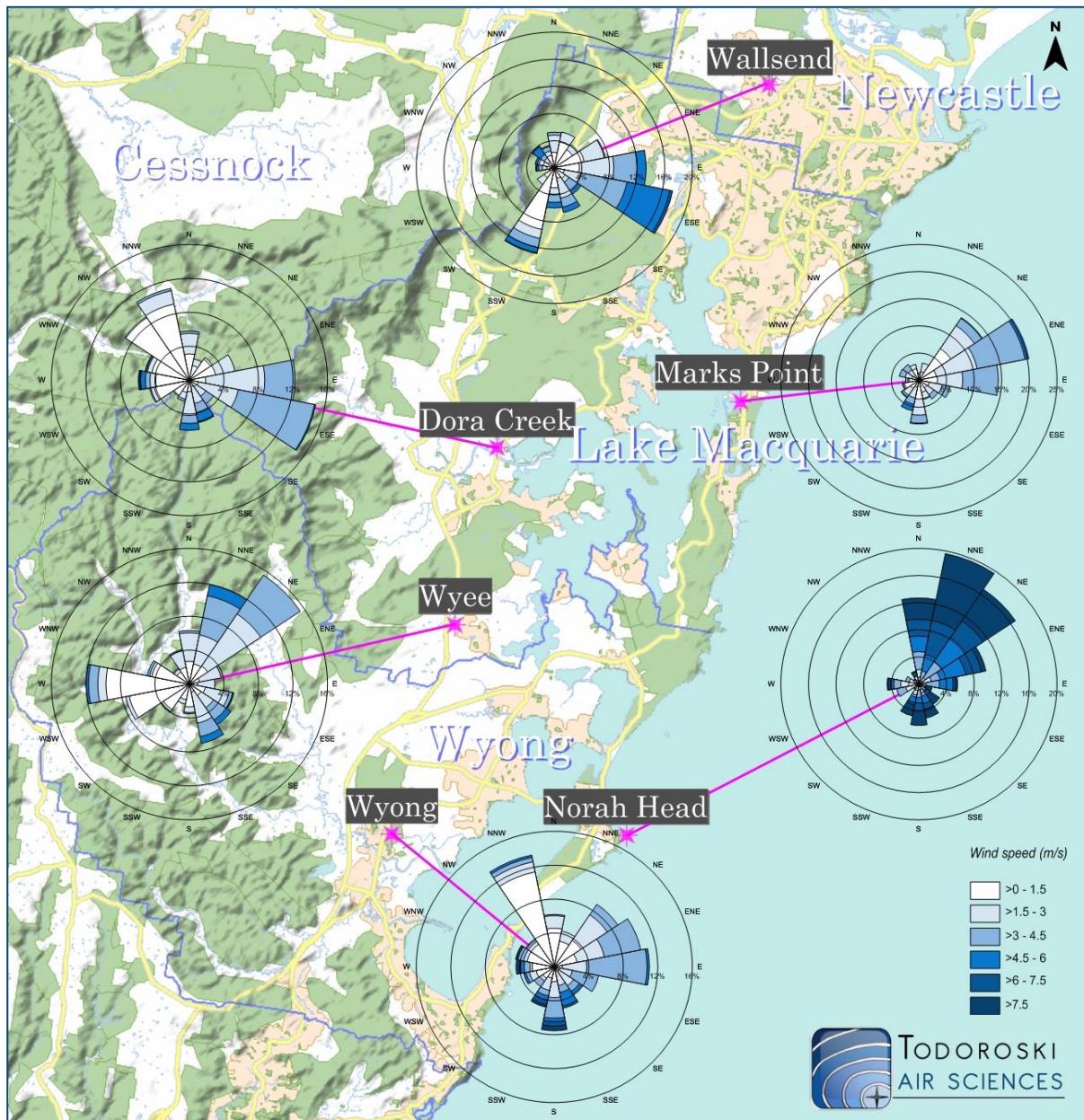


Figure 6-1: December windroses – Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

The meteorological stations recorded a similar underlying trend of winds blowing onshore in December 2013. Norah Head experienced higher wind speeds, typical of its unsheltered coastal location.

7 AMBIENT AIR QUALITY MONITORING DATA

7.1 Preamble

The monitoring data in this report are presented in raw form as provided to Todoroski Air Sciences by the NSW EPA.

The 24-hour average data presented in this report have been averaged using the 1-hour average readings. Days which contain less than 75% data (less than 18 hours of 1-hour average data) have not been included in this report.

All of the monitoring data provided to Todoroski Air Sciences are presented in this report. The data are shown in the results and appendices as relevant. Hourly data are presented in a graphical format in **Appendix B** and 24-hour average data are presented in tabulated format in **Appendix C**.

7.2 Analysis of Monitoring Data

Table 7-1 presents a summary of the maximum pollutant levels measured during December 2013. The results indicate that the Wakefield HVAS recorded PM₁₀ concentrations above the PM₁₀ criterion of 50µg/m³. All other data recorded in December were below the relevant criteria.

Table 7-1: Maximum pollutant levels - December 2013

Site	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO ₂ (µg/m ³)	SO ₂ (µg/m ³)
	24-hour average	24-hour average	24-hour average	1-hour average	1-hour average
	50	25*	228	246	570
Wallsend	34.5	14.2	13.9	41.4	131.0
Wyong	38.3	12.3	8.3	37.6	49.8
Dora Creek	-	-	8.3	36.7	57.0
Marks Point	-	-	6.5	44.1	38.8
Lake Munmorah P.S.	-	-	1.7	33.6	2.5
Wyee	-	18.1	0.2	61.6	1.8
Wakefield HVAS	57.0	-	-	-	-

* Advisory reporting standard for PM_{2.5} concentrations (refer to Section 5.1)

- Not applicable

7.3 PM₁₀

Figure 7-1 presents all of the 24-hour average PM₁₀ monitoring results recorded in the Lake Macquarie - Wyong region in December 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM₁₀ levels were generally very good or good at all locations most of the time. The Wyong monitoring site recorded very good to good levels 94% of the time and fair levels 6% of the time. The Wallsend monitoring site recorded very good or good levels 97% of the time and fair levels 3% of the time. The Wakefield HVAS recorded one day of poor levels.

The Wakefield HVAS recorded a 24-hour average PM₁₀ level of 57µg/m³ on 29 December 2013, which was over the relevant criterion of 50µg/m³. **Section 8** examines the situation on this day in more detail. All other data recorded at the Lake Macquarie - Wyong monitoring sites were below the criterion in December 2013.

Figure B-1 to Figure B-2 in Appendix B present the 1-hour average PM₁₀ data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM₁₀ levels and these 1-hour results are not intended to be compared with the PM₁₀ criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM₁₀ levels will fluctuate more significantly than 24-hour average PM₁₀ levels.

7.4 PM_{2.5}

Figure 7-2 presents all of the 24-hour average PM_{2.5} monitoring data recorded in the Lake Macquarie - Wyong region in December 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that PM_{2.5} levels were very good to good at all locations at all times except for the Wyee monitoring site which recorded fair levels 6% of the time.

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average PM_{2.5} advisory reporting standard of 25µg/m³ in December 2013.

Figure B-3 to Figure B-5 in Appendix B present the 1-hour average PM_{2.5} data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM_{2.5} levels and these 1-hour results are not intended to be compared with the PM_{2.5} advisory reporting standard. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM_{2.5} levels will fluctuate more significantly than 24-hour average PM_{2.5} levels.

