



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

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# Lake Macquarie – Wyong

## Review of Monthly Ambient Air Quality Data

### October 2013

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#### DOCUMENT CONTROL

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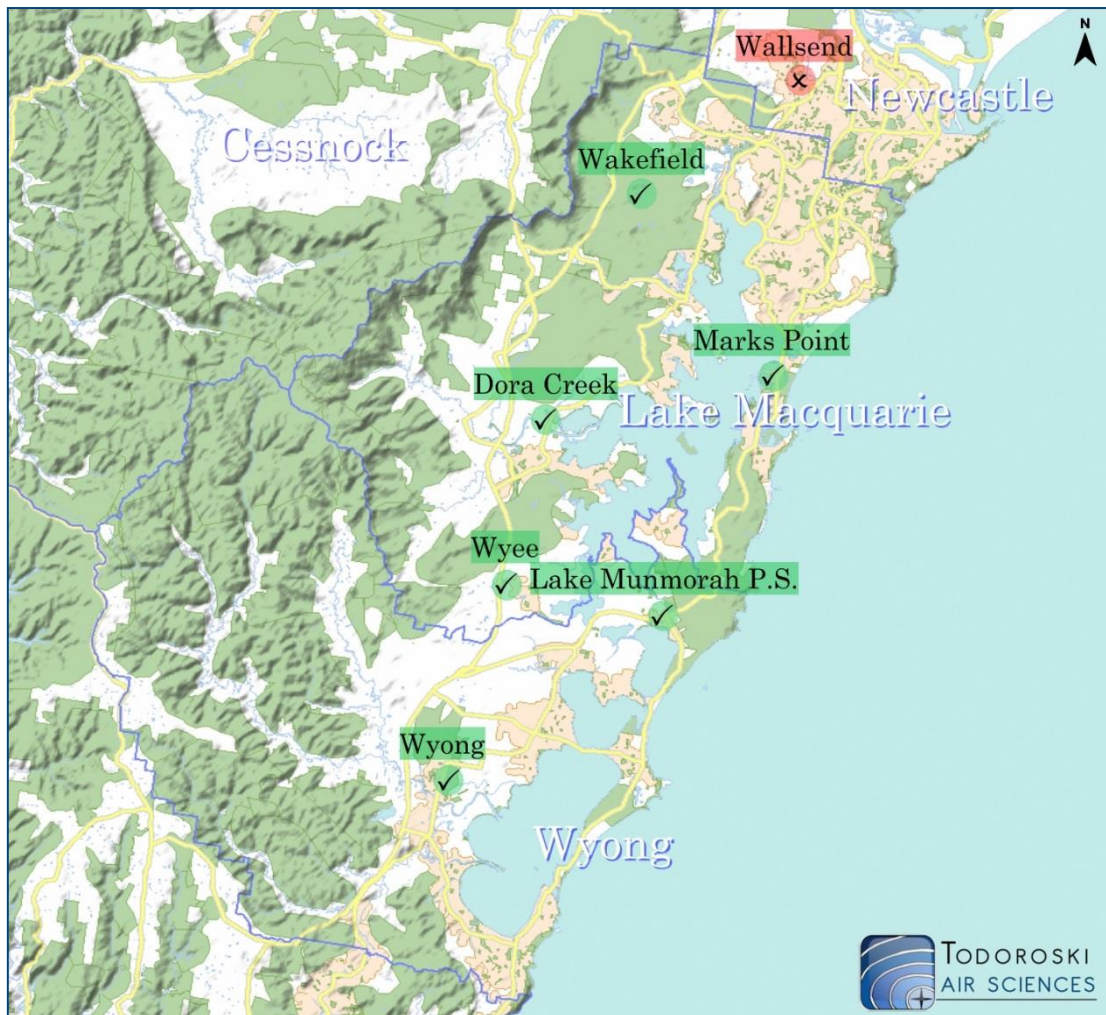
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## EXECUTIVE SUMMARY

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 October 2013. The results indicate that the air quality was generally very good in the Lake Macquarie - Wyong region during October.

The data summary (shown below) indicates that in October 2013, Wallsend recorded PM<sub>10</sub> above the applicable criteria and PM<sub>2.5</sub> levels above the advisory reporting standard. Further details are provided in the report. The 24-hour average data are provided in the Appendices.

Lake Macquarie - Wyong Air Quality Pictorial Summary - October 2013



Lake Macquarie – Wyong Air Quality Tabular Summary - October 2013

Site	PM <sub>10</sub> (µg/m <sup>3</sup> )	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )	NO <sub>2</sub> (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )
	24-hour average	24-hour average	24-hour average	1-hour average	1-hour average
	Air Quality Impact Criteria				
	50	25*	228	246	570
Wallsend	x	x	✓	✓	✓
Wyong	✓	✓	✓	✓	✓
Dora Creek	-	-	✓	✓	✓
Marks Point	-	-	✓	✓	✓
Lake Munmorah P.S.	-	-	✓	✓	✓
Wyee	-	-	✓	✓	✓
Wakefield HVAS	✓	-	-	-	-

✓ - All data below applicable criteria

- - Not applicable

\* - Advisory reporting standard for PM<sub>2.5</sub> concentrations (refer to Section 5.1)

x - At least one elevated level above applicable criteria

HVAS - High Volume Air Sampler

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## 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 October 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 PM<sub>10</sub>, 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.

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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 criteria.
  - o <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.
  - o <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.
  - o <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.
  - o <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.
  - o <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.
  - o <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 October 2013.

