PORT HEDLAND
INDUSTRIES COUNCIL

Annual Report - 2015/2016 Port Hedland Ambient Air Quality Monitoring Program

FINAL

Port Hedland Industries Council

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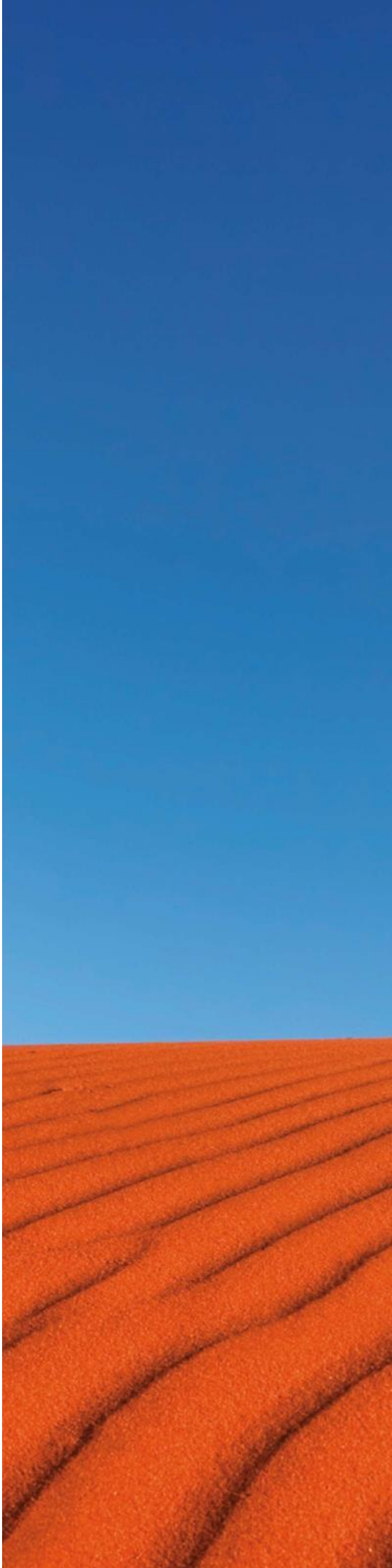
Prepared by Katestone Environmental Pty Ltd



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Prepared by:	Andrew Vernon and Michael Burchill
Reviewed by:	Simon Welchman and Christine Killip
Approved by:	 Christine Killip 31/10/2016

Port Hedland Industries Council

Port Hedland
PO Box 415
Port Hedland WA 6721

Website: http://www.phic-hedland.com.au
Email: management@phic-hedland.com.au

Katestone Environmental Pty Ltd
ABN 92 097 270 276

Brisbane
Ground Floor, 16 Marie Street
Milton, Queensland, 4064

Ph: +61 7 3369 3699

Website: http://www.katestone.com.au
Email: us@katestone.com.au

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EXECUTIVE SUMMARY

The Port Hedland Industries Council (PHIC) was established in 2009 to form an integrated approach to air quality (and noise) management in Port Hedland, Western Australia. This has included the establishment of an ambient air quality monitoring network and provision of real time monitoring information available to the community.

The Port Hedland ambient air quality monitoring network consists of eight (8) stations distributed across the region that measure a combination of particles ($PM_{2.5}$ and/or PM_{10}), combustion gases: oxides of nitrogen (NO_x) and sulfur dioxide (SO_2), and meteorological conditions (wind speed and wind direction). A summary of the monitoring conducted at each station for the 2015 /16 financial year is provided in the table below.

Monitoring Station	Latitude	Longitude	Type	Parameters				
				PM_{10}	$PM_{2.5}$	NO_x	SO_x	Meteorology
BoM	20.371508°	118.631353°	Background	✓	✓	✓[1]	✓[1]	✓
Kingsmill	20.309717°	118.585187°	Residential	✓				✓
Neptune	20.303910°	118.622836°	Residential	✓				✓
Richardson	20.310221°	118.578037°	Residential	✓	✓			✓
South Hedland	20.407376°	118.607549°	Residential	✓	✓	✓[1]	✓[1]	✓
Taplin	20.309746°	118.599700°	Residential	✓	✓	✓	✓[1]	✓
Wedgefield	20.370454°	118.584820°	Industrial	✓				✓
Yule	20.595167°	118.296311°	Background	✓	✓			✓

Table Note:

[1] Monitoring of parameter discontinued during the 2015/16 financial year

This annual report presents a performance summary of the Port Hedland ambient air quality monitoring network for the 2015/16 financial year. Performance of the monitoring network has been assessed through the following:

- Data capture for each parameter at each station compared with the PHIC criterion of at least 75% capture per calendar quarter, as per the AAQ NEPM
- Pollutant concentrations at each monitoring station compared with relevant air quality standards and guidelines, namely:
  - *National Environmental Protection (Ambient Air Quality) Measure* (AAQ NEPM)
  - Port Hedland Dust Management Taskforce Dust Management Plan – interim PM_{10} guideline of 70 µg/m³ (24-hour average) with 10 exceedences per year at Taplin Street

Data Capture

The performance of the monitoring network in terms of data capture rates was met with greater than 75% data recovery per quarter being achieved for all stations measuring NO_X, PM_{10} and $PM_{2.5}$ for the entire 2015/16 financial year. At the majority of sites data capture per quarter was greater than the 95% desirable target.

Monitoring of NO_x at BoM and South Hedland met the data capture criterion of 75% per quarter for the first two quarters before NO_x monitoring at the two sites was decommissioned in January 2016 following the recommendation in the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015).

Monitoring of SO_2 by the Port Hedland ambient air quality monitoring network met the data capture criterion of 75% per quarter for the first two quarters before SO_2 monitoring at all sites was decommissioned in January 2016 following the recommendation in the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015).

PM_{10}

PM_{10} was measured at eight (8) stations in the Port Hedland monitoring network. Analysis of the PM_{10} data found the following:

- For the 2015 /16 financial year the monitoring station at Taplin recorded 10 days above the 24-hour average interim guideline for PM_{10} of 70 µg/m³.The interim guideline allows for 10 exceedance days per year. Consequently, the interim guideline was just met at Taplin.
- Notwithstanding this, detailed analysis of PM_{10} and meteorological conditions for the 10 days at Taplin that were above 70 µg/m³ indicated that:
  - On 3 days industry was the cause of the event
  - On 2 days industry and elevated regional levels was the cause of the event
  - On 1 day it was a local source, other than industry, that was the cause of the event
  - On 4 days elevated regional dust was the cause of the event
- The 24-hour average AAQ NEPM standard for PM_{10} of 50 µg/m³ (with 5 exceedances) was not met at seven of the Port Hedland monitoring stations. The standard was just met at Yule with 5 exceedances recorded.
- The annual average AAQ NEPM standard for PM_{10} of 25 µg/m³ was not met at seven of the Port Hedland monitoring stations. The standard was met at Yule. It should be noted that the AAQ NEPM annual average PM_{10} standard was only introduced in the February 2016 AAQ NEPM revision.

PM_{10} trend analysis suggests that, compared to the last financial year (2014/15), Taplin recorded the same number of 24-hour average concentrations of PM_{10} above the interim guideline (as shown in the table below). However, the number of days elevated PM_{10} concentrations can be attributed to Port Hedland industry operations decreased from 7 days in 2014/15 to 5 days in 2015/16 (this report).

Monitoring Station	Interim Guideline (µg/m³)	Days above Interim Guideline			
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16
Taplin	70	17	6	10	10

For the 2015/16 financial year, all Port Hedland monitoring stations recorded fewer days when the 24-hour average concentration of PM_{10} was above the AAQ NEPM standard, as shown in the table below.

Monitoring Station	AAQ NEPM Standard (µg/m³)	Days above AAQ NEPM Standard			
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16
BoM	50	24	10	17	12
Kingsmill		89	98	156	112
Neptune		25	25	67	43
Richardson		74	50	79	39
South Hedland		23	13	19	12
Taplin		48	48	55	48
Wedgefield		157	148	169	150
Yule		24	8	18	5

$PM_{2.5}$

$PM_{2.5}$ was measured at five (5) stations in the Port Hedland monitoring network. It should be noted that $PM_{2.5}$ standards were only officially introduced into the AAQ NEPM in the February 2016 revision (prior to this the AAQ NEPM only provided advisory reporting standards for $PM_{2.5}$). Notwithstanding this, analysis of the $PM_{2.5}$ data found the following (as detailed in the table below):

- The 24-hour average AAQ NEPM standard for $PM_{2.5}$ of 25 µg/m³ was met all stations with the exception of Taplin
- The 24-hour average AAQ NEPM standard for $PM_{2.5}$ was not met at Taplin on one occasion. A value of 25.6 µg/m^3 was measured on 20 December 2015
- The annual average AAQ NEPM standard for $PM_{2.5}$ of 8 µg/m³ was met all stations with the exception of Taplin
- The annual average $PM_{2.5}$ concentration at Taplin was 11.8 µg/m³

Monitoring Station	24-hour AAQ NEPM Standard (µg/m³)	Days above Standard FY 2015/16	Annual AAQ NEPM Standard (µg/m³)	Days above Standard FY 2015/16
BoM	25	0	8	0
Richardson		0		0
South Hedland		0		0
Taplin		1		1
Yule		0		0

NO_2

NO_x was measured at three (3) monitoring stations in the Port Hedland monitoring network. Monitoring included nitrogen dioxide (NO_2), nitric oxide (NO) and total NO_X (reported as NO_2). Monitoring of NO_X ceased at two stations (BoM and South Hedland) during the financial year following the recommendation in the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015) to downsize NO_x monitoring to a single station at Taplin.

Performance with the AAQ NEPM standards was assessed at the remaining station: Taplin. The performance assessment found the following:

- The Taplin monitoring station met the 1-hour average AAQ NEPM standard for NO_2.
- The Taplin monitoring station met the annual average AAQ NEPM standard for NO_2.

NO_2 concentrations at BoM and South Hedland were low for the period of measurement. The AAQ NEPM standards would have been met at these stations had monitoring continued.

SO_2

SO_2 was measured at three (3) stations in the Port Hedland monitoring network for the first half of the financial year. Monitoring for SO_2 ceased in the second half of the financial year following the recommendation in the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015) to discontinue the SO_2 monitoring program.

SO_2 concentrations at all stations were low for the period of measurement. The AAQ NEPM standards would have been met at these stations had monitoring continued.

1. INTRODUCTION

Air quality, and specifically dust, in Port Hedland has been recognised as a significant issue by the Western Australia Government. In 2009, at the direction of the Premier, the Port Hedland Dust Management Taskforce (the Taskforce) was established to plan for and provide effective air quality (and noise) management strategies in Port Hedland, including the establishment of the Port Hedland Air Quality and Noise Management Plan (Port Hedland Dust Management Taskforce, DSD 2010).

The Port Hedland Industries Council (PHIC) was established in 2009, in parallel with the Taskforce, to manage industry cooperation and coordination of air quality monitoring and noise management in Port Hedland. Amongst other things, PHIC operates the Port Hedland ambient air quality monitoring network, which provides real time data access to the public and prepares annual performance reports for submission to the Taskforce.

The Port Hedland ambient air quality monitoring network consists of eight (8) stations distributed across the region (Figure 2-1) that measure a combination of particulate matter (as $PM_{2.5}$[a] and/or PM_{10}[b]), combustion gases: oxides of nitrogen (NO_x) and sulfur dioxide (SO_2), and meteorological conditions (wind speed, wind direction and temperature).

PHIC has commissioned Katestone Environmental Pty Ltd (Katestone) to prepare this annual report on the performance of the Port Hedland ambient air quality monitoring network for the 2015/16 financial year. This is the fourth annual report of its kind and includes the following information to assist the Taskforce during its review:

- Overview of ambient air quality monitoring network and assessment methods (Section 2)
- Summary of Port Hedland meteorology (Section 3)
- Ambient air quality monitoring data summary by pollutant (Section 4)
- Ambient air quality monitoring data summary by monitoring station (Section 5)
- Summary of PM_{10} trends (Section 6).
- Investigation of PM_{10} events (Section 7)
- Annual report conclusions (Section 8).

[a] $PM_{2.5}$ is particulate matter with aerodynamic diameters that are less than 2.5 micrometres

[b] PM_{10} is particulate matter with aerodynamic diameters that are less than 10 micrometres

2. PORT HEDLAND AMBIENT AIR QUALITY MONITORING NETWORK OVERVIEW AND ASSESSMENT METHODS

2.1 Background

The Port Hedland Air Quality and Noise Management Plan (DSD, 2010) identified the need to establish an 'independent, comprehensive air quality monitoring regime' in Port Hedland. The Taskforce intended that the monitoring regime would provide a basis to measure the performance of industry against relevant targets, and the data would inform and guide future industry and community planning.

Through industry co-operation, under the guidance of PHIC, Port Hedland has established an ambient air quality monitoring network. The network was designed with the objectives of the Taskforce's plan in mind and includes eight (8) ambient air quality monitoring sites across the region with real time data made available via a public website.

The Port Hedland ambient air quality monitoring network was independently audited during the 2013-2014 year (PEL, 2013). The key finding of the audit was that monitoring station siting, and the positioning of the monitoring instrumentation, was in accordance with the associated method and standard, as far as practical. The monitoring program was also found to be producing data sets that were useful for their intended purposes.

2.2 Monitoring network stations

The Port Hedland ambient air quality monitoring network is comprised of eight (8) stations at strategic locations in the Port Hedland region. The Kingsmill Street (Kingsmill), Neptune Place (Neptune), Richardson Street (Richardson) and Taplin Street (Taplin) monitoring stations are sited within residential areas of Port Hedland.

The South Hedland monitoring station serves as a generally representative site for the South Hedland township. The Wedgefield monitoring station is within a light industrial area that includes some residences and is located between the South Hedland and Port Hedland townships.

The Bureau of Meteorology (BoM) station in Port Hedland is relatively distant from the bulk of port related industrial activities and residential populations, and serves as a general Port Hedland background monitoring location. The Yule River (Yule) monitoring station is well removed from any industry and populations being some 45 km from Port Hedland and serves as a rural background location.

A summary of each monitoring station is provided in Table 2-1 and a map of the Port Hedland ambient air quality monitoring network is shown in Figure 2-1.

Table 2-1: Summary of Port Hedland ambient air quality monitoring network

Monitoring Station	Latitude	Longitude	Type	Parameters				
				PM_{10}	$PM_{2.5}$	NO_x	SO_x	Meteorology
BoM	-20.371508°	118.631353°	Port Hedland Background	✓	✓	✓[1]	✓[1]	✓
Kingsmill	-20.309717°	118.585187°	Residential	✓				✓
Neptune	-20.303910°	118.622836°	Residential	✓				✓
Richardson	-20.310221°	118.578037°	Residential	✓	✓			✓
South Hedland	-20.407376°	118.607549°	Residential	✓	✓	✓[1]	✓[1]	✓
Taplin	-20.309746°	118.599700°	Residential	✓	✓	✓	✓[1]	✓
Wedgefield	-20.370454°	118.584820°	Industrial	✓				✓
Yule	-20.595167°	118.296311°	Rural Background	✓	✓			✓

Table Note:

[1] Monitoring of parameter discontinued during the 2015/16 financial year

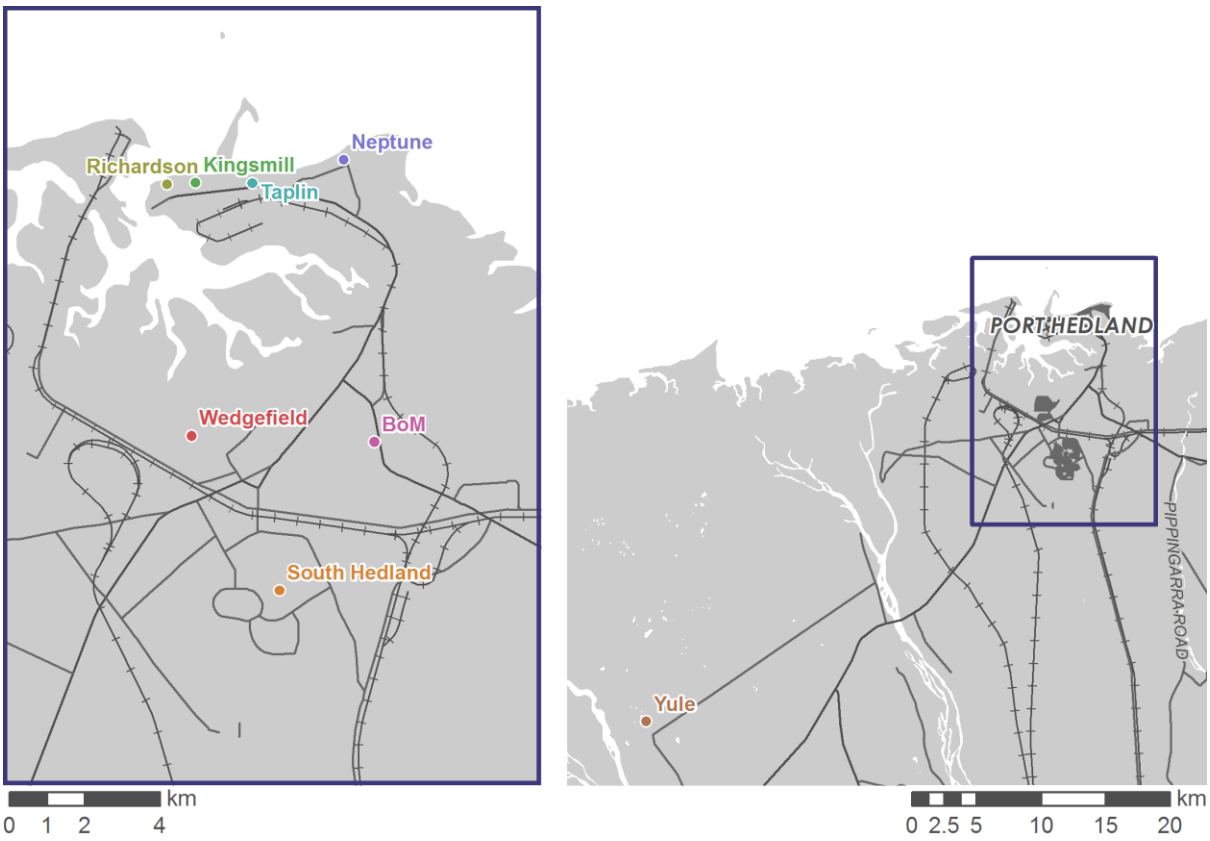

Figure 2-1: Port Hedland Ambient Air Quality Monitoring Network

2.3 Monitoring methods

The Port Hedland ambient air quality monitoring network is operated and maintained by Ecotech, an independent third party contractor. A description of the monitoring methods used at each site to measure particles ($PM_{2.5}$ and PM_{10}) and combustion gases ((NO_x and SO_2) is provided in Table 2-2.

It should be noted that the Port Hedland 1020 BAM monitors are operated in accordance with two monitoring methods. The accredited beta attenuation method (BAM) as 1-hour averages, as detailed in Table 2-2, and a real time module (light scattering method). The real time module allows for the provision of PM_{10} and $PM_{2.5}$ concentrations at sub hourly intervals (for display on the public website).

