PORT HEDLAND
INDUSTRIES COUNCIL

Annual Report – FY 2016/17 Port Hedland Ambient Air Quality Monitoring Program

FINAL

Port Hedland Industries Council

November 2017

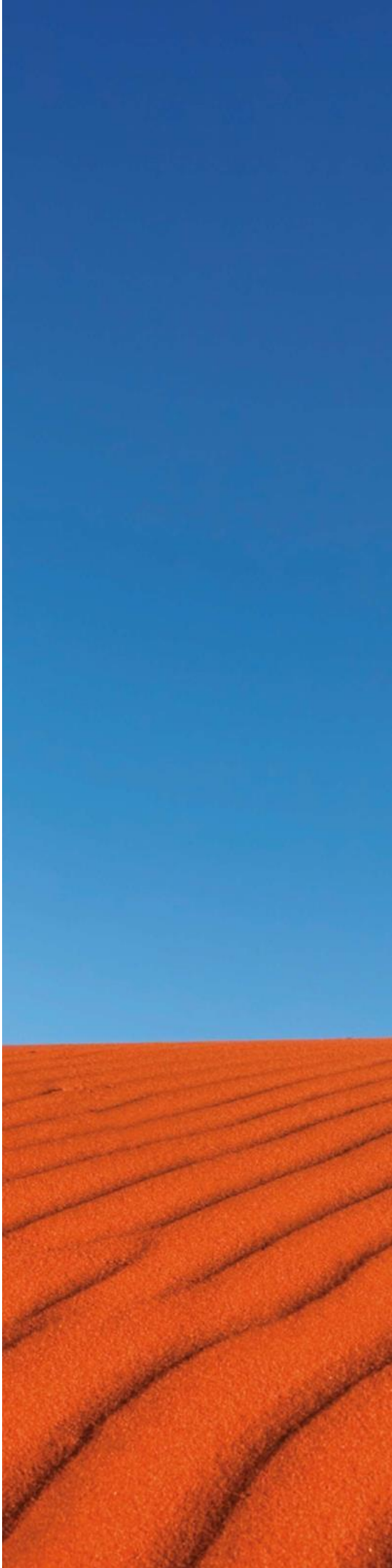

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Port Hedland, a regional town in Western Australia, is home to the world's largest iron ore export port. Air quality, and specifically dust, has been recognised as a significant environmental issue by the Western Australia Government.

Dust in Port Hedland can be generated from natural sources (such as the dry dusty land of the Pilbara region) and anthropogenic sources (such as urban and industrial development, including the handling and stockpiling of bulk commodities such as iron ore). The Port Hedland Industries Council (PHIC) was founded in 2009 to provide an integrated and coordinated approach to establishing and operating an ambient air quality monitoring network.

Currently the PHIC ambient air quality monitoring network consists of eight (8) stations distributed across the Port Hedland region. The stations measure a combination of PM_{10}, $PM_{2.5}$, meteorological conditions (wind speed, wind direction and temperature) and oxides of nitrogen (reported as NO_2). Data from each station is uploaded to a public website for viewing in real-time (www.phicmonitoring.com.au).

A summary of the PHIC ambient air quality monitoring network in FY 2016/17 is provided in the table below.

Monitoring Station	Latitude	Longitude	Type	Parameters			
				PM_{10}	$PM_{2.5}$	NO_x	Meteorology
BoM	20.371508°	118.631353°	Background	✓	✓		✓
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	✓			✓
Taplin	20.309746°	118.599700°	Residential	✓	✓	✓	✓
Wedgefield	20.370454°	118.584820°	Industrial	✓			✓
Yule	20.595167°	118.296311°	Background	✓	✓		✓

This annual report presents a summary of the Port Hedland ambient air quality monitoring network performance for FY 2016/17. Performance of the monitoring network has been assessed through the following:

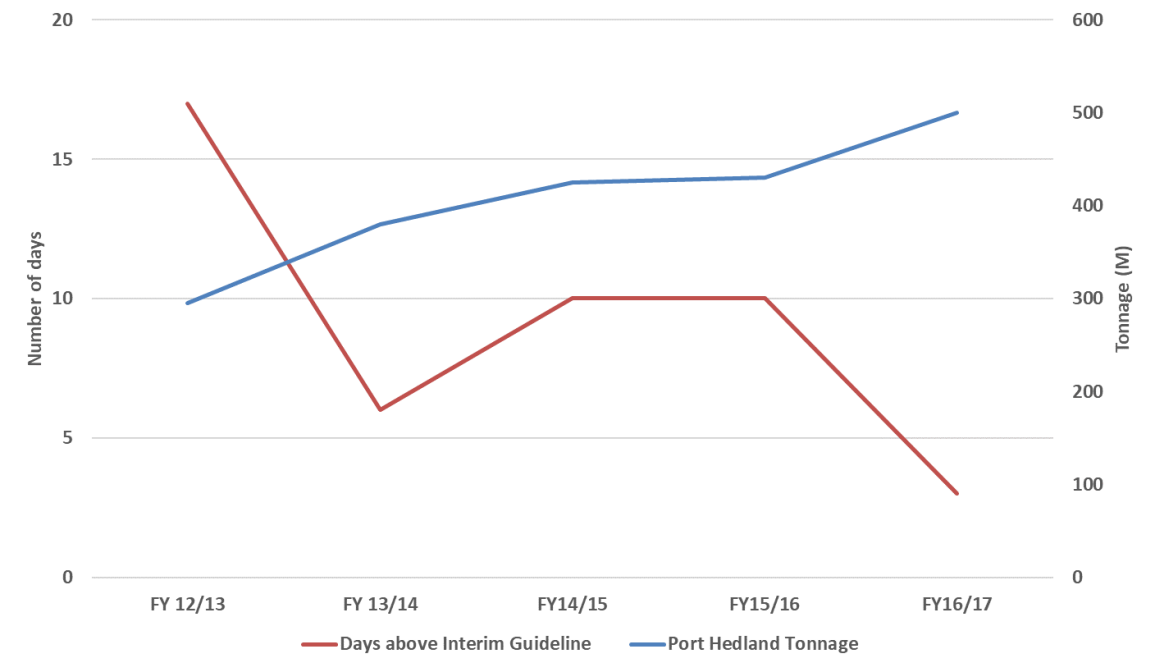
- Pollutant concentrations at each monitoring station compared with relevant air quality guidelines and standards, namely:
  - Port Hedland Dust Management Taskforce Dust Management Plan – interim guideline for PM_{10} of 70 µg/m³ (24-hour average) with 10 allowable exceedances at Taplin.
  - *National Environmental Protection (Ambient Air Quality) Measure* (AAQ NEPM) standards for PM_{10}, $PM_{2.5}$ and NO_2.
- Data capture for each parameter at each station compared with the PHIC criterion of at least 75% capture per calendar quarter and annually, as per the AAQ NEPM protocol.

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 Taskforce interim guideline for 24-hour average PM_{10} is 70 µg/m³ with 10 exceedances allowed per year. In FY 2016/17 there were 3 days at Taplin when the concentration of PM_{10} exceeded 70 µg/m³.
  - Compared with previous reporting years, this is the lowest number of days in one year when the 24-hour average concentration of PM_{10} was above the interim guideline (as shown in the table and figure below). This trend is in contrast to the Port Hedland export tonnage that has steadily increased over the past five reporting years.

Interim Guideline (µg/m³)	Number of days above interim guideline				
	FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17
70	17	6	10	10	3
Export Tonnage (Mt)	295	380	425	430	500



- Detailed analysis of the 3 days at Taplin when the 24-hour average PM_{10} concentration was above 70 µg/m³ determined that:
  - On 22 November 2016, dust concentrations were elevated across the region and, therefore, industry was not the cause of the event.
  - On 26 November 2016 and 2 March 2017, industry was identified as likely to have caused the event.
- In FY 2016/17 the 24-hour average AAQ NEPM standard for PM_{10} of 50 µg/m³ was not met at any of the Port Hedland ambient air quality monitoring stations. The following points are relevant:
  - The past five reporting years show a stable or decreasing trend in the number of days when the 24-hour average concentration of PM_{10} is above the AAQ NEPM standard at all sites except for Richardson.
  - At Richardson, the number of days above the AAQ NEPM standard was significantly increased in Q4 during FY 2016/17. This is consistent with a local source such as urban development that has a localised effect but does not influence levels at the other monitoring sites.
- In FY 2016/17 the annual average AAQ NEPM standard for PM_{10} of 25 µg/m³ was not met at five of the monitoring stations, namely: Kingsmill (40.4 µg/m³), Richardson (40.0 µg/m³), Taplin (31.3 µg/m³), Neptune (27.4 µg/m³) and Wedgefield (43.1 µg/m³).
- In FY 2016/17 the annual average AAQ NEPM standard for PM_{10} of 25 µg/m³ was met at BoM (21.4 µg/m³), South Hedland (22.2 µg/m³) and Yule (15.4 µg/m³).
- The annual average concentrations of PM_{10} in FY 2016/17 decreased compared to FY 2015/16 at all sites except for Richardson.

- The urban development near to Richardson that occurred in Q4 of FY 2016/17 also resulted in higher annual average concentrations of $PM_{2.5}$ than in FY 2015/16.

$PM_{2.5}$

$PM_{2.5}$ was measured at four (4) stations in the Port Hedland ambient air quality monitoring network for the FY 2016/17 reporting period. 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 at BoM (24.2 µg/m³) and Yule (17.3 µg/m³) monitoring stations.
- The 24-hour average AAQ NEPM standard for $PM_{2.5}$ was exceeded at Taplin (28.3 µg/m³) on one day, 22 November 2016, a day when the 24-hour PM_{10} concentration at Taplin was above 70 µg/m³ due to a regional dust event.
- The annual average AAQ NEPM standard for $PM_{2.5}$ of 8 µg/m³ was met at all stations except for Taplin.
- The annual average $PM_{2.5}$ concentration at Taplin was 10.7 µg/m³.
- $PM_{2.5}$ concentrations measured at Richardson were not assessed against the AAQ NEPM standard due to the data capture rate being below 75%.