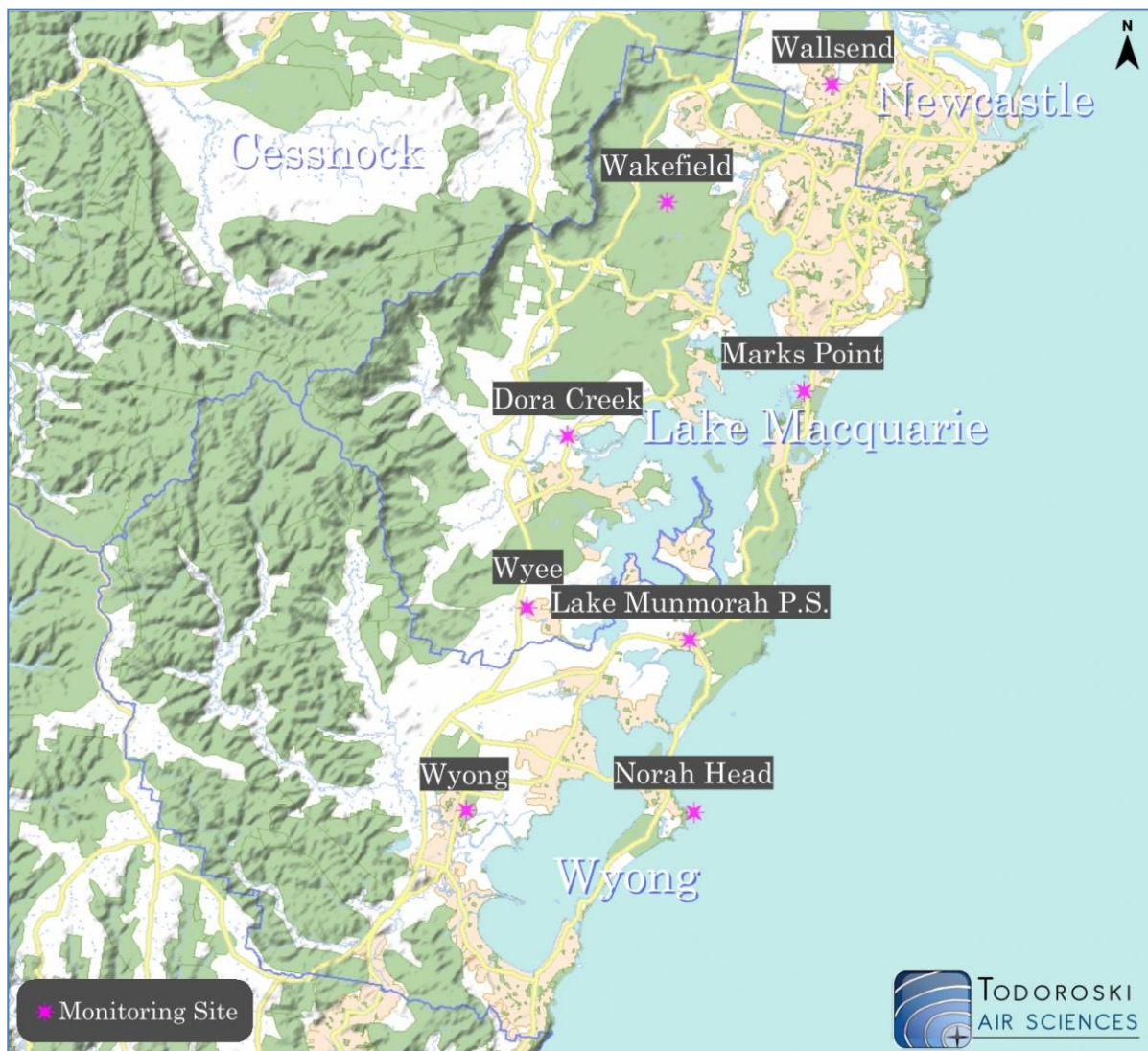


Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

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

PM<sub>10</sub> - Particulate matter < 10µm

PM<sub>2.5</sub> - Particulate matter < 2.5µm

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

NO<sub>2</sub> - Nitrogen dioxide

SO<sub>2</sub> - 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 ( $\mu\text{m}$ ) as in practice particles larger than 30 to 50 $\mu\text{m}$  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  $\text{PM}_{10}$  particles, particulate matter with aerodynamic diameters of 10 $\mu\text{m}$  or less, and  $\text{PM}_{2.5}$ , particulate matter with aerodynamic diameters of 2.5 $\mu\text{m}$  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 $\mu\text{m}$ ( $\text{PM}_{10}$ )	Annual	30 $\mu\text{g}/\text{m}^3$
	24-hour	50 $\mu\text{g}/\text{m}^3$

Source: **NSW DEC, 2005**

#### 5.1.1 $\text{PM}_{2.5}$ concentrations

The NSW EPA currently do not have impact assessment criteria for  $\text{PM}_{2.5}$  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  $\text{PM}_{2.5}$  (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  $\text{PM}_{2.5}$  concentrations

Pollutant	Averaging Period	Concentration
Particulate Matter < 2.5 $\mu\text{m}$ ( $\text{PM}_{2.5}$ )	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 ( $\text{NO}_2$ ) 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.  $\text{NO}_2$  belongs to a family of reactive gases called nitrogen oxides ( $\text{NO}_x$ ). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (**USEPA, 2013**).  $\text{NO}_x$  may also be generated by blasting activities. It is important to note that when formed,  $\text{NO}_2$  is generally a small fraction of the total  $\text{NO}_x$  generated.

Sulfur dioxide (SO<sub>2</sub>) 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<sub>2</sub> can have impacts upon human health and the habitability of the environment for flora and fauna. SO<sub>2</sub> 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<sub>2</sub> and SO<sub>2</sub>.

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

Pollutant	Averaging period	Criterion
NO <sub>2</sub>	1-hour	246µg/m <sup>3</sup>
	Annual	62µg/m <sup>3</sup>
SO <sub>2</sub>	10-minute	712µg/m <sup>3</sup>
	1-hour	570µg/m <sup>3</sup>
	24-hour	228µg/m <sup>3</sup>
	Annual	60µg/m <sup>3</sup>

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. Annually averaged 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<sub>2</sub> 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 < 10µm (PM <sub>10</sub> )	24-hour	Criterion	50µg/m <sup>3</sup>
Particulate Matter < 2.5µm (PM <sub>2.5</sub> )	24-hour	Advisory Reporting Standard	25µg/m <sup>3</sup>
Nitrogen Dioxide (NO <sub>2</sub> )	1-hour	Criterion	246µg/m <sup>3</sup>
Sulfur Dioxide (SO <sub>2</sub> )	1-hour	Criterion	570µg/m <sup>3</sup>
	24-hour	Criterion	228µg/m <sup>3</sup>

## 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 October 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 western to north-northwestern 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.

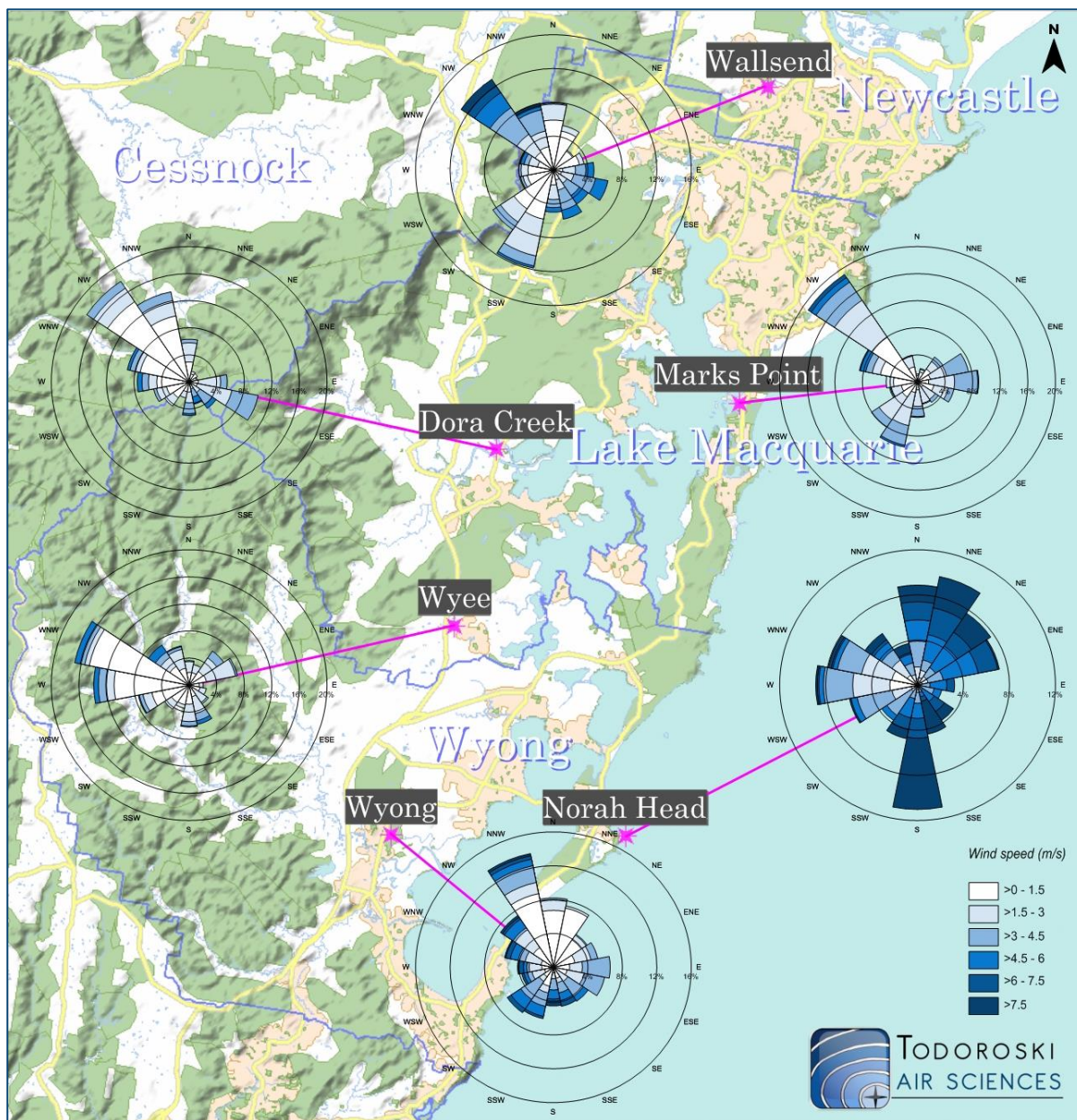


Figure 6-1: October windroses – Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

The meteorological stations recorded a similar underlying trend of winds which originated from the western to north-northwestern directions in October 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 October 2013. The results indicate that the Wallsend monitoring station recorded ambient air concentrations above the relevant criteria during October 2013. All other monitoring sites were below the relevant criteria.