Table 2-2: Port Hedland ambient air quality monitoring network monitoring methods

Parameter	Equipment	Monitoring Method (Australian and New Zealand Standard AS/NZS)	Monitoring Station							
			BoM	Kingsmill	Neptune	Richardson	South Hedland	Taplin	Wedgefield	Yule
PM_{10}	Thermo BAM	AS/NZS 3580.9.11:2008	✓				✓[1]			
	1020 BAM	AS/NZS 3580.9.11:2008		✓	✓	✓	✓[1]	✓	✓	✓
$PM_{2.5}$	Thermo BAM	AS/NZS 3580.9.12:2013	✓							
	1020 BAM	AS/NZS 3580.9.12:2013				✓	✓[2]	✓		✓
NO_x	Ecotech ML9841	AS/NZS 3580.5.1:2011	✓[2]				✓[2]	✓		
SO_2	Ecotech EC9850	AS/NZS 3580.4.1:2008	✓[2]				✓[2]	✓[2]		

Table Note:

[1] PM_{10} at South Hedland was measured using a Thermo BAM until May 2016 and then using a 1020 BAM from June 2016.

[2] Monitoring of parameter discontinued during the 2015/16 financial year

2.4 2015/16 Port Hedland ambient air quality monitoring network activities

The Port Hedland ambient air quality monitoring network activities for the 2015/16 financial year are detailed in Table 2-3. At South Hedland the Thermo BAM monitor measuring PM_{10} was decommissioned in May 2016 after consistent instrument failures. PHIC prioritised the continued measurement of PM_{10} at South Hedland over $PM_{2.5}$. Therefore in June 2016 the 1020 BAM that was measuring $PM_{2.5}$ was switched to measure PM_{10}. $PM_{2.5}$ measurement at South Hedland has not recommenced.

Measurements of combustion gases NO_x and SO_2 were conducted at 3 stations for the first half of the 2015/16 financial year. In January 2016 the NO_x and SO_2 monitors at South Hedland and BoM stations and the SO_2 monitor at the Taplin station were decommissioned. NO_x monitoring at Taplin continued for the whole 2015/16 financial year.

The decision to decommission the NO_x and SO_2 monitors was based on the recommendations of the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015). The analysis report stated that monitored levels of NO_2 and SO_2 from the past three calendar years (2012, 2013 and 2014) were very low and there were no excursions of any of the relevant criterion at the monitoring locations. The report recommended the following:

- The monitoring program for SO_2 be discontinued
- The NO_2 monitoring network be downsized to a single monitoring station at Taplin.

Table 2-3: 2015/16 Port Hedland ambient air quality monitoring network activities

Monitoring Station	Parameter	Averaging time [A]	Monitoring Activity											
			Jul 15	Aug 15	Sep 15	Oct 15	Nov 15	Dec 15	Jan 16	Feb 16	Mar 16	Apr 16	May 16	Jun 16
BoM	PM_{10}	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NO_x [B]	5-minute	✓	✓	✓	✓	✓	✓	✓					
	SO_2 [C]		✓	✓	✓	✓	✓	✓	✓					
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kingsmill	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neptune	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Richardson	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
South Hedland	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓[D]	✓[D]
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓[D]
	NO_x [B]	5-minute	✓	✓	✓	✓	✓	✓	✓					
	SO_2 [C]		✓	✓	✓	✓	✓	✓	✓					
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Taplin	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NO_x	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SO_2 [C]		✓	✓	✓	✓	✓	✓	✓					
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wedgefield	PM_{10}	5-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yule	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table Note:

[A] The Port Hedland 1020 BAM monitors are equipped with a real time module for PM_{10} and $PM_{2.5}$. Therefore, averaging periods for these monitors are 1-hour (AS/NZS method) and 10-minute or 5-minute intervals (real time module)

[B] NO_x was measured at Taplin, BoM and South Hedland until January 2016 when BoM and South Hedland were decommissioned

[C] SO_2 was measured at Taplin, BoM and South Hedland until January 2016 when all sites were decommissioned

[D] PM_{10} at South Hedland was measured using a Thermo BAM until May 2016 when it was decommissioned. In June 2016 the $PM_{2.5}$ 1020 BAM was switched to measure PM_{10}.

2.5 2015/16 Monitoring Data Processing

The 2015/16 Port Hedland ambient air quality monitoring network data was processed and analysed in accordance with the following procedures and documents:

- PHIC data handling procedure (approved by Department of Environment Regulation (DER))
- National Environment Protection (Ambient Air Quality) Measure Technical Paper No.5. Data Collection and Handling, Peer Review Committee (PRC, 2001)
- National Environment Protection (Ambient Air Quality) Measure. Technical Paper No.8. Annual Reports, PRC 2002 Peer Review Committee (PRC, 2002).

The process for data quality assurance and analysis was as follows:

- 2015/16 quality assured Port Hedland monitoring data was supplied by Ecotech for each site, as either 5-minute or 10-minute averaging, depending on the site/parameter (see Table 2-3)
- Further quality assurance was performed by Katestone that included:
    - ensuring that data fell within acceptable ranges (e.g. wind directions between 0° and 360°)
    - checking for outliers and inconsistencies
    - checking for abnormal patterns
- The Katestone quality assurance found that all the 2015/16 data was acceptable for final processing.

Final processing included the following steps:

- The 5-minute and 10-minute average datasets (from the Thermo BAMs at BoM and South Hedland and the NO_x and SO_2 analysers) were converted into 1-hour averages under the PRC protocol requirement of a minimum 75% data capture to produce a valid 1-hour average, namely:
    - Five 10-minute readings per hour are required for a valid 1-hour average
    - Nine 5-minute readings per hour are required for a valid 1-hour average
- For the stations using the 1020 BAM monitors, accredited PM_{10} and $PM_{2.5}$ data was provided as 1-hour averages
- All 1-hour average data was combined into a single file for the 2015/16 financial year
- Data capture rates from all stations and parameters was calculated from the 1-hour average dataset and compared with the data capture performance criterion (see Section 3.2.1)
- A 24-hour average dataset (midnight to midnight) was created from the 1-hour average dataset under the PRC protocol requirement of a minimum 75% data capture, that is eighteen (18) 1-hour readings per day are required for a valid 24-hour average
- Statistical analysis on the valid 1-hour and 24-hour average datasets was conducted and produced:
    - Maximum values
    - Mean value
    - Percentiles
    - Number of exceedance of relevant air pollutant standards and guidelines
    - Timeseries graphs
    - Wind roses
    - Pollution polar plots.

Events when the PM_{10} concentration was found to be above the interim PM_{10} guideline (see Section 3.2.2) at the Taplin monitoring station were further investigated through the examination of wind roses, PM_{10} polar plots and time series. In order to maximise the resolution of the available data, this analysis was made using the 'Real Time' measurements of PM_{10} (10-minute resolution), where available, instead of the Beta measurements (1-hour resolution). The greater temporal resolution allows for a more detailed understanding of the relationship between concentrations and meteorology throughout the day. The real time measurements and Beta measurements showed a high correlation. Further detail on the event day anaylsis is provided in Section 7.1.

Data visualisation made use of statistical software R (R Core Team, 2016) and the R-packages: Openair (Carslaw and Ropkins, 2012 and Carslaw, 2015), GGPlot2 (Wickham, 2009) and Cowplot (Wilke, 2016).

2.6 Network Performance

2.6.1 Data Capture Rate

The network performance for data capture rate for each pollutant is based on the PRC protocol requiring at least 75% data capture in each calendar quarter in addition to an annual data availability of at least 75%. This performance criteria is based on 1-hour average data.

2.6.2 Air Pollutants

The Port Hedland ambient air quality network measures the following air pollutants:

- Particles with an aerodynamic diameter less than 10 microns (PM_{10})
- Particles with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$)
- Oxides of nitrogen (NO_x)
- Sulfur dioxide (SO_2).

Air quality standards and guidelines for the above pollutants that have been used to determine performance of the 2015/16 monitoring network have been selected from federal and local legislation. At the federal level, the National Environment Protection Council (NEPC) set air quality standards for criteria pollutants, which includes PM_{10}, $PM_{2.5}$, NO_2 and SO_2, under the *National Environment Protection (Ambient Air Quality) Measure 1998* (AAQ NEPM).

In 2003, the AAQ NEPM was amended to include advisory reporting standards for $PM_{2.5}$. The AAQ NEPM amendment of 2016 introduced standards for 24-hour and annual average concentrations of $PM_{2.5}$. The AAQ NEPM amendment of 2016 also introduced an annual average standard for PM_{10}.

In 2010 the Taskforce specified a 24-hour average interim guideline for PM_{10} in its Port Hedland Air Quality and Noise Management Plan (DSD, 2010). The interim guideline for PM_{10} is defined as follows:

- Maximum concentration of 70 µg/m³ for a 24-hour average
- 10 exceedance events per calendar year due to industry (using a background station as a reference)
- Applies to residential areas east of Taplin Street
- Note: Interim guideline intended to be reviewed 5 years after implementation.

Air quality standards and guidelines for pollutants measured by the Port Hedland ambient air quality monitoring network that have been used to determine performance are detailed in Table 2-4.

Table 2-4: Ambient Air Quality Standards / Guideline

Pollutant	Averaging Period	Standard / Guideline (µg/m³)	Source
PM_{10}	24-hour	50 [A]	AAQ NEPM
	Annual	25	
	24-hour	70 [B, C]	Interim Guideline
$PM_{2.5}$	24-hour	25	AAQ NEPM
	Annual	8	
NO_2	1-hour	246	AAQ NEPM
	Annual	62	
SO_2	1-hour	570	AAQ NEPM
	24-hour	230	
	Annual	57	

Table note:
[A] 5 exceedance days allowed per year
[B] 10 exceedance days allowed per year
[C] Applies to residential areas at Taplin Street

Network performance against the air quality standards and guideline is recorded as either:

- Met
- Not met
- Not demonstrated, as a result of inadequate data recovery or data quality
- Not applicable (when comparison is made to the PM_{10} interim guideline for sites other than Taplin)
- For the interim PM_{10} guideline, the assessment was only made at Taplin. Determination of events is described in Section 7.1.

3. SUMMARY OF PORT HEDLAND METEOROLGOLICAL CONDITIONS

The focus of this annual report is the analysis of air pollutants measured by the Port Hedland ambient air quality monitoring network. However, meteorological conditions play an important role in the dispersion (and emission generation in the case of dust) of air pollutants.

Exposed dust sources (be it from industry sources, other anthropogenic sources or natural sources), will have higher dust emissions during strong winds. The dust emissions will also have a greater radius of impact during periods of higher wind speeds due to dust particles remaining suspended in the air and being carried further distances. The variability in the wind speed and wind direction in Port Hedland will result in variation of dust emissions and in the areas potentially affected by dust.

A graphical summary (in the form of wind roses) of the 10-minute average meteorological data collected at the BoM, Taplin and Yule Port Hedland monitoring stations during the 2015/16 financial year are provided in Figure 3-1, Figure 3-2 and Figure 3-3, respectively.

A wind rose is a tool used to illustrate the frequency and intensity of a given wind speed and its direction. Wind speeds (metres per second) are grouped based on the data range (for each site) and wind directions are grouped into sixteen, 22.5 degree sectors that represent all possible wind directions.

The wind roses at BoM, Taplin and Yule indicate the following:

- The predominant wind direction at all three sites is from the northwest quadrant. All three sites also show frequent winds from the southeast quadrant.
- Winds from the southwest quadrant are less common but occur more frequently than winds from the northeast quadrant,
- The distribution of winds shown in Figure 3-3 are typical of the Port Hedland region.
- Wind speeds measured at all three monitoring stations are relatively strong, indicating that the Port Hedland region experiences high winds.
- Wind speeds are highest at BoM. This is due to the exposed nature of the BoM monitoring station near Port Hedland airport and the fact that measurements are taken at 10 metres above ground, whereas Taplin and Yule measurements are taken at 2 metres.
- Yule has slight stronger winds than Taplin. This is due to the Yule monitoring site being located in an open area and more exposed to winds compared to Taplin that is within a residential area where buildings can reduce wind speeds.

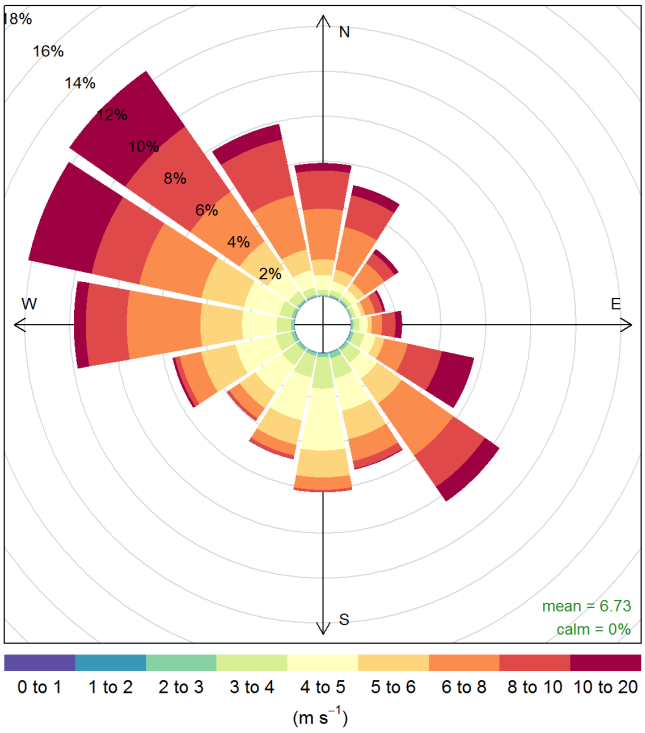

Figure 3-1: 2015/16 wind roses for BoM

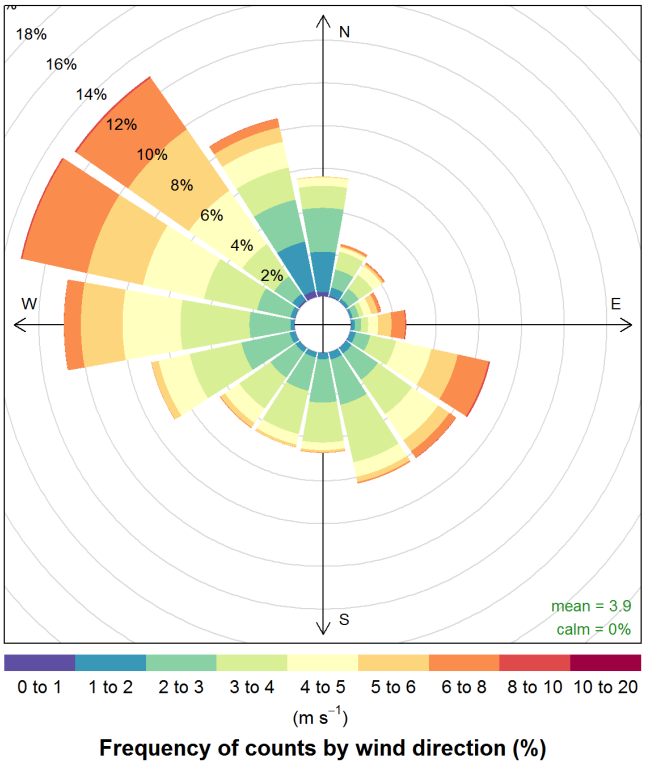

Figure 3-2: 2015/16 wind roses for Taplin

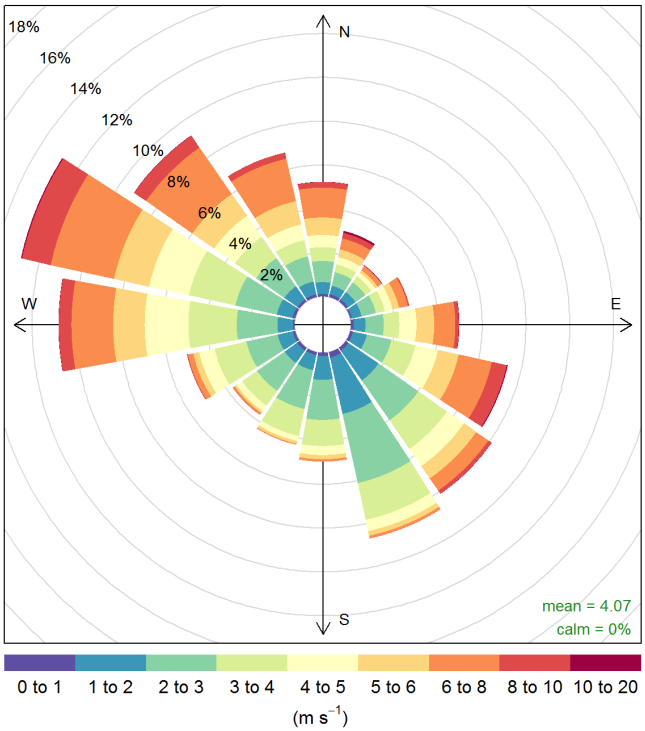

Figure 3-3: 2015/16 wind roses for Yule

4. AIR QUALITY MONITORING DATA - AIR POLLUTANT PERFORMANCE

The following sections describe the performance of each pollutant measured by the Port Hedland ambient air quality monitoring network through data capture and comparison of measurements against relevant air quality standards and guidelines.

4.1 PM_{10}

PM_{10} was measured at eight (8) monitoring stations during the 2015/16 financial year; namely:

- BoM
- Kingsmill
- Neptune
- Richardson
- South Hedland
- Taplin
- Wedgefield
- Yule.

4.1.1 Data capture

PM_{10} data capture rates (based on 1-hour average data) for the Port Hedland monitoring stations are detailed in Table 4-1 and shows that for the 2015/16 financial year, all stations achieved an annual PM_{10} capture rate greater than 92%. This meets the PHIC criterion of 75% data capture. South Hedland recorded the lowest data capture rate due to the gap in data collection during Q4 when the monitoring equipment was switched from a Thermo BAM to a 1020 BAM.

Table 4-1: 2015/16 PM_{10} Data Capture Summary

Monitoring Station ID	2015/16 PM_{10} Data Capture Rate					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	94.7	98.3	94.1	92.6	94.9	Met
Kingsmill	95.2	97.2	94.6	94.9	95.5	Met
Neptune	93.8	98.9	94.4	88.4	93.9	Met
Richardson	97.1	98.0	95.8	99.8	97.7	Met
South Hedland	98.4	95.3	94.1	83.6	92.9	Met
Taplin	96.7	96.7	93.4	99.1	96.5	Met
Wedgefield	98.6	99.3	96.6	98.8	98.3	Met
Yule	93.8	90.4	93.9	98.9	94.2	Met

4.1.2 Comparison to standards and guideline

The maximum measured 24-hour average PM_{10} concentration (calculated as midnight to midnight) and the number of days above the AAQ NEPM standard and interim guideline for each station are detailed in Table 4-2. The measurements show that for the 2015/16 financial year:

- All stations exceeded the 24-hour average PM_{10} AAQ NEPM standard of 50 µg/m³ (allowing for 5 exceedances) with the exception of Yule
- The 24-hour average concentration of PM_{10} was above 70 µg/m³ for 10 days at Taplin and is compliant with the interim guideline which allows for 10 exceedances

Table 4-2: 24-hour Average PM_{10} Data Summary

Monitoring Station ID	Maximum 24-hour average PM_{10} concentration (µg/m³)	Number of days >50 µg/m³ (AAQ NEPM standard)	Performance (AAQ NEPM)	Number of days >70 µg/m³ (Taskforce)	Performance (Taskforce)
BoM	82.0	12	Not met	2	Not applicable
Kingsmill	110.1	112	Not met	46	Not applicable
Neptune	112.8	43	Not met	14	Not applicable
Richardson	82.3	39	Not met	6	Not applicable
South Hedland	85.5	12	Not met	5	Not applicable
Taplin	108.7	48	Not met	10	Met
Wedgefield	189.6	150	Not met	50	Not applicable
Yule	73.3	5	Met	2	Not applicable

The annual average PM_{10} concentration for the 2015/16 financial year for each station are detailed in Table 4-3. The AAQ NEPM standard for annual average concentrations of PM_{10} of 25 µg/m³ was introduced part way through the year in the February 2016. Consequently, performance of the network has not been assessed against this standard. However, it should be noted that all stations with the exception of Yule exceeded the annual average PM_{10} standard.