NO_2

NO_2 was only measured at the Taplin monitoring station in the Port Hedland ambient air quality monitoring network for the FY 2016/17 reporting period. The performance assessment found the following:

- Taplin monitoring station met the 1-hour average AAQ NEPM standard of 246 µg/m³.
- The highest 1-hour average concentration corresponds to 29% of the AAQ NEPM standard.
- Taplin monitoring station met the annual average AAQ NEPM standard of 62 µg/m³.
- The annual average concentration corresponds to 21 % of the AAQ NEPM standard.

Overall, the levels of NO_2 measured at Taplin in FY 2016/17 are low and consistent with the NO_2 levels measured in previous years, including at the now decommissioned sites, as detailed in the Pilbara Ports Authority (PPA) monitoring data analysis report (PEL, 2015).

Data Capture

The PHIC data capture criterion was met for NO_2 and PM_{10}, with greater than 75% data capture per quarter and annually at all monitoring stations. The PHIC data capture criterion was also met for $PM_{2.5}$ at Taplin and Yule monitoring stations, with greater than 75% data capture achieved per quarter and annually.

$PM_{2.5}$ data capture at the BoM monitoring station met the annual PHIC criterion of 75%. However, during Q3 $PM_{2.5}$ data capture did not meet the 75% criterion due to an instrument fault.

$PM_{2.5}$ data capture at the Richardson monitoring station did not meet the annual PHIC criterion of 75% due to an instrument fault that required significant repairs between March and July 2017.

1. INTRODUCTION

Port Hedland, a regional town in Western Australia, is home to the world's largest iron ore export port. Air quality, and specifically dust, has been recognised as a significant environmental issue by the Western Australia Government. Dust in Port Hedland can be generated from natural sources (such as the dry dusty land of the Pilbara region) and anthropogenic sources (such as urban and industrial development, including the handling and stockpiling of bulk commodities such as iron ore).

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. In parallel with the Taskforce, the Port Hedland Industries Council (PHIC) was formed to provide industry cooperation and a more coordinated approach in considering and addressing environment issues from users of the Port.

In 2010, the Taskforce introduced the *Port Hedland Air Quality and Noise Management Plan (*DSD 2010). Amongst other things, it required PHIC to establish and operate an ambient air quality monitoring network in Port Hedland that included real-time data access for the public and preparation of an annual performance report for review by the Taskforce.

PHIC has commissioned Katestone Environmental Pty Ltd (Katestone) to prepare this annual performance report on the Port Hedland ambient air quality monitoring network for FY 2016/17. This is the fifth annual performance report of its kind.

This report includes the following information:

- 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**).

2. 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. In 2009 PHIC established an ambient air quality monitoring network in Port Hedland.

The Port Hedland ambient air quality monitoring network was independently audited in 2013 (PEL, 2013) and again in 2016 (PEL, 2016) to ensure the requirements of the Taskforce were being meet. The key finding of the audits were:

- A number of monitoring sites no longer meet the required standards or the intended purpose they were installed for and were decommissioned
- the revised network still meets the requirements of the Taskforce.

2.2 Monitoring Network Summary

The Port Hedland ambient air quality monitoring network is comprised of eight (8) stations at strategic locations in the Port Hedland region that measure a combination of PM_{10}, $PM_{2.5}$, meteorological conditions (wind speed, wind direction and temperature) and oxides of nitrogen (NO_x).

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.

Real time data from each station is made available via a public website (www.phicmonitoring.com.au).

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

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

Monitoring Station	Latitude	Longitude	Type	Parameter			
				PM_{10}	$PM_{2.5}$	NO_x	Meteorology
BoM	-20.371508°	118.631353	Port Hedland Background	✓	✓		✓
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	✓			✓
Taplin	-20.309746°	118.599700	Residential	✓	✓	✓	✓
Wedgefield	-20.370454°	118.584820	Industrial	✓			✓
Yule	-20.595167°	118.296311	Rural Background	✓	✓		✓

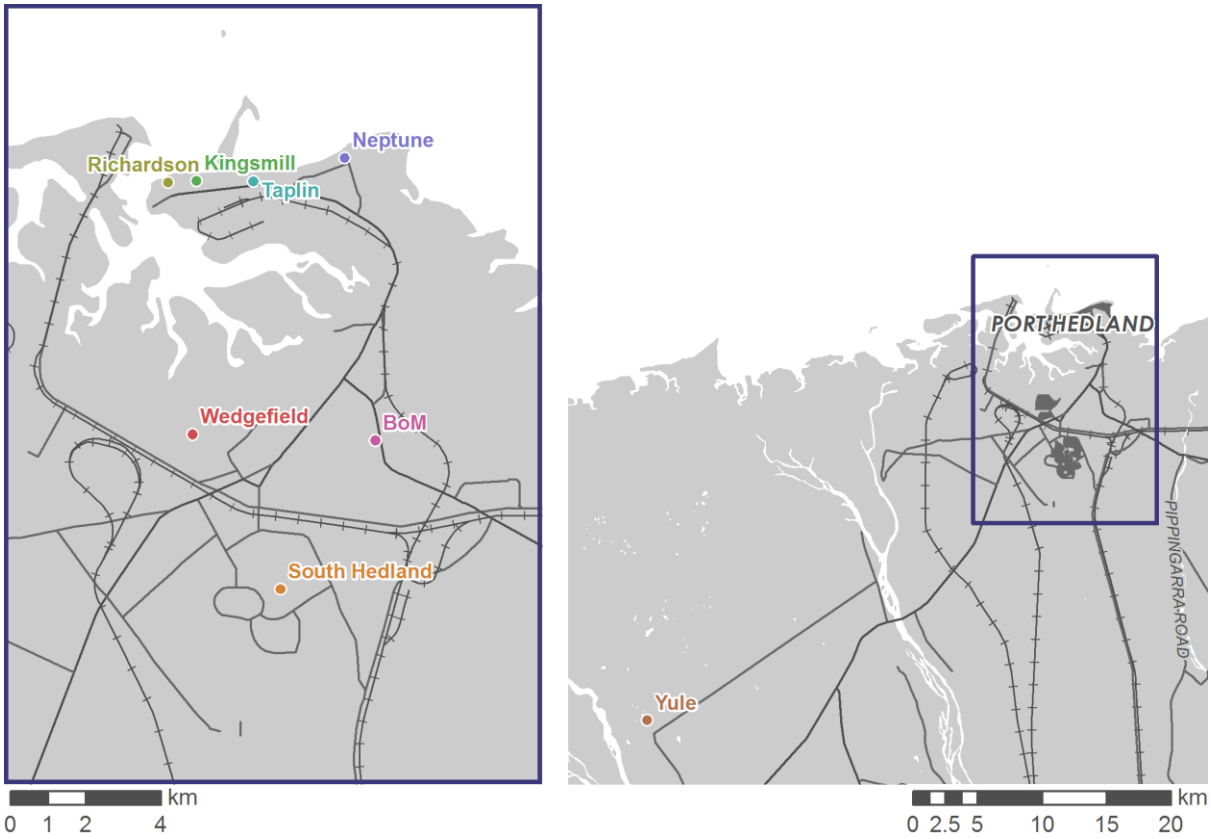


Figure 2-1: Port Hedland Ambient Air Quality Monitoring Network

2.3 Monitoring Methods

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

It should be noted that the Port Hedland BAM1020 monitors are operated in accordance with two monitoring methods. The BAM1020 has both the Australian Standard (AS) accredited beta attenuation method (BAM) for 1-hour average measurement, and a real-time module (light scattering method) that measures PM_{10} and $PM_{2.5}$ concentrations at sub hourly intervals (used for display on the public website). Ecotech provided both the real-time data and BAM accredited data as 5-minute or 10-minute averages.

To produce the BAM data as 5-minute or 10-minute averages, the monitoring system repeats the 1-hour average BAM measurements across each of the 5-minute or 10-minute time intervals that make up each 1-hour average. For example, if the 1-hour average measured by the BAM was 27 µg/m³, the system would record six 10-minute averages of 27 µg/m³ and assign timestamps to each that span the period represented by the 1-hour average. Katestone produced a 1-hour average dataset from each BAM 5-minute or 10-minute average dataset. If a BAM 1-hour average measurement is not obtained or is invalidated then "-99" is repeated across each of the 5-minute or 10-minute time intervals that make up the relevant 1-hour average.

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 & 2016	✓[1]							
	BAM1020	AS/NZS 3580.9.11:2008 & 2016	✓[1]	✓	✓	✓	✓	✓	✓	✓
$PM_{2.5}$	Thermo BAM	AS/NZS 3580.9.12:2013	✓[1]							
	BAM1020	AS/NZS 3580.9.12:2013	✓[1]			✓		✓		✓
NO_x	Ecotech ML9841	AS/NZS 3580.5.1:2011						✓		

Table note:

[1] Thermo BAM replaced by BAM1020 in April 2017

2.4 FY 2016/17 Activities

The Port Hedland ambient air quality monitoring network activities for FY 2016/17 are detailed in Table 2-3. Notable data gaps include the following:

- $PM_{2.5}$ Thermo BAM at BoM monitoring station faulted on 6 February 2017 and was decommissioned. Replaced with a BAM1020 on 11 April 2017.
- $PM_{2.5}$ BAM1020 at Richardson monitoring station faulted on 22 March 2017. Attempts to fix the fault were unsuccessful and the unit was replaced on 6 July 2017 (outside of FY 2016/17 reporting period).

