TODOROSKI AIR SCIENCES

LAKE MACQUARIE – WYONG

REVIEW OF MONTHLY AMBIENT AIR QUALITY DATA

SEPTEMBER 2015

NSW Environment Protection Authority

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Lake Macquarie – Wyong

Review of Monthly Ambient Air Quality Data

September 2015

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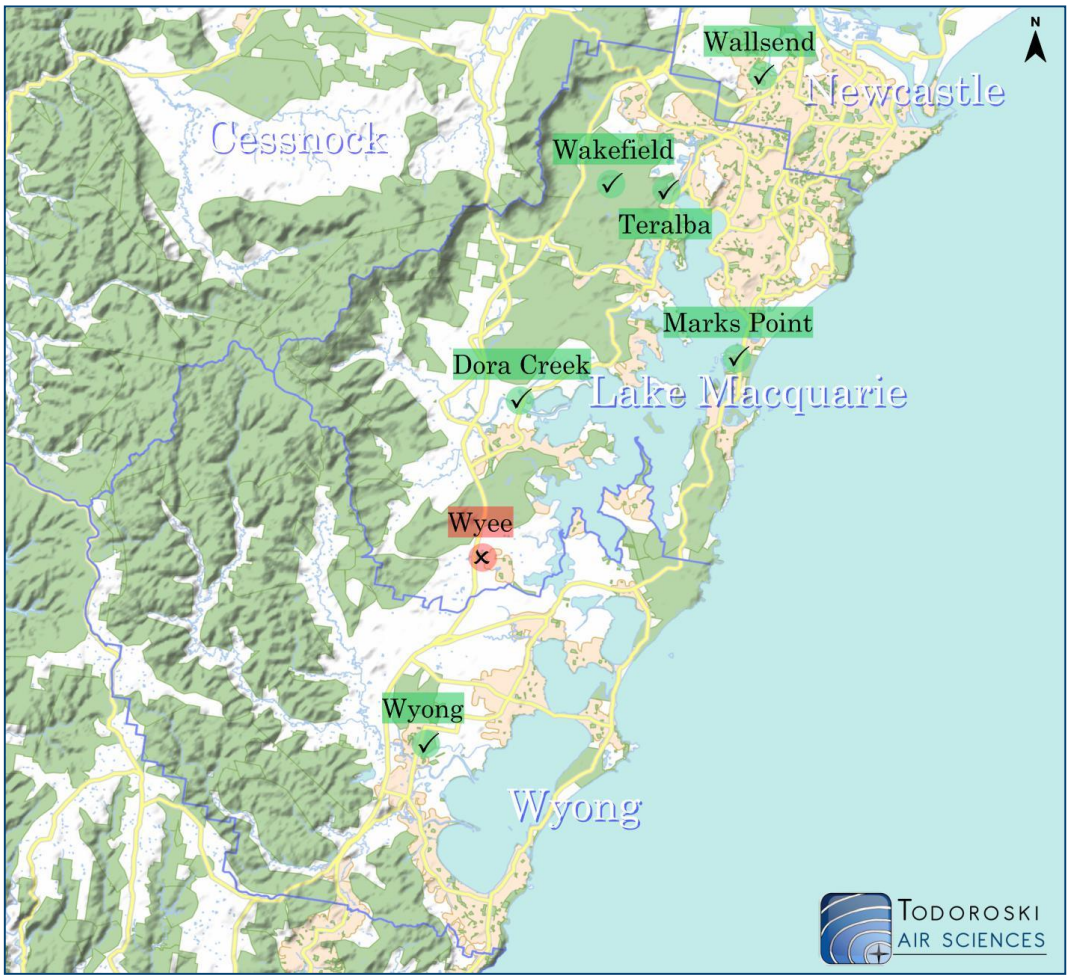
EXECUTIVE SUMMARY

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 September 2015. The results indicate that the air quality was generally good in the Lake Macquarie - Wyong region during September.

The data summary (shown below) indicates that in September, the Wyee monitor recorded a 24-hour average $PM_{2.5}$ level above the advisory reporting standard of 25µg/m^3. All other data were below the applicable criteria. Further details are provided in the report.

Lake Macquarie - Wyong Air Quality Pictorial Summary - September 2015



Lake Macquarie – Wyong Air Quality Tabular Summary - September 2015

Site	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	SO_2 (µg/m^3)	O_3 (µg/m^3)	O_3 (µg/m^3)	NO_2 (µg/m^3)	SO_2 (µg/m^3)
	24-hour average			4-hour average[1]	1-hour average		
	Air Quality Impact Criteria						
	50	25*	228	171	214	246	570
Wallsend	✓	✓	✓	✓	✓	✓	✓
Wyong	✓	✓	✓	✓	✓	✓	✓
Dora Creek	-	-	✓	-	-	✓	✓
Marks Point	-	-	✓	-	-	✓	✓
Wyee	-	×	✓	-	-	✓	✓
Wakefield HVAS	✓	-	-	-	-	-	-
Teralba 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] - Rolling average

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 September 2015.

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 NSW 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 Wyee, Marks Point, Dora Creek, Wakefield and Teralba.
- 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 2016.

3 THE PURPOSE OF AMBIENT MONITORING

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

NSW 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 NSW EPA sites can be compared with national air quality standards. Where the levels measured at NSW 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_{10}, 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 NSW EPA impact assessment criteria. Where the levels measured at industry monitoring sites are above the applicable impact assessment criteria on a prolonged and consistent basis, this indicates that further investigation is warranted to determine the potential cause and what action is required by industry to reduce or better manage the pollutant.

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 criteria.
    - http://www.environment.nsw.gov.au/AQMS/aboutaqi.htm
- Aqicn.org provides 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 September 2015.

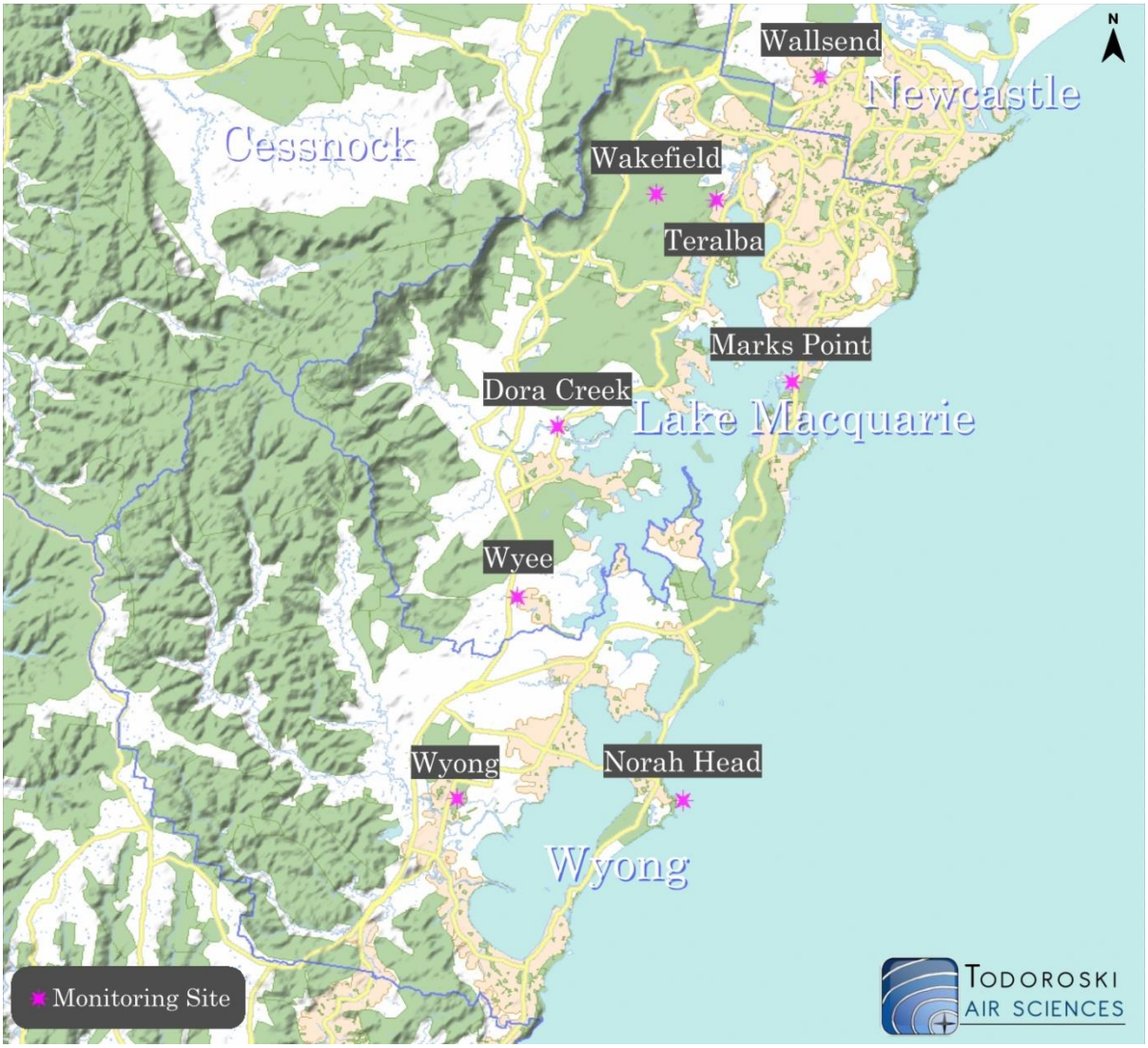


Figure 4-1: Monitoring site locations

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, O_3, WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, O_3, 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
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day
Teralba HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day

PM_{10} - Particulate matter < 10µm
$PM_{2.5}$ - Particulate matter < 2.5µm
TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)
NO_2 - Nitrogen dioxide
SO_2 - 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 50µm 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 PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

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

Table 5-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	30µg/m^3
	24-hour	50µg/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 < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m^3
	Annual	8µg/m^3

Source: **NEPC, 2003**

5.2 Other air pollutants

Nitrogen dioxide (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. NO_2 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, NO_2 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.