Table 4-3: Annual Average PM_{10} Data Summary

Monitoring Station ID	Annual average PM_{10} concentration (µg/m³)	Performance (AAQ NEPM of 25 µg/m³)
BoM	25.4	Not applicable
Kingsmill	44.7	Not applicable
Neptune	32.3	Not applicable
Richardson	35.2	Not applicable
South Hedland	26.5	Not applicable
Taplin	35.6	Not applicable
Wedgefield	51.1	Not applicable
Yule	18.5	Not applicable

4.1.3 PM_{10} timeseries analysis

Timeseries plots of the measured 24-hour average PM_{10} concentration for the 2015/16 financial year for each monitoring station are shown in Figure 4-1. The 24-hour average concentrations of PM_{10} above 70 µg/m³ at Taplin are accentuated through shading.

Figure 4-1: Measured 24-hour average PM_{10} time series plots for the 2015/16 financial year

4.2 $PM_{2.5}$

$PM_{2.5}$ was measured at five (5) monitoring stations during the 2015/16 financial year; namely:

- BoM
- Richardson
- South Hedland
- Taplin
- Yule.

4.2.1 Data capture

$PM_{2.5}$ data capture rates for the monitoring stations are detailed in Table 4-4 and shows that for the 2015/16 financial year, all sites achieved annual $PM_{2.5}$ capture rate equal to or greater than 90% and, therefore, met the PHIC criterion of 75% for data capture.

Table 4-4: 2015/16 $PM_{2.5}$ Data Capture Summary

Monitoring Station ID	2015/16 $PM_{2.5}$ Data Capture Rate					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	93.8	97.1	93.9	96.2	95.2	Met
Richardson	96.9	97.2	95.5	99.6	97.3	Met
South Hedland	97.3	97.8	95.1	75.6*	91.5	Met
Taplin	97.0	97.4	95.9	99.3	97.4	Met
Yule	95.9	90.7	94.0	99.1	94.9	Met

Table note:
*South Hedland $PM_{2.5}$ monitoring ceased in June 2016

4.2.2 Comparison to $PM_{2.5}$ standards

The maximum measured 24-hour average (midnight to midnight) and annual average $PM_{2.5}$ concentrations are detailed for each station in Table 4-2. The number of days (24-hour average periods) above the AAQ NEPM standard for $PM_{2.5}$ is also shown.

It should be noted that $PM_{2.5}$ standards were only officially introduced into the AAQ NEPM in the February 2016 revision (prior to this the AAQ NEPM provided advisory reporting standards for $PM_{2.5}$). Notwithstanding this, the $PM_{2.5}$ measurements show the following:

- All stations complied with the 24-hour average $PM_{2.5}$ AAQ NEPM standard of 25 µg/m³ with the exception of Taplin
- At Taplin, the maximum 24-hour average $PM_{2.5}$ concentration was 25.6 µg/m³ which exceeds the AAQ NEPM standard. This occurred for one day on 20 December 2015.
- All stations complied with the annual average $PM_{2.5}$ AAQ NEPM standard of 8 µg/m³ with the exception of Taplin
- The Taplin annual average $PM_{2.5}$ concentration was 11.8 µg/m³

Table 4-5: $PM_{2.5}$ Data Summary

Monitoring Station ID	Maximum 24-hour average $PM_{2.5}$ concentration (µg/m³)	Number of days >25 µg/m³ (AAQ NEPM)	Performance (AAQ NEPM)[A]	Annual average $PM_{2.5}$ concentration (µg/m³)	Performance (AAQ NEPM)[B]
BoM	21.5	0	Met	7.3	Met
Richardson	21.7	0	Met	6.7	Met
South Hedland	19.6	0	Met	6.9	Met
Taplin	25.6	1	Not met	11.8	Not met
Yule	19.9	0	Met	6.0	Met

Table note:

[A] 24-hour average $PM_{2.5}$ AAQ NEPM standard requires maximum concentration less than 25 µg/m³

[B] Annual average $PM_{2.5}$ AAQ NEPM standard requires annual concentration less than 8 µg/m³

4.2.3 $PM_{2.5}$ timeseries analysis

Timeseries plots of the measured 24-hour average $PM_{2.5}$ concentration for the 2015/16 financial year for each station are shown in Figure 4-2. The 24-hour average $PM_{2.5}$ concentration above the AAQ NEPM standard at Taplin is accentuated through shading.

Figure 4-2: Measured 24-hour average $PM_{2.5}$ time series plots for the 2015/16 financial year

4.3 Oxides of Nitrogen

NO_x was measured at three (3) monitoring stations in the Port Hedland monitoring network namely:

- BoM
- South Hedland
- Taplin.

Monitoring included nitrogen dioxide (NO_2), nitric oxide (NO) and total NO_X (reported as NO_2). As discussed in Section 2, NO_x instrumentation at the BoM and South Hedland stations was decommissioned in January 2016 following the recommendation in the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015) to downsize NO_x monitoring to a single station at Taplin .

4.3.1 Data capture

NO_x data capture rates for the monitoring stations are detailed in Table 4-6, which shows that for the 2015/16 financial year, Taplin achieved annual NO_x data capture greater than 90% and, therefore, met the PHIC criterion of 75% data capture. Monitoring of NOx was discontinued at the BoM and South Hedland sites in January 2016 and therefore performance against the PHIC criterion was not demonstrated. However, the BoM and South Hedland NO_x data capture rates for the first two calendar quarters met the PHIC criterion of 75%.

Table 4-6: 2015/16 NO_x Data Capture Summary

Monitoring Station ID	2015/16 NO_x Data Capture Rate					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	95.1	93.3	11.2[A]	-	-	Met for period 1 July 2015 to 31 December 2015
South Hedland	95.7	95.2	19.3 [A]	-	-	Met for period 1 July 2015 to 31 December 2015
Taplin	95.6	92.1	88.8	95.1	92.9	Met

Table note:
[A] BoM and South Hedland NO_x instrumentation decommissioned in January 2016

4.3.2 Comparison to NO_2 standards

For the 2015/16 financial year, the maximum measured 1-hour average and annual average NO_2 concentrations for each station are detailed in Table 4-7.

NO_2 concentrations at all stations were low for the period of measurement. The performance assessment found the following:

- The Taplin monitoring station met the 1-hour average AAQ NEPM standard for NO_2.
- The Taplin monitoring station met the annual average AAQ NEPM standard for NO_2.

Monitoring of NO_X was discontinued at two stations (BoM and South Hedland) during the financial year. Performance with the AAQ NEPM standards was not assessed at these stations. However, the AAQ NEPM 1 hour average standard was met for the period of monitoring.

Table 4-7: PHIC 2015/16 Air Quality Monitoring - NO_2 Data Summary

Monitoring Station ID	Maximum 1-hour average NO_2 concentration (µg/m³)	Performance (AAQ NEPM)[A]	Annual average NO_2 concentration (µg/m³)	Performance (AAQ NEPM)[B]
BoM [C]	65.7	Met	9.3	Not demonstrated
South Hedland [C]	73.0	Met	9.0	Not demonstrated
Taplin	80.7	Met	13.0	Met

Table note:

[A] 1-hour average NO_2 AAQ NEPM standard requires maximum concentration less than 246 µg/m³

[B] Annual average NO_2 AAQ NEPM standard requires annual concentration less than 62 µg/m³

[C] BoM and South Hedland NO_x instrumentation decommissioned in January 2016

4.3.3 NO_2 time series analysis

Timeseries plots of the measured 1-hour average NO_2 concentration for the 2015/16 financial year for each station are shown in Figure 4-3. Note that the AAQ NEPM standard of 246 µg/m³ is not shown on Figure 4-3 due to the low levels measured at each station.

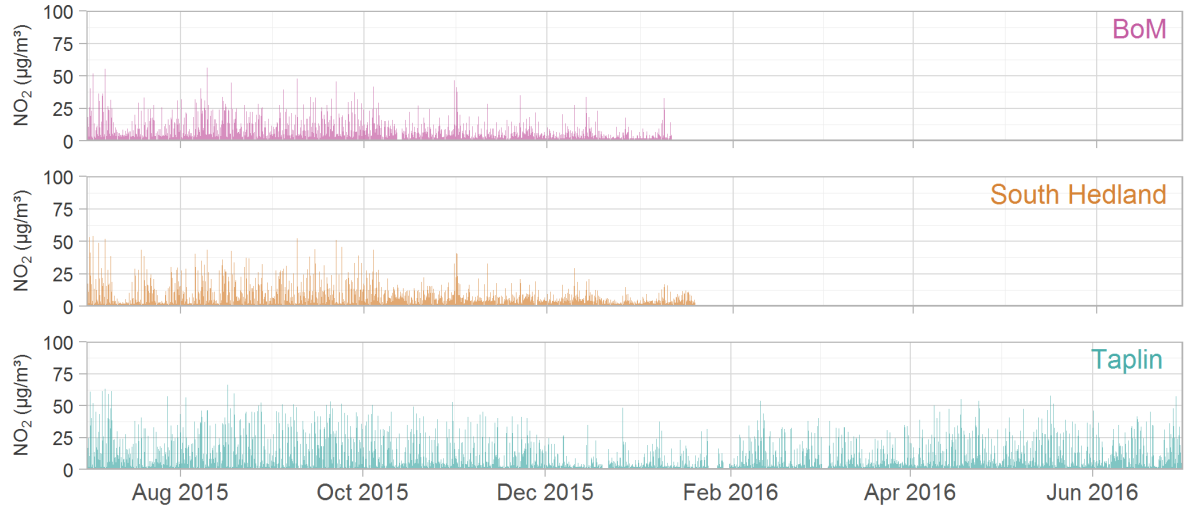

Figure 4-3: Measured 1-hour average NO_2 time series plots for the 2015/16 financial year

4.4 Sulfur Dioxide

SO_2 was measured at three (3) monitoring stations during the 2015/16 financial year; namely:

- BoM
- South Hedland
- Taplin.

As discussed in Section 2, all SO_x instrumentation in Port Hedland was decommissioned in January 2016 following the recommendation in the Port Hedland NO_x and SO_x monitoring data analysis report (PEL, 2015) to discontinue the SO_x monitoring program.

4.4.1 Data capture

SO_2 data capture rates for the monitoring stations are detailed in Table 4-6. The 3 stations did not monitor for the entire year and are therefore the annual PHIC criterion of 75% data capture is not applicable. However, the PHIC criterion of 75% data capture per quarter was achieved for the period of monitoring.

Table 4-8: 2015/16 SO_2 Data Capture Summary

Monitoring Station ID	2015/16 SO_2 Data Capture Rate					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM*	80.7	86.1	9.5	-	-	Met for period 1 July 2015 to 31 December 2015
South Hedland*	90.3	93.9	17.2	-	-	Met for period 1 July 2015 to 31 December 2015
Taplin*	88.5	89.0	18.6	-	-	Met for period 1 July 2015 to 31 December 2015

Table note:
* SO_2 monitoring equipment decommissioned in January 2016 at all sites

4.4.2 Comparison to SO_2 standards

The maximum measured 1-hour average, maximum 24-hour average and annual average SO_2 concentrations for each station for the period of measurement are detailed in Table 4-7.

SO_2 concentrations at all stations were low for the period of measurement. The AAQ NEPM standards would have been met at these stations had monitoring continued.

Table 4-9: SO_2 Data Summary

Monitoring Station ID	Maximum 1-hour average SO_2 concentration (µg/m³)	Performance (AAQ NEPM)[A]	Maximum 24-hour average SO_2 concentration (µg/m³)	Performance (AAQ NEPM)[B]	Annual average SO_2 concentration (µg/m³)	Performance (AAQ NEPM)[C]
BoM[(D)]	19.3	Met	4.3	Met	1.1	Not demonstrated
South Hedland[(D)]	17.2	Met	2.6	Met	0.4	Not demonstrated
Taplin[(D)]	92.9	Met	19.5	Met	4.5	Not demonstrated

Table note:
[A] 1-hour average SO_2 AAQ NEPM standard requires maximum concentration less than 570 µg/m³
[B] 24-hour average SO_2 AAQ NEPM standard requires maximum concentration less than 230 µg/m³
[C] Annual average SO_2 AAQ NEPM standard requires annual concentration less than 57 µg/m³
[D] SO_2 monitoring equipment decommissioned in January 2016 at all sites

4.4.3 SO_2 time series analysis

Timeseries plots of the measured 1-hour average SO_2 concentrations for the period of monitoring during the 2015/16 financial year for each station are shown in Figure 4-4. Note that the AAQ NEPM standard of 570 µg/m³ is not shown on Figure 4-4 due to the low levels measured at each station.

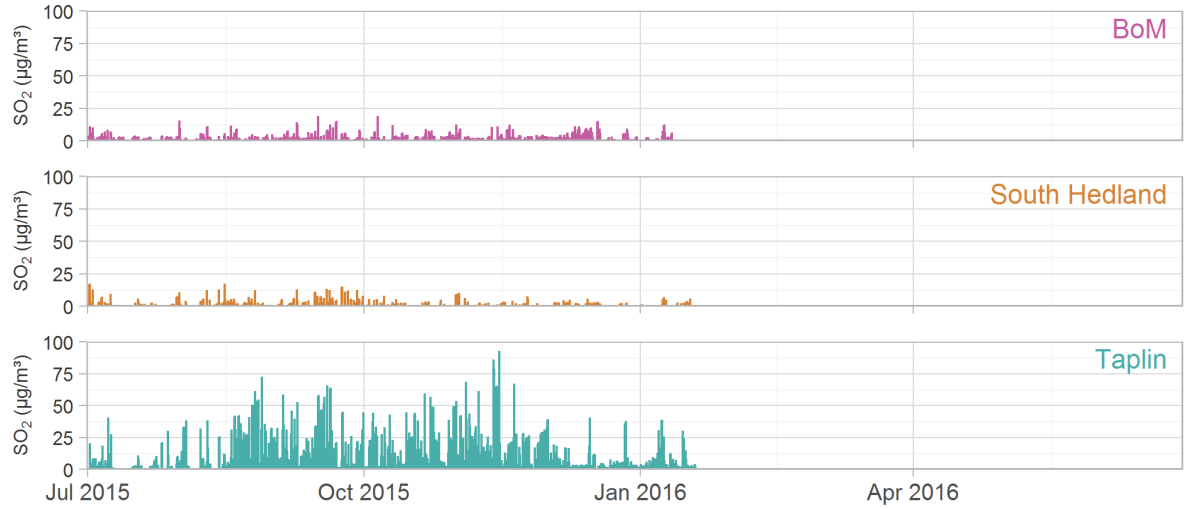

Figure 4-4: Measured 1-hour average SO_2 time series plots for the 2015/16 financial year

5. AIR QUALITY MONITORING DATA - MONITORING STATION PERFORMANCE

The following section details a summary of the 2015/16 PHIC ambient air quality monitoring network performance by station.

5.1 Taplin

The Taplin monitoring station is located in Port Hedland Figure 2-1 and represents a residential site in the town of Port Hedland. Parameters measured at the Taplin station are:

- PM_{10}
- $PM_{2.5}$
- NOx
- SO_2
- Wind speed and wind direction.

A summary of the performance of the Taplin monitoring station is detailed in Table 5-1.

Table 5-1: Taplin Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above the standard/ guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	48 days	Not met
		70	24-hour	10 days	Met
		25	Annual	Yes	Not met
$PM_{2.5}$	Met	25	24-hour	1 day	Not met
		8	Annual	Yes	Not met
NO_2	Met	246	1-hour	0 days	Met
		62	Annual	No	Met
SO_2 [A]	Met for period 1 July 2015 to 31 December 2015	570	1-hour	0 days	Met for period of monitoring
		245	24-hour	0 days	
		57	Annual	No	Not demonstrated

Table note:
[A] Monitoring equipment decommissioned in January 2016

5.2 BoM

The BoM monitoring station is located at Port Hedland airport (Figure 2-1) and represents a background monitoring site in the Port Hedland region. Parameters measured at the BoM station are:

- PM_{10}
- $PM_{2.5}$
- NOx
- SO_2
- Wind speed and wind direction.

A summary of the performance of the BoM monitoring station is detailed in Table 5-2.

Table 5-2: BoM Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standards / Guidelines		Events above the standard / guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	12 days	Not met
		70[A]	24-hour	2 days	Not applicable
		25	Annual	Yes	Not met
$PM_{2.5}$	Met	25	24-hour	0 days	Met
		8	Annual	No	Met
NO_2[B]	Met for period 1 July 2015 to 31 December 2015	246	1-hour	0 days	Met for period of monitoring
		62	Annual	No	Not demonstrated [B]
SO_2[B]	Met for period 1 July 2015 to 31 December 2015	570	1-hour	0 days	Met for period of monitoring
		245	24-hour	0 days	Met for period of monitoring
		57	Annual	No	Not demonstrated [B]

Table note:
[A] Interim guideline of 70 µg/m³ not applicable to BoM station
[B] Monitoring equipment decommissioned in January 2016

5.3 Kingsmill

The Kingsmill monitoring station is located in Port Hedland (Figure 1) and represents a residential monitoring site in the Port Hedland. Parameters measured at the Kingsmill station include:

- PM_{10}
- Wind speed and wind direction.

A summary of the performance of the Kingsmill monitoring station is detailed in Table 5-3.

Table 5-3: Kingsmill Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above standard / guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	112 days	Not met
		70[A]	24-hour	43 days	Not applicable
		25	Annual	Yes	Not met

Table note:
[A] Interim guideline of 70 µg/m³ not applicable to Kingsmill station

5.4 Neptune

The Neptune monitoring station is located at Port Hedland (Figure 1) and represent a residential monitoring site in the eastern part of Port Hedland. Parameters measured at the Neptune station include:

- PM_{10}
- Wind speed and wind direction.

A summary of the performance of the Neptune monitoring station is detailed in Table 5-4.