Table 7-1: Maximum pollutant levels - October 2013

Site	PM <sub>10</sub> (µg/m <sup>3</sup> )	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )	NO <sub>2</sub> (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )
	24-hour average	24-hour average	24-hour average	1-hour average	1-hour average
	Air Quality Impact Criteria				
	50	25*	228	246	570
Wallsend	52.5	37.0	11.4	56.4	47.2
Wyong	40.3	24.2	6.0	47.0	31.4
Dora Creek	-	-	6.5	54.2	58.5
Marks Point	-	-	12.3	62.0	63.0
Lake Munmorah P.S.	-	-	1.1	62.0	2.5
Wyee	-	-	11.5	55.1	81.9
Wakefield HVAS	43.8	-	-	-	-

\* Advisory reporting standard for PM<sub>2.5</sub> concentrations (refer to Section 5.1)

- Not applicable

### 7.3 PM<sub>10</sub>

**Figure 7-1** presents all of the 24-hour average PM<sub>10</sub> monitoring results recorded in the Lake Macquarie - Wyong region in October 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM<sub>10</sub> levels were generally very good or good in October 2013. The Wyong monitoring site recorded very good or good levels 84% of the time, and fair levels 16% of the time. The Wallsend monitoring site recorded very good to good levels 90% of the time, fair levels 3% of the time, and poor levels on two days.

The Wallsend monitoring site recorded 24-hour average PM<sub>10</sub> levels above the criterion of 50µg/m<sup>3</sup> on 17 and 23 October 2013. **Section 8** examines the situation on these days in more detail. All other PM<sub>10</sub> data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average PM<sub>10</sub> criterion level in October 2013.



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**Figure B-1 to Figure B-2 in Appendix B** present the 1-hour average PM<sub>10</sub> data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM<sub>10</sub> levels and these 1-hour results are not intended to be compared with the PM<sub>10</sub> criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM<sub>10</sub> levels will fluctuate more significantly than 24-hour average PM<sub>10</sub> levels.

#### 7.4 PM<sub>2.5</sub>

**Figure 7-2** presents all of the 24-hour average PM<sub>2.5</sub> monitoring data recorded in the Lake Macquarie - Wyong region in October 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that PM<sub>2.5</sub> levels were very good or good in October 2013. The Wyong monitoring site recorded very good or good levels 90% of the time and fair levels 10% of the time. The Wallsend monitoring site recorded very good or good levels 73% of the time, and fair to poor levels for the remainder of the time (27%).

The Wallsend monitoring site recorded 24-hour average PM<sub>2.5</sub> levels above the advisory reporting standard of 25µg/m<sup>3</sup> on four days; 17, 18, 19 and 23 October 2013. Section 8 examines the situation on these days in more detail. All other PM<sub>2.5</sub> data recorded at the Lake Macquarie - Wyong monitoring sites were below the advisory reporting standard in October 2013.

**Figure B-3 to Figure B-4 in Appendix B** present the 1-hour average PM<sub>2.5</sub> data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM<sub>2.5</sub> levels and these 1-hour results are not intended to be compared with the PM<sub>2.5</sub> advisory reporting standard. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM<sub>2.5</sub> levels will fluctuate more significantly than 24-hour average PM<sub>2.5</sub> levels.

#### 7.5 Nitrogen dioxide NO<sub>2</sub>

**Figure 7-3** presents the 1-hour average NO<sub>2</sub> monitoring data recorded in the Lake Macquarie - Wyong region in October 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the NO<sub>2</sub> 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 SO<sub>2</sub>

**Figure 7-4** presents the 1-hour average SO<sub>2</sub> monitoring data recorded in the Lake Macquarie - Wyong region in October 2013.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO<sub>2</sub> levels were very good all of the time at all of the monitors.

All data were below the applicable criterion on all days.

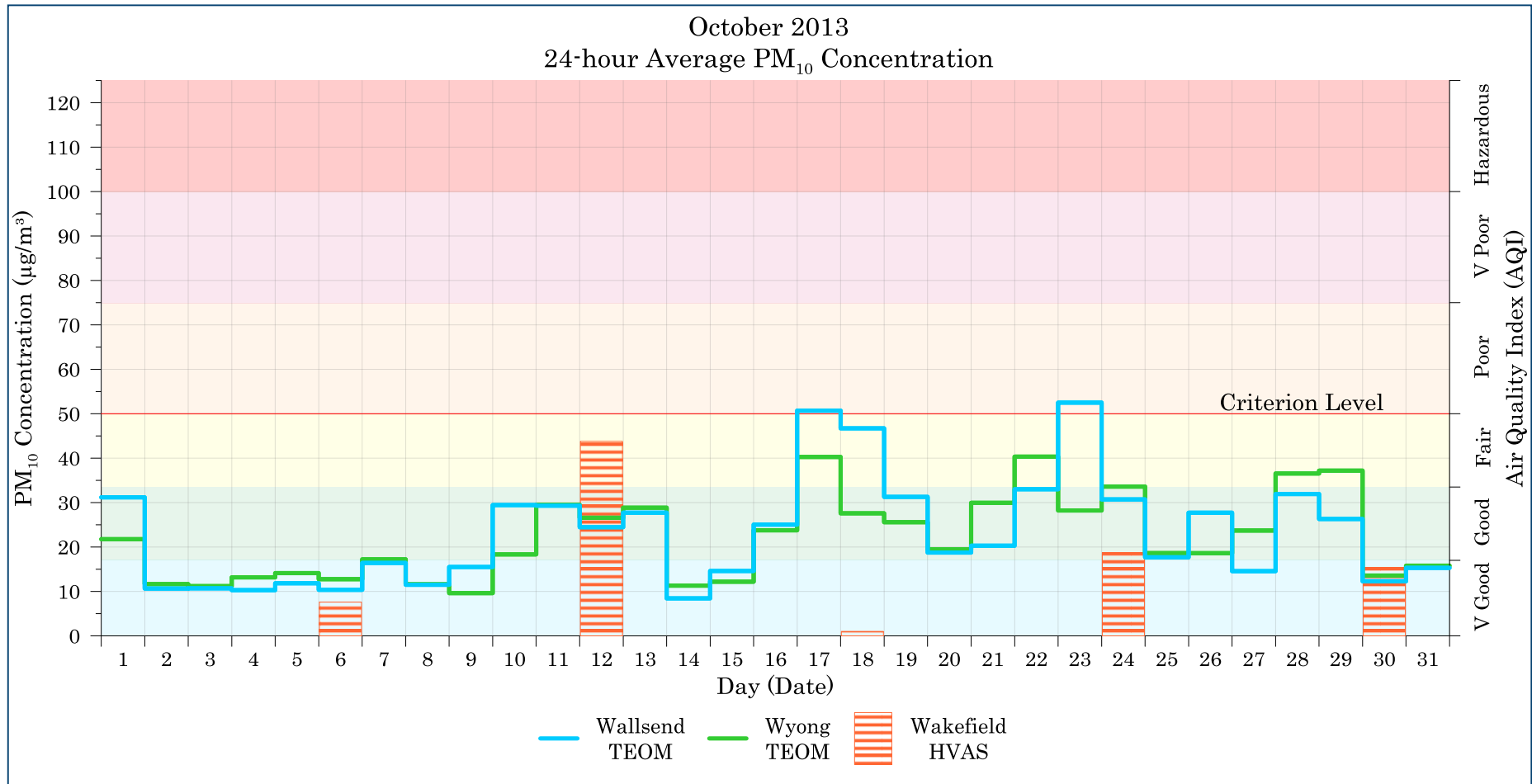


Figure 7-1: Lake Macquarie - Wyong 24-hour average PM<sub>10</sub> levels – October 2013

PM<sub>10</sub> levels recorded in October were very good to good 84% and 90% of the time at Wyong and Wallsend respectively. The Wallsend monitoring site recorded two days with poor PM<sub>10</sub> levels above the 24-hour average criterion of 50µg/m<sup>3</sup>. These days coincide with significant bushfire activity in the surrounding regions. All other data recorded at the Lake Macquarie - Wyong monitoring sites were below the criterion.