7.5 Nitrogen dioxide NO₂

Figure 7-3 presents the 1-hour average NO₂ monitoring data recorded in the Lake Macquarie - Wyong region in December 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the NO₂ levels were very good all of the time at all of the monitors.

All data were below the applicable criterion on all days.

7.6 Sulfur dioxide SO₂

Figure 7-4 presents the 1-hour average SO₂ monitoring data recorded in the Lake Macquarie - Wyong region in December 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO₂ levels were very good all of the time at all of the monitors.

All data were below the applicable criterion on all days.

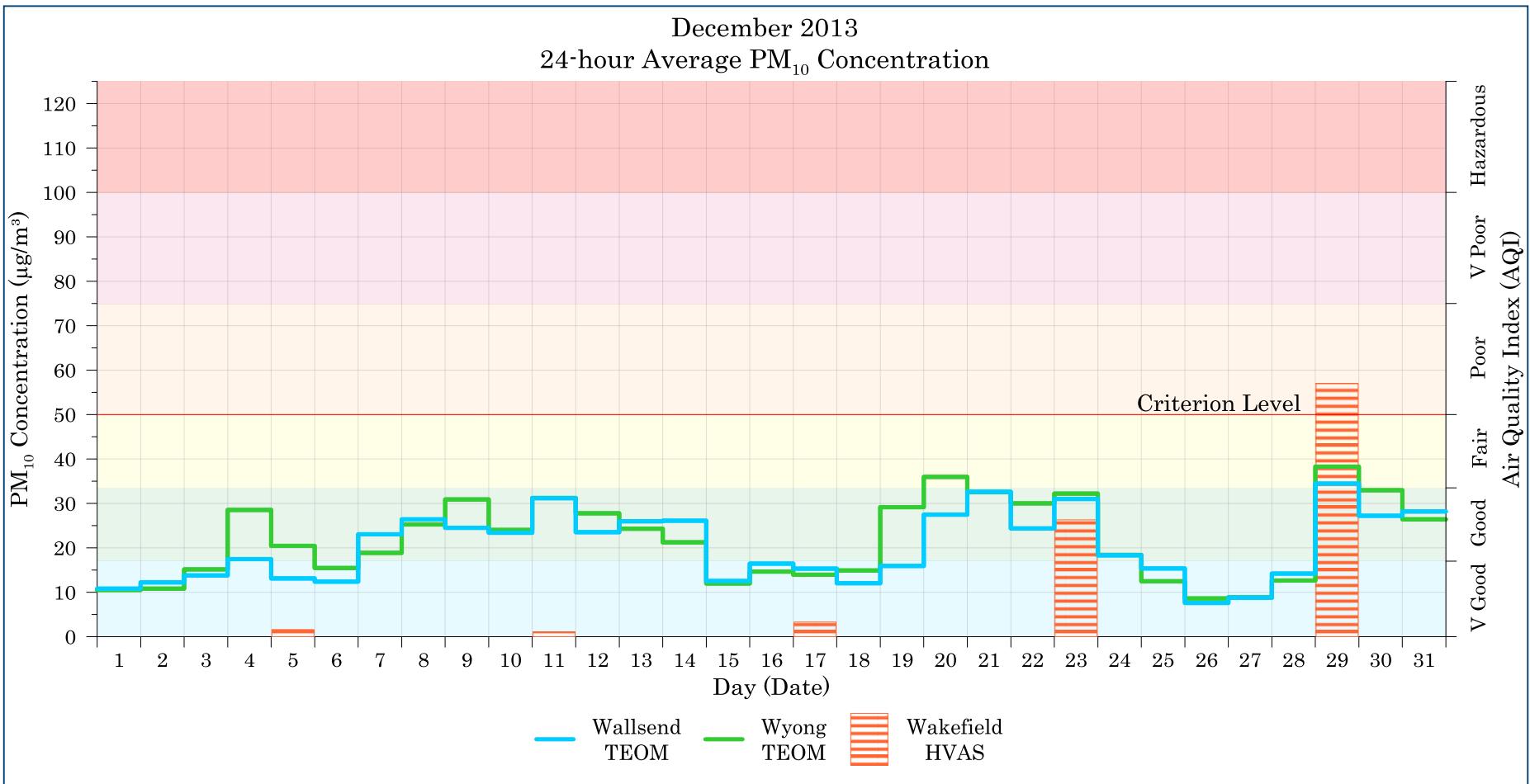


Figure 7-1: Lake Macquarie - Wyong 24-hour average PM₁₀ levels – December 2013

PM₁₀ levels were generally very good to good at all locations most of the time. The Wakefield HVAS monitoring site recorded poor levels on one day. All other data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average criterion of 50 $\mu\text{g}/\text{m}^3$.