Table 5-4: Neptune Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above the standard / guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	43 days	Not met
		70[A]	24-hour	14 days	Not applicable
		25	Annual	Yes	Not met

Table note:
[A] Interim guideline of 70 µg/m³ not applicable to Kingsmill station

5.5 Richardson

The Richardson monitoring station is located at Port Hedland (Figure 1) and represents a residential monitoring site in Port Hedland. Parameters measured at the Richardson station are:

- PM_{10}
- $PM_{2.5}$
- Wind speed and wind direction.

A summary of the performance of the Richardson monitoring station is detailed in Table 5-5.

Table 5-5: Richardson Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above the standard/ guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	39 days	Not met
		70[A]	24-hour	6 days	Not applicable
		25	Annual	Yes	Not met
$PM_{2.5}$	Met	25	24-hour	0 days	Met
		8	Annual	No	Met

Table note: [A] Interim guideline of 70 µg/m³ not applicable to Richardson station

5.6 South Hedland

The South Hedland monitoring station is located in South Hedland (Figure 1) and represents a residential community away from the port. Parameters measured at the South Hedland station are:

- PM_{10}
- $PM_{2.5}$
- NOx
- SO_2
- Wind speed and wind direction

A summary of the performance of the South Hedland monitoring station is detailed in Table 5-6.

Table 5-6: South Hedland Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above the standard/ guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	12 days	Not met
		70 [A]	24-hour	5 days	Not applicable
		25	Annual	Yes	Not met
$PM_{2.5}$	Met	25	24-hour	0 days	Met
		8	Annual	No	Met
NO_2 [B]	Met for period 1 July 2015 to 31 December 2015	246	1-hour	0 days	Met for period of monitoring
		62	Annual	No	Not demonstrated
SO_2 [B]	Met for period 1 July 2015 to 31 December 2015	570	1-hour	0 days	Met for period of monitoring
		245	24-hour	0 days	Met for period of monitoring
		57	Annual	No	Not demonstrated

Table note:
[A] Interim guideline of 70 µg/m³ not applicable to South Hedland station
[B] Monitoring equipment decommissioned in January 2016

5.7 Wedgefield

The Wedgefield monitoring station is located in the Port Hedland region (Figure 1) and represents the industrial area to the south of Port Hedland. Parameters measured at the Wedgefield station are:

- PM_{10}
- Wind speed and wind direction.

A summary of the performance of the Wedgefield monitoring station is detailed in Table 5-7.

Table 5-7: Wedgefield Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above the standard/ guideline	Performance against standard / guideline
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	150 days	Not met
		70 [A]	24-hour	50 days	Not applicable
		25	Annual	Yes	Not met

Table note:
[A] Interim guideline of 70 µg/m³ not applicable to Wedgefield station

5.8 Yule

The Yule monitoring station is located 30 km away from Port Hedland (Figure 1) and represents a background monitoring site in the region, removed from industrial sources. Parameters measured at the Yule station are:

- PM_{10}
- $PM_{2.5}$
- Wind speed and wind direction.

A summary of the performance of the Yule monitoring station is detailed in Table 5-8.

Table 5-8: Yule Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard / Guideline		Events above the standard/ guideline	Performance against standard / guideline
PM_{10}	Met	50	24-hour	5 days	Met
		70 [A]	24-hour	2 days	Not applicable
		25	Annual	No	Met
$PM_{2.5}$	Met	25	24-hour	0 days	Met
		8	Annual	No	Met

Table note:
[A] Interim guideline of 70 µg/m³ not applicable to Yule station

6. PM_{10} TREND SUMMARY

This section presents a summary analysis of the trends in PM_{10} monitoring data across four years of Port Hedland ambient air quality monitoring network data. Trend analysis for $PM_{2.5}$ has not been conducted due to the lack of statistical data presented in the previous annual reports.

Trend analysis has also not been conducted for NO_x and SO_2 as the majority of NO_x and SO_2 monitoring equipment was decommissioned during the 2015/16 financial year. Further to this, three calendar years (2012, 2013 and 2014) of data analysis for NO_2 and SO_2 monitoring in Port Hedland has previously been conducted for PHIC (PEL, 2015) and showed that levels were very low and there were no excursions of any of the relevant criterion at the monitoring locations.

6.1 24-hour average PM_{10} Taskforce Interim Guideline

The number of days the 24-hour average PM_{10} concentration at Taplin was above the interim PM_{10} guideline concentration of 70 µg/m³ for the last four financial years is presented in Table 6-1.

The data shows the following:

- The number of 24-hour average PM_{10} concentrations at Taplin above 70 µg/m³ ranges from 6 - 17 days per financial year.
- The most recent year (FY 2015/16) recorded the same number of days above 70 µg/m³ as the previous year (10 days) and demonstrates compliance with the interim guideline that allows for 10 exceedance days per year.
- Only the 2012/13 financial year showed more than 10 days when the 24-hour average PM_{10} concentration was greater than 70 µg/m³.

Table 6-1: Summary of 24-hour average PM_{10} concentrations above the Taskforce interim guideline for the last 4 financial years

Monitoring Station	Interim Guideline (µg/m³)	Number of days above guideline			
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16
Taplin	70	17	6	10	10

6.2 24-hour average PM_{10} AAQ NEPM Standard

The number of days the 24-hour average PM_{10} concentration at each Port Hedland monitoring stations was above the AAQ NEPM standard of 50 µg/m³ for the last four financial years is presented in Table 6-2 and Figure 6-1.

The data shows the following:

- The number of 24-hour average PM_{10} exceedences against the AAQ NEPM standard of 50 µg/m³ at all sites were lower for the latest financial year (FY 20151/6) compared to the previous year (FY 2014/15)
- The number of 24-hour average PM_{10} exceedences against the AAQ NEPM standard 50 µg/m³ at all sites were similar to, or lower for the latest financial year (FY 20151/6) compared to the 2013/14 financial year.

Table 6-2: Summary of 24-hour average PM_{10} concentrations above the AAQ NEPM standard for the last 4 financial years

Monitoring Station	AAQ NEPM Standard (µg/m³)	Events above standard			
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16
BoM	50	24	10	17	12
Kingsmill		89	98	156	112
Neptune		25	25	67	43
Richardson		74	50	79	39
South Hedland		23	13	19	12
Taplin		48	48	55	48
Wedgefield		157	148	169	150
Yule		24	8	18	5

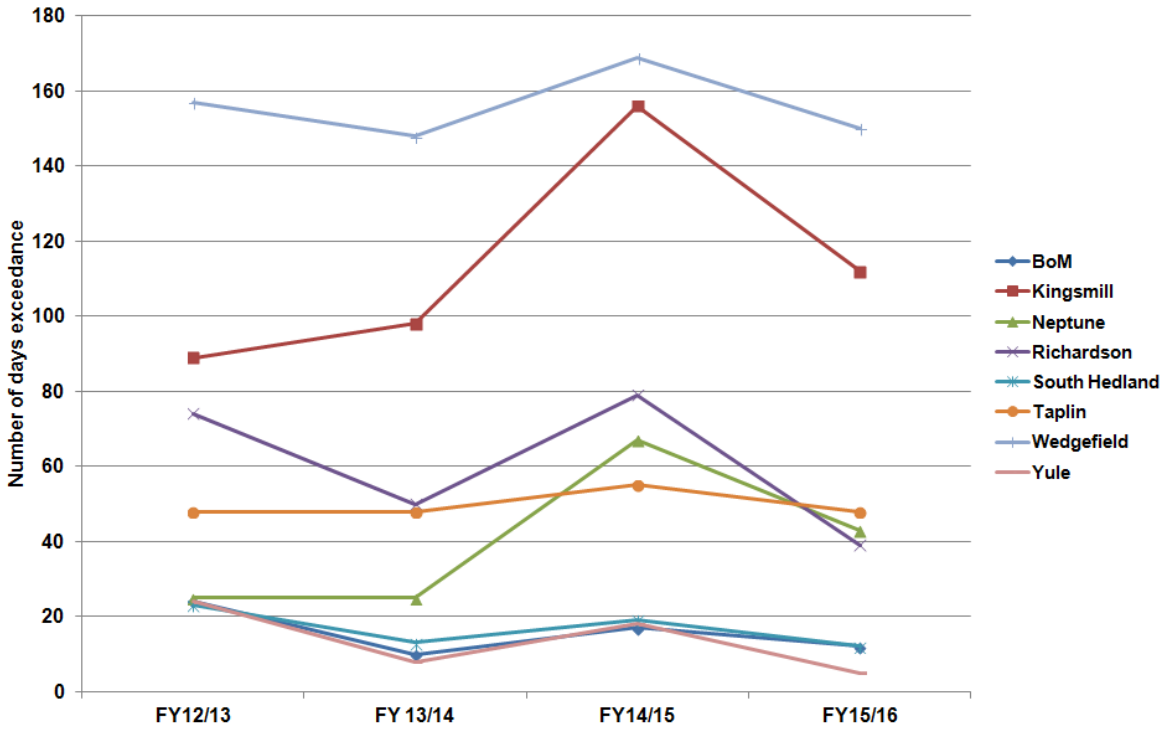

Figure 6-1: Events above the 24-hour average PM_{10} AAQ NEPM standard by financial year

6.3 PM_{10} data trends

The following statistics for 24-hour average PM_{10} are displayed graphically in Appendix A for the past four financial years:

- maximum
- 99th percentile
- 98th percentile
- 95th percentile
- 90th percentile
- 50th percentile
- minimum.

The graphs in Appendix A show the following:

- Maximum 24-hour average PM_{10} concentrations show a decreasing trend at all monitoring stations over the four financial years
- 98^{th} percentile 24-hour average PM_{10} concentrations show a decreasing trend at all monitoring stations over the four financial years with the exception of Kingsmill and Neptune that show a slight increasing trend over the last three years
- 50^{th} percentile 24-hour average PM_{10} concentrations (indicative of an annual average) exhibit a stable trend at all monitoring stations for the past four financial years.

7. INVESTIGATION OF PM_{10} EVENTS

The interim guideline for PM_{10} allows for 10 exceedances of 70 µg/m³ as a result of Port Hedland industry. For the 2015/16 financial year the interim guideline is met at Taplin without the determination of exceedances events. Notwithstanding this, the following sections investigate each day at Taplin the PM_{10} concentration was above 70 µg/m³ (10 in total).

7.1 Investigation methodology

The aim of investigating each day PM_{10} at Taplin is greater than 70 µg/m³ is to determine if the “event” is also an “exceedance” of the interim guideline. An “event” is not considered an “exceedance” where it can be demonstrated to be a result of regional dust or a local dust source other than industry.

To determine the number of "exceedance" events of the interim guideline at the Taplin monitoring station the following methodology has been followed:

1. Determine whether the event is "regional" or "local"
    - A "regional" event is defined as a 24-hour average PM_{10} concentration at Taplin greater than 70 µg/m³ (interim guideline) and greater than 60 µg/m³ at BoM monitoring station (trigger level). Regional events are not considered an exceedance of the interim guideline.
    - A "local" event (in the context of air quality or emission sources) is defined as a 24-hour average PM_{10} concentration at Taplin greater than 70 µg/m³ (interim guideline) but less than 60 µg/m³ at BoM monitoring station.
2. For each "local" event the likelihood that Port Hedland industry contributed to the PM_{10} concentration above 70µg/m³ has been investigated through analysis of meteorological conditions (using wind roses, polar plots and time series) and the Port Hedland industry 'arc of influence'.
    - The Port Hedland industry 'arc of influence' is defined as any wind direction that has the potential to carry emissions from industry activities to the monitoring station. The Port Hedland industry 'arc of influence' at Taplin is shown in Figure 7-1 (shaded area) and represents wind directions between 115° and 290°.

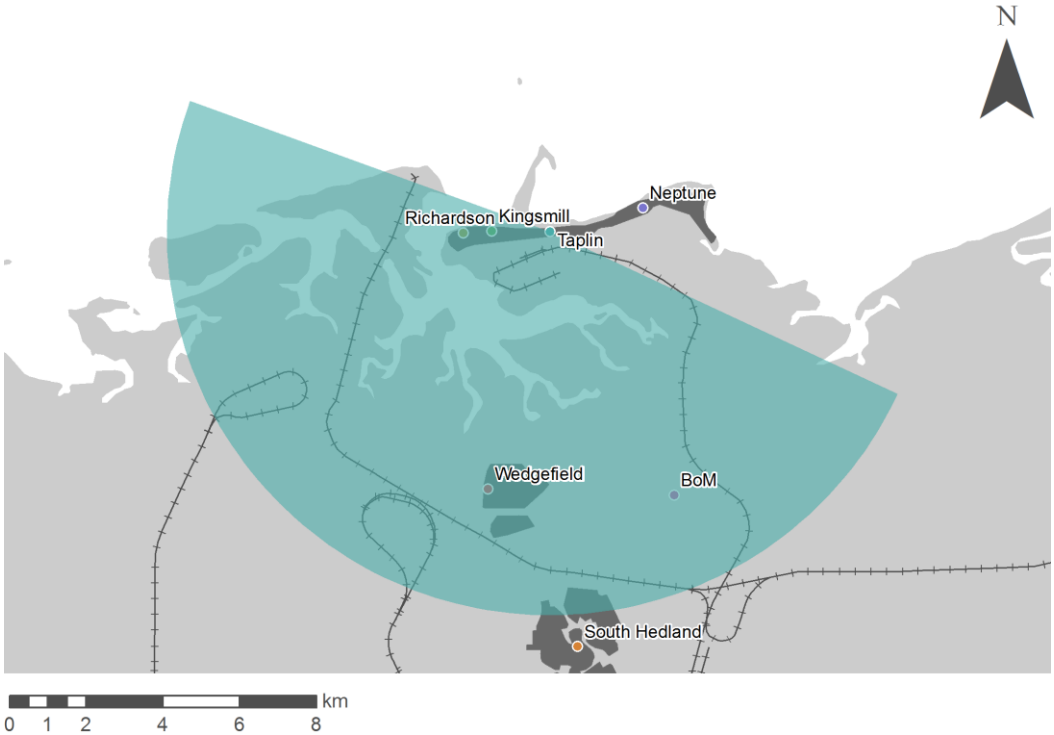

Figure 7-1: Port Hedland industry arc of influence (shaded area) at Taplin monitoring station

A wind rose is a tool used to illustrate the frequency and intensity of a given wind speed and its direction at a chosen location. In the following sections, the 10-minute average wind speed and wind direction measurements for each event day at Taplin are shown. Wind speeds are grouped based on the data range and wind direction is grouped into sixteen, 22.5 degree sectors that represent all possible wind directions.

A polar plot shows the dependence of PM_{10} concentrations on wind speed and wind direction as measured at the Taplin monitoring station during each event day (10-minute average data has been used to increase resolution). The colour scale represents the average concentration of PM_{10} with higher concentrations shown in red graduating to lower concentrations, which are shown in orange, yellow, green and then blue. The placement on the figure reflects the wind speed and wind direction at the time of measurement. Measurements during stronger winds are placed further from the centre with each ring denoting an increment in wind speeds. The wind direction at the time of measurement is reflected by plotting the point relative to its direction from north. It should be noted that the PM_{10} concentration is the average of the 10-minute data for each wind speed group and wind direction sector.

A time series plot is a tool used to illustrate the change over time. Time series plots for PM_{10} concentration, wind direction and wind speed at the Taplin monitoring station and have been produced for each event day. The 10-minute average data has been used to increase resolution.

7.2 Overview

Table 7-1 details the days when the Taplin 24-hour average PM_{10} concentration was above 70 µg/m³ during the 2015/16 financial year, PM_{10} concentrations at BoM and Yule for the same time period are also displayed. The cause of the PM_{10} event days is detailed in Table 7-1 as determined in Section 7.1.

Table 7-1 Taplin Interim Guideline Exceedance Summary

Date	24-hour average PM_{10} (µg/m³)			Likely cause (as determined by methodology presented in Section 7.1)
	Taplin	BoM	Yule	
8 September 2015	**72.5**	39.7	no data	Industry and elevated regional dust
21 September 2015	**80.0**	30.5	18.5	Industry and elevated regional dust
25 October 2015	**71.5**	52.1	23.2	Industry
14 November 2015	**73.0**	41.9	35.9	Industry
1 December 2015	**94.7**	**82.0**	**61.6**	Elevated regional dust
19 December 2015	**79.1**	**67.5**	**73.3**	Elevated regional dust
20 December 2015	**87.4**	**74.5**	**68.1**	Elevated regional dust
26 December 2015	**77.6**	**67.5**	**70.8**	Elevated regional dust
26 February 2016	**108.7**	18.9	12.0	Local source (other than industry)
28 June 2016	**78.6**	21.9	19.2	Industry

7.3 8 September 2015

On the 8 September 2015 the 24 hour average PM_{10} concentration at Taplin was 72.5 µg/m³ and 39.7 µg/m³ at BoM. A valid 24-hour average PM_{10} concentration was not recorded at Yule. The 24-hour average concentrations at Taplin and BoM indicate a local event at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for the 8 September 2015 event is shown in Figure 7-2. A time series of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-3.

The figures show the following:

- The wind rose indicates that winds occurred from the southeast quadrant for over 50% of the day with strongest winds predominantly from the east southeast but also from the east.
- The PM_{10} polar plot indicates the highest average 10-minute concentrations of PM_{10} recorded at Taplin occurred during strong winds (>8 m/s) from the east southeast (red colour area). Average 10-minute PM_{10} concentrations were also elevated during lighter winds (<4 m/s) from the southwest (yellow area).
- The time series plots for the 8 September 2015 shows that the stronger daytime winds from the southeast quadrant resulted in elevated PM_{10} at Taplin. PM_{10} concentrations at BoM were also elevated during the stronger daytime winds. This is indicative of a dust source other than industry influencing the Taplin monitoring station.
- During the early afternoon and evening the wind direction shifts from a south-easterly to a northerly and then a south-westerly direction and into the industry arc of influence for Taplin. Elevated PM_{10} levels were recorded for the duration of the evening at Taplin (7pm onwards) but not at BoM and can therefore be attributed to industry sources.

Overall, on 8 September 2015, both industry and elevated regional dust contributed to the event recorded at Taplin.