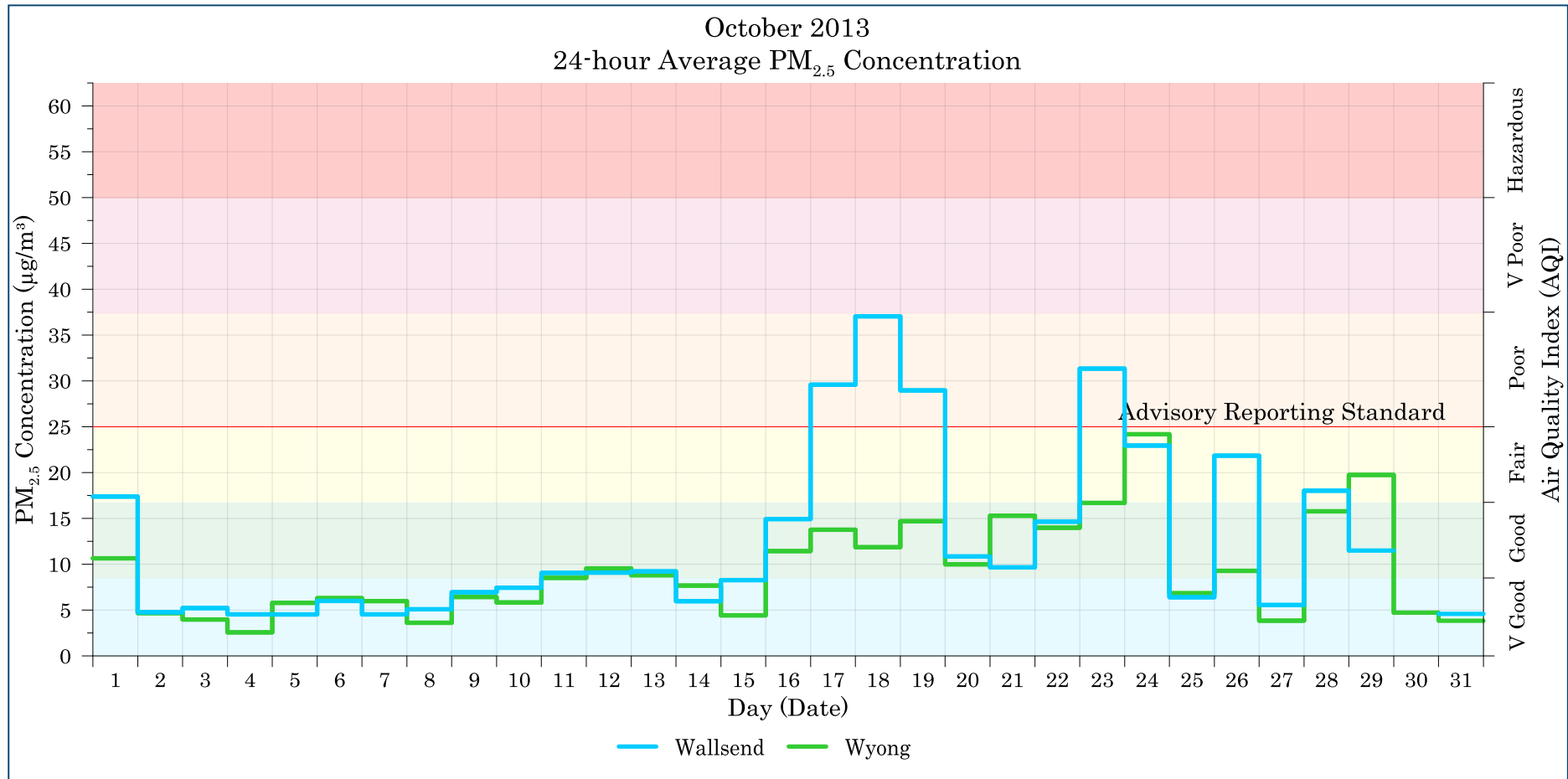


Figure 7-2: Lake Macquarie - Wyong 24-hour average PM<sub>2.5</sub> levels – October 2013

PM<sub>2.5</sub> levels recorded in October were very good to good 90% and 73% of the time at Wyong and Wallsend respectively. The Wallsend monitoring site recorded four days with poor PM<sub>2.5</sub> levels above the 24-hour average advisory reporting standard of 25µg/m<sup>3</sup>. These days coincide with significant bushfire activity in surrounding regions. All other data recorded at the Lake Macquarie - Wyong monitoring sites were below the PM<sub>2.5</sub> advisory reporting standard.

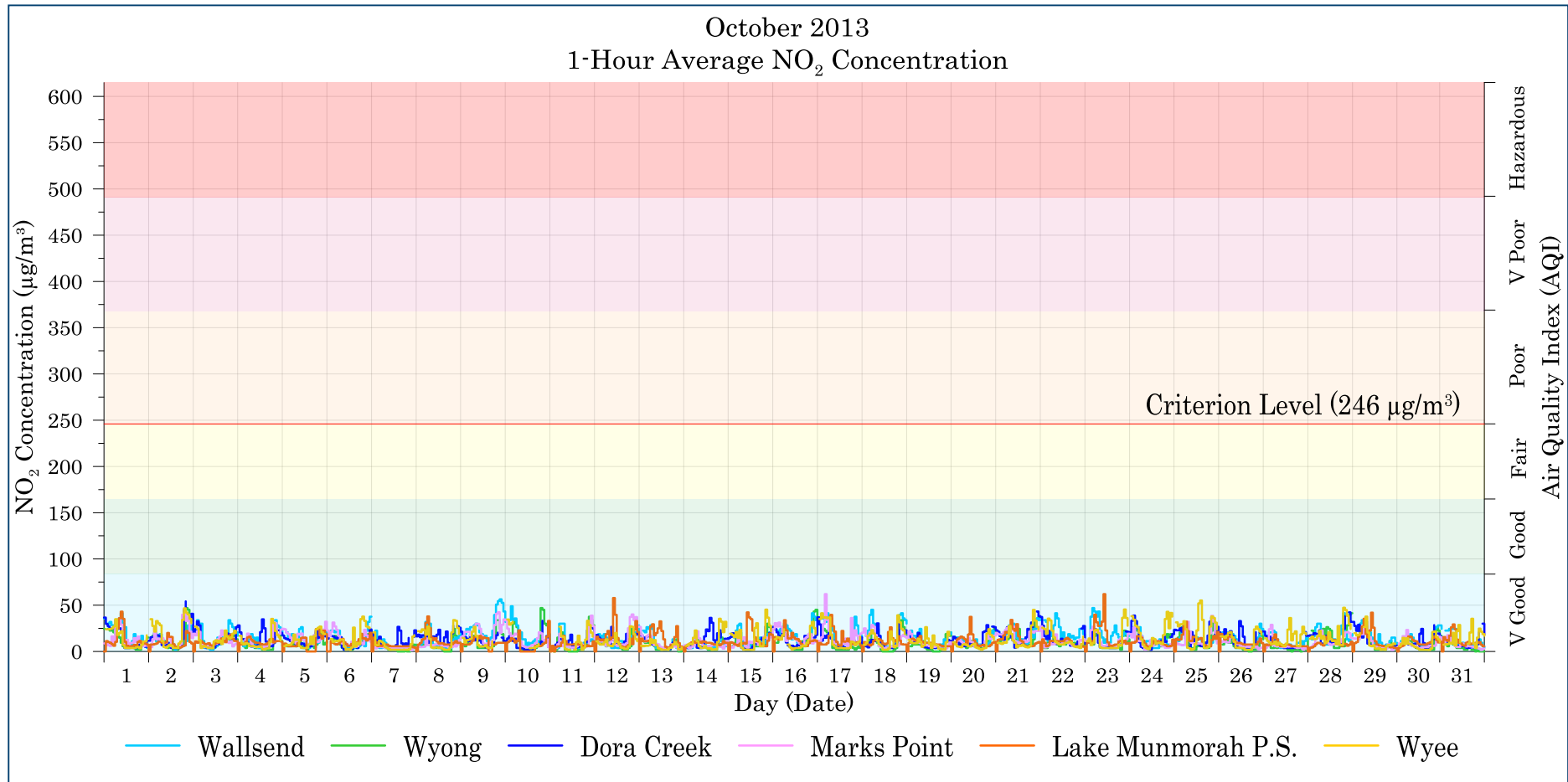


Figure 7-3: Lake Macquarie - Wyong 1-hour average NO<sub>2</sub> levels – October 2013

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO<sub>2</sub> criterion level of 246µg/m<sup>3</sup> in October 2013. Measured levels of NO<sub>2</sub> were very good at all monitors at all times.