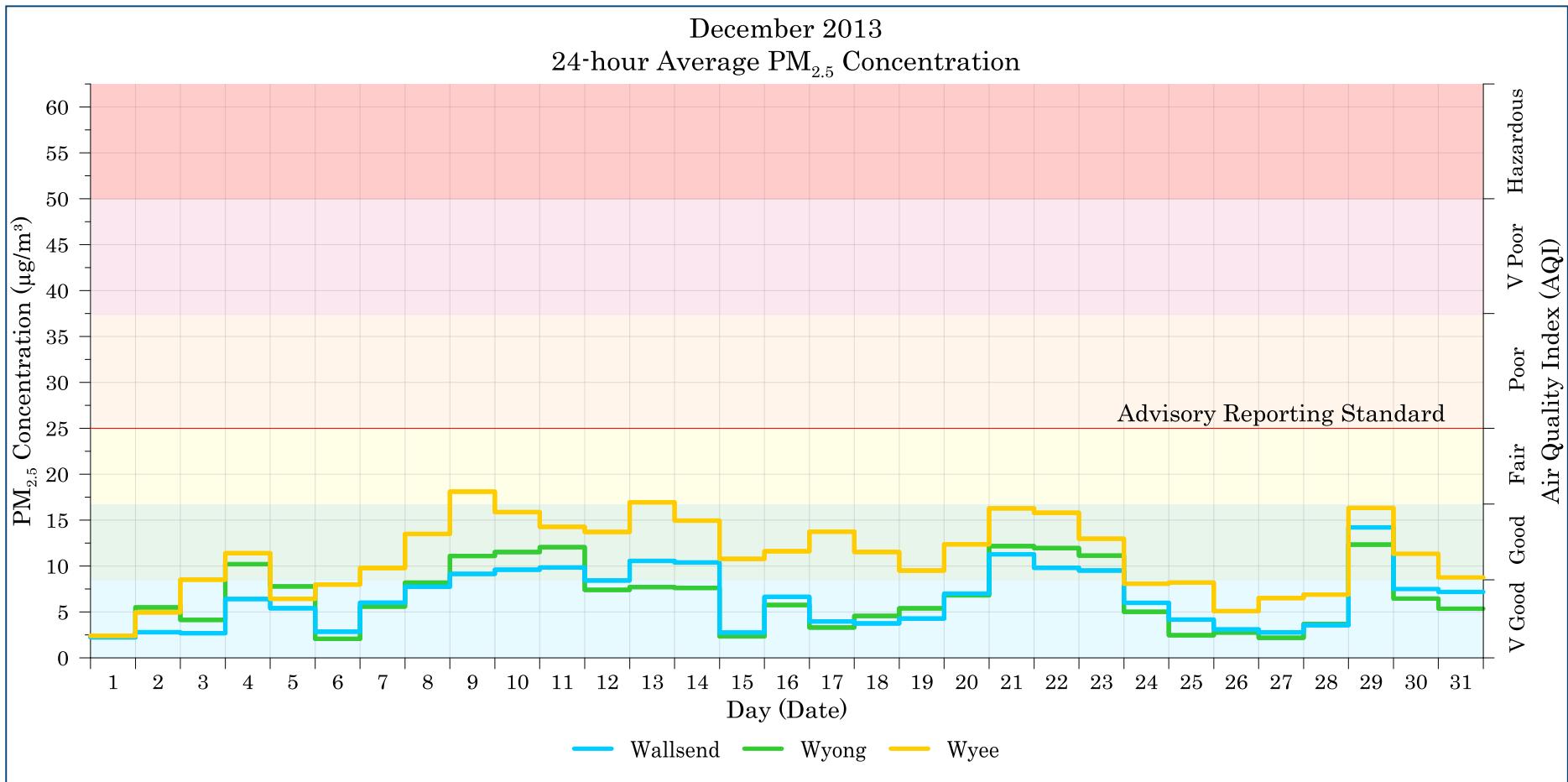


Figure 7-2: Lake Macquarie - Wyong 24-hour average PM_{2.5} levels – December 2013

PM_{2.5} levels were very good to good at all locations at all times except for the Wye monitoring site which recorded fair levels 6% of the time. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average PM_{2.5} advisory reporting standard of 25 $\mu\text{g}/\text{m}^3$.



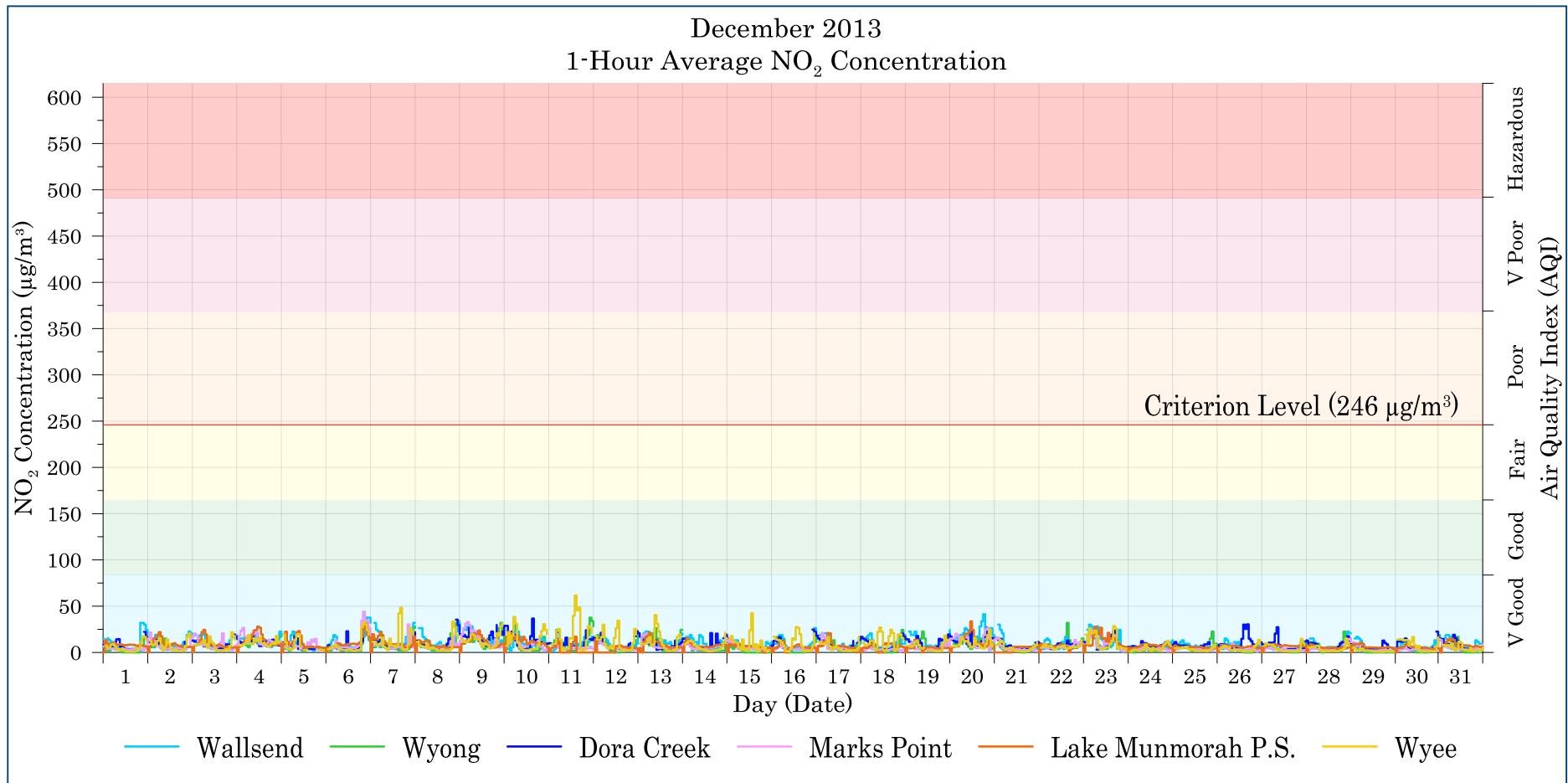


Figure 7-3: Lake Macquarie - Wyong 1-hour average NO₂ levels – December 2013

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO₂ criterion level of 246 $\mu\text{g}/\text{m}^3$ in December 2013. Measured levels of NO₂ were very good at all monitors at all times.