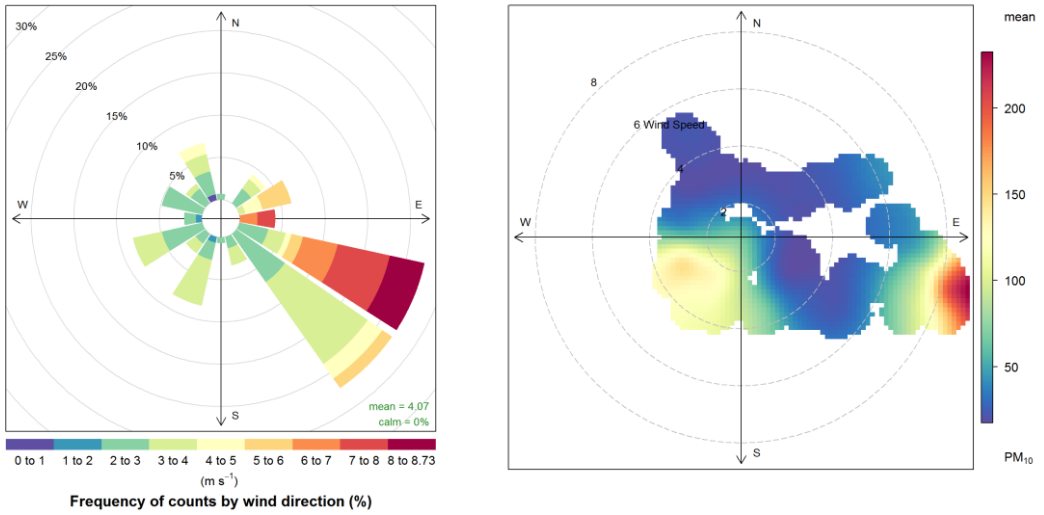

Figure 7-2: Taplin wind rose (left) and PM_{10} polar plot (right) on 8 September 2015

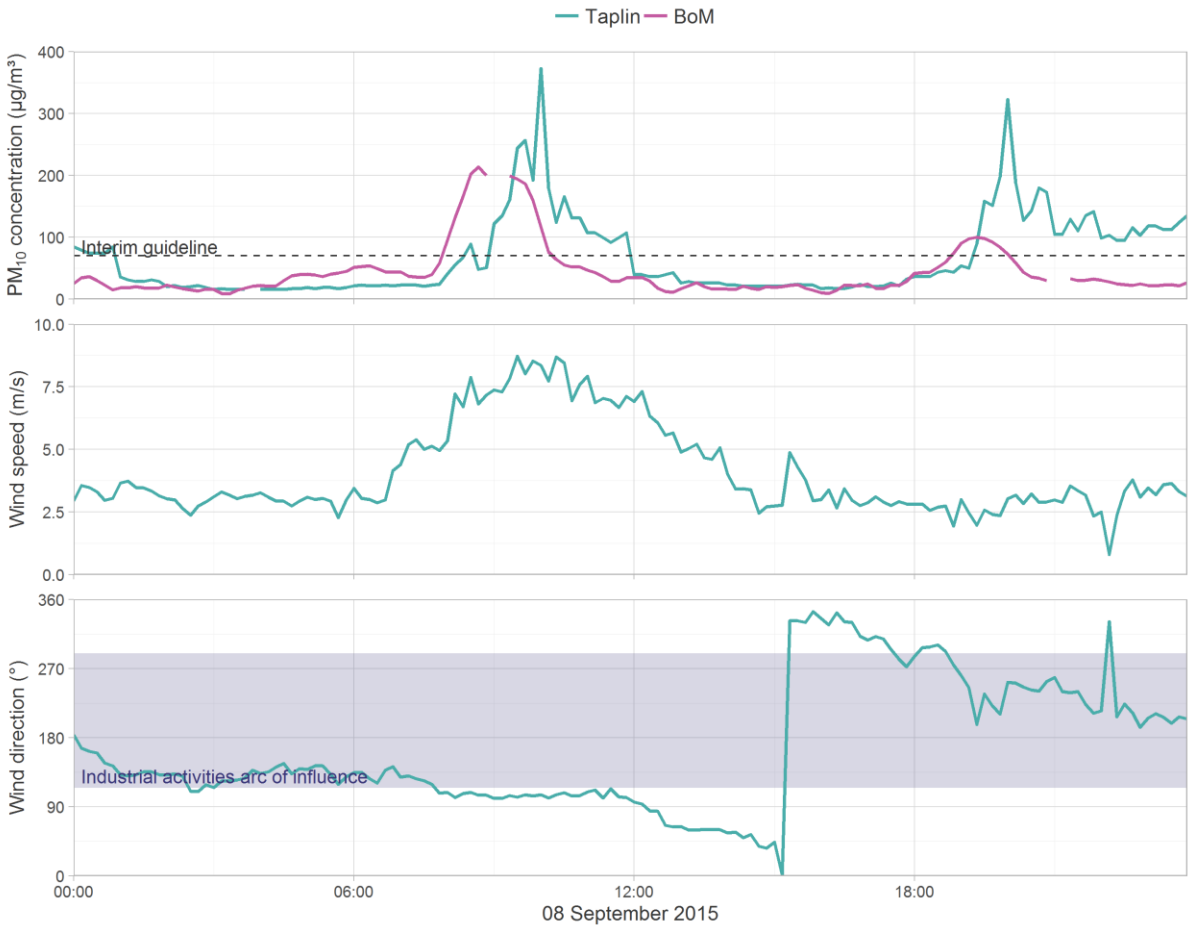

Figure 7-3: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 8 September 2015

7.4 21 September 2015

On the 21 September 2015 the 24 hour average PM_{10} concentration at Taplin was 80.0 µg/m³, 30.5 µg/m³ at BoM and 18.5 µg/m³ at Yule. The 24-hour average concentrations at Taplin, BoM and Yule indicate a local event at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for the 21 September 2015 event is shown in Figure 7-4. A time series of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-5.

The figures show the following:

- The wind rose indicates that winds occurred from the southeast quadrant for over 50% of the day with strongest winds predominantly from the east southeast but also from the east but less frequently.
- The PM_{10} polar plot indicates that when winds were from the southwest the average 10-minute concentrations of PM_{10} was consistently between 70-110 µg/m³ (yellow to red colours). Elevated average 10-minute PM_{10} concentrations (between 90-100 µg/m³) occurred from the south-southeast however, lower PM_{10} concentrations (blue and green) were also measured when winds were from the south east quadrant.
- The time series plots for the 21 September 2015 shows that the highest elevated levels of PM_{10} at Taplin occurred predominantly in the evening (between 7-9 pm) but also to a lesser extent during the early morning, mid-morning and mid-afternoon.
- The wind directions at Taplin during the early morning and evening PM_{10} peaks were within the industry arc of influence. Wind directions at Taplin during the mid-morning and early-afternoon PM_{10} peaks were outside the industry arc of influence suggesting other dust sources are contributing.

Overall, on 21 September 2015 industry and elevated regional dust levels caused the event recorded at Taplin.

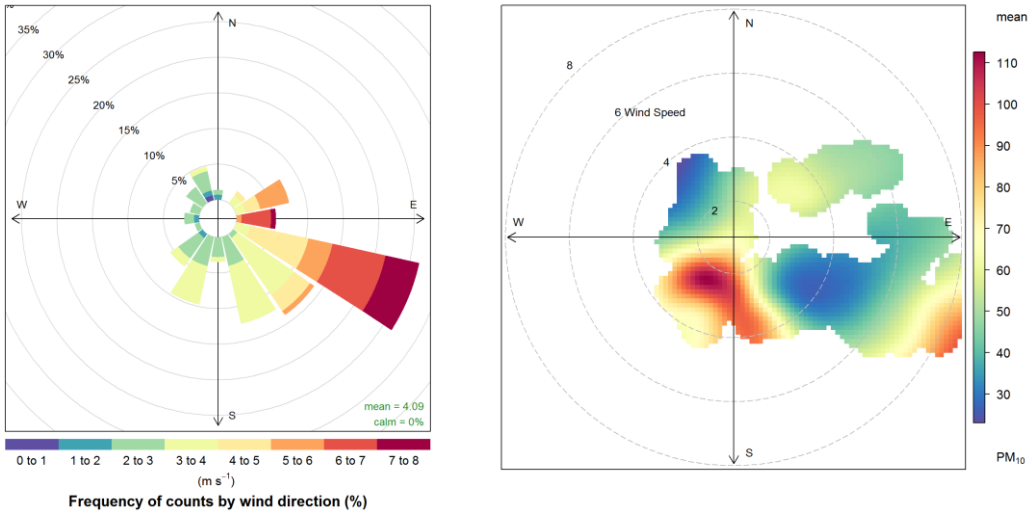

Figure 7-4: Taplin wind rose (left) and PM_{10} rose (right) on 21 September 2015

Figure 7-5: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 21 September 2015

7.5 25 October 2015

On the 25 October 2015 the 24 hour average PM_{10} concentration at Taplin was 71.5 µg/m³, 52.1 µg/m³ at BoM and 23.2 µg/m³ at Yule. The 24-hour average concentrations at Taplin, BoM and Yule indicate a local event at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for the 25 October 2015 event is shown in Figure 7-6. A time series of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-7.

The figures show the following:

- The wind rose indicates that strong winds occurred throughout the day and from a south to west direction. Strongest winds occurred from the west.
- The PM_{10} polar plot indicates the highest average 10-minute PM_{10} concentrations (red and yellow areas) occurred during the strongest winds (> 6 m/s) and from either the west (highest PM_{10} concentration) and the south. Lower PM_{10} concentrations (blue and green areas) occurred when winds were from the south west quadrant.
- The time series plots for the 25 October 2015 shows that PM_{10} at Taplin was above or near 70 µg/m³ for the majority of time (midnight to midnight) with PM_{10} levels increasing above 70 µg/m³ during strong afternoon winds. The wind direction at Taplin was from the direction of industry throughout the day.

Overall, on 25 October 2015, with strong winds from the direction of the Port Hedland industry arc of influence for the entire day, it is likely that industry caused the event recorded at Taplin.

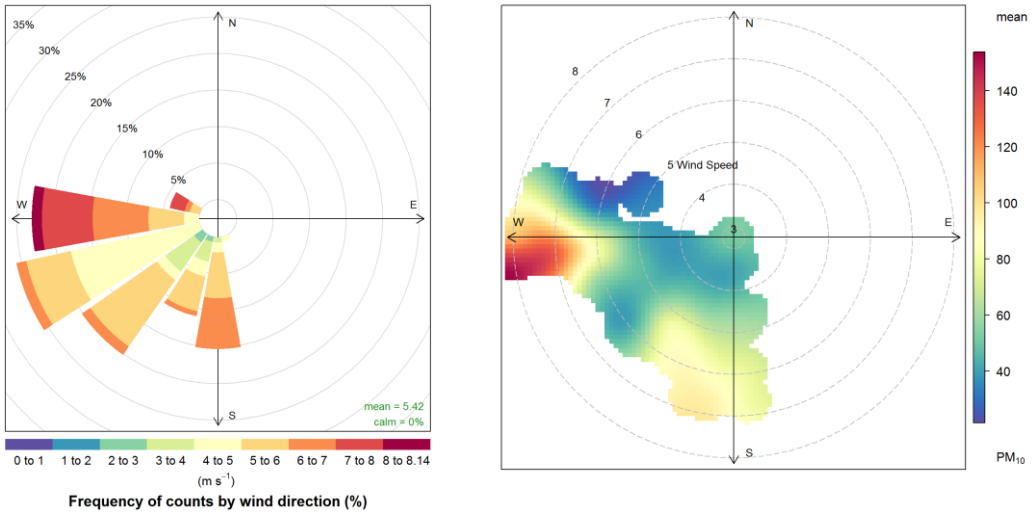

Figure 7-6: Taplin wind rose (left) and PM_{10} rose (right) on 25 October 2015

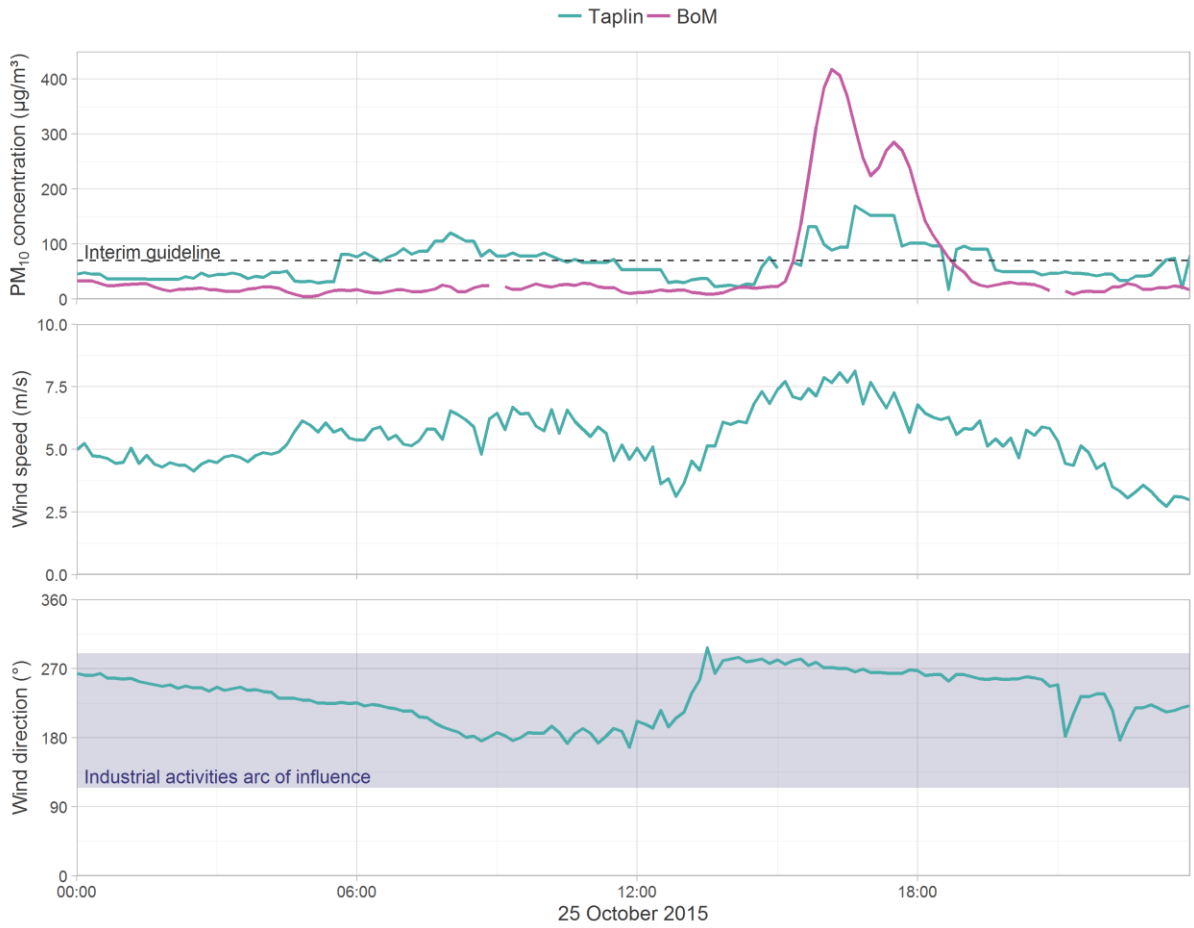

Figure 7-7: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 25 October 2015

7.6 14 November 2015

On the 14 November 2015 the 24 hour average PM_{10} concentration at Taplin was 73.0 µg/m³, 41.9 µg/m³ at BoM and 35.9 µg/m³ at Yule. The 24-hour average concentrations at Taplin, BoM and Yule indicate a local event at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for the 14 November 2015 event is shown in Figure 7-8. A time series of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-9.

The figures show the following:

- The wind rose indicates that strong winds occurred throughout the day from a predominantly southwest to northwest direction. Strongest winds occurred from the west to northwest.
- The PM_{10} polar plot indicates the highest average 10-minute PM_{10} concentrations (red and orange areas) occurred during winds less than 4 m/s and from the southwest
- The timeseries plots for the 14 November 2015 show that PM_{10} at Taplin was above or near the interim guideline for the majority of daytime hours (6am - 6pm). The highest PM_{10} levels were recorded during the morning (6am - 10am) when the wind direction was from the direction of industry.

Overall, on 14 November 2015, with winds from the direction of the industry during the highest PM_{10} measurements, it is likely that industry caused the event recorded at Taplin.

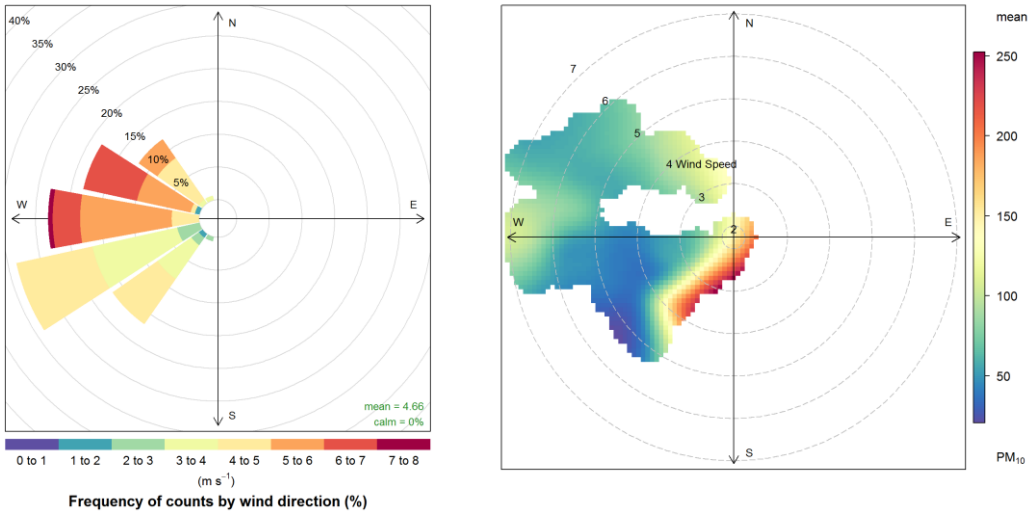

Figure 7-8: Taplin wind rose (left) and PM_{10} rose (right) on 14 November 2015

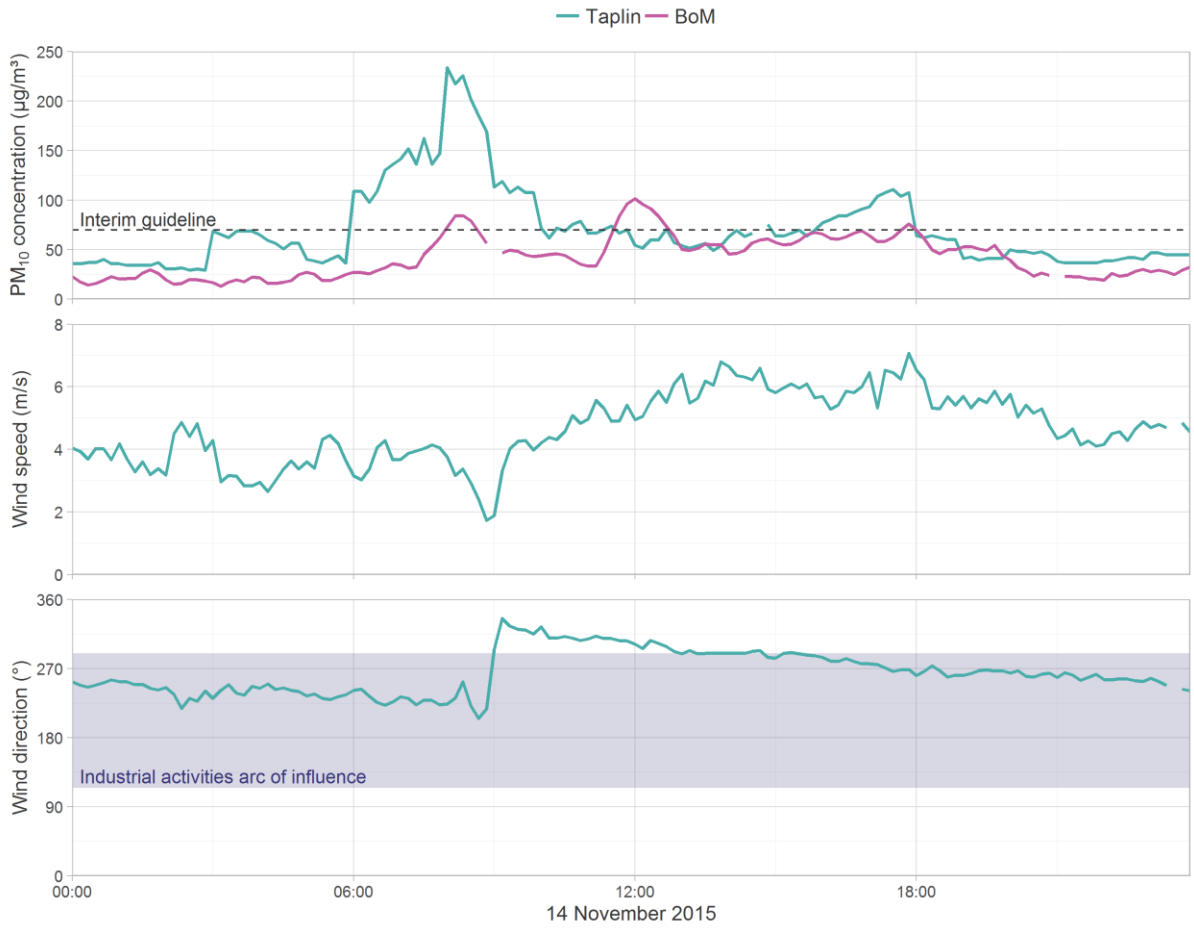

Figure 7-9: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 14 November 2015

7.7 1 December 2015

On the 1 December 2015 the 24 hour average PM_{10} concentration at Taplin was 94.7 µg/m³, 82.0 µg/m³ at BoM and 61.6 µg/m³ at Yule. This is the first instance in the FY2015/16 period in which Taplin was above the interim guideline and BoM and Yule measured PM_{10} greater than 60 µg/m³ (regional trigger level), indicating a potential regional event.