Further to the data gaps noted above, the Taplin monitoring station PM_{10} instrument went offline for a period of five continuous days between 27 January 2017 to 1 February 2017 due to an instrument failure, following increased rain events and subsequent recommissioning calibrations of a replacement unit. Investigation from the monitoring contractor has rectified this issue and has confirmed no further impact to the data set has occurred.

Table 2-3: FY 2016/17 Port Hedland ambient air quality monitoring network activities

Monitoring Station	Parameter	Averaging time [A]	Q1			Q2			Q3			Q4		
			July 16	August 16	September 16	October 16	November 16	December 16	January 17	February 17	March 17	April 17	May 17	June 17
BoM	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓[B]		✓[B]	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kingsmill	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neptune	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Richardson	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓[C]			
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
South Hedland	PM_{10}	5-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	5-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Taplin	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓[D]	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NO_x	5-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wedgefield	PM_{10}	5-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	5-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yule	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	$PM_{2.5}$		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table Note:

✓ Shaded and ticked cells indicate a complete month of data for the stated parameter. Unshaded ticked cells indicate a partially complete month for that parameter. The table note indicates the extent to which data is missing. Unticked, unshaded cells indicate that no data was collected in the month.

[A] All Port Hedland BAM1020 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] BoM $PM_{2.5}$ Thermo BAM faulted on 6 February 2017 and was decommissioned. Replaced with a $PM_{2.5}$ BAM1020 on 11 April 2017.

[C] Richardson $PM_{2.5}$ BAM1020 faulted on 22 March 2017. Unit not replaced until 6 July 2017 (outside of FY 2016/17 reporting period).

[D] Taplin PM_{10} BAM1020 faulted on 27 January 2017 and was offline until 1 February 2017.

2.5 Data Processing

The FY 2016/17 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:

- Quality assured Port Hedland monitoring data was supplied by Ecotech for each site, as either 5-minute or 10-minute averaged data, depending on the site/parameter (see Table 2-3).
- For the stations using a BAM1020, two sets of data were provided: one set being the raw real-time data that was displayed on the public website and the second set (beta data) being the BAM1020 measurements reported as 5-minute or 10-minute averages (see Section 2.3). Unless specifically stated, only the beta data is considered in this report as it is in accordance with the AS method.
- Further quality assurance was performed by Katestone that included:
    - ensuring data fell within acceptable ranges (e.g. wind directions between 0° and 360°)
    - checking for outliers and inconsistencies
    - checking for abnormal patterns
    - checking that the two BAM1020 and light scattering datasets (real-time and beta data) showed good correlation.
- The Katestone quality assurance found that all the FY 2016/17 data was acceptable for final processing.

Final processing included the following steps:

- All 1-hour average data was combined into a single file.
- The light scattering data was separated from the 1-hour data and not analysed unless required to investigate elevated events.
- Data capture rates from all stations and air pollutants 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 the following:
    - Maximum values
    - Mean value
    - Percentiles
    - Number of exceedance of relevant air pollutant standards and guidelines
    - Time series graphs
    - Wind roses
    - Pollution polar plots.

Events when the PM_{10} concentration was found to be above the interim PM_{10} guideline at the Taplin monitoring station (see Section 2.6.2) were further investigated through the examination of wind roses, PM_{10} polar plots and time series plots. To maximise the resolution of the available data, this analysis was made using the light scattering measurements of PM_{10} (10-minute resolution). The greater temporal resolution allows for a more detailed understanding of the relationship between concentrations and meteorology throughout the day. Further detail on the event day analysis 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

Network performance (Section 4) is recorded against the data capture rate and air quality guidelines and standards as:

- Met
- Not met
- Not demonstrated (as a result of inadequate data recovery or data quality)

2.6.1 Data Capture Rate

The network performance for data capture rate for each air 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%. Performance criteria is based on 1-hour average data.

2.6.2 Air Quality Guidelines and Standards

Air quality guidelines and standards for the pollutants measured by the Port Hedland ambient air quality network (PM_{10}, $PM_{2.5}$ and NO_x) that have been used to determine performance of FY 2016/17 monitoring have been selected from local and federal legislation.

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 (the Taskforce released a draft version of its 5-year review in August 2017. The report recommends that the interim guideline of 70 µg/m³ (with 10 exceedances) should apply to residential areas of Port Hedland. The report was advertised for public comment and at the time of publishing this Annual Monitoring Report the Government of Western Australia had not committed to any recommendations or responded to the report).

At the federal level, the National Environment Protection Council (NEPC) set air quality standards for criteria pollutants, which includes PM_{10}, $PM_{2.5}$ and NO_2, under AAQ NEPM. These are defined as follows:

- Maximum concentration of 50 µg/m³ for 24-hour average PM_{10}
- Maximum concentration of 25 µg/m³ for annual average PM_{10}
- Maximum concentration of 25 µg/m³ for 24-hour average $PM_{2.5}$
- Maximum concentration of 8 µg/m³ for annual average $PM_{2.5}$
- Maximum concentration of 246 µg/m³ for 24-hour average NO_2 with maximum allowable exceedances of 1 day a year
- Maximum concentration of 62 µg/m³ for annual average NO_2.

Relevant air quality standards and guidelines used to determine network 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	70 [A, B]	Interim Guideline
	24-hour	50	AAQ NEPM 2016
	Annual	25	
$PM_{2.5}$	24-hour	25	AAQ NEPM 2016
	Annual	8	
NO_2	1-hour	246[C]	AAQ NEPM 2016
	Annual	62	

Table note:
[A] 10 exceedance days allowed per year due to industry
[B] Applies to residential areas at Taplin Street
[C] Maximum allowable exceedances of 1 day a year

3. SUMMARY OF PORT HEDLAND METEOROLOGICAL 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 in the Port Hedland region.

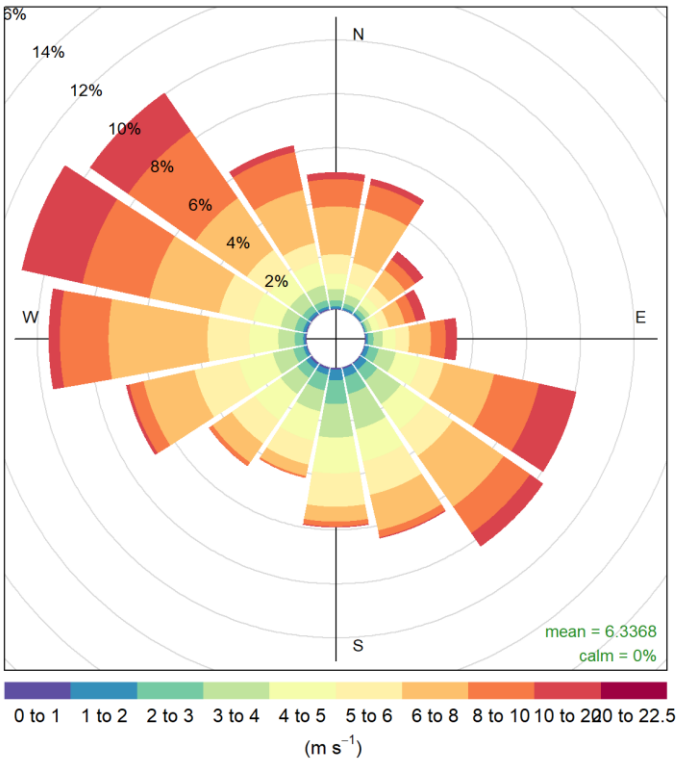
Exposed dust sources (be it from industry sources, other anthropogenic sources or natural sources), will have higher dust emissions during dry conditions and strong winds. The dust emissions will also have a greater radius of impact during periods of stronger wind speeds due to dust remaining suspended in the air for longer periods and therefore 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 monitoring stations during FY 2016/17 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 distribution of winds shown in Figure 3-1, Figure 3-2 and Figure 3-3 are typical of the Port Hedland region.
- 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 and northeast quadrants are less common but occur on occasion.
- Wind speeds measured at all three monitoring stations are relatively strong (important for dust generation and dispersion).
- 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 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, which is within a residential area where structures and urban development are likely to reduce wind speeds.
- The seasonal distribution of winds is characterised by the climate drivers in Port Hedland. During spring and summer (wet season) the winds are generally from the northwest quadrant. During autumn and winter (dry season) the winds are predominately from the southeast quadrant.