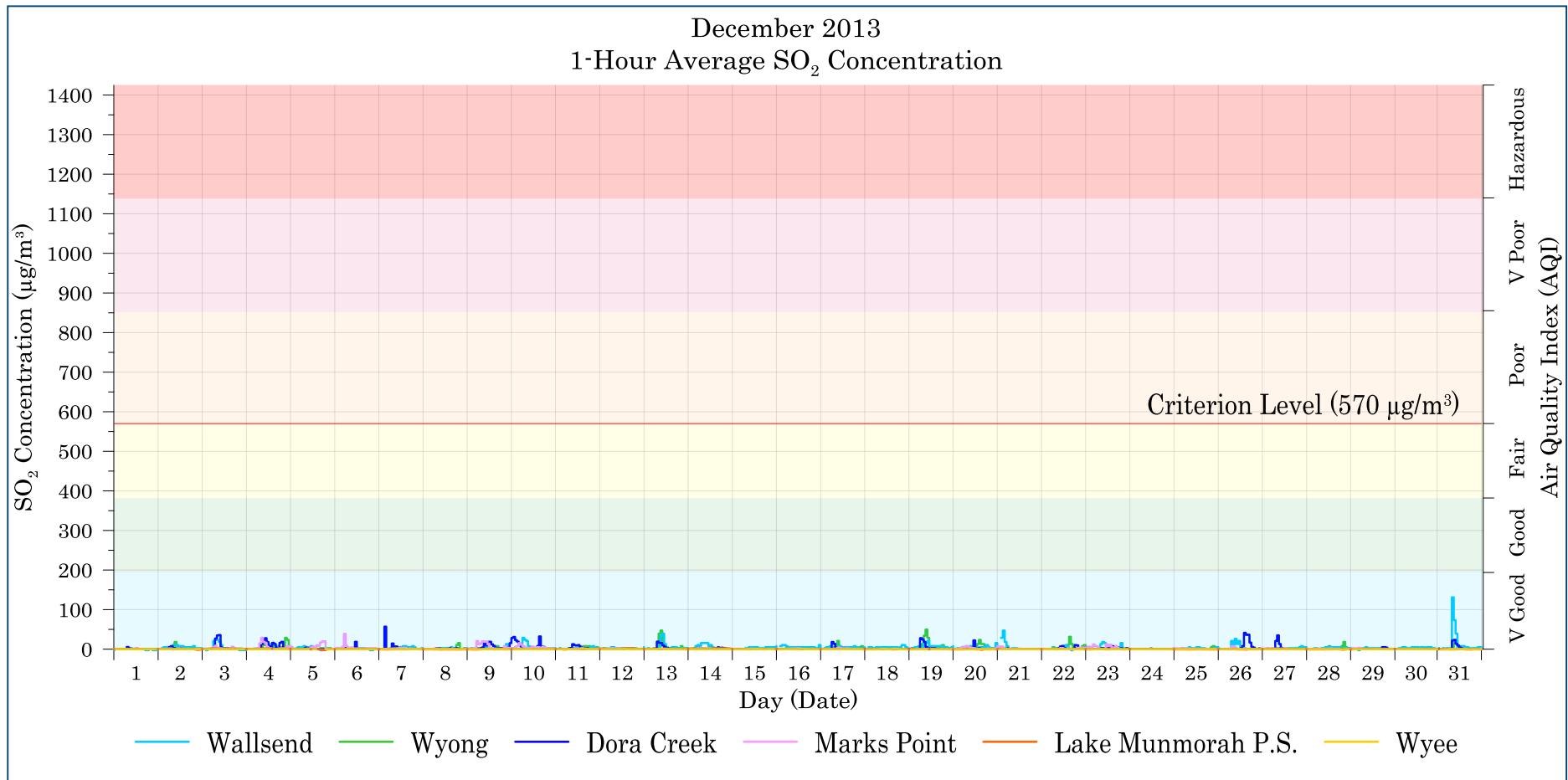


Figure 7-4: Lake Macquarie - Wyong 1-hour average SO₂ levels – December 2013

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO₂ criterion level of $570 \mu\text{g}/\text{m}^3$ in December 2013. Measured levels of SO₂ were very good at all monitors at all times.



8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

8.1 Wakefield HVAS - 29 December 2013

- + HVAS 24-hour average PM₁₀ level of 57µg/m³

The Wakefield HVAS monitor recorded a 24-hour average PM₁₀ level of 57µg/m³. No other PM₁₀ or meteorological data were available for the area surrounding this monitoring location.

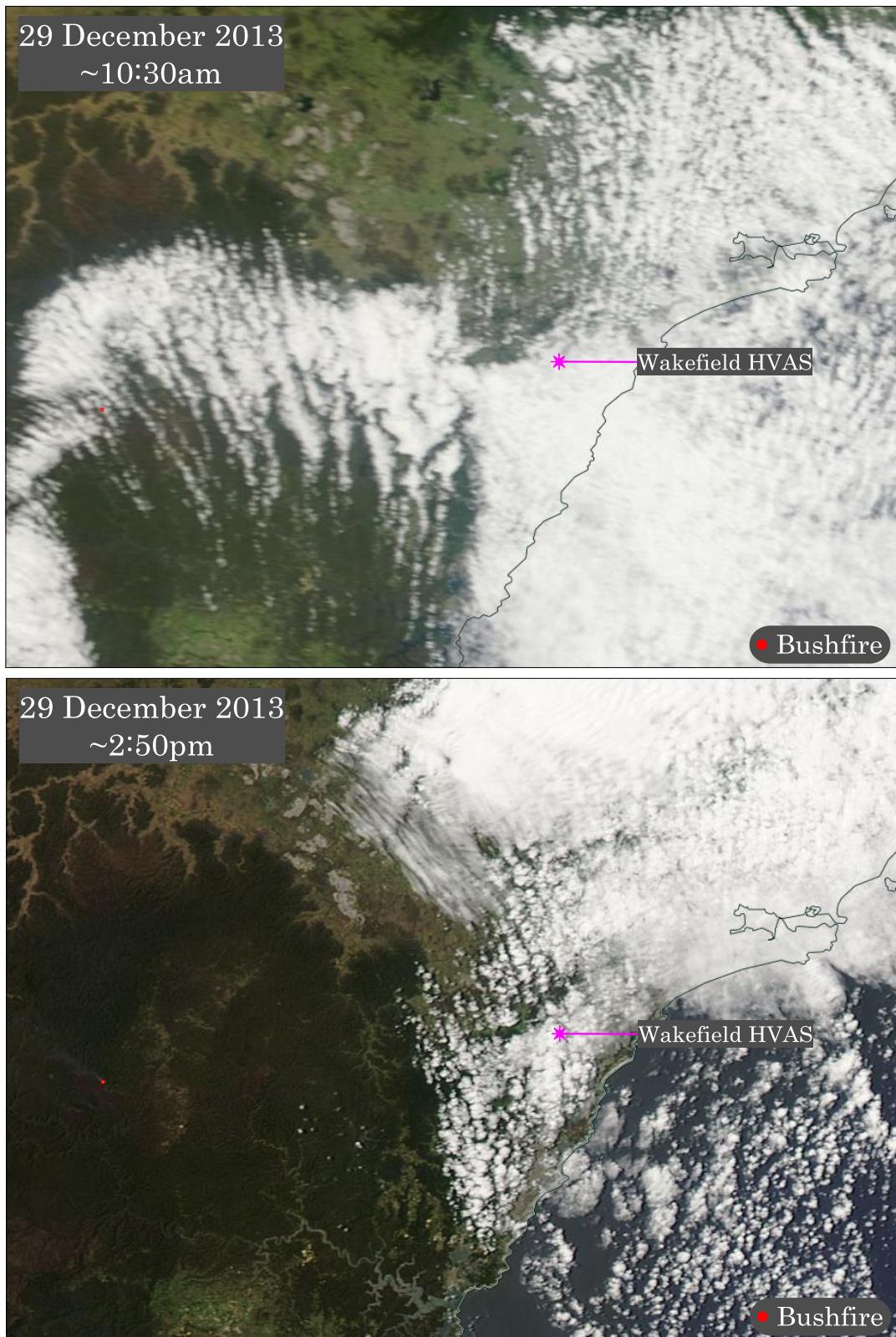
The level recorded by the HVAS monitor is based on a single sample taken over a period of 24-hours and on its own cannot be used to identify short term trends in PM₁₀ concentration over the monitoring period.

The Wakefield HVAS monitor is part of the West Wallsend Colliery air quality monitoring network and the elevated level recorded on 29 December 2013 was analysed in accordance with the requirements of the project's approval (**WWC, 2014**). The West Wallsend Colliery Annual Review 2013 states:

"There was one exceedance of the short term monitoring criteria on 29 December 2013. The exceedance was reported to P&I [NSW Planning and Infrastructure (P&I), formerly DP&I] on 14 January 2014 in accordance with the requirements of Condition 7 of Schedule 6 of the Project Approval. In accordance with consultation undertaken with the NSW Rural Fire Service (RFS) and P&I, the exceedance is believed to have been caused by bushfires in the region and was not attributable to WWC operations."