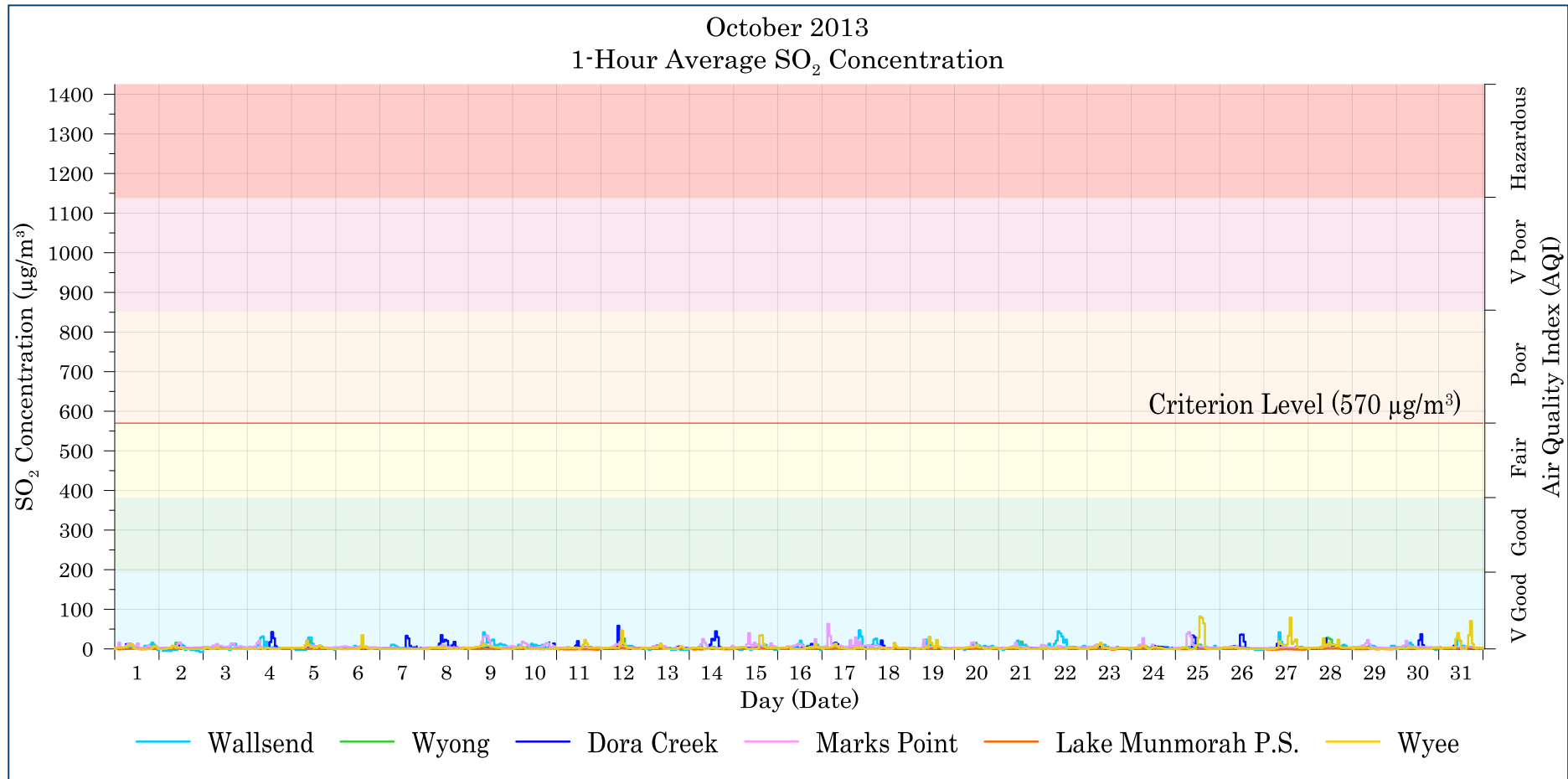


Figure 7-4: Lake Macquarie - Wyong 1-hour average SO<sub>2</sub> levels – October 2013

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO<sub>2</sub> criterion level of 570µg/m<sup>3</sup> in October 2013. Measured levels of SO<sub>2</sub> were very good at all monitors at all times.

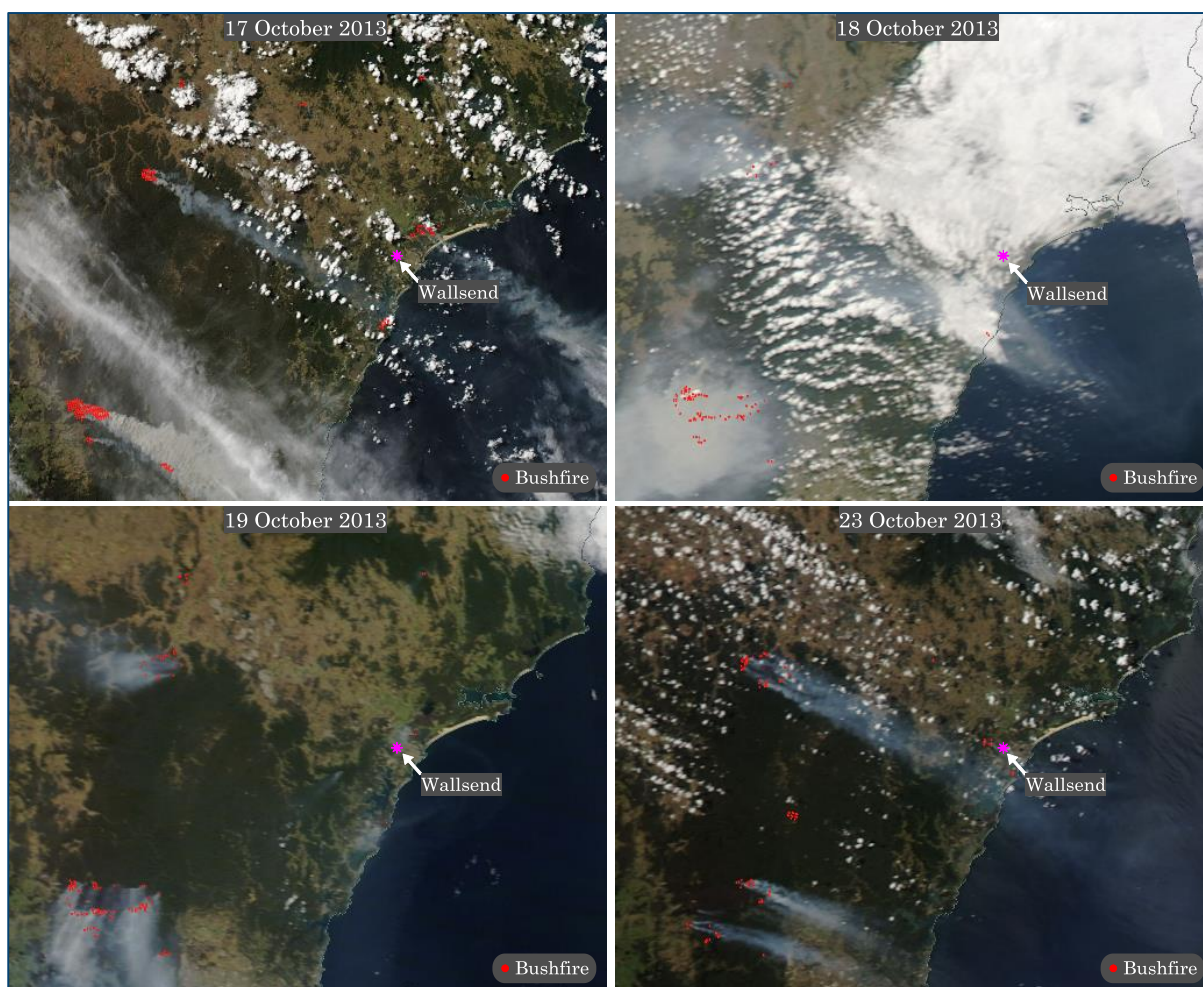
## 8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

### 8.1 Wallsend - 17 October to 23 October

During the second half of October 2013 the Lake Macquarie - Wyong area and surrounding regions experienced hot, dry and windy conditions resulting in widespread bushfire activity. **Figure 8-1** presents a series of satellite images of the Lake Macquarie - Wyong region during 17-23 October 2013 (NASA, 2015).

The images show that there were a number of bushfires emitting smoke in the area surrounding the Lake Macquarie - Wyong region, as indicated by the red dots. These bushfires affected large areas of eastern NSW during this period.

The elevated PM<sub>2.5</sub> and PM<sub>10</sub> levels recorded between 17 October and 23 October were most likely due to bushfire smoke.



Source: NASA, 2015

Figure 8-1: Satellite images of Lake Macquarie – Wyong and surrounding regions during October bushfires (17-23 October 2013)

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## 9 CONCLUSIONS

The results indicate that the monitoring sites recorded PM<sub>10</sub> and PM<sub>2.5</sub> levels which were generally good in the first half of October and fair to poor in the second half of the month, particularly at Wallsend. The SO<sub>2</sub> and NO<sub>2</sub> levels were very good in October.