Ozone (O_3) has a slight blue colour and is a reactive gas comprised of three oxygen atoms. It is typically found in the upper atmosphere, and forms what is referred to as the ozone layer which filters harmful ultraviolet radiation from the sun, and the near ground level in the troposphere. Tropospheric ozone forms through reactions between nitrogen oxides and volatile organic compounds (VOCs) in the presence of ultraviolet radiation. Tropospheric ozone is the main component of photochemical smog and can impact human health.

Table 5-3 summarises the air quality goals for NO_2, SO_2 and O_3.

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

Pollutant	Averaging period	Criterion
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	10-minute	712µg/m^3
	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3
Ozone (O_3)	1-hour	214µg/m^3
	Rolling 4-hour	171µg/m^3

Source: **NSW DEC, 2005**

5.3 Summary of applicable criteria for this review

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_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 review.

Table 5-4: Air quality criteria used in this review

Pollutant	Averaging Period	Type	Concentration
Particulate Matter < 10µm (PM_{10})	24-hour	Criterion	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	Advisory Reporting Standard	25µg/m^3
Nitrogen Dioxide (NO_2)	1-hour	Criterion	246µg/m^3
Sulfur Dioxide (SO_2)	1-hour	Criterion	570µg/m^3
	24-hour	Criterion	228µg/m^3
Ozone (O_3)	1-hour	Criterion	214µg/m^3
	Rolling 4-hour	Criterion	171µg/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 of windroses. For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 6-1 presents the September 2015 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. The meteorological stations generally recorded winds from varied directions which typically ranged from the northwest quadrant to the southwest quadrant. The Marks Point monitoring site recorded a high frequency of easterly and east-southeasterly winds compared to the other stations in September.

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.

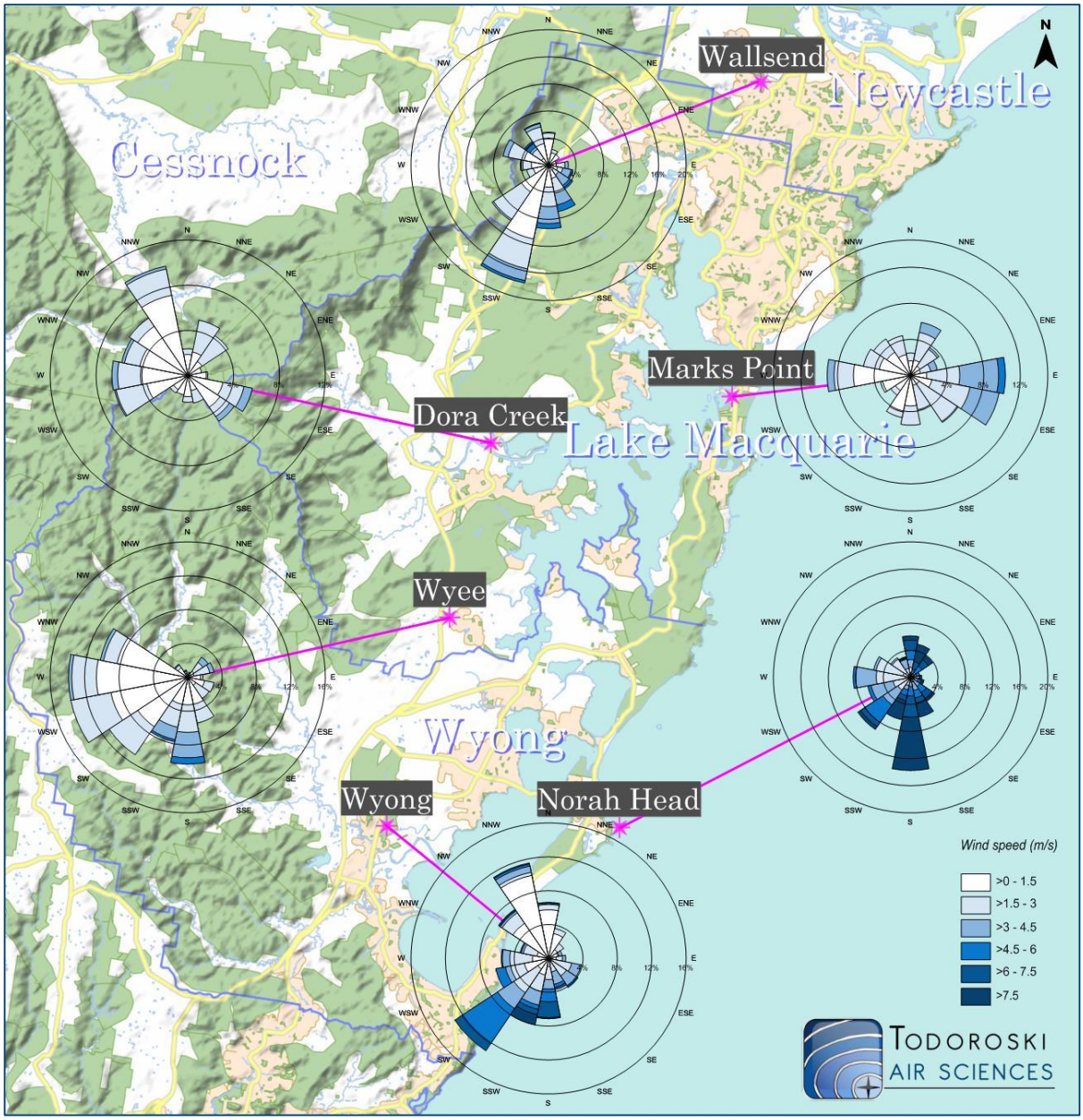


Figure 6-1: September windroses – Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

The meteorological stations generally recorded winds from varied directions which typically ranged from the northwest quadrant to the southwest quadrant. The Marks Point monitoring site recorded a high frequency of easterly and east-southeasterly winds compared to the other stations in September.

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. 1-hour, 24-hour average and rolling annual average 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 September 2015. The results indicate that pollutant levels were below the applicable criteria for all monitors at all times.

Table 7-1: Maximum pollutant levels - September 2015

Site	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	O_3 (µg/m³)	O_3 (µg/m³)	NO_2 (µg/m³)	SO_2 (µg/m³)
	24-hour average	24-hour average	24-hour average	Rolling 4-hour average	1-hour average	1-hour average	1-hour average
	Air Quality Impact Criteria						
	50	25*	228	171	214	246	570
Wallsend	26.5	11.4	11.5	92.1	100.7	67.7	57.1
Wyong	26.6	8.8	9.2	96.4	100.7	49.3	51.4
Dora Creek	-	-	7.5	-	-	45.6	40.7
Marks Point	-	-	5.4	-	-	47.5	37.4
Wyee	-	**26.3**	16.2	-	-	56.8	60.2
Wakefield HVAS	18.1	-	-	-	-	-	-
Teralba HVAS	16.0	-	-	-	-	-	-

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

- Not applicable

7.3 PM_{10}

Figure 7-1 presents all of the 24-hour average PM_{10} monitoring results recorded in the Lake Macquarie - Wyong region in September 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM_{10} levels were very good or good at all monitors at all times.

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the PM_{10} criterion level in September.

Figure B-1 to **Figure B-2** in **Appendix B** present the 1-hour average, 24-hour average and rolling annual average PM_{10} data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM_{10} levels and these 1-hour results are not intended to be compared with the PM_{10}

criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM_{10} levels will fluctuate more significantly than 24-hour average PM_{10} levels.

Figure B-1 to **Figure B-2** show the rolling annual average PM_{10} levels recorded at the Wallsend and Wyong monitors were 17.2µg/m^3 and 15.1µg/m^3 respectively at the end of September 2015. The rolling annual average levels can be compared to the annual average criterion of 30µg/m^3, however typically a calendar year of data are used to determine whether the annual average goal has been met.

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 September 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that the recorded $PM_{2.5}$ levels were very good to good at all monitors at all times with the exception of the Wyee monitor which recorded one day of poor levels.

The Wyee monitor recorded a 24-hour average $PM_{2.5}$ level above the advisory reporting standard of 25µg/m^3 on 13 September 2015. All other data recorded at the Lake Macquarie - Wyong monitoring sites were below the advisory reporting standard in September 2015

Figure B-3 to **Figure B-5** in **Appendix B** present the 1-hour average, 24-hour average and rolling annual 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.

Figure B-3 to **Figure B-5** show the rolling annual average $PM_{2.5}$ levels recorded at the Wallsend, Wyong and Wyee monitors were 7.3µg/m^3, 5.5µg/m^3 and 5.5µg/m^3 respectively at the end of September 2015. The rolling annual average levels can be compared to the annual average advisory reporting standard of 8µg/m^3, however typically a calendar year of data are used to determine whether the annual average advisory reporting standard goal has been met.

7.5 NO_2

Figure 7-3 presents the 1-hour average NO_2 monitoring data recorded in the Lake Macquarie - Wyong region in September 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the NO_2 levels were very good all monitors at all times.

All data were below the applicable criterion on all days.

7.6 SO_2

Figure 7-4 presents the 1-hour average SO_2 monitoring data recorded in the Lake Macquarie - Wyong region in September 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO_2 levels were very good all monitors at all times.

All data were below the applicable criterion on all days.

7.7 O_3

Figure 7-5 presents the 1-hour average O_3 monitoring data recorded in the Lake Macquarie - Wyong region in September 2015.

Figure 7-6 presents the rolling 4-hour average O_3 monitoring data recorded in the Lake Macquarie - Wyong region in September 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figures, the data indicate the 1-hour average O_3 levels were generally very good at both locations. The Wallsend and Wyong monitors recorded good levels 4% and 7% of the time respectively.