Figure 8-1 presents the satellite imagery for the region surrounding the Wakefield HVAS monitor at approximately 10:30am and 2:50pm on 29 December 2013. The figure does not show any obvious signs of the bushfire activity which would have impacted the monitor, however this is likely for several reasons; bushfires were not visible under cloud cover, were not present at the times of day the images were taken and/ or were too small and localised to be visible in the satellite imagery.

The lack of elevated readings at the other monitors indicates that the elevated PM₁₀ level of 57µg/m³ recorded at the Wakefield HVAS monitor was caused by a localised source.



Source: NASA, 2015

Figure 8-1: Satellite images of Lake Macquarie – Wyong and surrounding regions on 29 December 2013

9 CONCLUSIONS

The results indicate that the monitoring stations recorded very good to good air quality for the majority of the time.

The Wakefield HVAS monitor recorded a 24-hour average level of $57\mu\text{g}/\text{m}^3$ on 29 December 2013, which was above the criterion of $50\mu\text{g}/\text{m}^3$. It is believed that this elevated level was caused by bushfire activity in the region, as investigated at the time by the West Wallsend Colliery in consultation with RFS and P&I.

Relative to the Air Quality Index:

- ◆ The measured levels of NO_2 were very good at all monitors at all times;
- ◆ The measured levels of SO_2 were very good at all monitors at all times;
- ◆ The measured $\text{PM}_{2.5}$ levels were very good to good at all locations at all times except for at the Wyee monitoring site which recorded fair levels on two days; and
- ◆ The measured PM_{10} levels were very good to good at all locations at all times except for the Wakefield HVAS monitor which experienced one day of poor levels.

On this basis it can be concluded that the air quality in the Lake Macquarie - Wyong region was generally very good to good in December 2013.