The Wallsend monitoring site recorded two 24-hour average PM<sub>10</sub> levels above the criterion of 50µg/m<sup>3</sup> and four 24-hour average PM<sub>2.5</sub> levels above the advisory reporting standard of 25µg/m<sup>3</sup> in October. The elevated PM<sub>2.5</sub> and PM<sub>10</sub> levels recorded between 17 and 23 October were most likely due to bushfire smoke in the Lake Macquarie - Wyong region.

All other data indicate pollutant levels were below the applicable criteria for the remaining periods.

Relative to the Air Quality Index:

- ✦ The measured levels of NO<sub>2</sub> were very good at all monitors at all times;
- ✦ The measured levels of SO<sub>2</sub> were very good at all monitors at all times;
- ✦ The measured levels of PM<sub>2.5</sub> were generally very good at both locations for the first half of October, followed by good levels at Wyong and fair to poor conditions at Wallsend during the second half of the month. The Wallsend monitor recorded poor levels on four days; and
- ✦ The measured PM<sub>10</sub> levels were generally very good to good in the first half of October and good to fair in the second half of the month. The Wallsend monitor recorded poor levels on two days.

On this basis it can be concluded that the air quality in the Lake Macquarie – Wyong region was generally very good to fair in the first half of October 2013, with particulate (PM<sub>10</sub> and PM<sub>2.5</sub>) levels in the latter half of the month affected by bushfire smoke.



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## 10 REFERENCES

NASA (2015)

NASA Worldview Alpha website. <<https://earthdata.nasa.gov/labs/worldview/>>, accessed March 2015.

NEPC (2003)

"Variation to the National Environment Protection (Ambient Air Quality) Measure for Particles as PM<sub>2.5</sub>", National Environment Protection Council, May 2003.

NSW DEC (2005)

"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", Department of Environment and Conservation (NSW), August 2005.

USEPA (2013)

Health Effects of Pollution, United States Environmental Protection Agency website, <<http://www.epa.gov/region07/air/quality/health.htm>>, accessed May 2013.





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## **Appendix A**

### ***How to read a windrose***



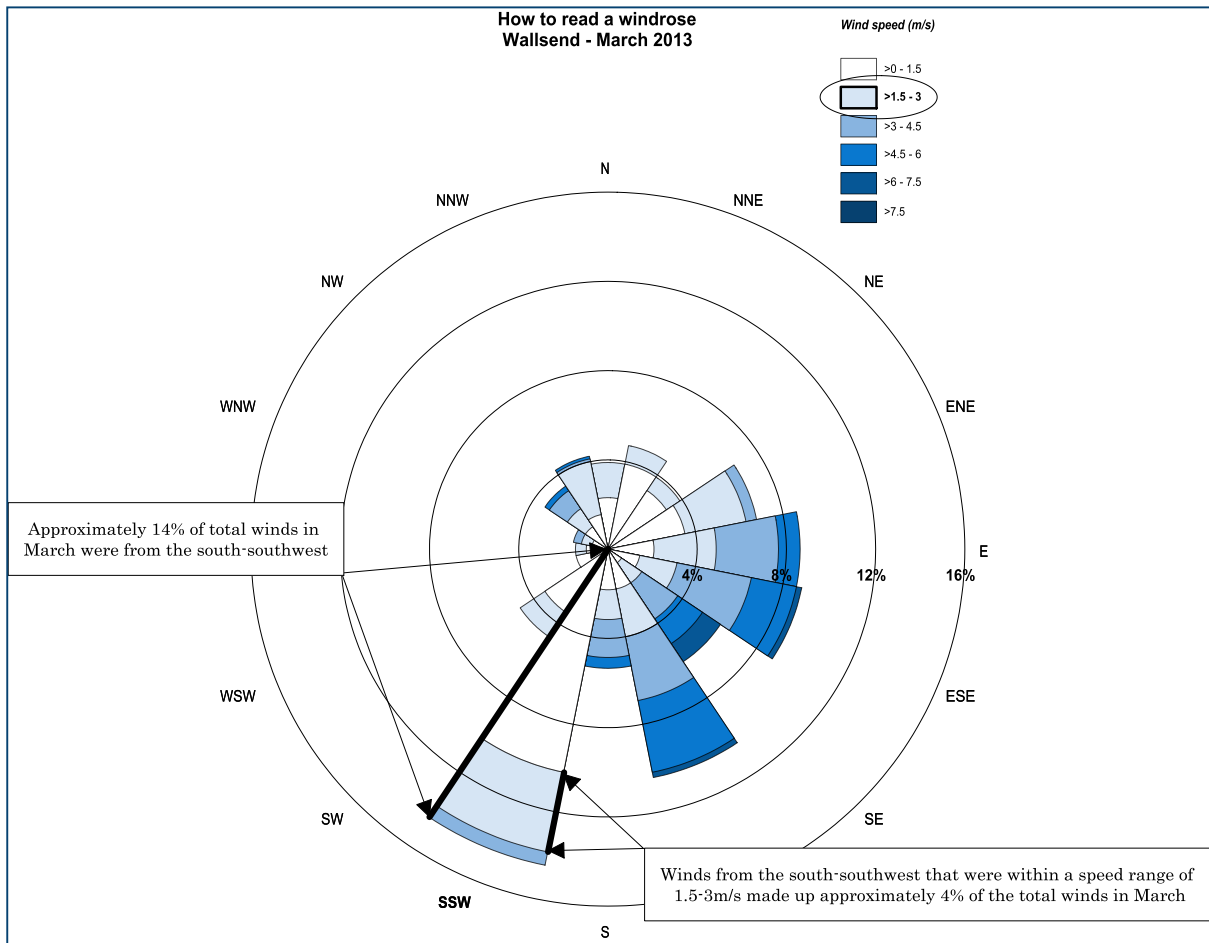


Figure A-1: How to read a windrose

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**Appendix B**  
*Monitoring Data (Graphical)*