The measured rolling 4-hour average levels were generally very good. The Wallsend and Wyong monitors recorded good levels 20% and 26% of the time respectively.

All data were below the applicable criterion on all days.

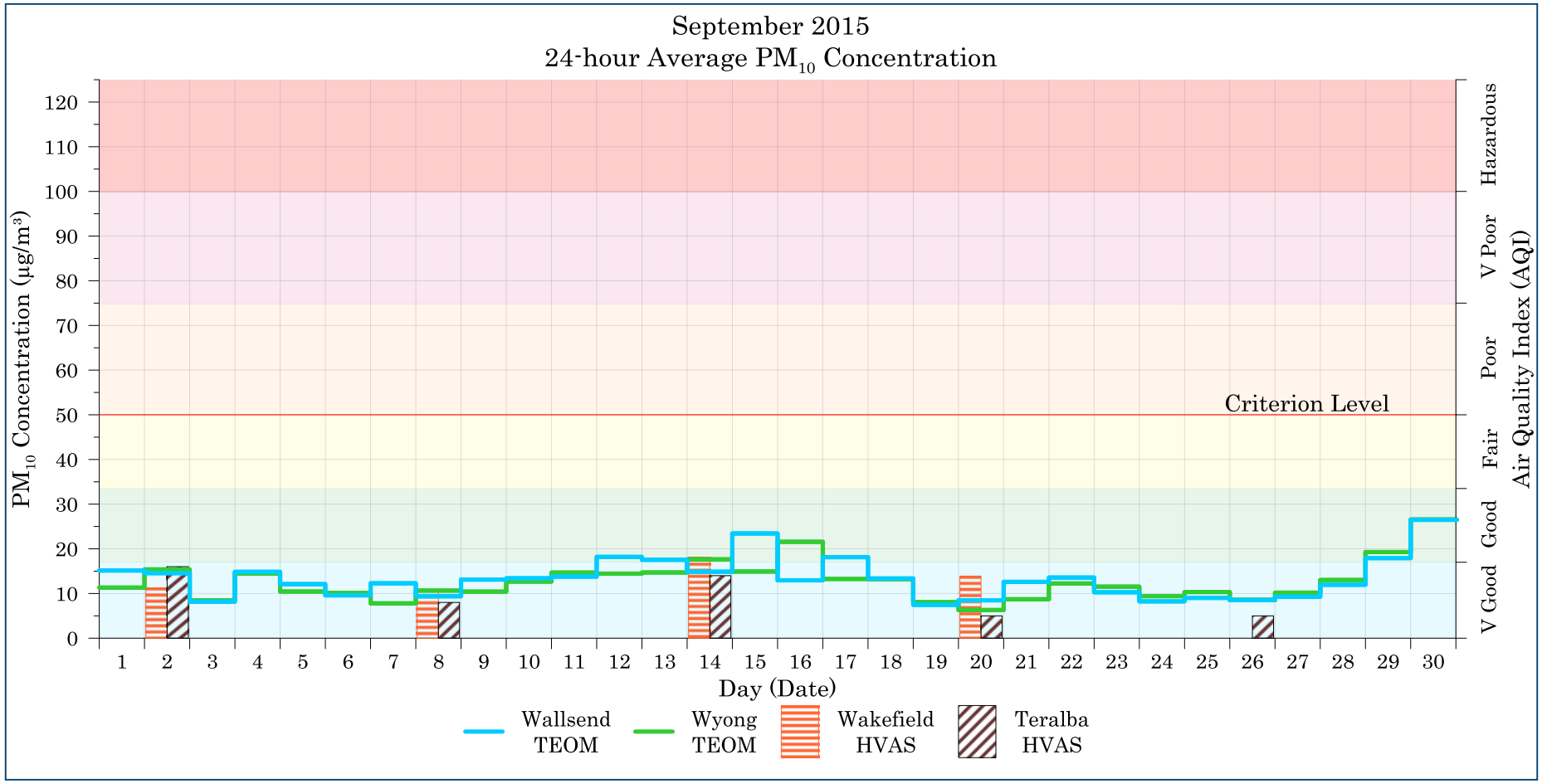


Figure 7-1: Lake Macquarie - Wyong 24-hour average PM_{10} levels – September 2015

The recorded PM_{10} levels were very good or good at all monitors at all times in September 2015. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average criterion of 50µg/m³.

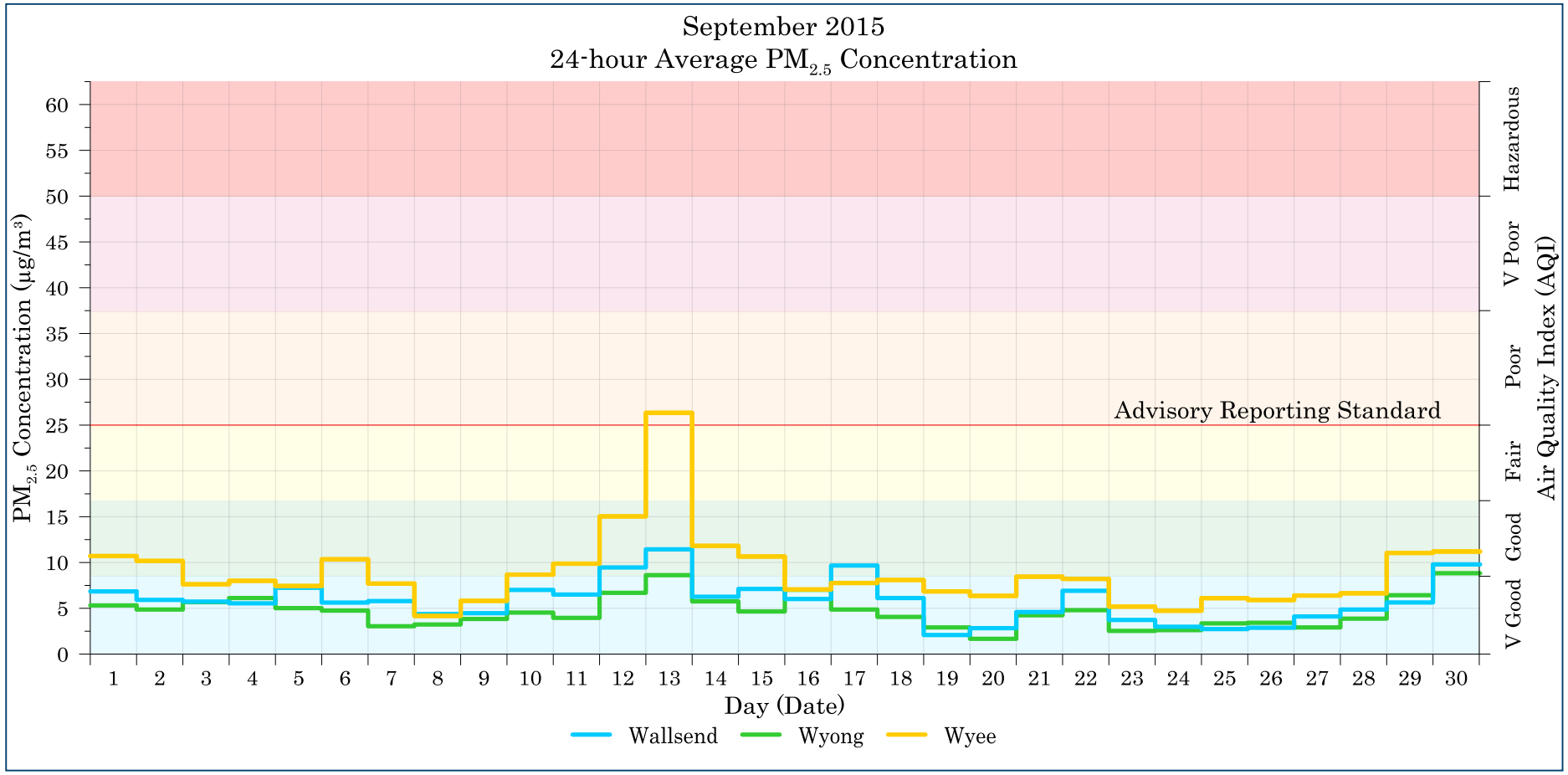


Figure 7-2: Lake Macquarie - Wyong 24-hour average $PM_{2.5}$ levels – September 2015

The recorded $PM_{2.5}$ levels were very good to good at all monitors at all times with the exception of the Wyee monitor which recorded one day of poor levels above the 24-hour average $PM_{2.5}$ advisory reporting standard of 25µg/m^3. All other data recorded at the Lake Macquarie - Wyong monitoring sites were below the advisory reporting standard in September 2015.