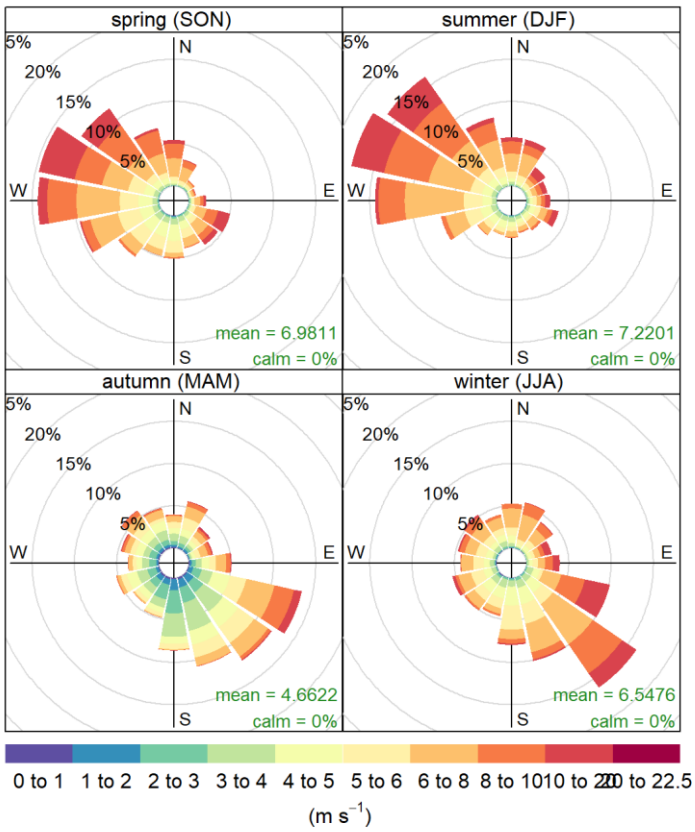
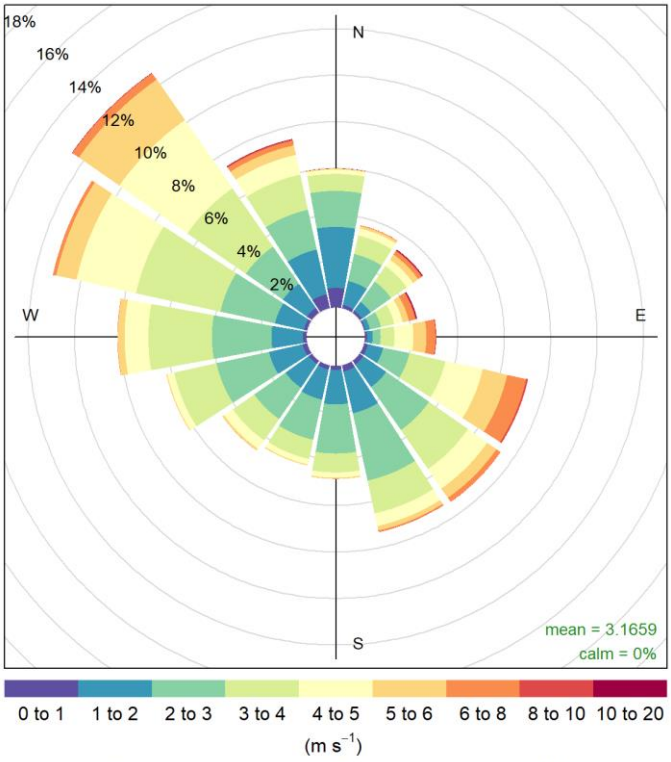


Figure 3-1: FY 2016/17 wind roses for BoM annual (top) seasonal (bottom)



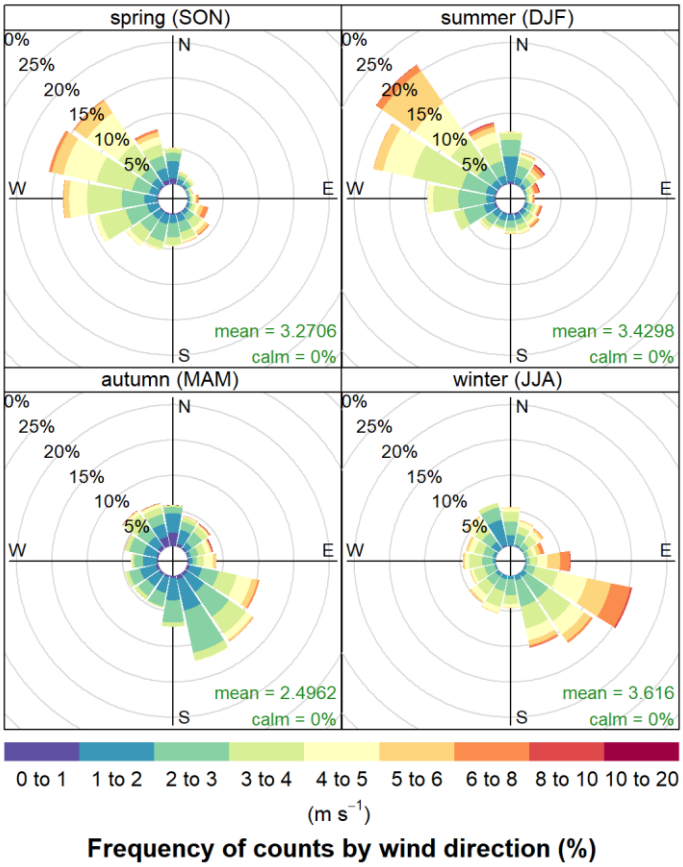
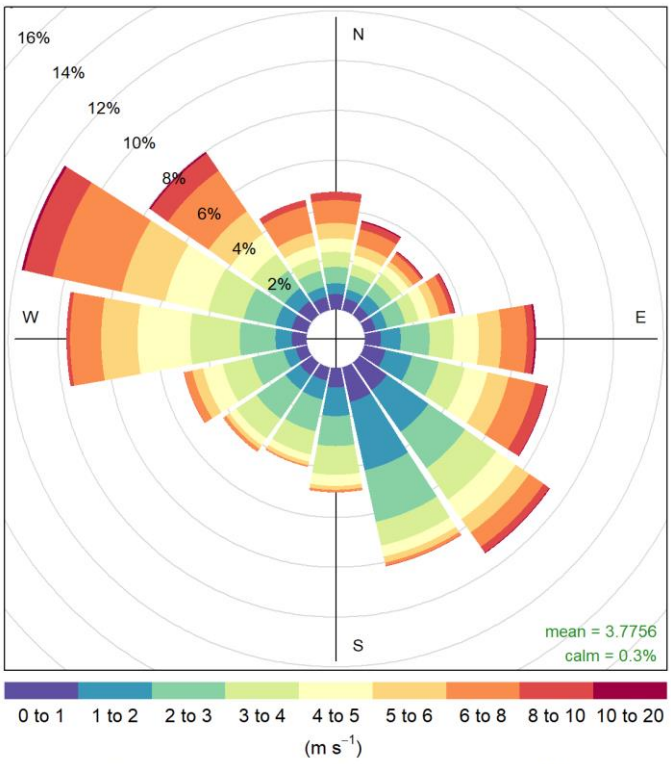


Figure 3-2: FY 2016/17 wind roses for Taplin annual (top) seasonal (bottom)



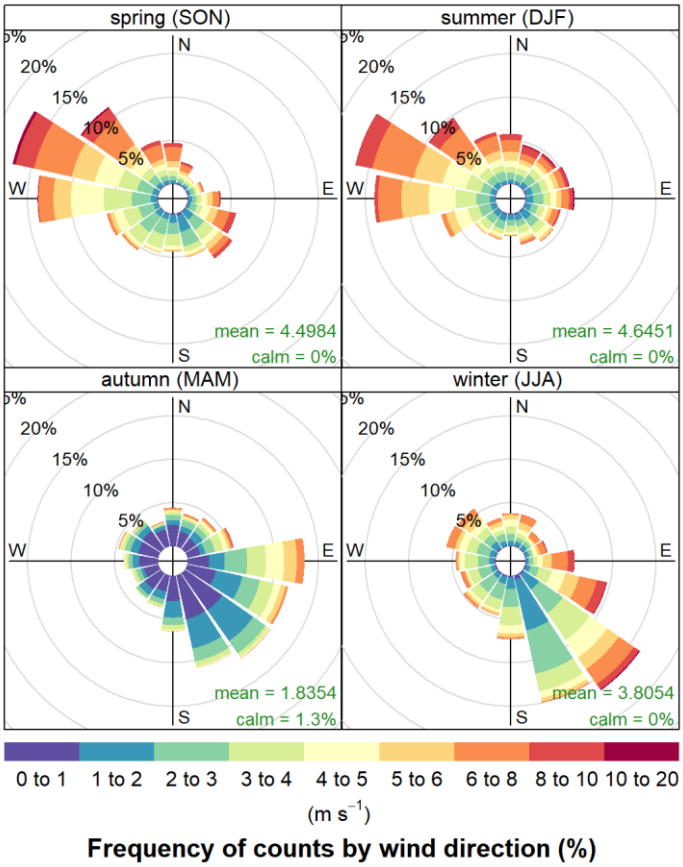


Figure 3-3: FY 2016/17 wind roses for Yule annual (top) seasonal (bottom)

4. AIR QUALITY MONITORING DATA - AIR POLLUTANT PERFORMANCE

The following section describes 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 all eight (8) monitoring stations during FY 2016/17.

4.1.1 Data Capture

Data capture rates for 1-hour average concentrations of PM_{10} for each monitoring station in FY 2016/17 are detailed in Table 4-1. All stations achieved a quarterly and annual PM_{10} capture rate greater than 84%. This meets the PHIC criterion of 75% data capture.

Table 4-1: FY 2016/17 1-hour average PM_{10} Data Capture Summary

Monitoring Station	PM_{10} Data Capture Rate (%)					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	92	92	94	84	90	Met
Kingsmill	99	92	97	95	96	Met
Neptune	95	89	91	88	91	Met
Richardson	100	85	96	100	95	Met
South Hedland	98	97	97	95	97	Met
Taplin	98	100	92[A]	99	97	Met
Wedgefield	100	100	93	100	98	Met
Yule	98	89	93	99	95	Met

Table Note:

[A] Taplin PM_{10} BAM1020 faulted on 27 January 2017 and was offline until 1 February 2017.

4.1.2 Comparison to Air Quality Standards and Guideline

The maximum measured 24-hour average PM_{10} concentration (calculated as midnight to midnight) and the number of days above the 24-hour average AAQ NEPM standard and interim guideline for each station are detailed in Table 4-2. The average PM_{10} concentration for FY 2016/17 for each station is detailed in Table 4-3.