10 REFERENCES

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Appendix A

How to read a windrose

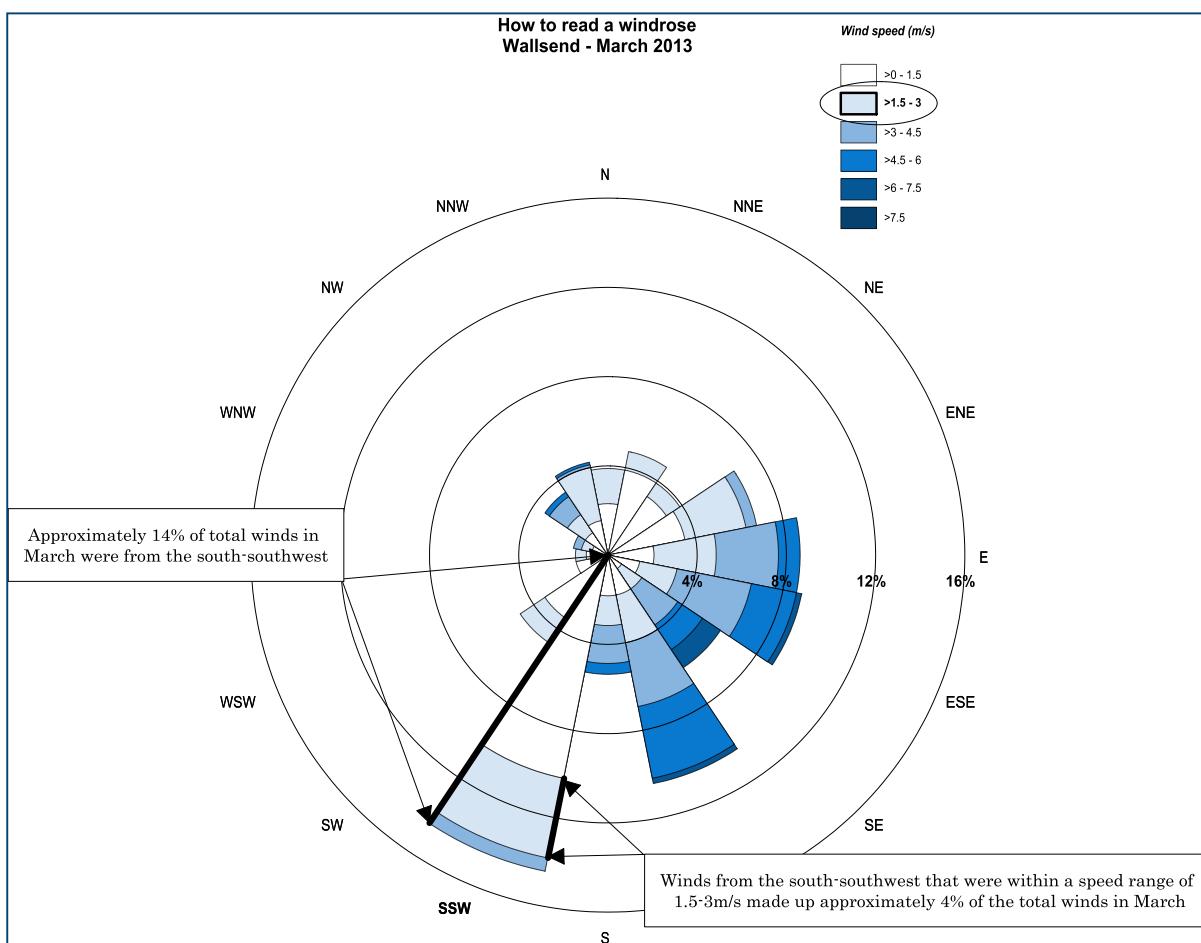
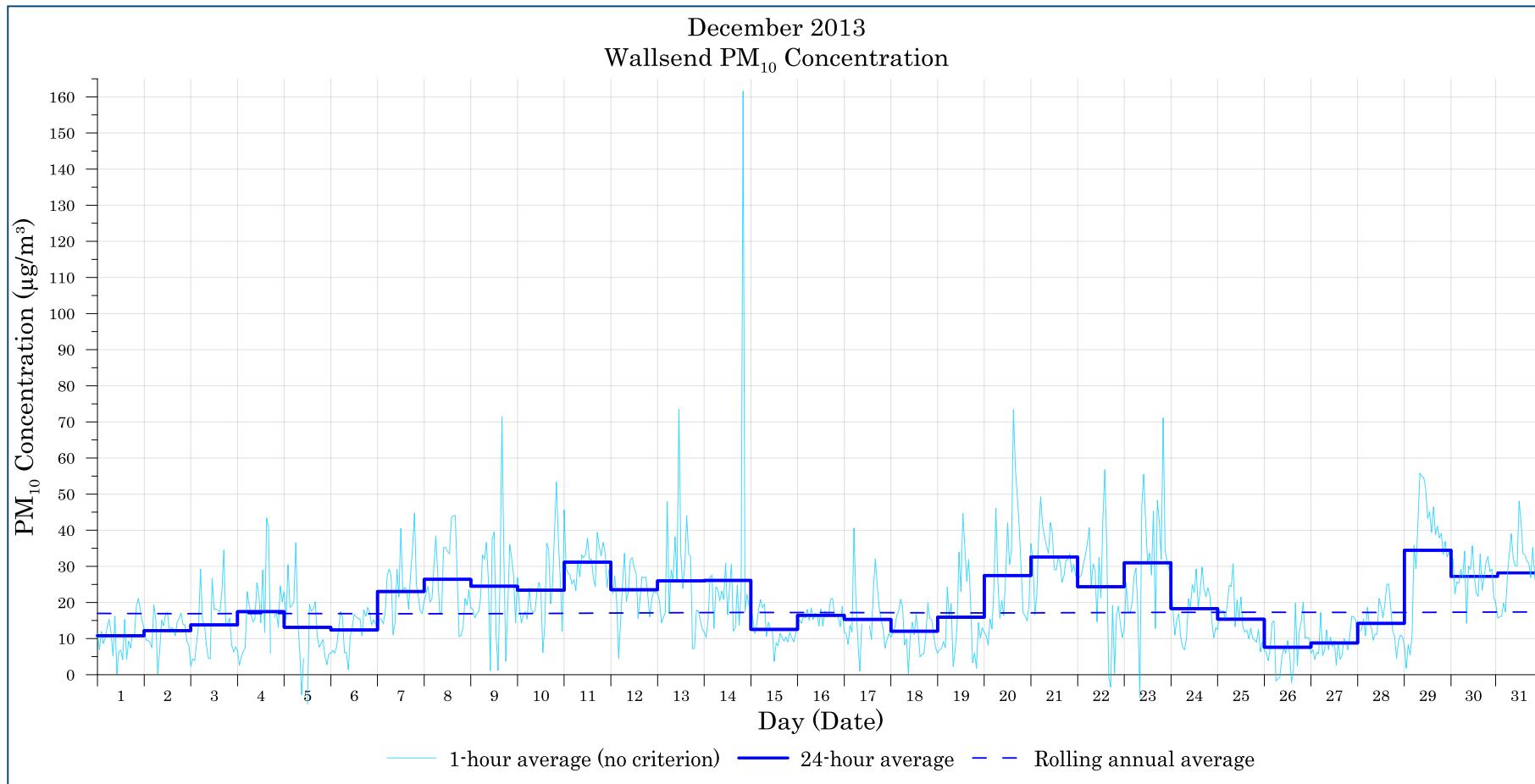
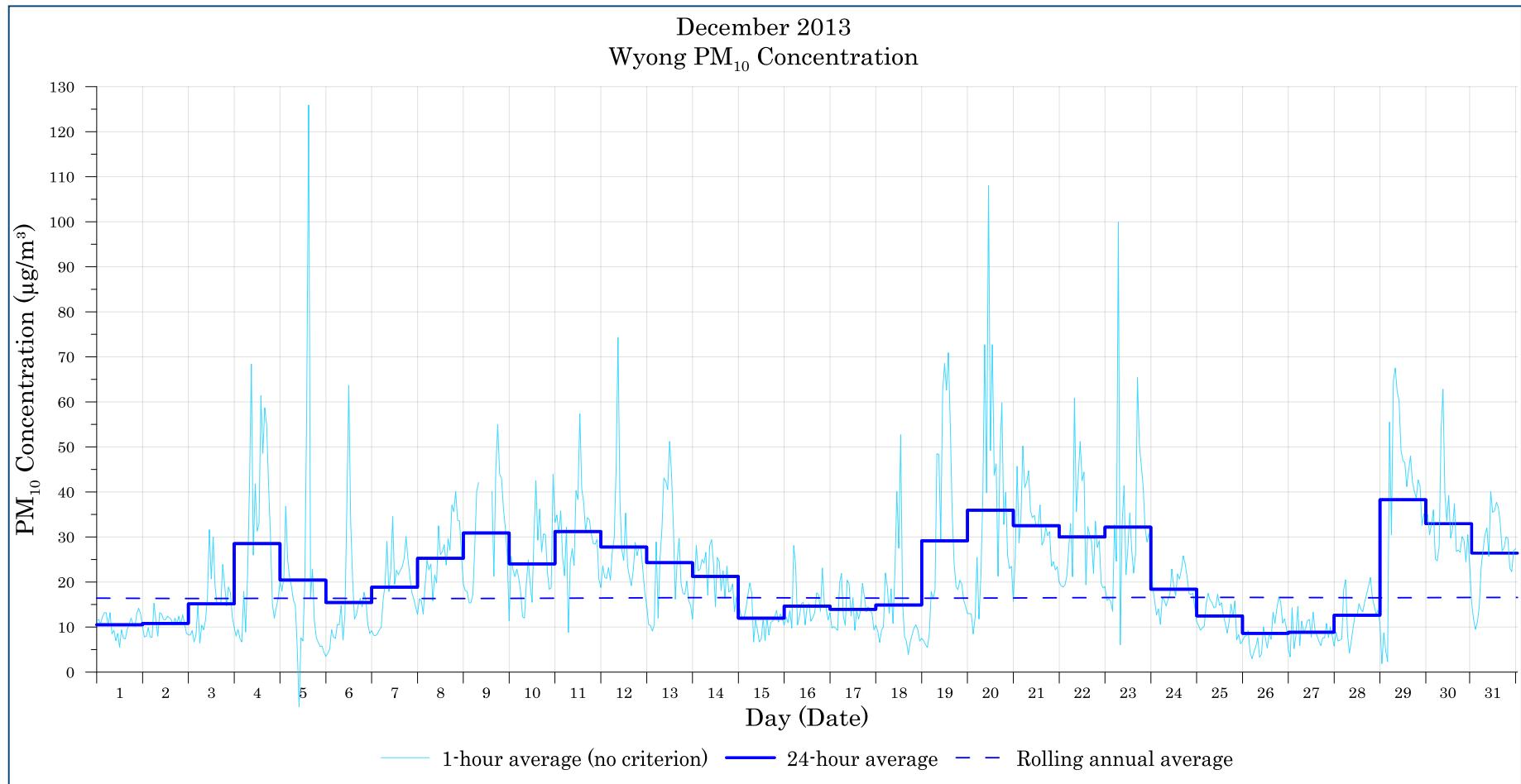