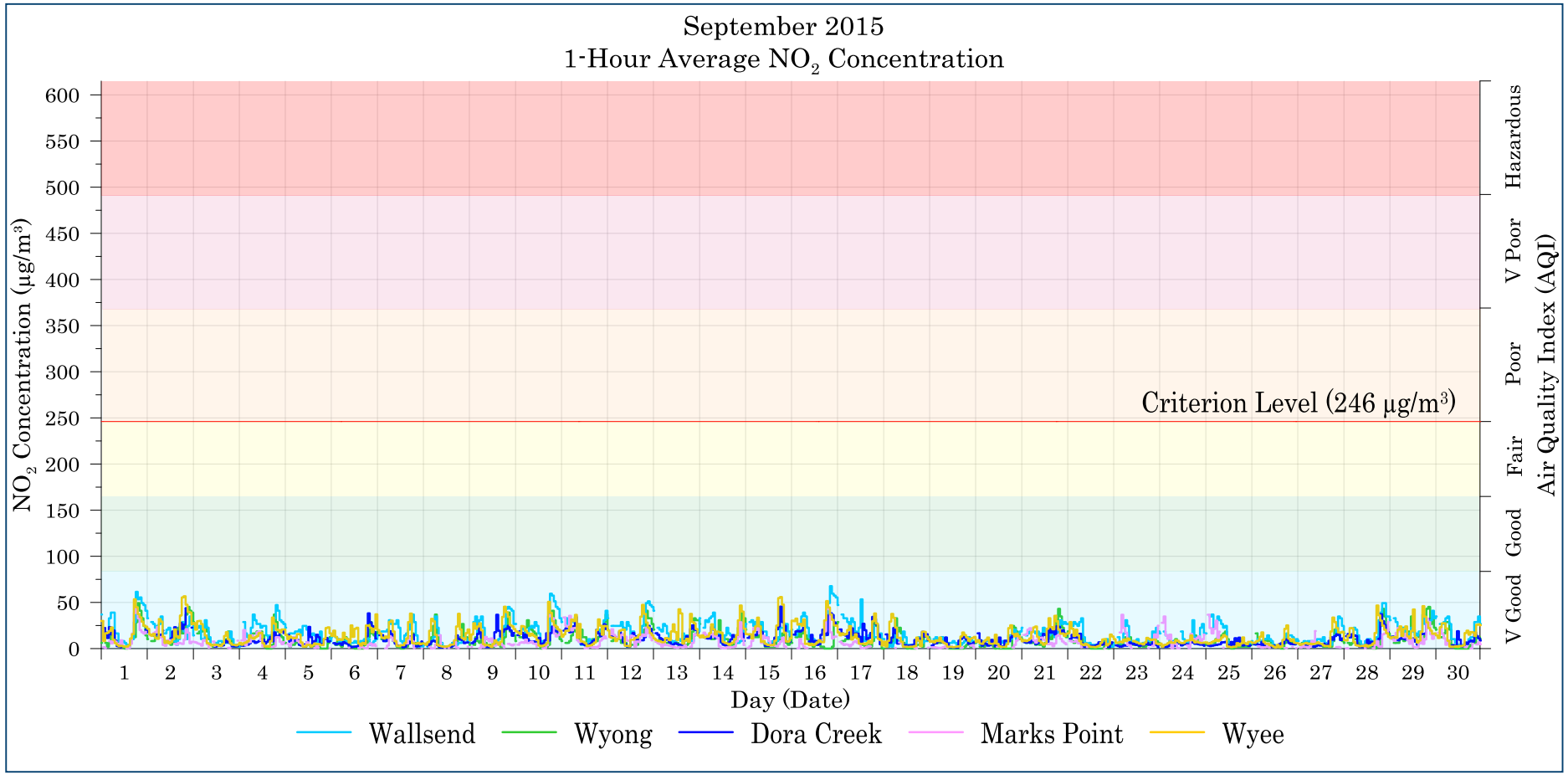


Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – September 2015

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO_2 criterion level of 246µg/m^3 in September 2015. Measured levels of NO_2 were very good at all monitors at all times.

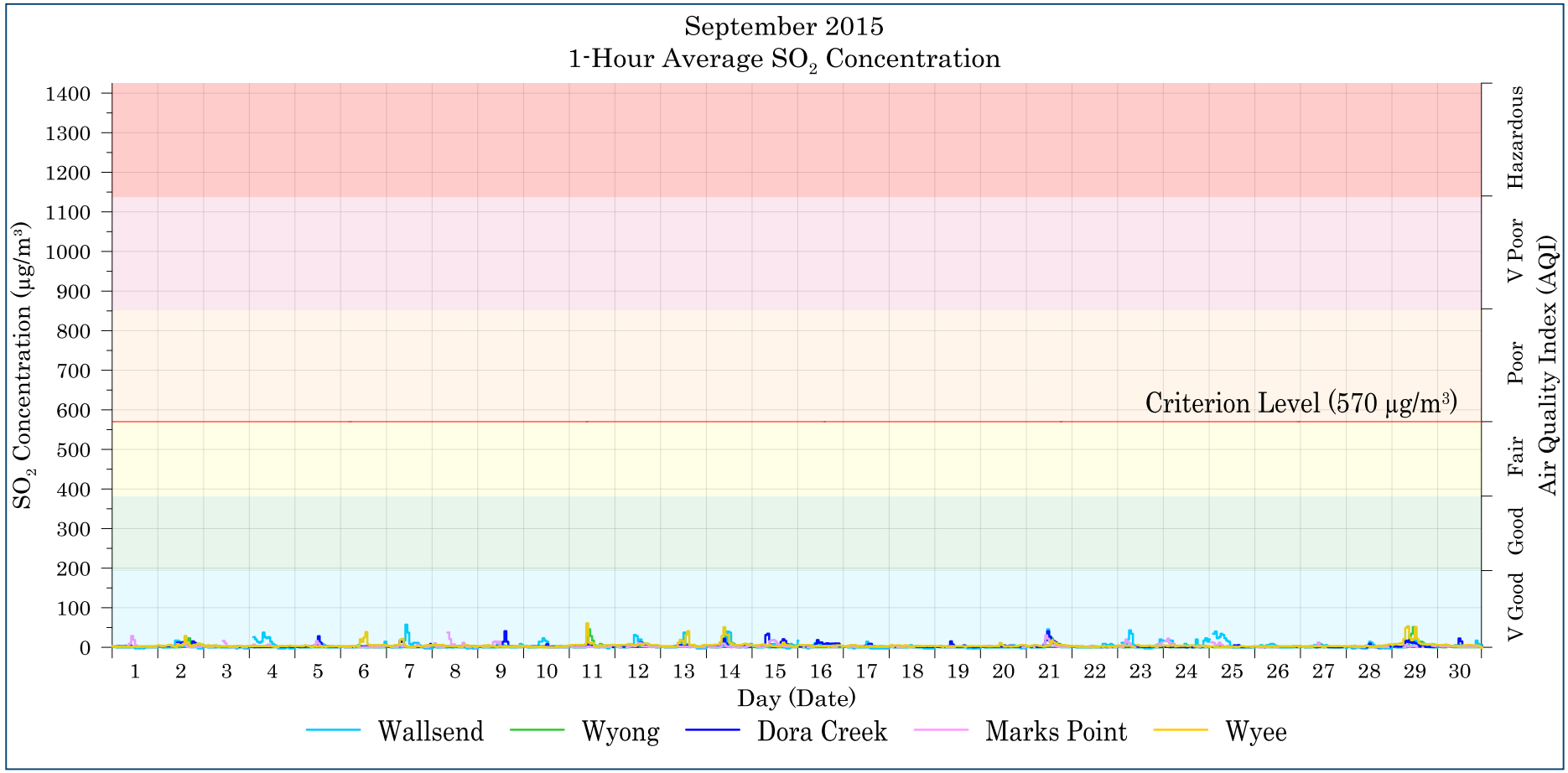


Figure 7-4: Lake Macquarie - Wyong 1-hour average SO_2 levels – September 2015

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO_2 criterion level of 570µg/m^3 in September 2015. Measured levels of SO_2 were very good at all monitors at all times.

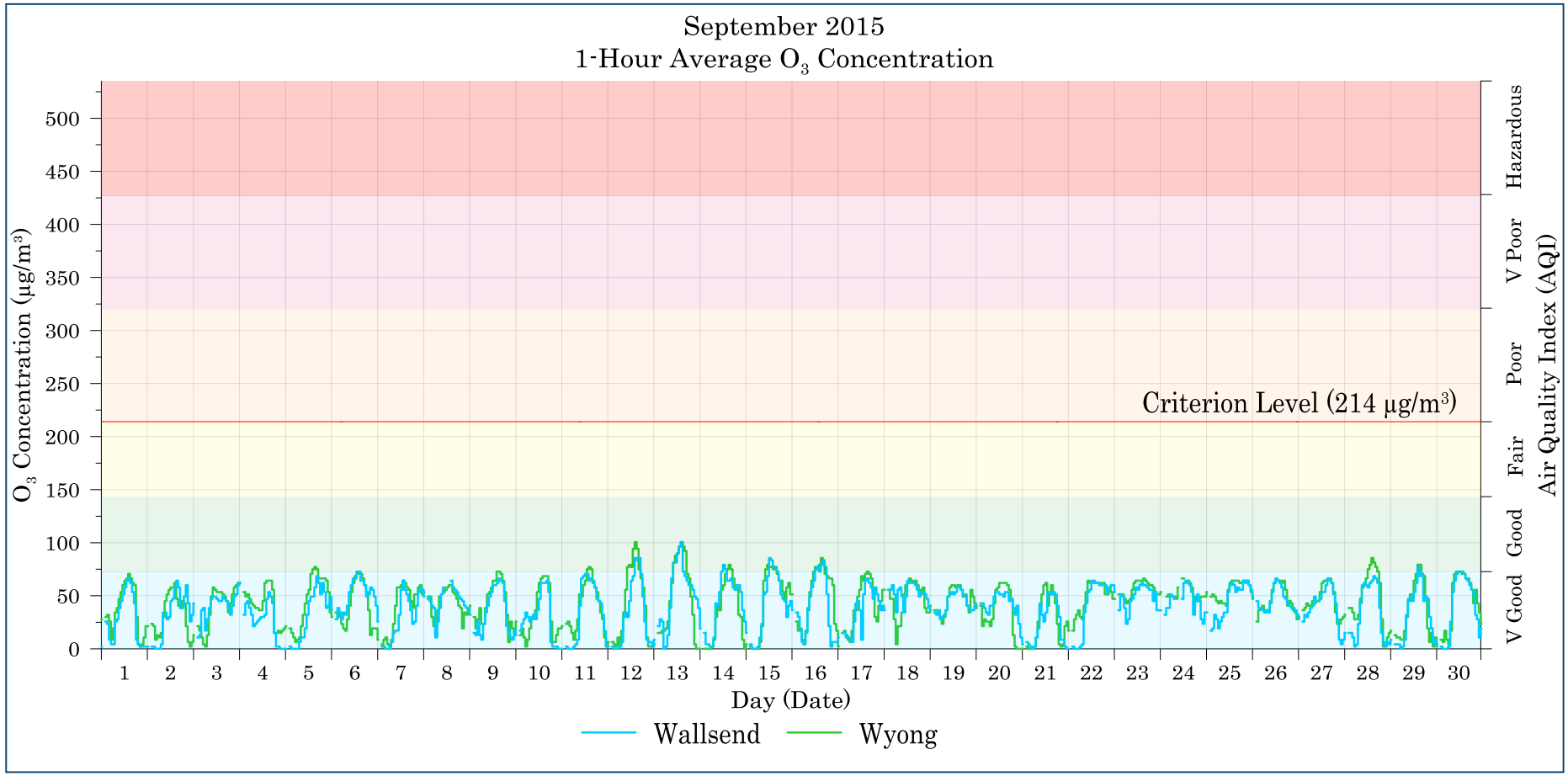


Figure 7-5: Lake Macquarie - Wyong 1-hour average O_3 levels – September 2015

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average O_3 criterion level of 214µg/m^3 in September 2015. Measured 1-hour average levels of O_3 were generally very good. The Wallsend and Wyong monitors recorded good levels 4% and 7% of the time respectively.