Investigation of 24-hour average PM_{10} concentrations at the five other Port Hedland monitoring stations on 1 December 2015 revealed that all other stations recorded 24-hour average PM_{10} greater than 60 µg/m³ providing further evidence that a regional event occurred on this day.

Notwithstanding this, a wind rose and PM_{10} polar plot of the Taplin station data for the 1 December 2015 event is shown in Figure 7-10. A timeseries of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-11.

The figures show the following:

- The wind rose indicates that strong winds occurred on 1 December and from a predominantly west to northwest direction. Strongest winds occurred from the northwest. It should be noted that the Port Hedland Spoil Bank (used as a large sandy recreation reserve) is located in this direction.
- The PM_{10} polar plot indicates that when winds were from the northwest and greater than 5 m/s the average 10-minute concentrations of PM_{10} were high (red colour area). As the wind direction moved from the northwest to west, the average 10-minute PM_{10} concentrations decreased in magnitude.
- The time series plots for the 1 December 2015 show that PM_{10} concentrations at both Taplin and BoM followed a similar pattern, increasing from around 7am to a peak at 11am before decreasing in the afternoon. The wind speed was relatively strong all day.

Overall, on 1 December 2015, with all Port Hedland monitoring stations recording elevated PM_{10} concentrations this event has been classed as "Regional".

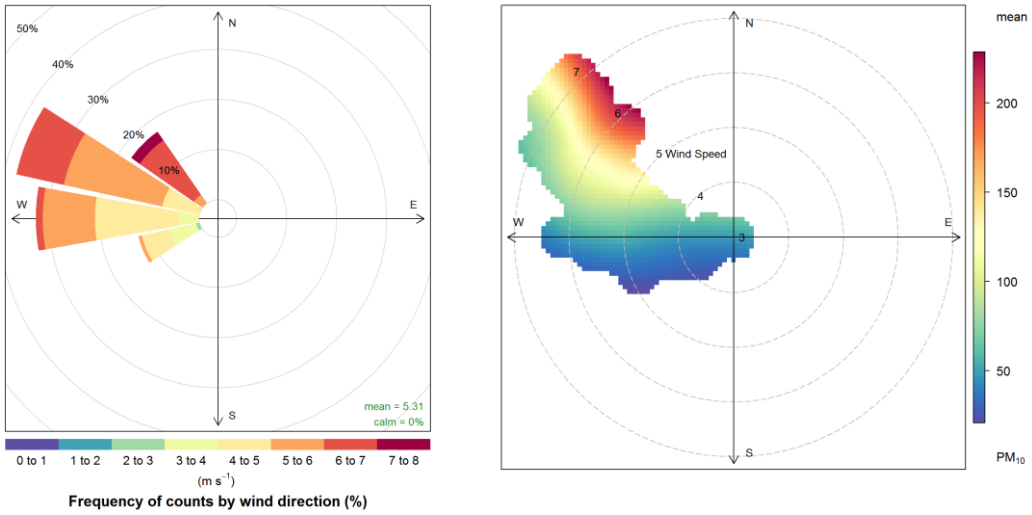

Figure 7-10: Taplin wind rose (left) and PM_{10} polar plot (right) on 1 December 2015

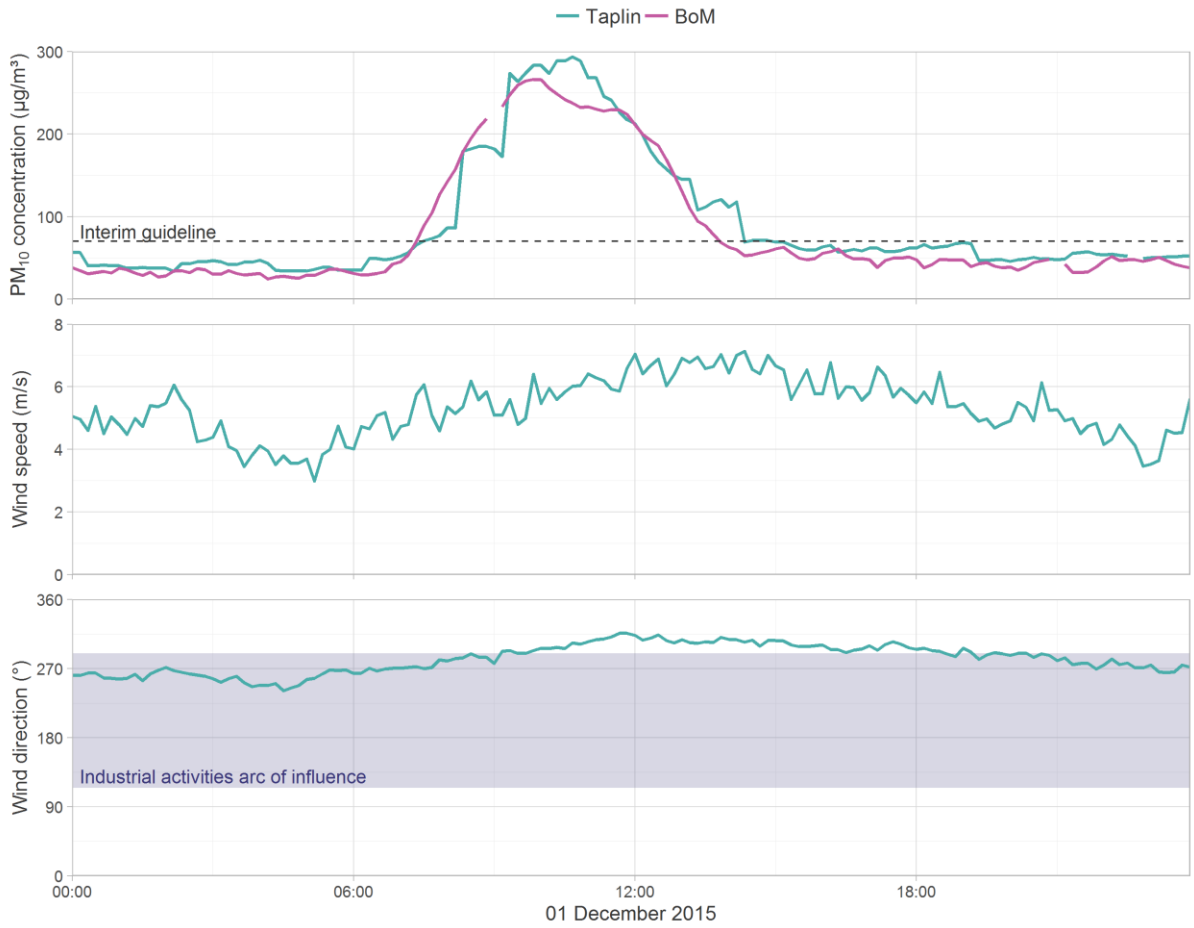

Figure 7-11: Timeseries of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 1 December 2015

7.8 19 December 2015

On the 19 December 2015 the 24 hour average PM_{10} concentration at Taplin was 79.1 µg/m³, 67.5 µg/m³ at BoM and 73.3 µg/m³ at Yule. With Taplin was above the interim guideline and BoM and Yule measuring PM_{10} greater than 60 µg/m³ this indicates a potential regional event.

Investigation of 24-hour average PM_{10} concentrations at the five other Port Hedland monitoring stations on 19 December 2015 revealed that all other stations recorded 24-hour average PM_{10} greater than 60 µg/m³ providing further evidence that a regional event occurred on this day.

Notwithstanding this, a wind rose and PM_{10} polar plot of the Taplin station data for the 19 December 2015 event is shown in Figure 7-12. A time series of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-13.

The figures show the following:

- The wind rose indicates that very strong winds occurred on 19 December 2015 from a predominantly west-northwest direction and the direction of the Port Hedland Spoil Bank.
- The PM_{10} polar plot indicates that a wind from the west-northwest with a 5 m/s wind speed resulted in the highest average 10-minute PM_{10} concentrations (red colour area).
- The time series plots for the 19 December 2015 show that PM_{10} concentrations at Taplin and BoM followed a similar pattern, increasing to above 70 µg/m³ in the early morning (4 am) and decreasing in the afternoon and evening. The wind speed was strong all day and consistently from the direction of the Spoil Bank.

Overall, on 19 December 2015, with all Port Hedland monitoring stations recording elevated PM_{10} concentrations this event has been classed as "Regional".

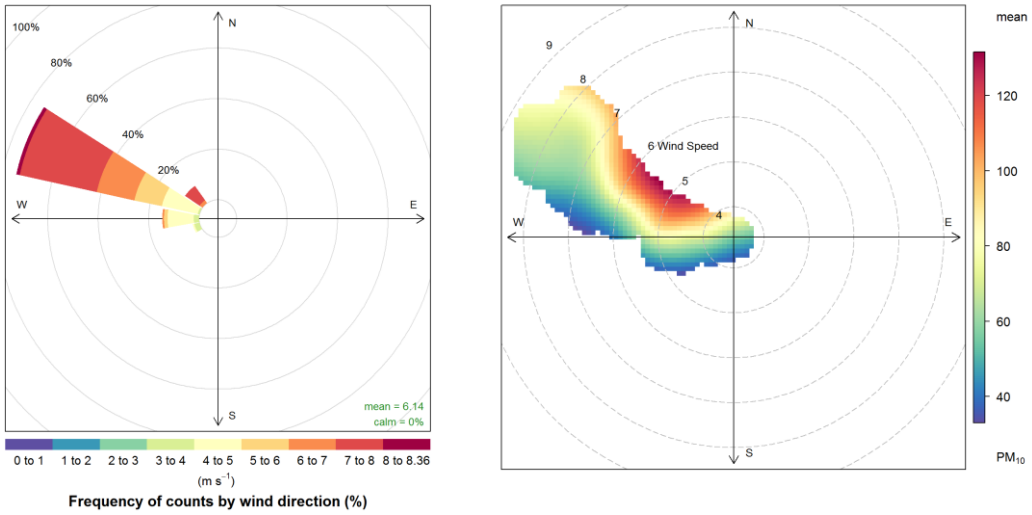

Figure 7-12: Taplin wind rose (left) and PM_{10} rose (right) on 19 December 2015

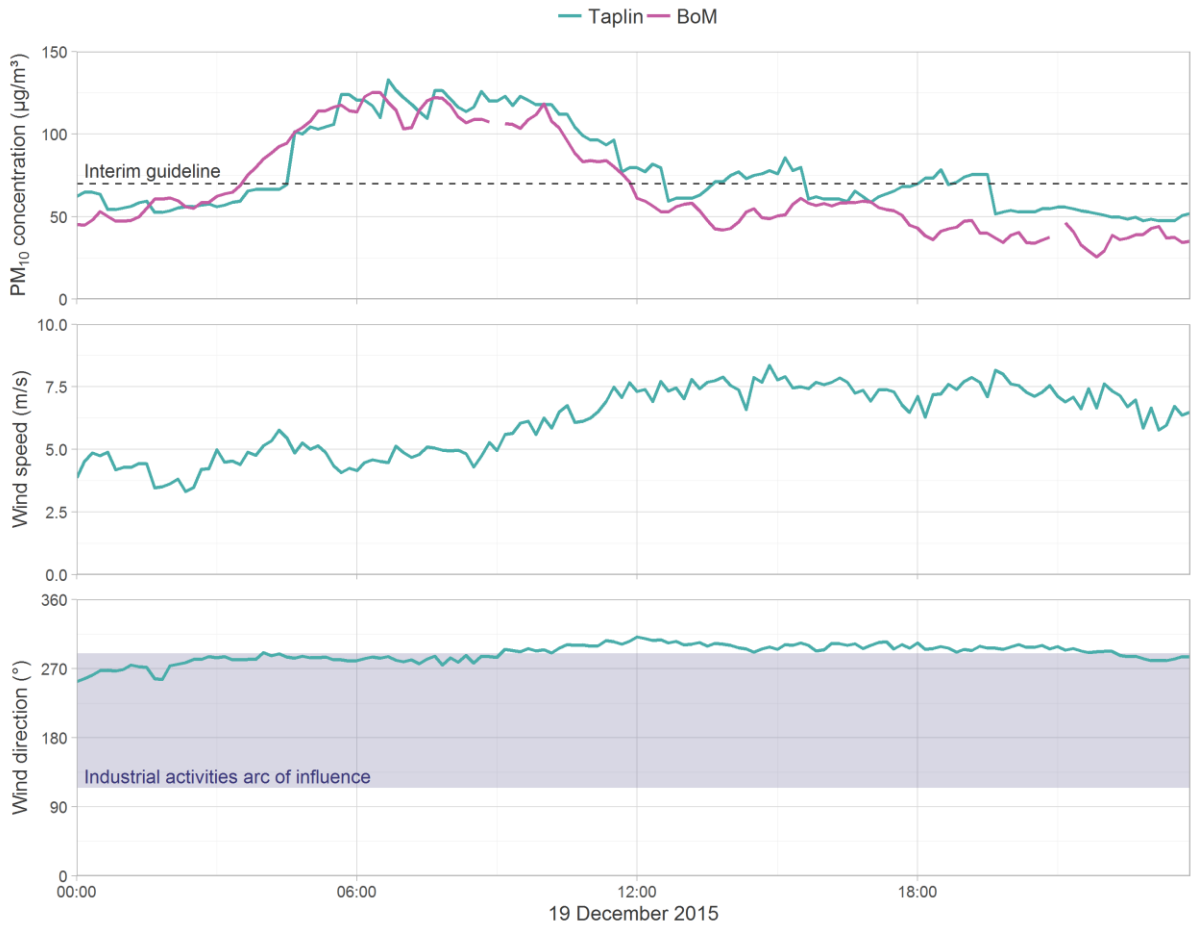

Figure 7-13: Timeseries of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 19 December 2015

7.9 20 December 2015

On the 20 December 2015 the 24 hour average PM_{10} concentration at Taplin was 87.4 µg/m³, 74.5 µg/m³ at BoM and 68.1 µg/m³ at Yule. With Taplin was above the interim guideline and BoM and Yule measuring PM_{10} greater than 60 µg/m³ this indicates a potential regional event.

Investigation of 24-hour average PM_{10} concentrations at the five other Port Hedland monitoring stations on 20 December 2015 revealed that all other stations recorded 24-hour average PM_{10} greater than 60 µg/m³ providing further evidence that a regional event occurred on this day.

Notwithstanding this, a wind rose and PM_{10} polar plot of the Taplin station data for the 20 December 2015 event is shown in Figure 7-14. A time series of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-15.

The figures show the following:

- The wind rose indicates that very strong winds, consistently above 4 m/s, occurred on 20 December 2015 from a predominantly west-northwest direction (Spoil Bank) and also from a westerly direction (within the outer limit of the arc of influence - Finucane Point).
- The PM_{10} polar plot indicates that winds from the west-northwest with a wind speed greater than 7.5 m/s resulted in the highest average 10-minute PM_{10} concentrations (red colour area). When the winds were from the west, the high PM_{10} concentrations (orange area) occurred under 4-5 m/s wind speeds.
- The time series plots for 20 December 2015 indicate that PM_{10} concentrations at Taplin and BoM followed a similar pattern, increasing to above 70 µg/m³ in the early morning and decreasing in the afternoon and evening. The wind speed was strong all day and either from the direction of the Spoil Bank or the industry arc of influence.

Overall, on 20 December 2015, with all Port Hedland monitoring stations recording elevated PM_{10} concentrations this event has been classed as "Regional".