The PM_{10} measurements show that for FY 2016/17:

- The 24-hour average PM_{10} concentration was above 70 µg/m³ for 3 days at Taplin, (against the interim guideline which allows for up to 10 days above 70 µg/m³).
- All monitoring stations exceeded the 24-hour average PM_{10} AAQ NEPM standard of 50 µg/m³. The number of exceedances ranged from one day at Yule to 99 days at Wedgefield.
- The average PM_{10} concentration for FY 2016/17 exceeded the AAQ NEPM annual average standard of 25 µg/m³ at Kingsmill, Neptune, Richardson, Taplin and Wedgefield.
- The average PM_{10} concentration for FY 2016/17 complied with the AAQ NEPM annual average standard of 25 µg/m³ at BoM, South Hedland and Yule.

It is noted that during Q3 the Taplin PM_{10} BAM1020 was offline for a period of 6 consecutive days between 27 January 2017 and 1 February 2017 due to water ingress following a period of wet weather. Whilst the instrument fault did not affect the data capture rate performance (still achieved 92%) it was not possible to demonstrate compliance against the PM_{10} interim guideline during this time. To understand PM_{10} during this time Appendix A details a summary of the 24-hour average PM_{10} concentrations at the other seven monitoring stations, which shows that PM_{10} concentrations at the other seven monitoring stations were below the interim guideline.

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

Monitoring Station ID	Maximum 24-hour average PM_{10} concentration ($\mu g/m^3$)	Number of days >50 $\mu g/m^3$ (AAQ NEPM)	Performance (AAQ NEPM)	Number of days >70 $\mu g/m^3$ (Taskforce)	Performance (Taskforce)
BoM	80.3	7	Not met	-	-
Kingsmill	104.7	83	Not met		
Neptune	104.7	29	Not met		
Richardson	89.6	90	Not met		
South Hedland	261.3	8	Not met		
Taplin	80.6	27	Not met	3	Met
Wedgefield	162.2	99	Not met	-	-
Yule	57.7	1	Not met		

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

Monitoring Station ID	Annual average PM_{10} concentration ($\mu g/m^3$)	Performance (AAQ NEPM of 25 $\mu g/m^3$)
BoM	21.4	Met
Kingsmill	40.4	Not met
Neptune	27.4	Not met
Richardson	40.0	Not met
South Hedland	22.2	Met
Taplin	31.3	Not met
Wedgefield	43.1	Not met
Yule	15.4	Met

4.1.3 PM_{10} Timeseries Analysis

Timeseries plots of the 24-hour average PM_{10} concentration for FY 2016/17 for each monitoring station are shown in Figure 4-1. The three 24-hour average concentrations of PM_{10} above 70 $\mu g/m^3$ at Taplin are accentuated using a darker colour.

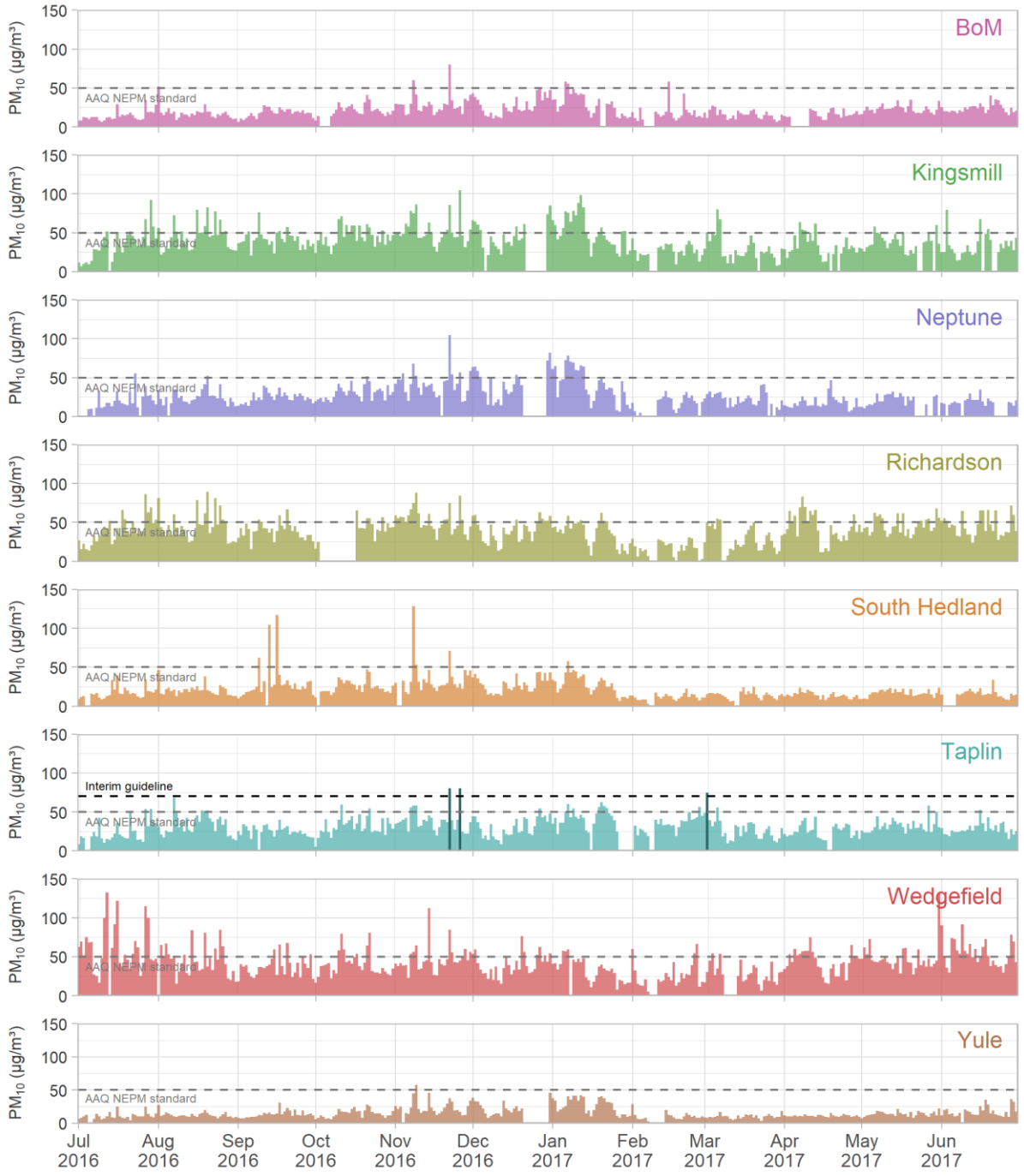


Figure 4-1: FY 2016/17 24-hour average PM_{10} concentration time series plots

4.2 $PM_{2.5}$

$PM_{2.5}$ was measured at four (4) monitoring stations (BoM, Richardson, Taplin and Yule) during FY 2016/17.

4.2.1 Data Capture

Data capture rates for 1-hour average concentrations of $PM_{2.5}$ for each monitoring station in FY 2016/17 are detailed in Table 4-4.

The Taplin and Yule monitoring stations achieved quarterly and annual $PM_{2.5}$ capture rates greater than 89% and meet the PHIC criterion of 75% data capture.

The BoM monitoring station achieved an annual $PM_{2.5}$ capture rate of 81%, which meets the PHIC criterion of 75%. However, during Q3, $PM_{2.5}$ data capture was 40% due to an instrument fault on 6 February 2017 that was not fixed until 11 April 2017.

The Richardson monitoring station achieved an annual $PM_{2.5}$ capture rate of 71%, which does not meet the PHIC criterion of 75%. This was due to an instrument fault on 22 March 2017 after the monitor was damaged by water in a storm that was not fixed until 6 July 2017.

Table 4-4: FY 2016/17 1-hour average $PM_{2.5}$ Data Capture Summary

Monitoring Station ID	2016/17 $PM_{2.5}$ Data Capture Rate (%)					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	98	98	40	85	81	Met
Richardson	100	98	85	0	71	Not met
Taplin	99	100	98	98	99	Met
Yule	97	89	93	98	95	Met

4.2.2 Comparison to Air Quality Standards

The maximum measured 24-hour average (midnight to midnight) and annual average concentrations of $PM_{2.5}$ are detailed for each station in Table 4-5. The number of days above the AAQ NEPM standard is also presented.

The $PM_{2.5}$ measurements show that for FY 2016/17:

- $PM_{2.5}$ concentrations at BoM and Yule monitoring stations were below the 24-hour average and annual average AAQ NEPM standards of 25 µg/m³ and 8 µg/m³, respectively.
- Taplin monitoring station exceeded the $PM_{2.5}$ 24-hour average AAQ NEPM standards of 25 µg/m³ for one day. A 24-hour average $PM_{2.5}$ concentration of 28.3 µg/m³ occurred on 22 November 2016 (it should be noted that the 24-hour average PM_{10} concentration at Taplin exceeded 70 µg/m³ on the same day and was a result of a regional dust event, as discussed in Section 7.3).
- Taplin monitoring station recorded an annual average $PM_{2.5}$ concentration of 10.7 µg/m³, exceeding the annual average AAQ NEPM standard of 8 µg/m³
- Performance of $PM_{2.5}$ at Richardson monitoring station was not demonstrated due to insufficient data capture.

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 of 25 µg/m³)[A]	Annual average $PM_{2.5}$ concentration (µg/m³)	Performance (AAQ NEPM of 8 µg/m³)
BoM	24.2	0	Met	6.3	Met
Richardson	14.6	0	Not demonstrated[B]	5.6	Not demonstrated[B]
Taplin	28.3	1	Not met	10.7	Not met
Yule	17.3	0	Met	3.6	Met

Table note:

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

[B] Not demonstrated due to Richardson annual $PM_{2.5}$ data capture rate below 75%

4.2.3 $PM_{2.5}$ Timeseries Analysis

A timeseries plot of the 24-hour average $PM_{2.5}$ concentration for FY 2016/17 for each monitoring station is shown in Figure 4-2. The 24-hour average $PM_{2.5}$ concentration above the AAQ NEPM standard at Taplin is accentuated through using a darker colour.