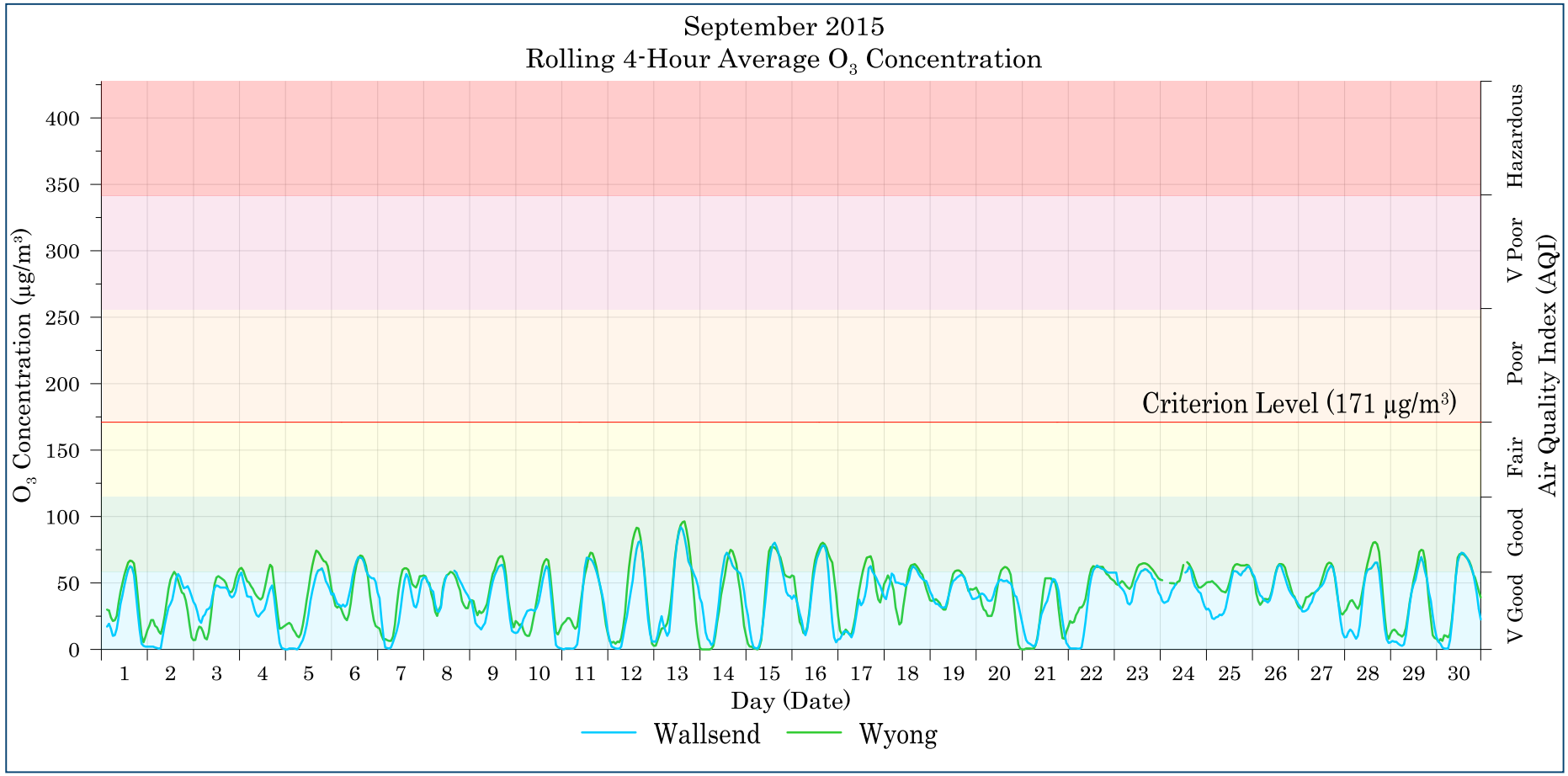


Figure 7-6: Lake Macquarie - Wyong rolling 4-hour average O_3 levels – September 2015

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the rolling 4-hour average O_3 criterion level of 171µg/m^3 in September 2015. The measured rolling 4-hour average levels were generally very good. The Wallsend and Wyong monitors recorded good levels 20% and 26% of the time respectively.

8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

8.1 Wyee – 13 September 2015

Figure 8-1 presents a plot of the 1-hour average $PM_{2.5}$, wind speed and wind direction data recorded at the Wyee monitoring site on 12 and 13 September 2015. The 1-hour average $PM_{2.5}$ levels recorded at Wallsend and Wyong have also been included.

The data presented in **Figure 8-1** show that the Wyee monitor recorded elevated $PM_{2.5}$ levels from 6:00pm on 12 September until 7:00am on 13 September, during calm wind conditions. The other monitors did not record elevated levels during these conditions.

Given the calm wind conditions and low levels at Wallsend and Wyong, it is likely the elevated $PM_{2.5}$ levels at Wyee originated from a local source (such as a household wood heater or other combustion sources) nearby to the monitor.

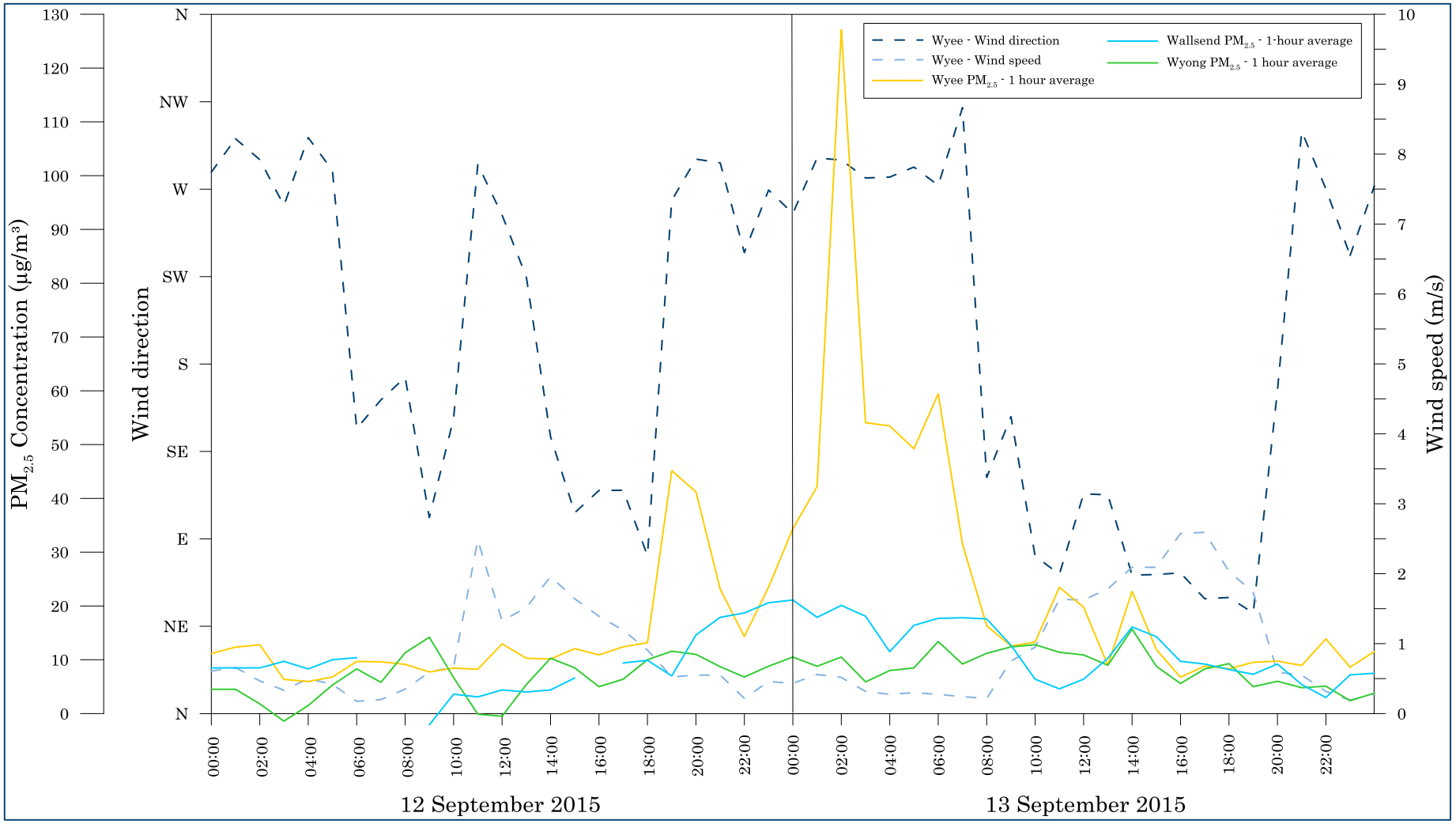


Figure 8-1: Analysis of elevated $PM_{2.5}$ levels on 13 September 2015 – Wyee

The Wyee monitor recorded elevated $PM_{2.5}$ levels from 6:00pm on 12 September until 7:00am on 13 September, during calm wind conditions.