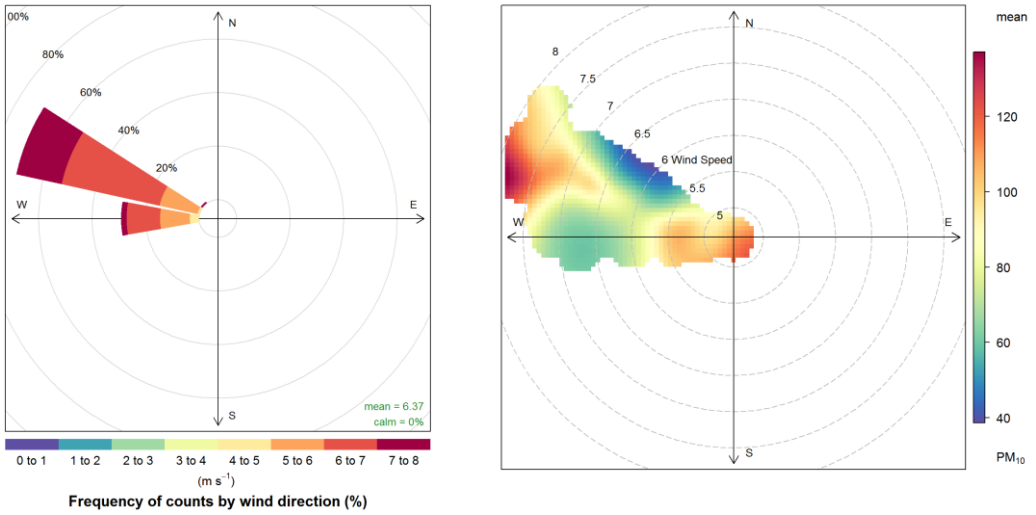

Figure 7-14: Taplin wind rose (left) and PM_{10} rose (right) on 20 December 2015

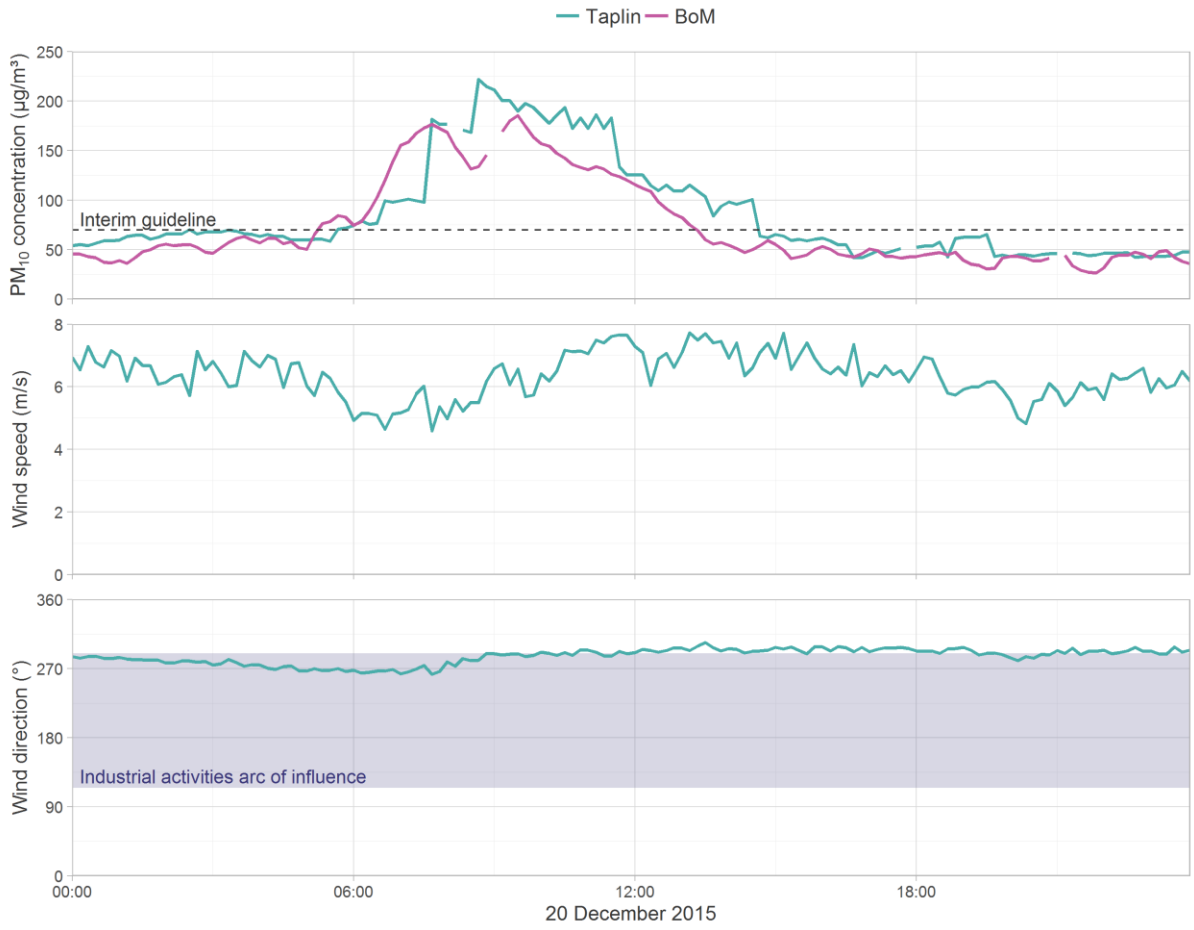

Figure 7-15: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 20 December 2015

7.10 26 December 2015

On the 26 December 2015 the 24 hour average PM_{10} concentration at Taplin was 77.6 µg/m³, 67.5 µg/m³ at BoM and 70.8 µg/m³ at Yule. With Taplin above the interim guideline and BoM and Yule measuring PM_{10} greater than 60 µg/m³ this indicates a potential regional event.

Investigation of 24-hour average PM_{10} concentrations at the five other Port Hedland monitoring stations on 20 December 2015 revealed that all other stations recorded 24-hour average PM_{10} greater than 60 µg/m³ providing further evidence that a regional event occurred on this day.

Notwithstanding this, a wind rose and PM_{10} polar plot of the Taplin station data for the 26 December 2015 event is shown in Figure 7-16. Time series plots of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin are provided in Figure 7-17.

The figures show the following:

- The wind rose indicates that relatively strong winds (>4 m/s) occurred on 26 December 2015 from a predominantly northwest and west-northwest direction (Spoil Bank).
- The PM_{10} polar plot indicates that winds from the southeast quadrant with a light wind speed 1-2 m/s resulted in the highest average 10-minute PM_{10} concentrations (red colour area). Elevated PM_{10} concentrations (orange areas) also occurred during northwest winds with a speed of 5 m/s.
- The time series plots for the 26 December 2015 shows that PM_{10} at Taplin and BoM followed a similar pattern, increasing to above 70 µg/m³ in the morning and decreasing to below the guideline in the afternoon. In the evening the Taplin PM_{10} concentration increased again to above 70 µg/m³ just prior to midnight when the wind speed dropped and the wind direction shifted from the north-west to south and southeast.

Overall, on 26 December 2015, with all Port Hedland monitoring stations recording elevated PM_{10} concentrations this event has been classed as "Regional".

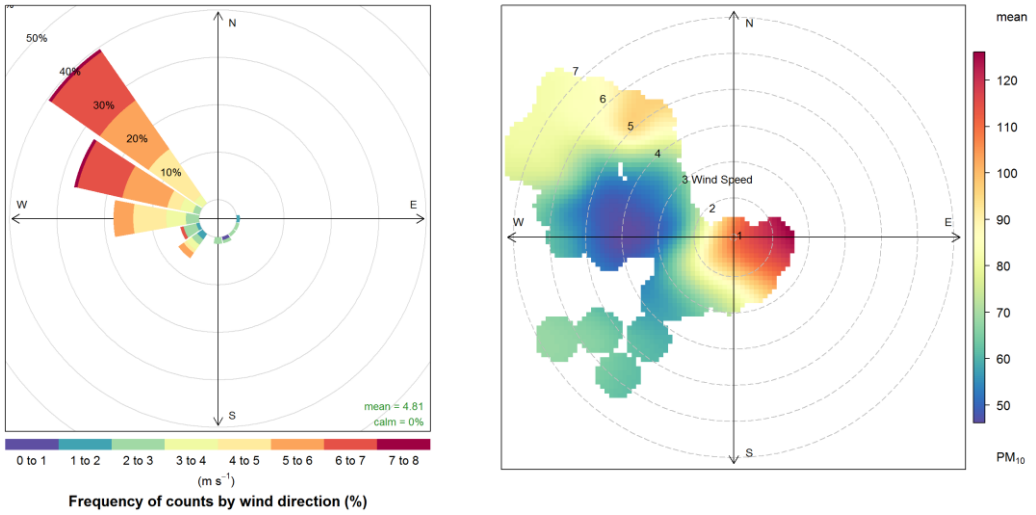

Figure 7-16: Taplin wind rose (left) and PM_{10} rose (right) on 26 December 2015

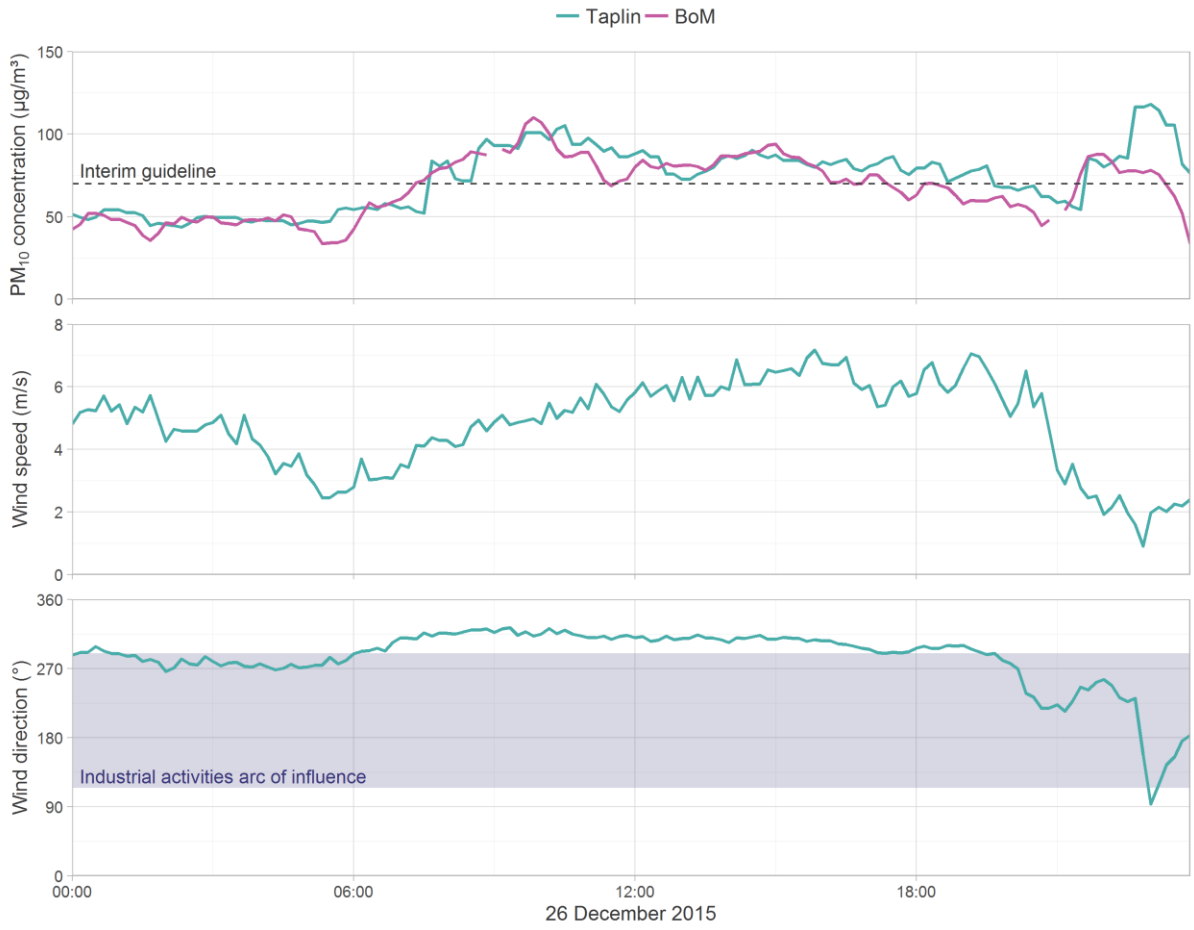

Figure 7-17: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 26 December 2015

7.11 26 February 2016

On the 26 February 2016 the 24 hour average PM_{10} concentration at Taplin was 108.7 µg/m³, 18.9 µg/m³ at BoM and 12.0 µg/m³ at Yule. The 24-hour average concentrations at Taplin, BoM and Yule indicate a local event at Taplin.

PHIC advised that land clearing on the block where the Taplin station is located occurred on this day between the hours of 9am and 2pm to comply with the land holders requirements. Time series plots of PM_{10} concentrations at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-18 and clearly shows the increase in PM_{10} at Taplin between the hours of 10am and 2pm when land clearing was occurring.

On 26 February the land clearing activities on the Taplin monitoring station block created a local source of PM_{10} and likely caused the 24-hour average PM_{10} concentration to exceed 70 µg/m³.

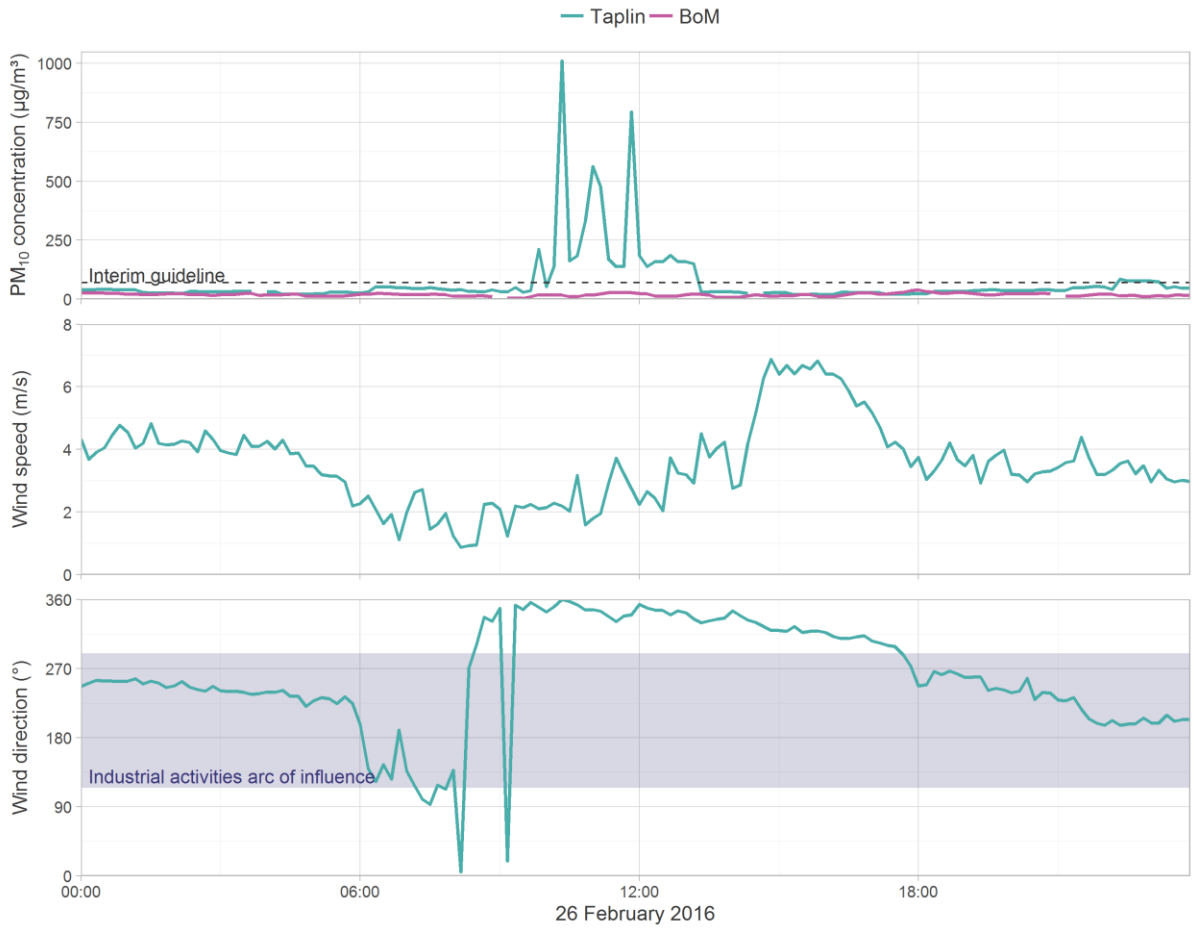

Figure 7-18: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 26 February 2016

7.12 28 June 2016

On the 28 June 2016 the 24 hour average PM_{10} concentration at Taplin was 78.6 µg/m³, 21.9 µg/m³ at BoM and 19.2 µg/m³ at Yule. The 24-hour average concentrations at Taplin, BoM and Yule indicate a local event at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for the 28 June 2016 is shown in Figure 7-19. Timeseries plots of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin are shown in Figure 7-20.

The figures show the following:

- The wind rose indicates that winds were relatively light (compared to other elevated PM_{10} days) and occurred predominantly from the south to south-southwest but also from the southeast to northwest.
- The PM_{10} polar plot indicates the highest average 10-minute PM_{10} concentrations (red and orange areas) occurred when winds were from the south-southwest, south and southeast (matching the matching the most frequent winds).
- The time series plots for the 28 June 2016 show that PM_{10} at Taplin was above or near 70 µg/m³ during the early morning, decreasing during the day before peaking in the late evening.
- The winds during the morning and late evening were within the Port Hedland industry arc of influence.

Overall, on 26 June 2016, with winds from the direction of the industry for the times when PM_{10} at Taplin was elevated, it is likely that industry caused the event recorded at Taplin.

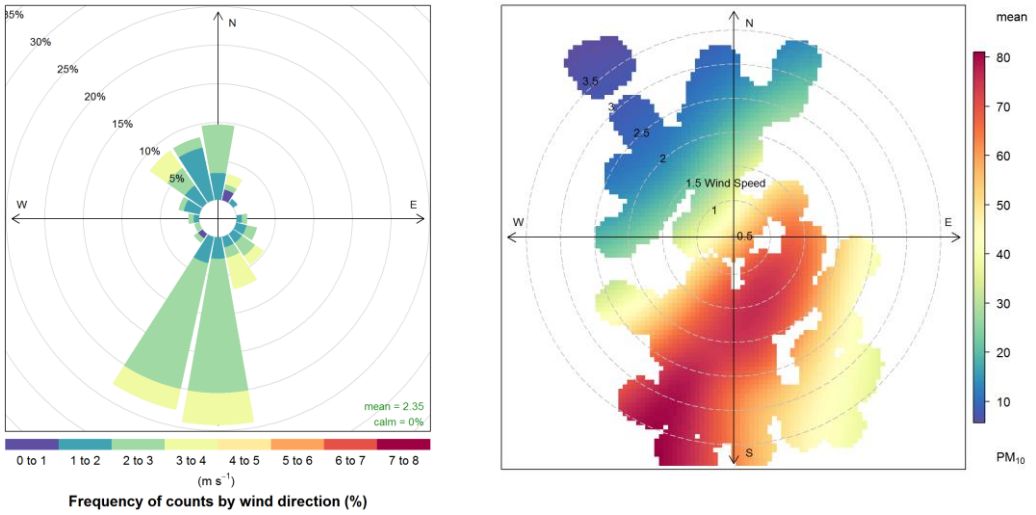

Figure 7-19: Taplin wind rose (left) and PM_{10} polar plot (right) on 28 June 2016

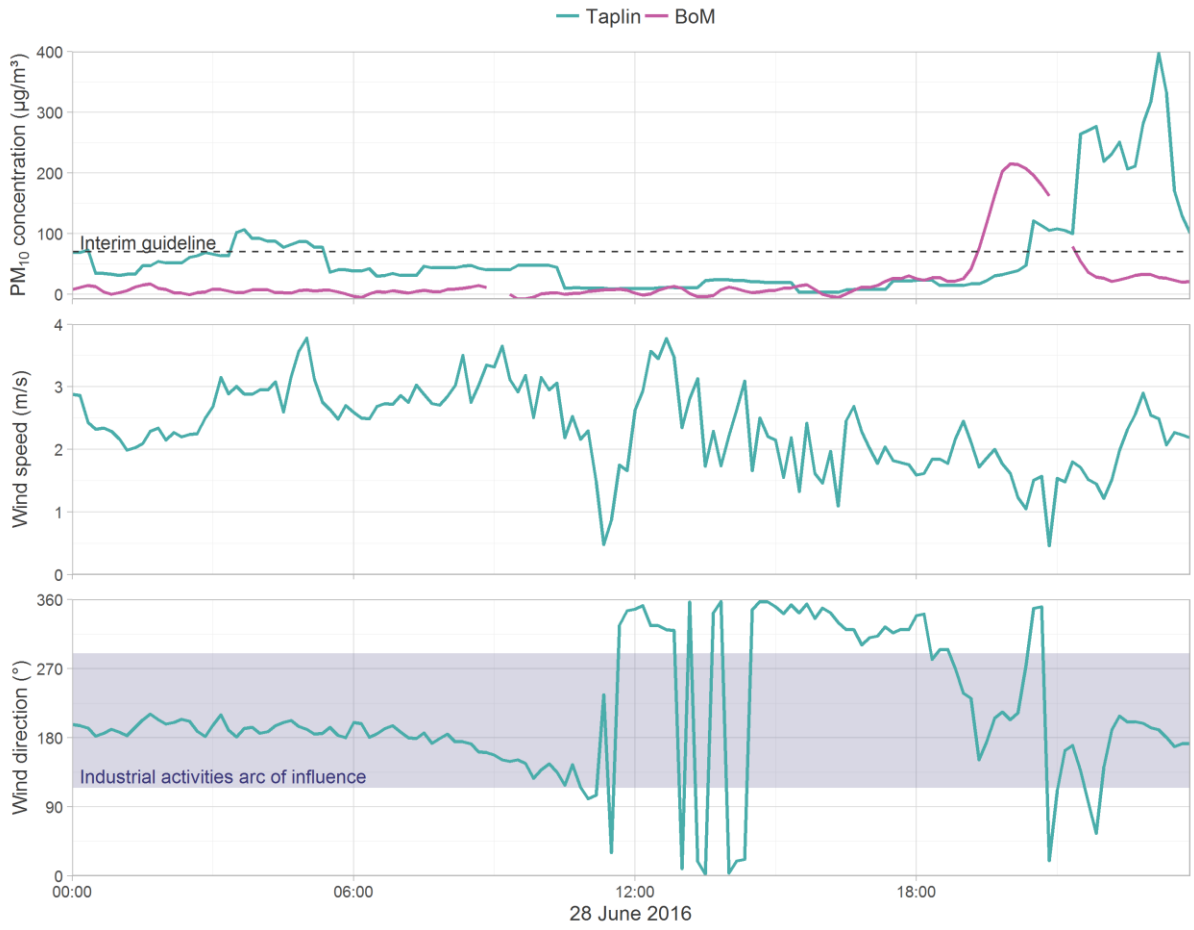

Figure 7-20: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 28 June 2016

8. ANNUAL REPORT CONCLUSIONS

8.1 Data Capture

The performance of the monitoring network in terms of data capture rates was met with greater than 75% data recovery per quarter being achieved for all stations measuring NO_X, PM_{10} and $PM_{2.5}$ for the entire 2015/16 financial year. At the majority of sites data capture per quarter was greater than the 95% desirable target.