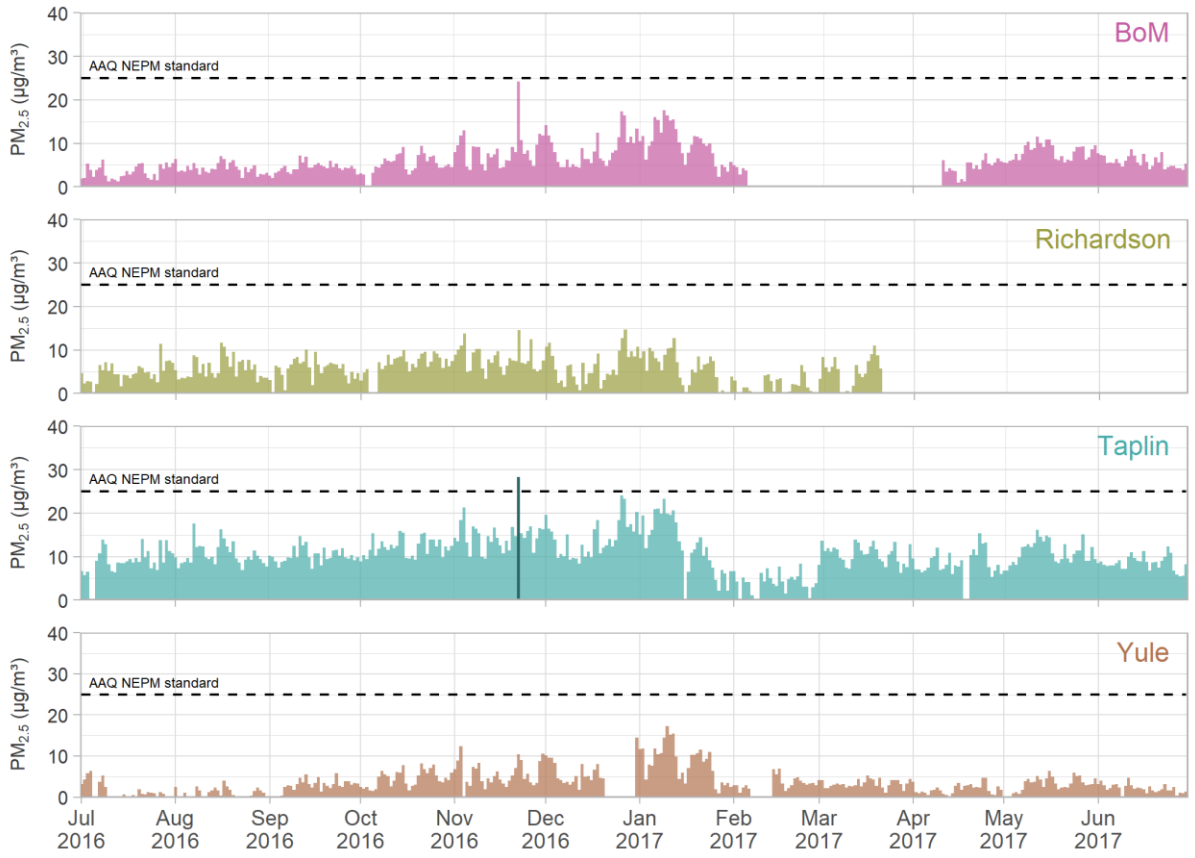


Figure 4-2: FY 2016/17 24-hour average $PM_{2.5}$ time series plots

4.3 Oxides of Nitrogen

NO_x was measured at the Taplin monitoring station during FY 2016/17. NO_x monitoring included nitrogen dioxide (NO_2), nitric oxide (NO) and total NO_X (reported as NO_2).

4.3.1 Data Capture

Data capture rates for 1-hour average concentrations of NO_x for the Taplin monitoring station are detailed in Table 4-6. Taplin monitoring station achieved quarterly and annual NO_x capture rate of 94%, which meets the PHIC criterion of 75% data capture.

Table 4-6: FY 2016/17 1-hour average NO_x Data Capture Summary

Monitoring Station ID	2016/17 NO_x Data Capture Rate (%)					Performance
	Q1	Q2	Q3	Q4	Annual	
Taplin	94	94	94	94	94	Met

4.3.2 Comparison to Air Quality Standards

The maximum measured 1-hour average and annual average concentrations of NO_2 at Taplin are detailed in Table 4-7. The NO_2 measurements show that for FY 2016/17:

- Taplin monitoring station met the 1-hour average AAQ NEPM standard of 246 µg/m³
- The highest 1-hour average concentration corresponds to 29% of the AAQ NEPM standard
- Taplin monitoring station met the annual average AAQ NEPM standard of 62 µg/m³
- The annual average concentration corresponds to 21 % of the AAQ NEPM standard.

Overall, the levels of NO_2 measured at Taplin in FY 2016/17 are low and consistent with the NO_2 levels measured in previous years, including at the now decommissioned sites, as detailed in the Pilbara Ports Authority (PPA) monitoring data analysis report (PEL, 2015).

Table 4-7: FY 2016/17 Air Quality Monitoring - NO_2 Data Summary

Monitoring Station ID	Maximum 1-hour average NO_2 concentration (µg/m³)	Performance (AAQ NEPM of 246 µg/m³)	Annual average NO_2 concentration (µg/m³)	Performance (AAQ NEPM of 62 µg/m³)
Taplin	70.5	Met	13.0	Met

4.3.3 NO_2 Time Series Analysis

A timeseries plot of the 1-hour average NO_2 concentration for FY 2016/17 at Taplin monitoring station is 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 the station.

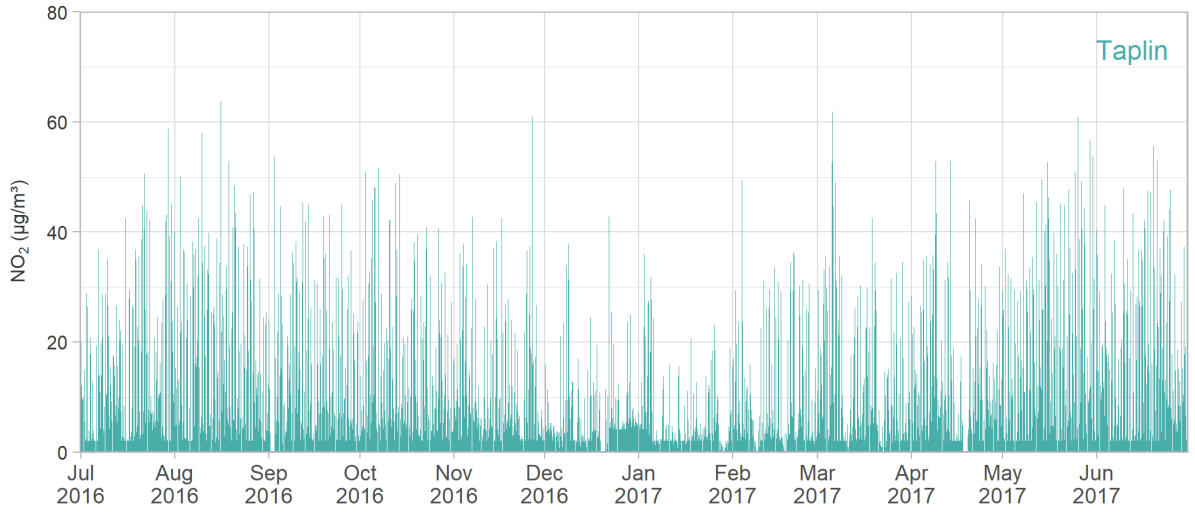


Figure 4-3: FY 2016/171-hour average NO_2 time series plot for Taplin

5. AIR QUALITY MONITORING DATA - MONITORING STATION PERFORMANCE

The following section describes the performance of each monitoring station in the Port Hedland ambient air quality monitoring network during the FY 2016/17.

5.1 Taplin

The Taplin monitoring station is located in Port Hedland (Figure 2-1) and is generally representative of a residential site in Port Hedland township. Parameters measured at the Taplin station are:

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

It should be noted that Taplin is the only station where measurements of 24-hour average concentrations of PM_{10} are compared with the Taskforce's interim guideline for PM_{10}.

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

Table 5-1: Taplin Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Interim Guideline / Standard		Number of instances above the Interim Guideline / Standard	Performance against Interim Guideline / Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	70[A]	24-hour	3	Met
		50	24-hour	27	Not met
		25	Annual	1	Not met
$PM_{2.5}$	Met	25	24-hour	1	Not met
		8	Annual	1	Not met
NO_2	Met	246	1-hour	0	Met
		62	Annual	0	Met

Table note:
[A] 10 exceedances of 24-hour average allowed per year due to industry

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 township region. Parameters measured at the BoM station are:

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

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

Table 5-2: BoM Monitoring Station Performance Summary

Pollutant	Data Capture Performance	Standard		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	7	Not met
		25	Annual	0	Met
$PM_{2.5}$	Met	25	24-hour	0	Met
		8	Annual	0	Met

5.3 Kingsmill

The Kingsmill monitoring station is located in Port Hedland (Figure 2-1) and is generally representative of a residential monitoring site in Port Hedland township. Parameters measured at the Kingsmill station include:

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

A summary of the air pollutant 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		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	83	Not met
		25	Annual	1	Not met

5.4 Neptune

The Neptune monitoring station is located at Port Hedland (Figure 2-1) and is generally representative of a residential monitoring site in the eastern part of Port Hedland township. Parameters measured at the Neptune station include:

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

A summary of the air pollutant 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		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	29	Not met
		25	Annual	1	Not met

5.5 Richardson

The Richardson monitoring station is located at Port Hedland (Figure 2-1) and is generally representative of a residential monitoring site in the western part of Port Hedland township. Parameters measured at the Richardson station include:

- PM_{10}
- $PM_{2.5}$

- Wind speed and wind direction.