9 CONCLUSIONS

The results indicate that the monitoring stations recorded good air quality for the majority of September 2015.

The Wyee monitor recorded a 24-hour average $PM_{2.5}$ level above the advisory reporting standard of 25µg/m^3 on 13 September 2015. The elevated $PM_{2.5}$ levels were recorded from 6:00pm on 12 September until 7:00am on 13 September, during calm wind conditions and likely originated from a local source (such as a household wood heater) nearby to the monitor.

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 levels of O_3 were generally very good. The rolling 4-hour average levels recorded by the Wallsend and Wyong monitors were good 20% and 26% of the time respectively;
- The measured $PM_{2.5}$ levels were very good to good at all monitors at all times with the exception of the Wyee monitor which recorded one day of poor levels; and,
- The measured PM_{10} levels were very good or good at all monitors at all times.

All recorded rolling annual average levels were below the applicable annual (calendar year) criteria in September 2015.

On this basis it can be concluded that the air quality in the Lake Macquarie - Wyong region was generally good in September 2015.

10 REFERENCES

NEPC (2001)

"National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 5 Data Collection and Handling", National Environment Protection Council, May 2001.

NEPC (2003)

"Variation to the National Environment Protection (Ambient Air Quality) Measure for Particles as $PM_{2.5}$", 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.

Appendix A

How to read a windrose

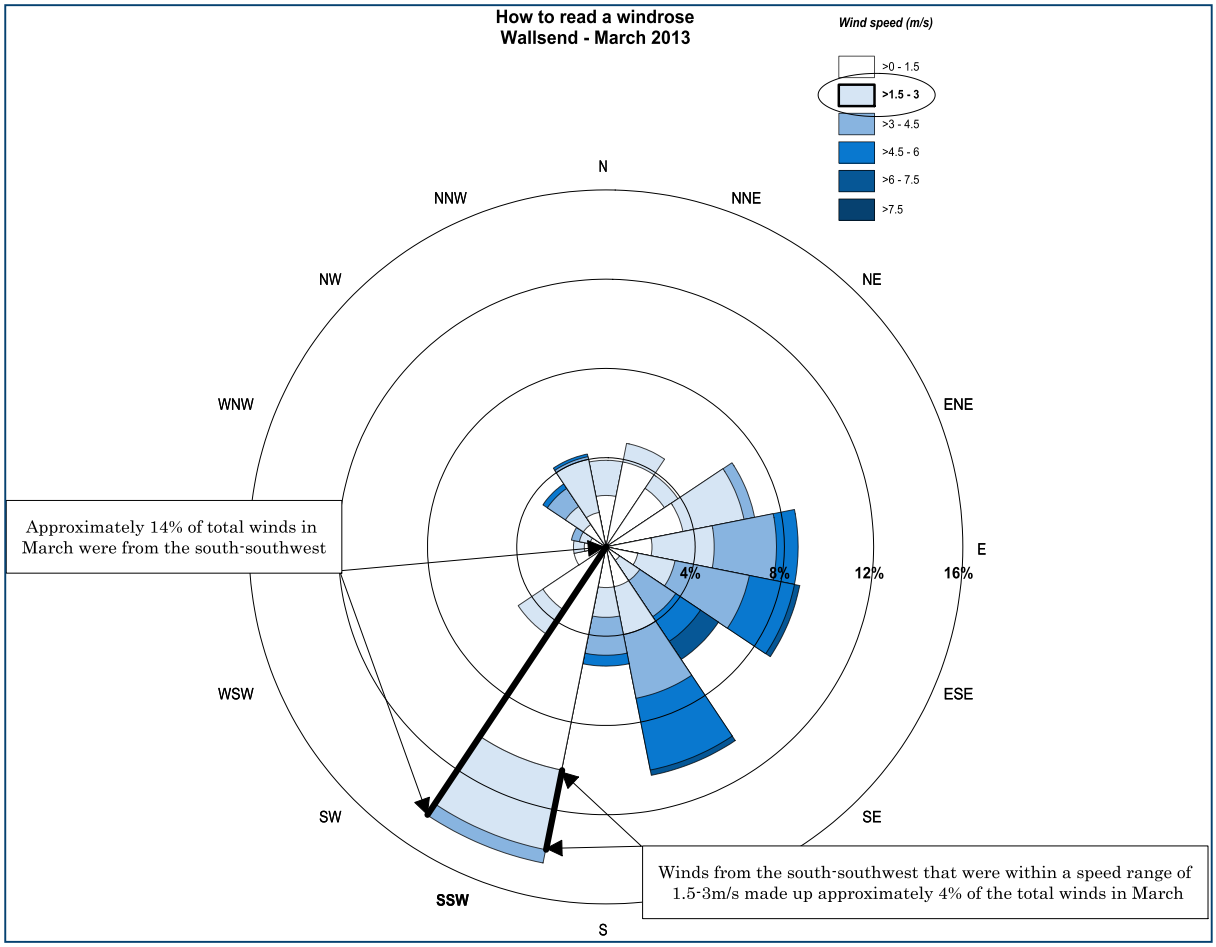


Figure A-1: How to read a windrose

Appendix B

Monitoring Data (Graphical)

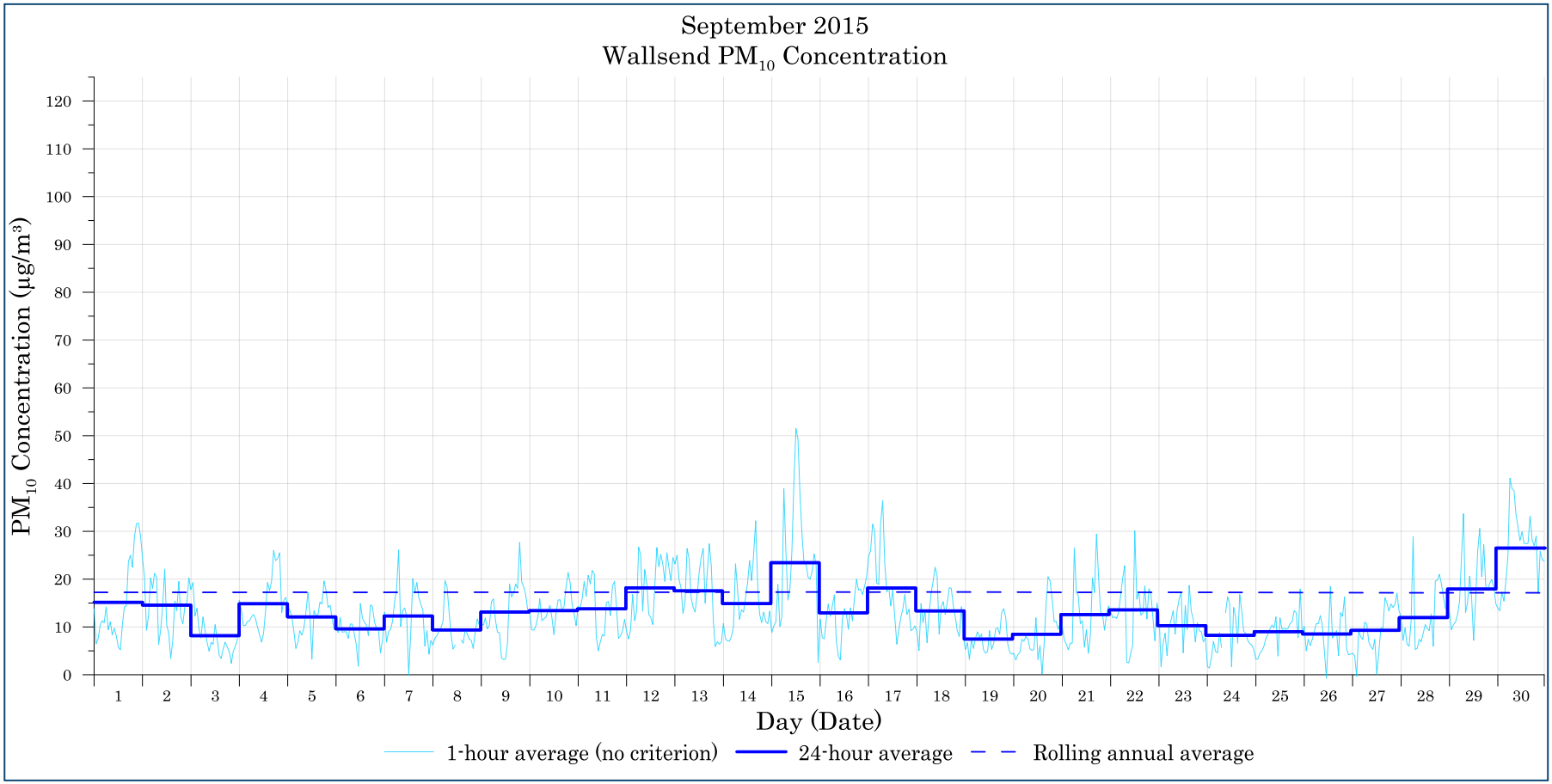


Figure B-1: Wallsend PM_{10} (1-hour, 24-hour and rolling annual average) concentration - September