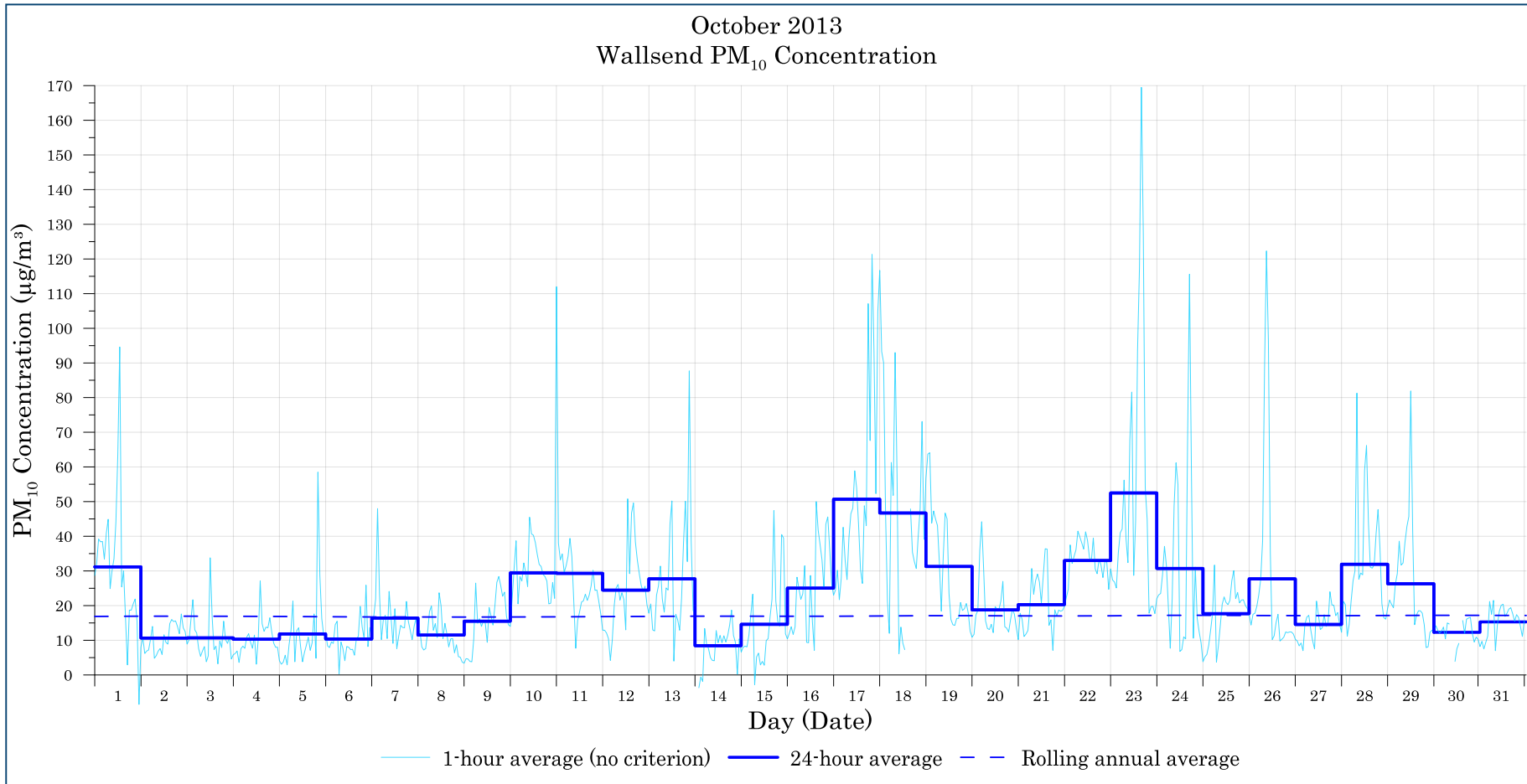


Figure B-1: Wallsend PM<sub>10</sub> concentration - October



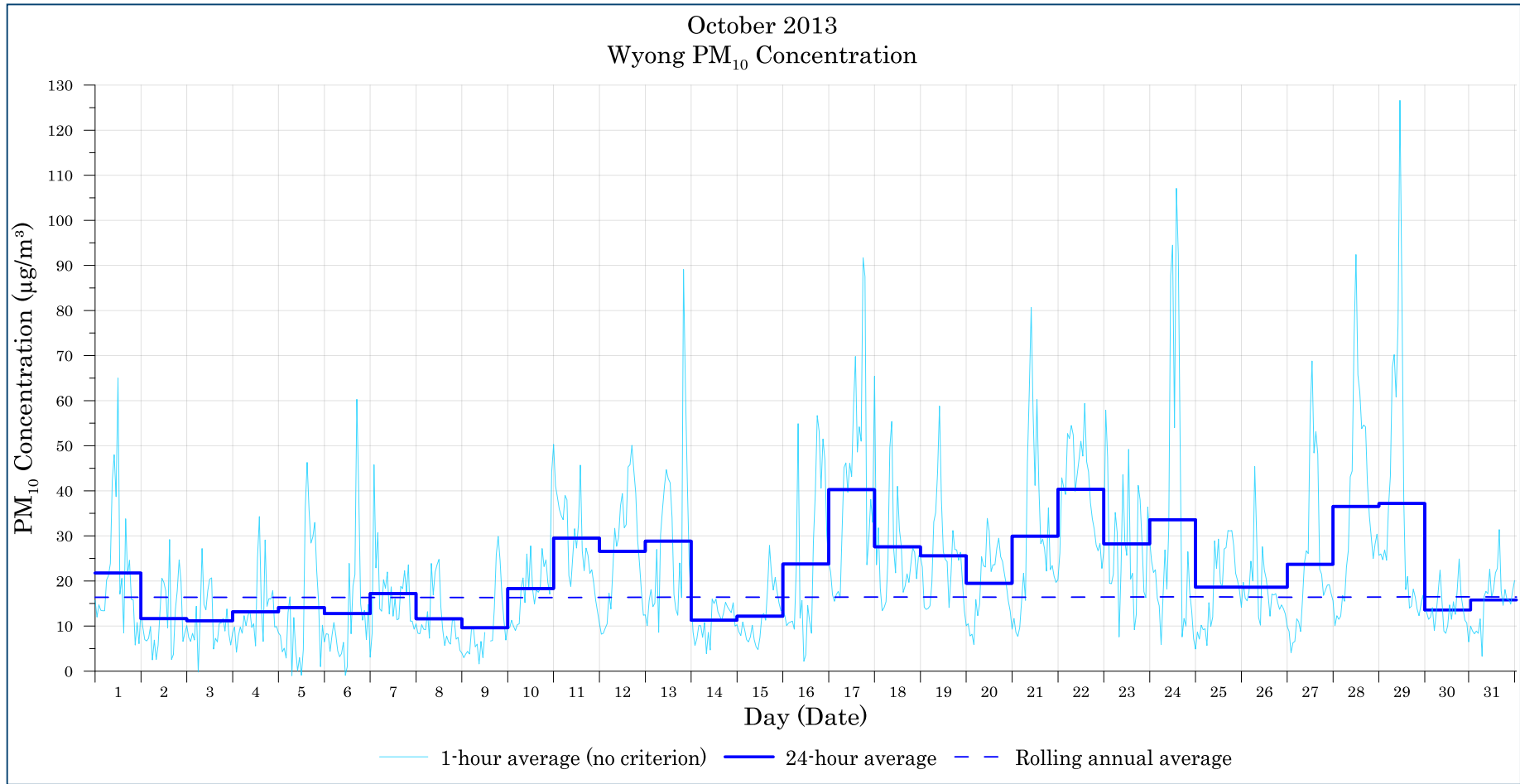


Figure B-2: Wyong PM<sub>10</sub> concentration - October

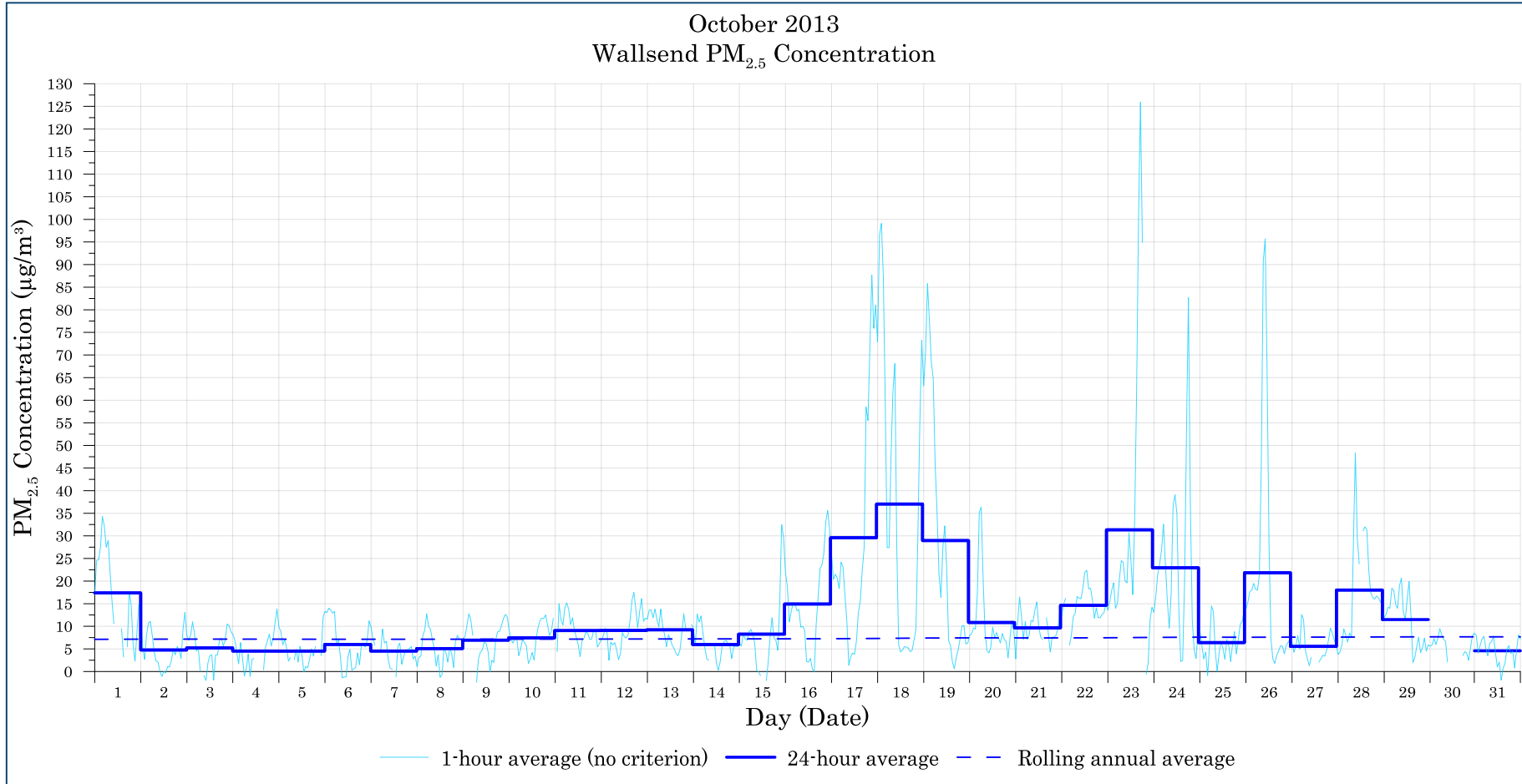


Figure B-3: Wallsend PM<sub>2.5</sub> concentration - October





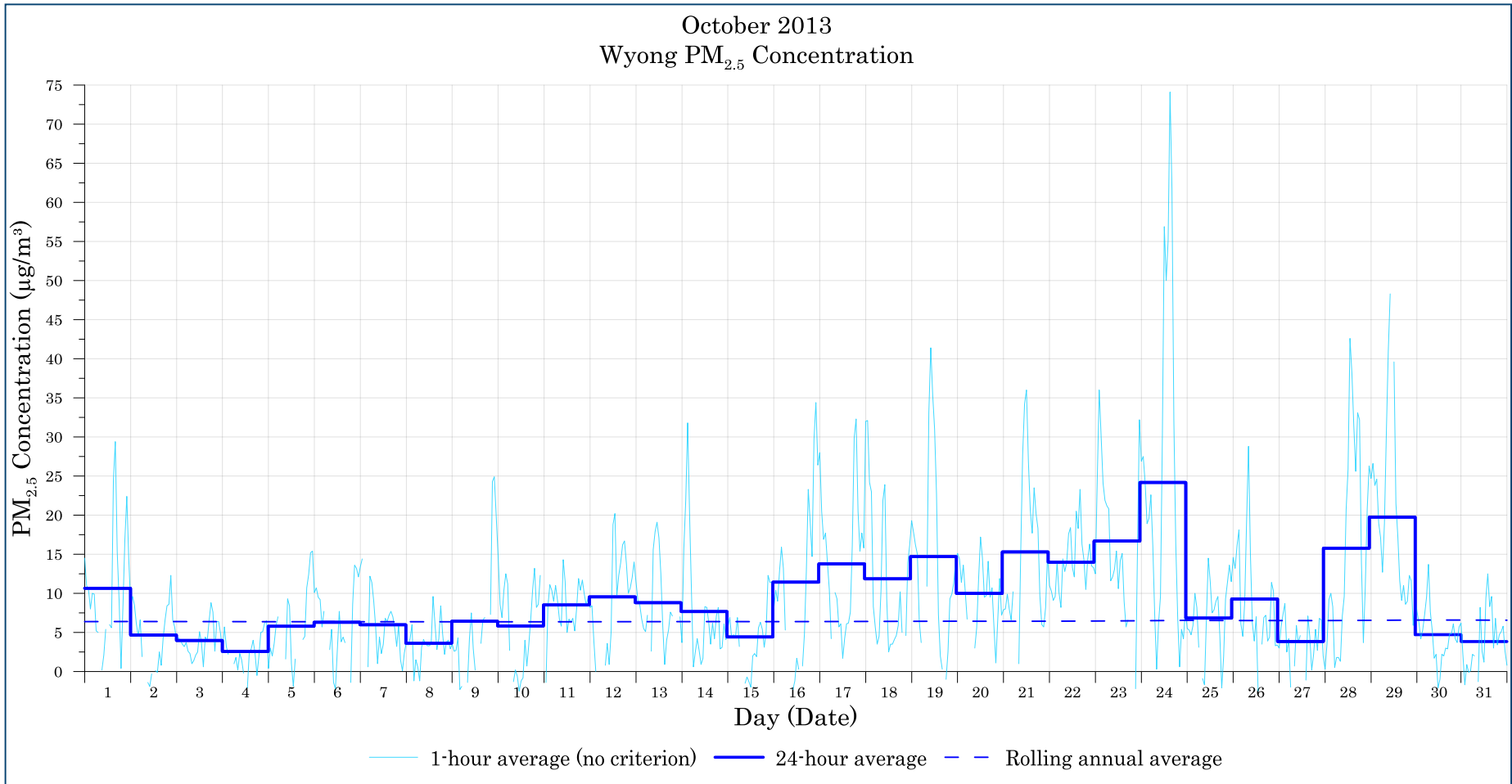


Figure B-4: Wyong PM<sub>2.5</sub> concentration - October

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**Appendix C**  
*Monitoring Data (Tabulated)*

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

Date	PM <sub>10</sub> (µg/m <sup>3</sup> )		PM <sub>2.5</sub> (µg/m <sup>3</sup> )		SO <sub>2</sub> (µg/m <sup>3</sup> )					
	Wallsend	Wyong	Wallsend	Wyong	Wallsend	Wyong	Dora Creek	Marks Point	Lake Munmorah P.S.	Wyee
01/10/2013	31.2	21.8	17.4	10.6	3.0	2.5	2.8	6.3	-0.2	2.9
02/10/2013	10.6	11.6	4.8	4.7	-1.4	1.3	1.3	4.6	0.4	1.3
03/10/2013	10.7	11.2	5.2	4.0	1.7	0.2	0.7	6.5	0.6	0.7
04/10/2013	10.3	13.2	4.5	2.6	5.7	0.0	4.1	4.0	0.2	1.1
05/10/2013	11.8	14.1	4.5	5.8	3.1	3.9	1.9	5.1	0.3	3.9
06/10/2013	10.4	12.8	6.0	6.3	1.4	1.6	0.2	4.5	0.3	2.4
07/10/2013	16.4	17.2	4.5	6.0	2.7	0.0	3.8	1.9	0.4	0.0
08/10/2013	11.5	11.6	5.1	3.6	2.5	0.0	6.5	4.3	0.2	1.4
09/10/2013	15.5	9.6	6.9	6.4	10.3	2.7	2.1	9.2	0.2	3.9
10/10/2013	29.4	18.3	7.4	5.8	5.5	0.1	1.3	7.3	0.1	1.0