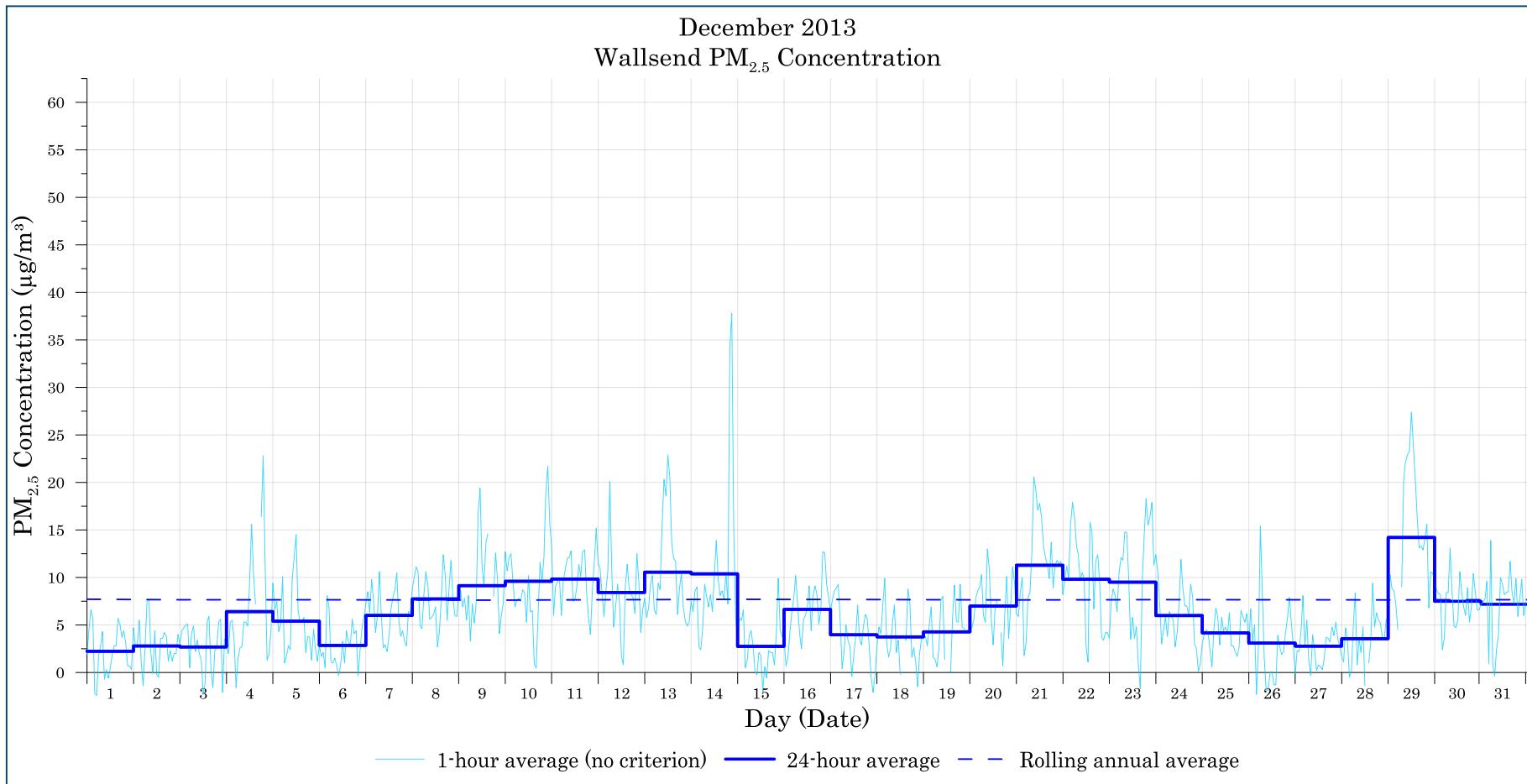
Figure A-1: How to read a windrose

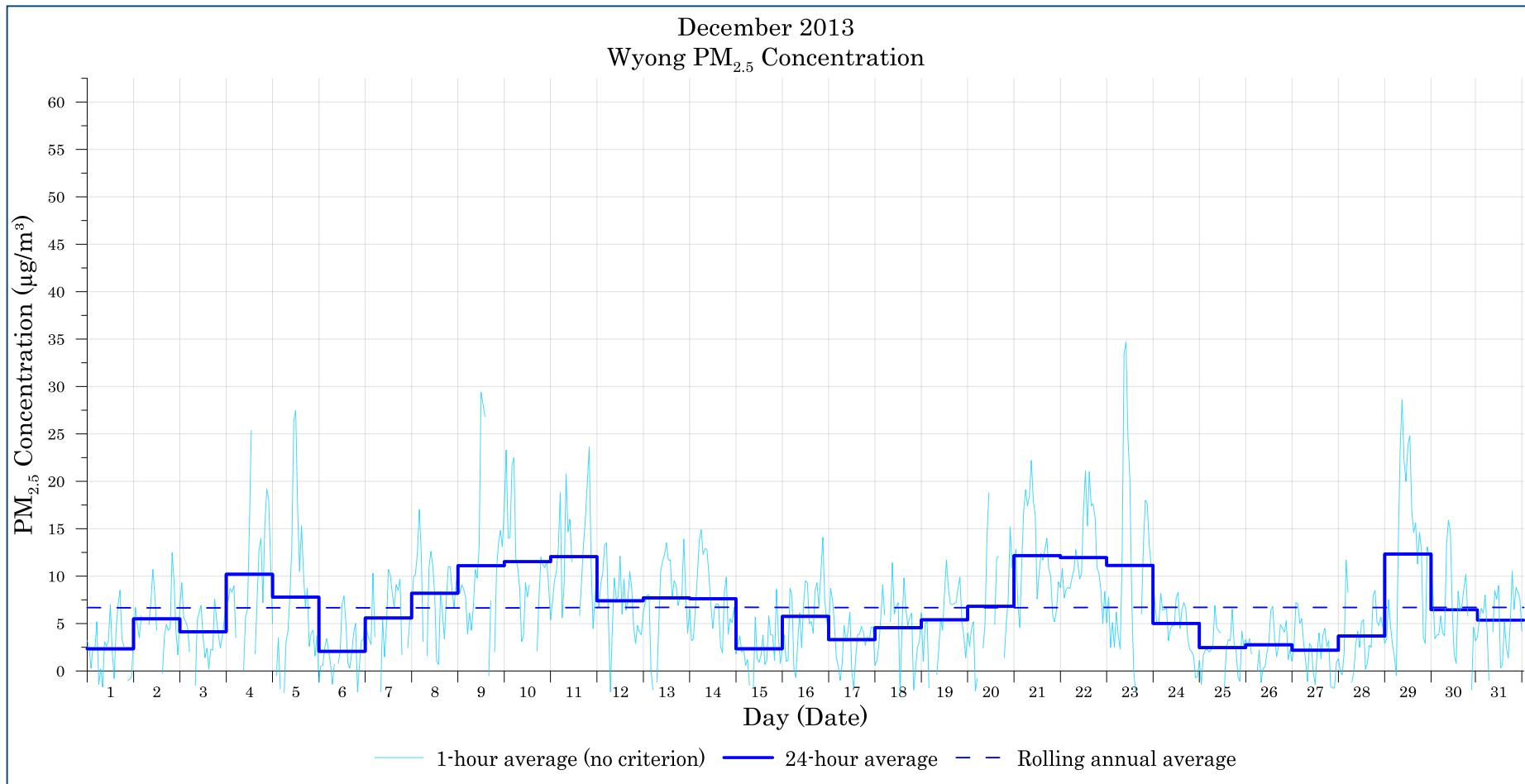
Appendix B

Monitoring Data (Graphical)