Monitoring of NO_x at BoM and South Hedland met the data capture criterion of 75% per quarter for the first two quarters before NO_x monitoring at the two sites was decommissioned in January 2016.

Monitoring of SO_2 by the Port Hedland ambient air quality monitoring network met the data capture criterion of 75% per quarter for the first two quarters before SO_2 monitoring at all sites was decommissioned in January 2016.

8.2 PM_{10}

PM_{10} was measured at eight (8) stations in the Port Hedland monitoring network. Analysis of the PM_{10} data found the following:

- The 24-hour average AAQ NEPM standard for PM_{10} of 50 µg/m³ (with 5 exceedances) was not met at seven of the Port Hedland monitoring stations. The standard was met at Yule.

- The annual average AAQ NEPM standard for PM_{10} of 25 µg/m³ was not met at seven of the Port Hedland monitoring stations. The standard was met at Yule. It should be noted that the AAQ NEPM annual average PM_{10} standard was only introduced in the February 2016 AAQ NEPM revision.

- The 24-hour average interim guideline for PM_{10} of 70 µg/m³ applies to the Taplin monitoring station and there were 10 days at Taplin where concentrations of PM_{10} were above 70µg/m³.Tthe interim guideline allows for 10 exceedance days per year. Consequently, the interim guideline was met at Taplin.

- Notwithstanding this, detailed analysis of PM_{10} and meteorological conditions for the 10 days at Taplin that were above 70 µg/m³ determined that:
    - On 3 days industry was the cause of the event
    - On 2 days industry and elevated regional levels was the cause of the event
    - On 1 day it was a local source, other than industry, that was the cause of the event
    - On 4 days elevated regional dust was the cause of the event

PM_{10} trend analysis shows that, compared to the last financial year (2014/15), Taplin recorded the same number of 24-hour average concentrations of PM_{10} above the interim guideline (10 days). However, the number of days elevated PM_{10} concentrations can be attributed to Port Hedland industry operations decreased from 7 days in 2014/15 (PHIC, 2015) to 5 days in 2015/16 (this report).

Further to this, for the 2015/16 financial year, all Port Hedland monitoring stations recorded fewer days when the 24-hour average concentration of PM_{10} was above the AAQ NEPM standard of 50 µg/m³.

8.3 $PM_{2.5}$

$PM_{2.5}$ was measured at five (5) stations in the Port Hedland monitoring network. It should be noted that $PM_{2.5}$ standards were only officially introduced into the AAQ NEPM in the February 2016 revision (prior to this the AAQ NEPM provided only advisory reporting standards for $PM_{2.5}$). Notwithstanding this, analysis of the $PM_{2.5}$ data found the following:

- The 24-hour average AAQ NEPM standard for $PM_{2.5}$ of 25 µg/m³ was met all stations with the exception of Taplin

- The 24-hour average AAQ NEPM standard for $PM_{2.5}$ was not met at Taplin on one occasion, which occurred on 20 December 2015

- The annual average AAQ NEPM standard for $PM_{2.5}$ of 8 µg/m³ was met all stations with the exception of Taplin

- The annual average $PM_{2.5}$ concentration at Taplin was 11.8 µg/m³

8.4 NO_2

NO_x was measured at three (3) monitoring stations in the Port Hedland monitoring network. Monitoring included nitrogen dioxide (NO_2), nitric oxide (NO) and total NO_X (reported as NO_2). Monitoring of NO_X ceased at two stations (BoM and South Hedland) during the financial year. Performance with the AAQ NEPM standards was assessed at the remaining station: Taplin. The performance assessment found the following:

- The Taplin monitoring station met the 1-hour average AAQ NEPM standard for NO_2.

- The Taplin monitoring station met the annual average AAQ NEPM standard for NO_2.

NO_2 concentrations at BoM and South Hedland were low for the period of measurement. The AAQ NEPM standards would have been met at these stations had monitoring continued.

8.5 SO_2

SO_2 was measured at three (3) stations in the Port Hedland monitoring network for the first half of the financial year and ceased in January 2016. SO_2 concentrations at all stations were low for the period of measurement. The AAQ NEPM standards would have been met at these stations had monitoring continued.

9. REFERENCES

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Appendix A PM_{10} TREND SUMMARY GRAPHS

A.1 PM_{10} Graphs

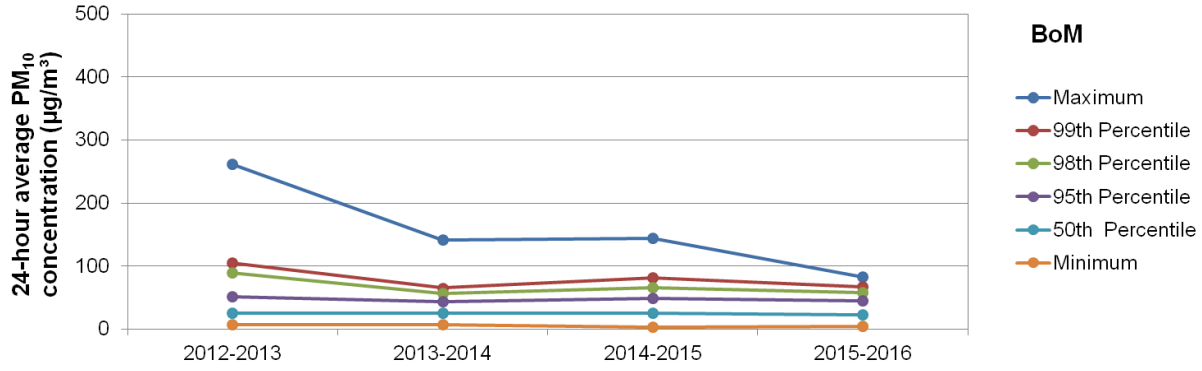

Figure A-1: 24-hour average PM_{10} Trends at BoM

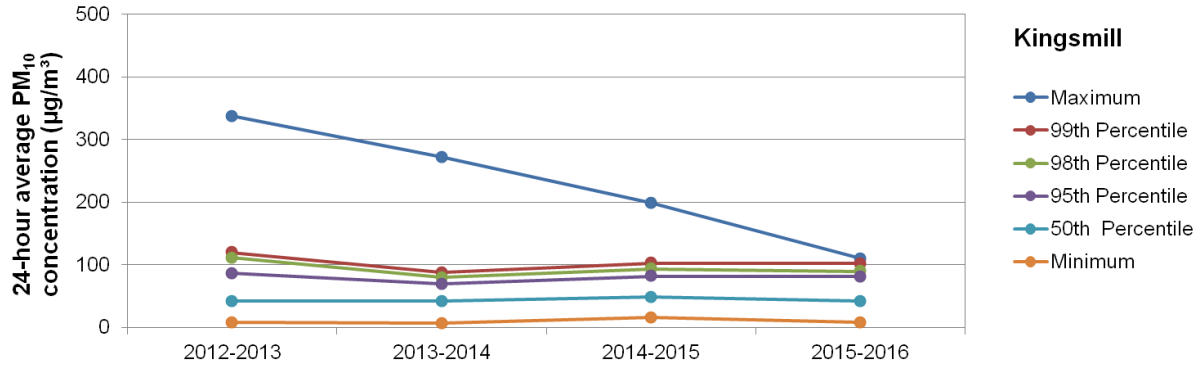

Figure A-2: 24-hour average PM_{10} Trends at Kingsmill

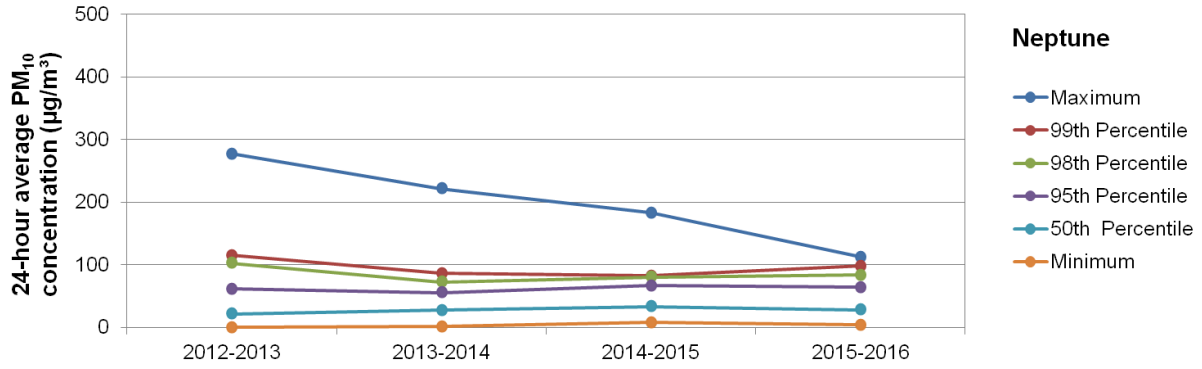

Figure A-3: 24-hour average PM_{10} Trends at Neptune

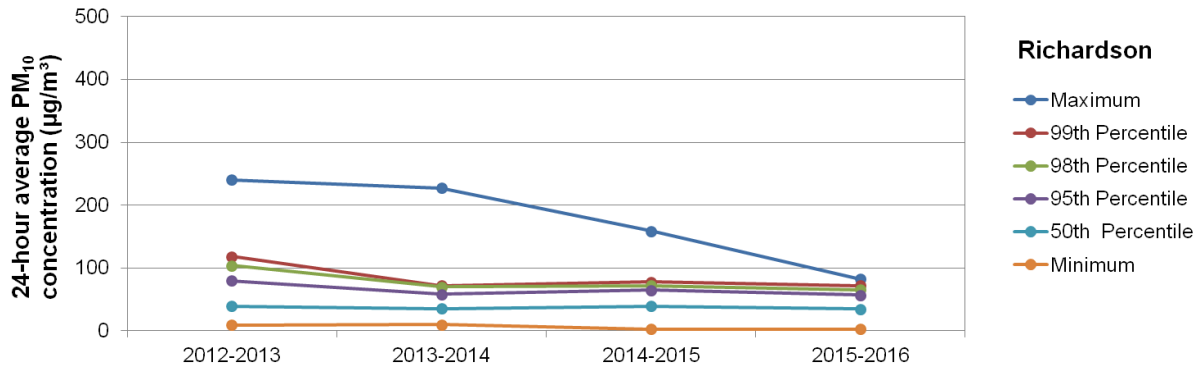

Figure A-4: 24-hour average PM_{10} Trends at Richardson

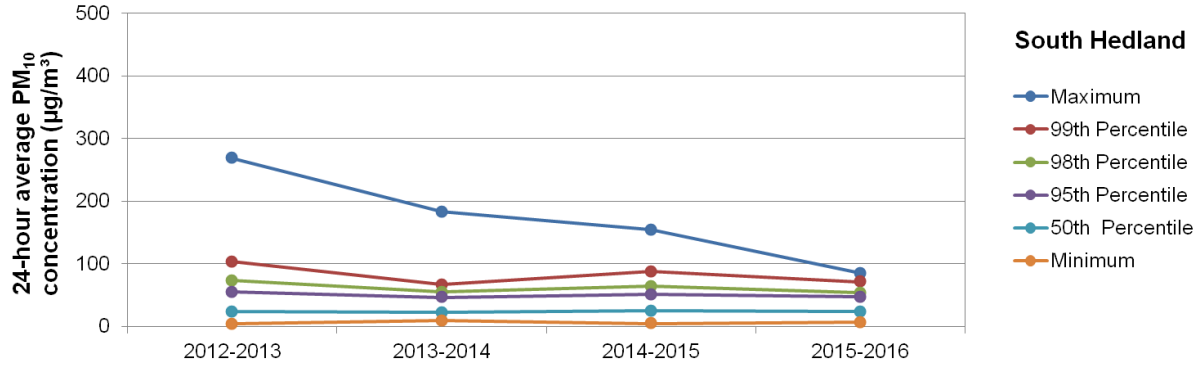

Figure A-5: 24-hour average PM_{10} Trends at South Hedland

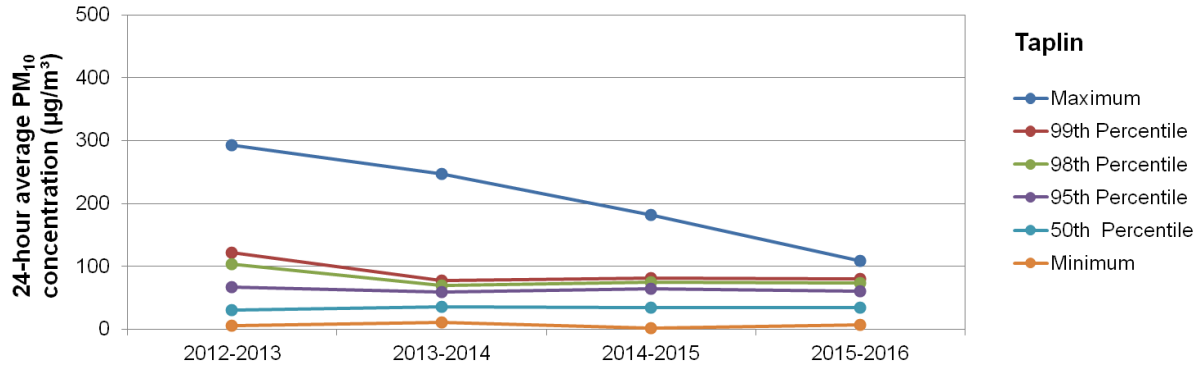

Figure A-6: 24-hour average PM_{10} Trends at Taplin

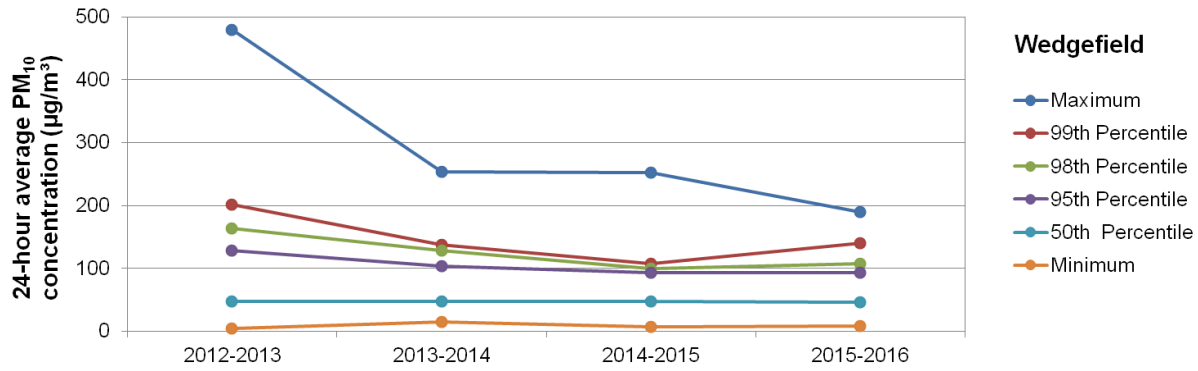

Figure A-7: 24-hour average PM_{10} Trends at Wedgefield

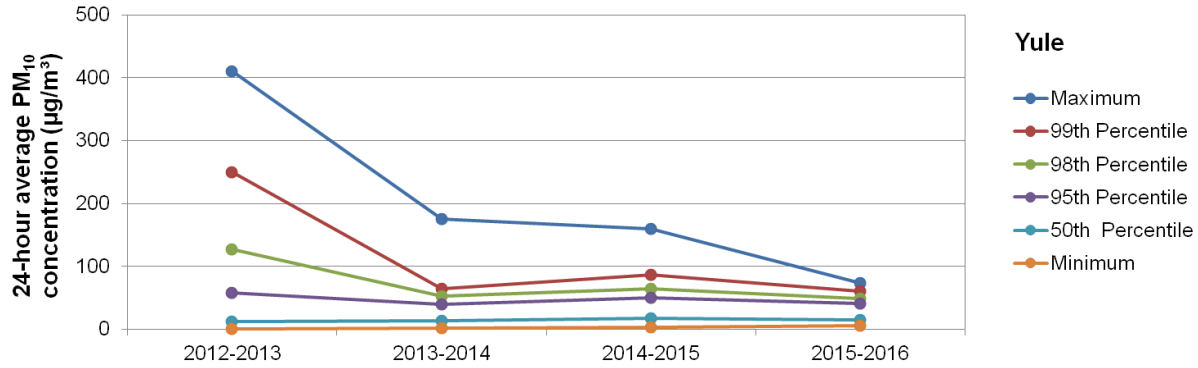

Figure A-8: 24-hour average PM_{10} Trends at Yule