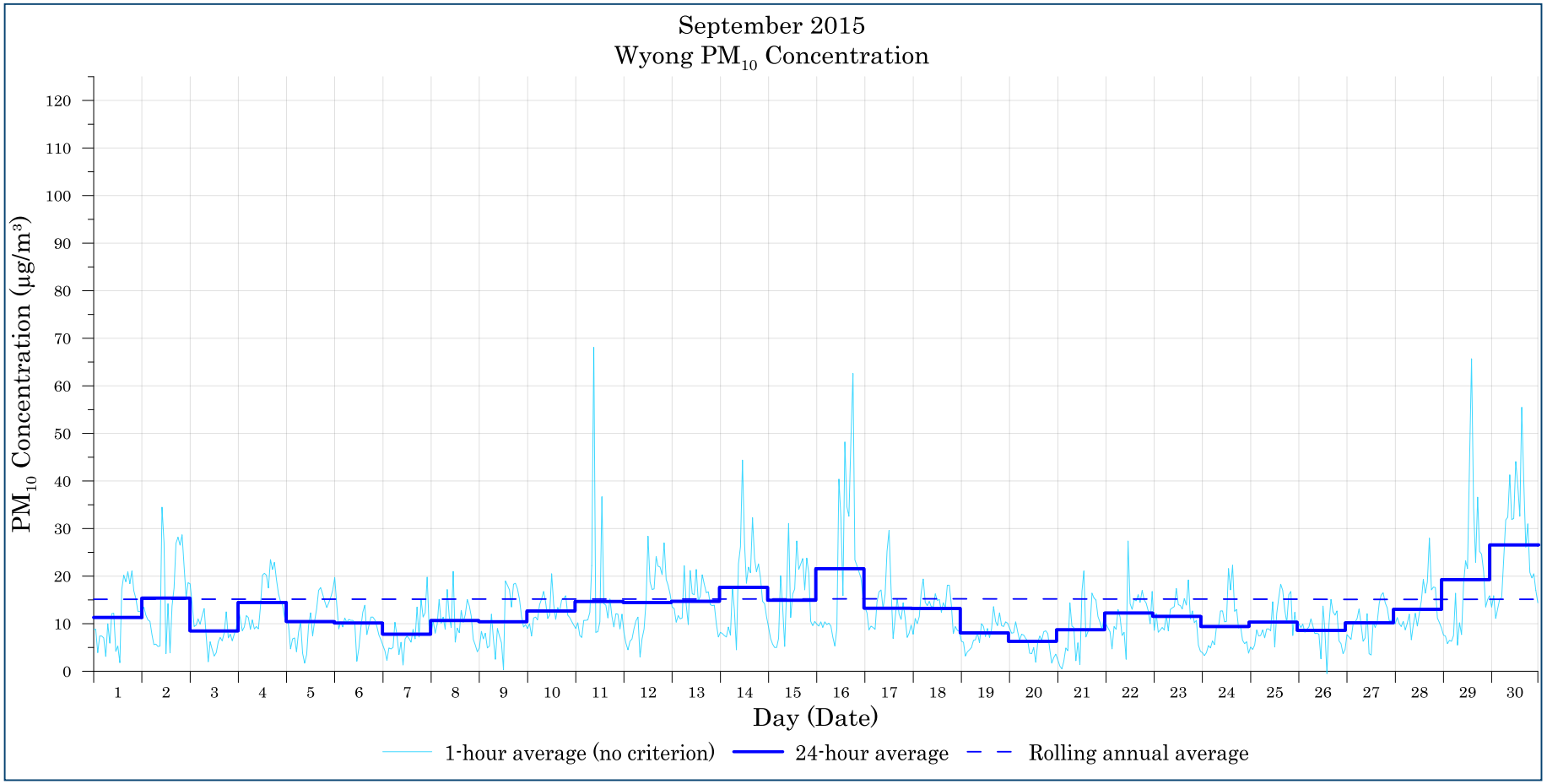


Figure B-2: Wyong PM_{10} (1-hour, 24-hour and rolling annual average) concentration – September

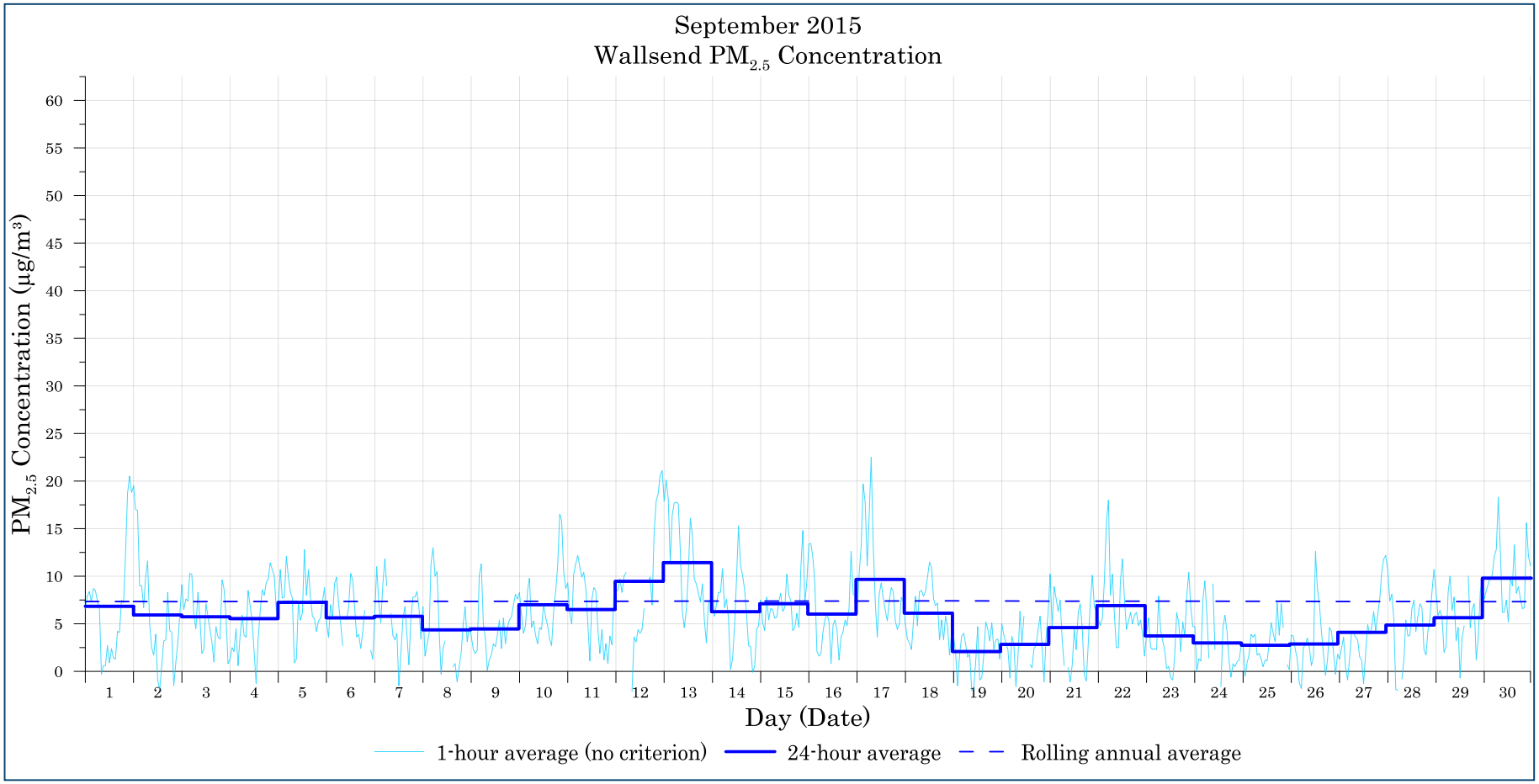


Figure B-3: Wallsend $PM_{2.5}$ (1-hour, 24-hour and rolling annual average) concentration – September