A summary of the air pollutant 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		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	90	Not met
		25	Annual	1	Not met
$PM_{2.5}$	Not met	25	24-hour	0	Not determined [A]
		8	Annual	0	Not determined [A]

Table note:
[A] Performance not determined due to annual $PM_{2.5}$ data capture rate below 75%

5.6 South Hedland

The South Hedland monitoring station is located in the South Hedland township (Figure 2-1) and is generally representative of the residential community away from the port. Parameters measured at the South Hedland station include:

- PM_{10}
- Wind speed and wind direction

A summary of the air pollutant 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		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	8	Not met
		25	Annual	0	Met

5.7 Wedgefield

The Wedgefield monitoring station is located within light industrial and residential areas (Figure 2-1) and is generally representative of the industrial area to the south of Port Hedland township. Parameters measured at the Wedgefield station include:

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

A summary of the air pollutant 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		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	99	Not met
		25	Annual	1	Not met

5.8 Yule

The Yule monitoring station is located 30 km away from Port Hedland (Figure 2-1) and is generally representative of a rural background monitoring site, removed from industrial sources. Parameters measured at the Yule station include:

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

A summary of the air pollutant 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		Number of instances above the Standard	Performance against Standard
		Concentration (µg/m³)	Averaging Period		
PM_{10}	Met	50	24-hour	1	Not met
		25	Annual	0	Met
$PM_{2.5}$	Met	25	24-hour	0	Met
		8	Annual	0	Met

6. PM_{10} TRENDS

This section presents analysis of trends in the data measured by the Port Hedland ambient air quality monitoring network data for the five years of PM_{10} data.

6.1 24-hour Average PM_{10} - Interim Guideline

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

The data shows the following:

- The most recent year (FY 2016/17) recorded the lowest number of days above 70 µg/m³ (3 days) against the interim guideline which allows for up to 10 days above this limit due to industry per year.
- Over the five years of annual reporting, one year (FY 2012/13) showed more than 10 days when the 24-hour average concentration of PM_{10} was greater than 70 µg/m³.
- Figure 6-1 also shows the Port Hedland export tonnage for the past five reporting years. The figure clearly shows that export tonnage at Port Hedland has steadily increased whilst the number of days above the interim guideline at Taplin has decreased over the fiver reporting years.

Table 6-1: Number of 24-hour average PM_{10} concentrations above the interim guideline at Taplin, per reporting year

Monitoring Station	Interim Guideline (µg/m³)	Number of days above Interim Guideline				
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17
Taplin	70[A]	17	6	10	10	3

Table note:
[A] 10 exceedances of 24-hour average allowed per year due to industry

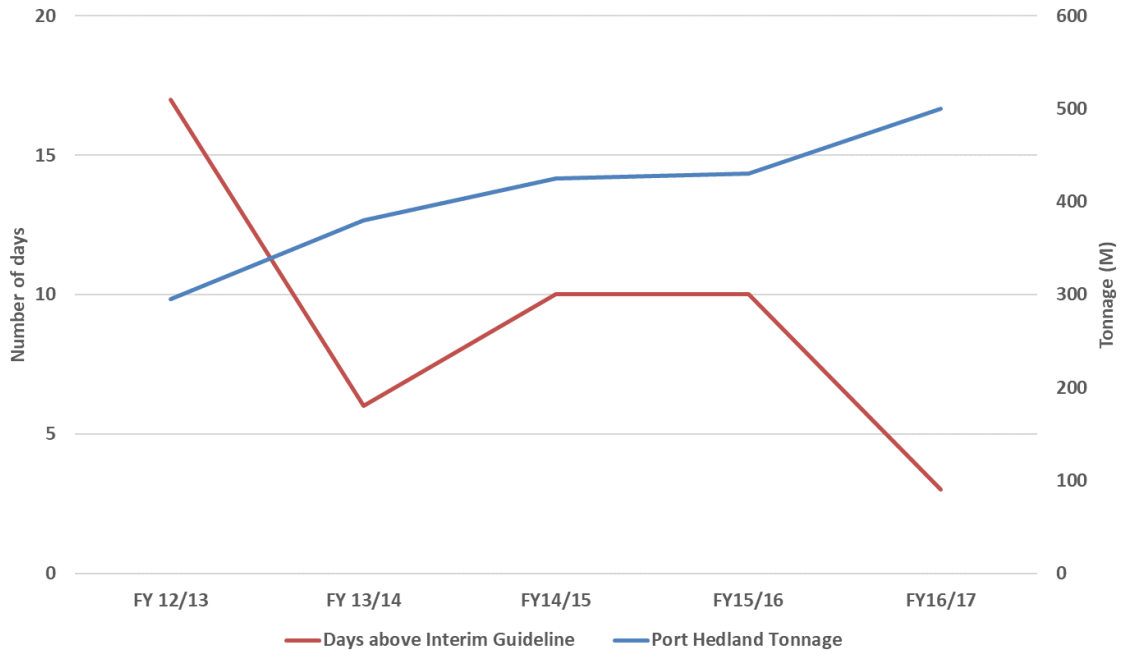


Figure 6-1: Number of days above the 24-hour average PM_{10} interim guideline for each reporting year compared with Port Hedland export tonnage

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

The number of days that the 24-hour average concentration of PM_{10} at each Port Hedland monitoring station was above the AAQ NEPM standard of 50 µg/m³ for each reporting year is presented in Table 6-2 and Figure 6-2.

The data shows the following:

- The number of days above the PM_{10} 24-hour average AAQ NEPM standard ranges from 1 day at Yule in FY 2016/17 to 169 days at Wedgefield in FY 2014/15
- The data shows a general downward trend over the last three reporting years at each station with the exception Richardson.
- The downward trend is in contrast to the Port Hedland export tonnage that has steadily increased over the past three reporting years (as shown in Figure 6-1)
- In FY 2016/17 Richardson recorded its highest number of days above the PM_{10} 24-hour average AAQ NEPM Standard (90 days).

Further analysis of the PM_{10} 24-hour average concentrations at Richardson for the last two reporting years showed that:

- The range of PM_{10} 24-hour average concentrations were similar between FY 2015/16 and FY 2016/17.
- FY 2016/17 showed a similar or slightly greater number of days above the PM_{10} 24-hour average AAQ NEPM standard across the first three quarters of FY 2016/17 compared with FY2015/16.
- Q4 showed a large difference in the number of days above the PM_{10} 24-hour average AAQ NEPM standard between FY 2015/16 (2 days) and FY 2016/17 (32 days). The increase can be attributed to a local source such as urban development that would not impact on other sites in Port Hedland.

Table 6-2: Summary of 24-hour average PM_{10} concentrations above the AAQ NEPM standard for the last 5 financial years

Monitoring Station	AAQ NEPM Standard (µg/m³)	Number of days above the Standard				
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17
BoM	50	24	10	17	12	7
Kingsmill		89	98	156	112	83
Neptune		25	25	67	43	29
Richardson		74	50	79	39	90
South Hedland		23	13	19	12	8
Taplin		48	48	55	48	27
Wedgefield		157	148	169	150	99
Yule		24	8	18	5	1

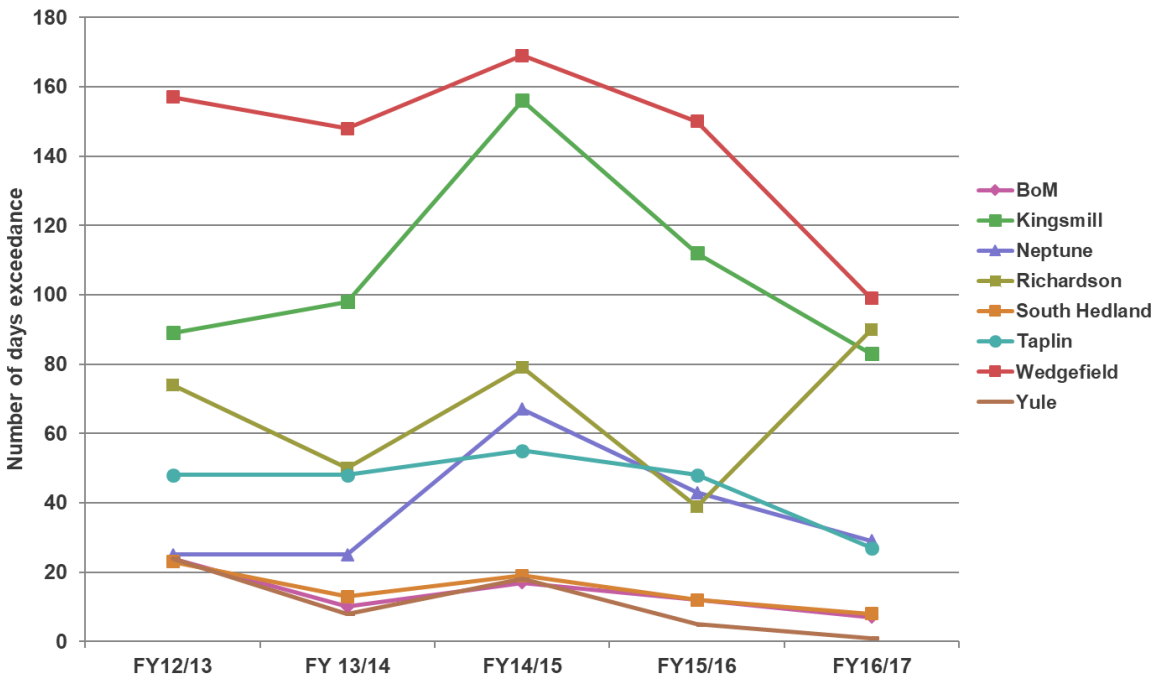


Figure 6-2: Number of days above the 24-hour average PM_{10} AAQ NEPM standard for each reporting year

6.3 Annual Average PM_{10} – AAQM NEPM Standard

An annual average PM_{10} standard was introduced into the AAQ NEPM in 2016. Accordingly, the annual average PM_{10} concentration at each Port Hedland monitoring station for the last two reporting years is presented in Table 6-3 and Figure 6-3. Annual average PM_{10} was not required to be reported prior to the FY 2015/16 reporting year.