Figure B-1: Wallsend PM₁₀ concentration - December

Figure B-2: Wyong PM₁₀ concentration - December

Figure B-3: Wallsend PM_{2.5} concentration - December

Figure B-4: Wyong PM_{2.5} concentration - December

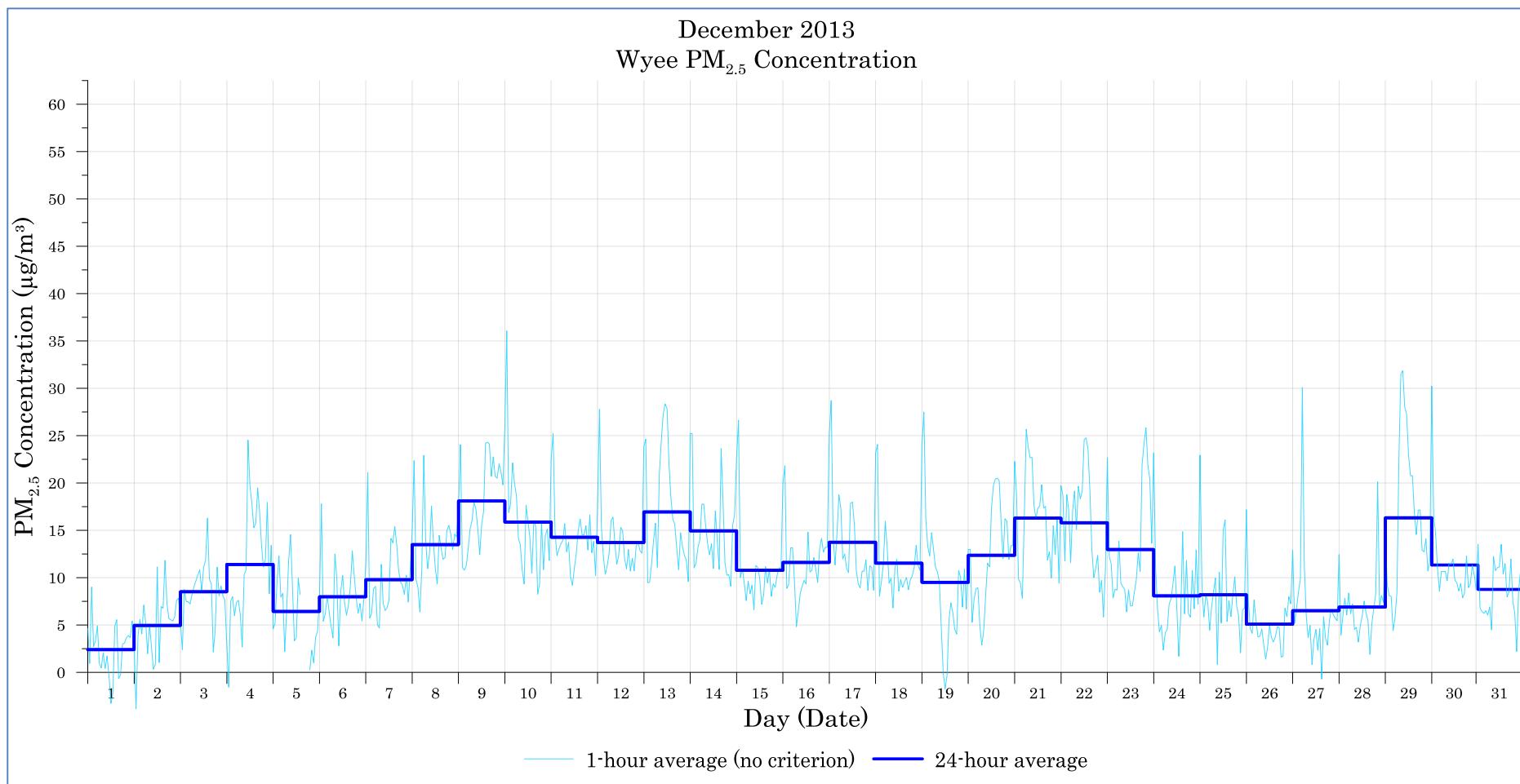


Figure B-5: Wyong PM_{2.5} concentration - December



Appendix C

Monitoring Data (Tabulated)

Table C-1: December 24-hour average monitoring data

Date	PM ₁₀ ($\mu\text{g}/\text{m}^3$)		PM _{2.5} ($\mu\text{g}/\text{m}^3$)			SO ₂ ($\mu\text{g}/\text{m}^3$)					
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Lake Munmorah P.S.	Wyee
01/12/2013	10.8	10.5	2.2	2.3	2.4	-0.6	0.0	0.4	0.7	0.3	0.0
02/12/2013	12.2	10.8	2.8	5.5	5.0	5.5	-	0.9	0.8	0.3	0.0
03/12/2013	13.8	15.2	2.7	4.1	8.5	4.0	-	4.9	2.0	1.4	0.1
04/12/2013	17.5	28.5	6.4	10.2	11.4	4.8	7.3	7.1	5.3	1.1	0.1
05/12/2013	13.1	20.4	5.4	7.8	6.4	1.6	1.1	0.5	5.6	-0.2	0.0
06/12/2013	12.4	15.5	2.9	2.1	8.0	1.1	0.3	1.5	4.2	0.6	0.0
07/12/2013	23.0	18.9	6.0	5.6	9.8	3.2	2.4	4.2	1.5	-0.2	0.1
08/12/2013	26.4	25.3	7.7	8.2	13.5	1.5	2.4	0.7	0.7	-0.5	0.0
09/12/2013	24.5	30.9	9.1	11.1	18.1	3.5	2.1	5.2	6.5	-0.3	0.0
10/12/2013	23.4	24.0	9.6	11.5	15.9	5.2	0.7	8.3	4.7	0.1	0.0
11/12/2013	31.2	31.2	9.8	12.1	14.3	2.3	2.3	2.8	0.8	0.0	0.2
12/12/2013	23.5	27.8	8.4	7.4	13.7	1.8	0.3	0.0	1.3	0.9	0.1
13/12/2013	26.0	24.3	10.6	7.7	16.9	6.3	6.6	3.2	-	0.8	0.2
14/12/2013	26.1	21.2	10.4	7.6	14.9	5.6	0.3	0.8	1.1	1.7	0.0
15/12/2013	12.5	12.0	2.8	2.3	10.8	3.2	0.0	0.0	0.5	-0.1	0.1
16/12/2013	16.4	14.7	6.6	5.8	11.6	6.0	0.1	0.0	1.0	0.5	0.2
17/12/2013	15.3	13.9	4.0	3.3	13.7	4.8	3.0	2.0	1.4	0.0	0.0
18/12/2013	12.0	14.9	3.7	4.6	11.5	5.1	0.1	0.0	-	-0.2	0.2
19/12/2013	15.9	29.2	4.3	5.4	9.5	7.1	8.3	4.0	-	-0.1	0.0
20/12/2013	27.5	36.0	7.0	6.8	12.4	5.1	5.2	1.8	2.4	-0.4	0.0
21/12/2013	32.6	32.5	11.3	12.2	16.3	5.0	0.8	0.7	1.8	0.1	0.0
22/12/2013	24.4	30.0	9.8	12.0	15.8	1.0	4.9	2.2	1.6	0.0	0.0
23/12/2013	31.0	32.2	9.5	11.1	13.0	4.3	0.8	2.4	5.1	0.0	0.0
24/12/2013	18.3	18.4	6.0	5.0	8.1	0.0	0.0	0.1	-	0.3	0.0
25/12/2013	15.4	12.5	4.2	2.5	8.2	2.4	0.9	0.0	1.4	-0.5	0.0
26/12/2013	7.6	8.6	3.1	2.8	5.1	4.2	0.1	6.8	1.3	-0.3	0.0
27/12/2013	8.8	8.9	2.8	2.2	6.5	2.5	0.0	3.5	1.3	0.5	0.0
28/12/2013	14.2	12.6	3.6	3.7	6.9	3.2	2.5	0.0	1.0	-0.4	0.0
29/12/2013	34.5	38.3	14.2	12.3	16.3	1.5	0.0	0.7	1.1	0.3	0.0
30/12/2013	27.2	33.0	7.5	6.5	11.3	3.4	0.0	0.0	-	0.5	0.0
31/12/2013	28.2	26.4	7.2	5.4	8.8	13.9	2.4	3.4	-	-0.3	0.0

- Not applicable

Table C-2: December 24-hour average HVAS monitoring data

Date	PM ₁₀ (HVAS) ($\mu\text{g}/\text{m}^3$)
	Wakefield (Westside)
5/12/2013	1.6
11/12/2013	1.1
17/12/2013	3.3
23/12/2013	26.3
29/12/2013	57.0

- Not applicable