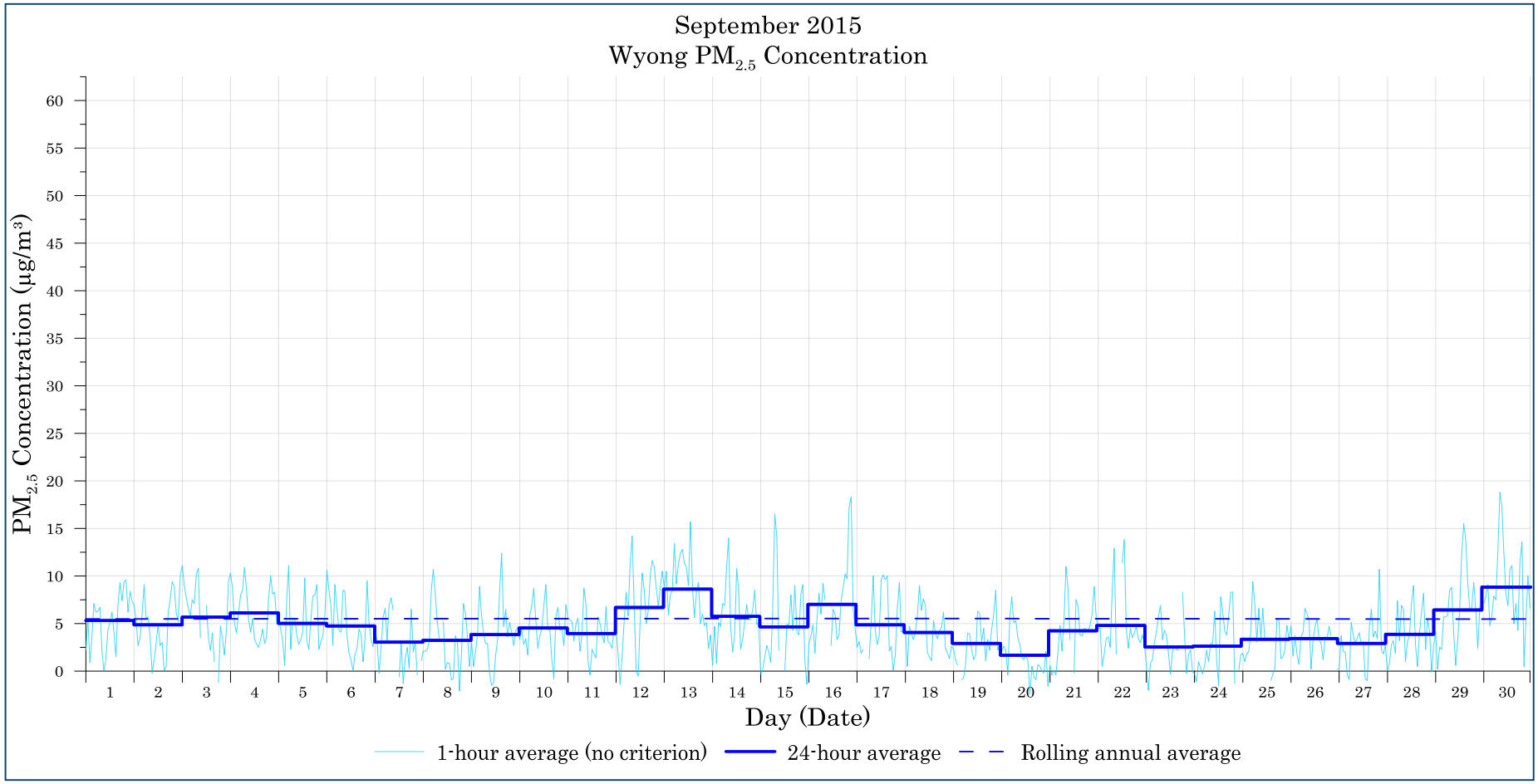


Figure B-4: Wyong $PM_{2.5}$ (1-hour, 24-hour and rolling annual average) concentration – September

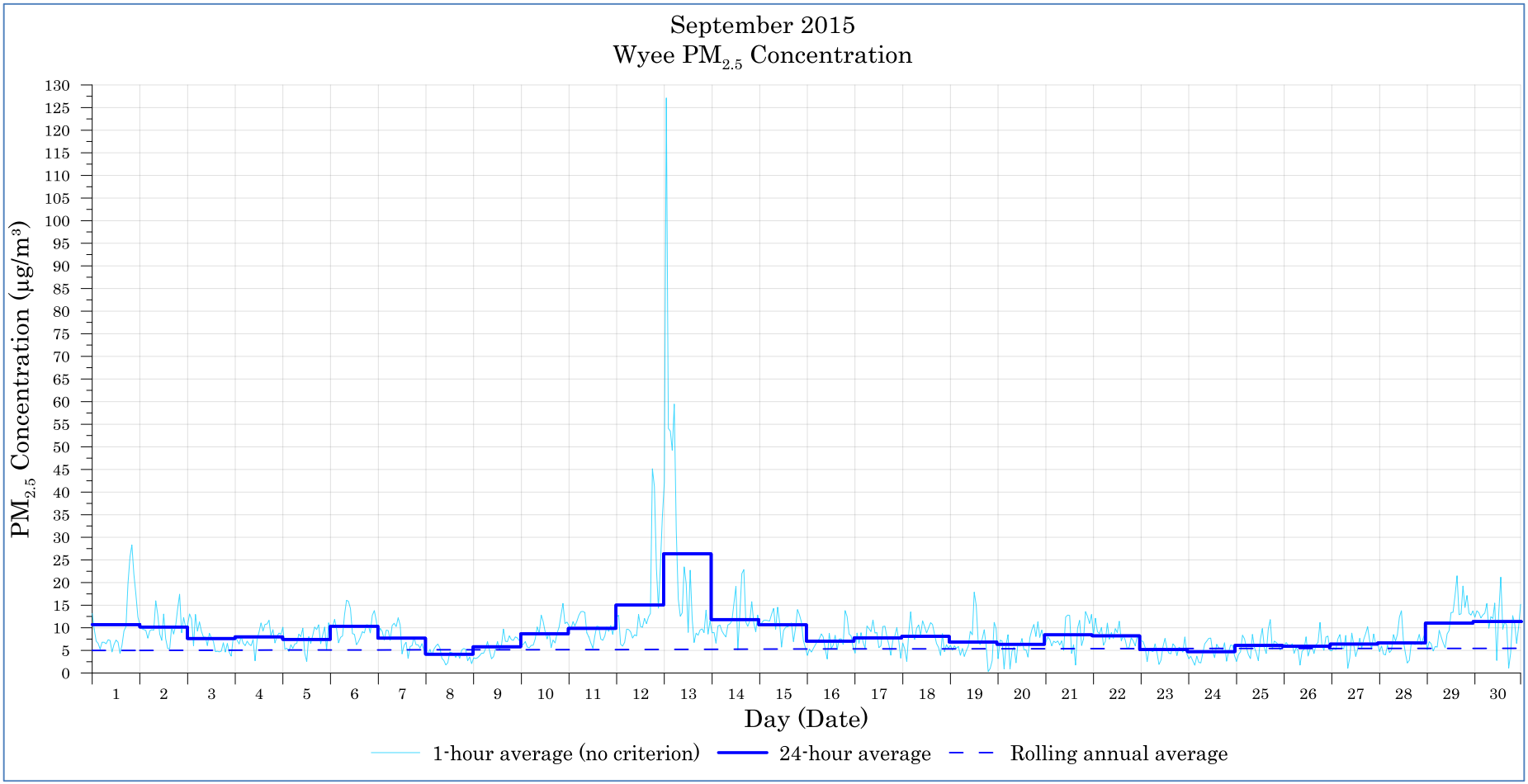


Figure B-5: Wyee $PM_{2.5}$ (1-hour, 24-hour and rolling annual average) concentration - September

Appendix C

Monitoring Data (Tabulated)

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

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
1/09/2015	15.1	11.3	6.8	5.3	10.7	-0.4	0.0	-	3.8	2.3
2/09/2015	14.6	15.4	5.9	4.9	10.2	3.6	4.1	6.6	-	6.5
3/09/2015	8.2	8.5	5.7	5.7	7.6	-0.2	0.2	-	2.6	3.3
4/09/2015	14.9	14.5	5.5	6.1	8.0	9.1	0.0	1.3	-	3.1
5/09/2015	12.1	10.4	7.2	5.0	7.4	2.4	0.0	4.0	-	3.0
6/09/2015	9.6	10.1	5.6	4.7	10.3	1.7	0.0	2.1	0.4	7.8
7/09/2015	12.3	7.8	5.8	3.0	7.7	6.8	0.6	2.9	1.9	5.2
8/09/2015	9.4	10.7	4.4	3.2	4.2	-0.8	0.3	3.2	5.4	4.1
9/09/2015	13.1	10.4	4.5	3.8	5.8	2.4	0.0	5.4	3.4	3.2
10/09/2015	13.4	12.7	7.0	4.5	8.7	4.1	0.0	2.5	0.7	1.7
11/09/2015	13.8	14.7	6.5	4.0	9.9	0.9	5.7	3.3	1.0	8.2
12/09/2015	18.2	14.5	9.5	6.7	15.0	6.7	2.2	3.2	2.6	6.5
13/09/2015	17.6	14.7	11.4	8.6	26.3	3.0	1.7	2.4	0.8	8.1
14/09/2015	14.9	17.6	6.3	5.8	11.8	6.1	5.2	3.6	1.7	12.0
15/09/2015	23.4	14.9	7.1	4.7	10.7	2.0	0.4	7.5	5.0	4.8
16/09/2015	13.0	21.6	6.0	7.0	7.1	4.6	0.0	7.3	-	4.0
17/09/2015	18.1	13.3	9.7	4.9	7.8	-0.7	0.0	2.6	1.0	3.2
18/09/2015	13.4	13.2	6.1	4.1	8.1	-0.4	0.0	1.4	-	3.8
19/09/2015	7.5	8.1	2.1	2.9	6.8	-0.4	0.0	2.6	-	2.9
20/09/2015	8.5	6.3	2.8	1.7	6.4	0.1	0.0	2.4	-	3.8
21/09/2015	12.6	8.7	4.6	4.2	8.4	4.6	4.2	7.1	-	5.6
22/09/2015	13.6	12.2	6.9	4.8	8.2	2.2	0.1	1.1	1.1	2.2
23/09/2015	10.3	11.5	3.7	2.5	5.2	6.7	0.0	1.7	-	3.9
24/09/2015	8.2	9.4	3.0	2.6	4.7	9.1	0.0	0.6	-	4.0
25/09/2015	9.0	10.3	2.7	3.4	6.1	11.5	0.0	1.2	-	1.4
26/09/2015	8.5	8.6	2.9	3.4	5.9	2.7	0.0	-	-	2.8
27/09/2015	9.3	10.2	4.1	2.9	6.4	2.1	0.0	0.6	-	2.6
28/09/2015	12.0	13.0	4.9	3.9	6.6	0.2	0.0	1.3	1.0	3.7
29/09/2015	17.9	19.3	5.6	6.4	11.0	3.5	9.2	5.2	-	16.2
30/09/2015	26.5	26.6	9.8	8.8	11.4	4.5	0.4	3.4	1.3	4.7

- Not applicable

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

Date	PM_{10} (HVAS) (µg/m³)	
	Wakefield (Westside)	Teralba
2/09/2015	11.2	16.0
8/09/2015	10.9	8.0
14/09/2015	18.1	14.0
20/09/2015	13.9	5.0
26/09/2015	-	5.0

- Not applicable