11/10/2013	29.3	29.5	9.1	8.5	2.5	0.0	1.7	3.3	-0.9	3.7
12/10/2013	24.5	26.6	9.1	9.5	2.3	3.8	4.3	4.7	1.1	4.7
13/10/2013	27.7	28.8	9.2	8.8	-0.3	0.9	2.2	3.5	0.5	2.2
14/10/2013	8.4	11.3	6.0	7.7	2.8	0.0	6.0	4.6	-0.4	1.7
15/10/2013	14.6	12.2	8.3	4.4	0.8	2.2	2.6	8.2	0.8	5.2
16/10/2013	25.0	23.8	14.9	11.4	3.3	3.2	2.3	6.4	0.4	2.3
17/10/2013	50.7	40.3	29.6	13.8	5.8	1.0	3.4	12.3	0.6	2.8
18/10/2013	46.7	27.6	37.0	11.9	5.1	0.1	1.5	4.5	0.3	2.0
19/10/2013	31.3	25.6	29.0	14.7	3.2	0.8	1.1	3.3	0.4	4.2
20/10/2013	18.8	19.5	10.8	10.0	3.5	3.4	1.4	4.7	0.3	2.8
21/10/2013	20.3	29.9	9.7	15.3	4.6	2.6	1.8	4.6	0.5	1.2
22/10/2013	33.0	40.3	14.6	14.0	11.4	0.9	0.4	4.7	0.2	1.0
23/10/2013	52.5	28.2	31.3	16.7	2.6	1.6	2.1	4.5	-0.1	3.0
24/10/2013	30.7	33.6	22.9	24.2	2.7	2.3	2.4	-	0.5	2.5
25/10/2013	17.7	18.6	6.4	6.8	3.6	1.8	3.9	8.8	-0.2	11.5
26/10/2013	27.7	18.6	21.8	9.3	0.9	0.6	4.6	3.1	0.6	1.0
27/10/2013	14.6	23.7	5.6	3.8	5.9	1.4	1.4	2.3	-1.1	10.4
28/10/2013	31.9	36.5	18.0	15.8	4.4	6.0	3.4	4.0	0.8	6.8
29/10/2013	26.3	37.2	11.5	19.7	3.4	0.7	0.6	5.4	-0.4	1.1
30/10/2013	12.3	13.6	-	4.7	3.3	0.0	3.1	5.6	0.4	1.4
31/10/2013	15.3	15.8	4.6	3.8	4.7	0.7	0.7	3.5	0.4	10.1

- Not applicable

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

Date	PM <sub>10</sub> (HVAS) (µg/m <sup>3</sup> )
	Wakefield (Westside)
6/10/2013	7.6
12/10/2013	43.8
18/10/2013	1.0
24/10/2013	18.7
30/10/2013	15.4

- Not applicable