The data shows the following:

- Annual average PM_{10} in FY 2016/17 decreased compared to FY 2015/16 at all sites except for Richardson
- The urban development changes near Richardson that occurred in Q4 of FY 2016/17 (as discussed in the previous section) also resulted in a higher annual average PM_{10} compared with in FY 2015/16.

Table 6-3: Summary of annual average PM_{10} concentrations for the last 2 reporting years

Monitoring Station	AAQ NEPM Standard (µg/m³)	Annual average PM_{10} concentration (µg/m³)				
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16[A]	FY 2016/17
BoM	25	Not required to report			25.4	21.4
Kingsmill					44.7	40.4
Neptune					32.3	27.4
Richardson					35.2	40.0
South Hedland					26.5	22.2
Taplin					35.6	31.3
Wedgefield					51.1	43.1
Yule					18.5	15.4

Table note:
[A] AAQ NEPM annual average PM_{10} standard introduced in 2016

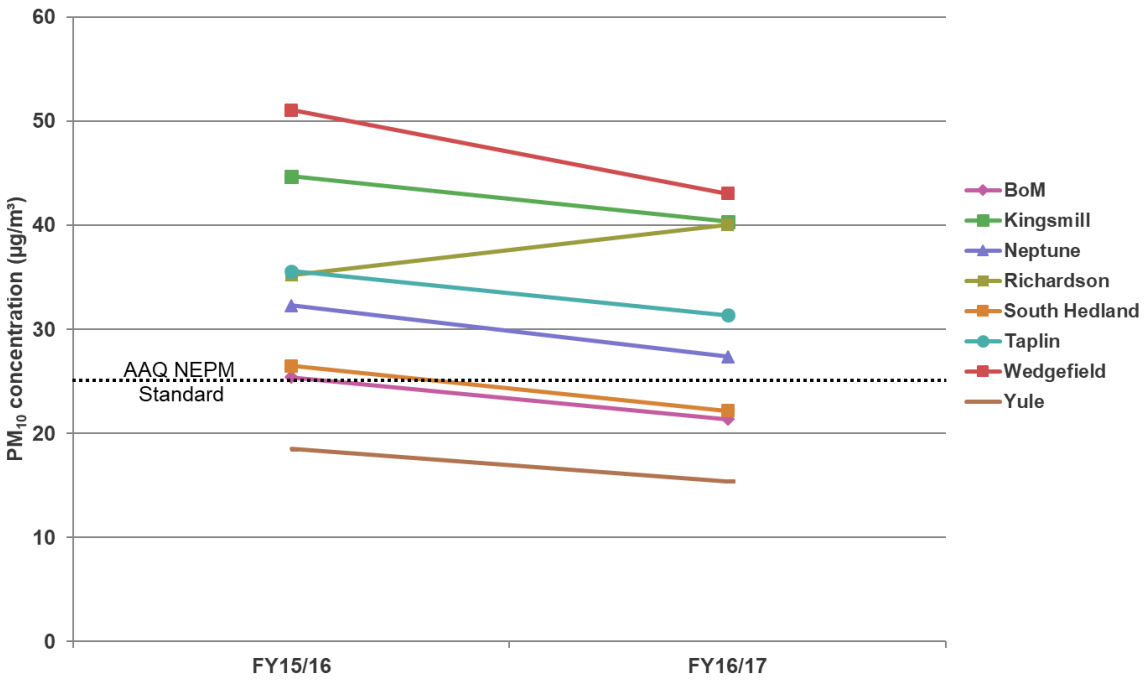


Figure 6-3: Annual average PM_{10} for the last two annual reports

6.3.1 PM_{10} Statistics

The following summary statistics for 24-hour average PM_{10} are displayed graphically in Appendix A for the past five reporting 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 concentrations of PM_{10} show a stable or slightly decreasing trend at all monitoring stations for the latest reporting year compared to the last 5 years, except for South Hedland.
- The maximum 24-hour average concentration of PM_{10} at South Hedland increased significantly for the latest reporting year compared to the previous year, with a result of 261 µg/m³ measured on 12 September 2016.
- This is considered to be a localised event as the other percentiles at South Hedland show a stable or decreasing trend.
- 99th, 98th and 95th percentile 24-hour average concentrations of PM_{10} show a stable or slightly decreasing trend at all monitoring stations over the five reporting years
- 50th percentile 24-hour average concentration of PM_{10} (indicative of the annual average) exhibit a stable trend at all monitoring stations over the five reporting years.

7. INVESTIGATION OF PM_{10} EVENTS

The Taskforce interim guideline for 24-hour average PM_{10} allows for 10 days above 70 µg/m³ at Taplin as a result of industry. During FY 2016/17, there were only three days above the interim guideline of 70 µg/m³. Notwithstanding this, the following sections investigate the three days at Taplin when the 24-hour average PM_{10} concentration was above 70 µg/m³.

7.1 Investigation methodology

The aim of the following investigation is to determine whether the events when the 24-hour average concentration of PM_{10} at Taplin was above 70 µg/m³ should be termed 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 "exceedances" 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. The background monitoring station at Yule is also considered when determining regional events.
    - 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 – described below) 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 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°.

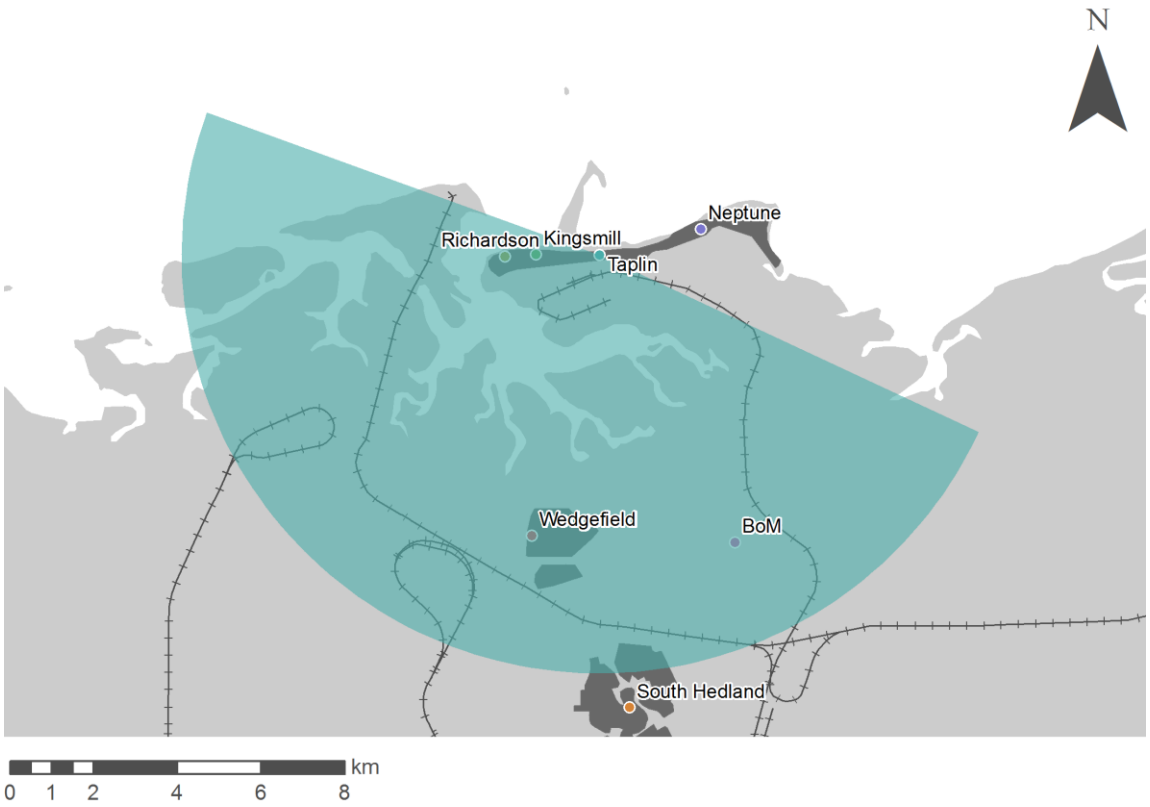


Figure 7-1: Port Hedland industry arc of influence (shaded area) at Taplin monitoring station

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 vector-averaged wind direction measurements for the three event days at Taplin are shown. Wind speeds have been grouped based on the data range for each day. 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 polar plot 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. Again, the 10-minute average data has been used to increase resolution.

7.2 Overview

Table 7-1 details the three days when the Taplin 24-hour average PM_{10} concentration was above 70 µg/m³ during FY 2016/17, 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.

Table 7-1 Summary of Taplin 24-hour average PM_{10} concentrations above 70 µg/m³

Date	24-hour average PM_{10} (µg/m³)			Likely cause (as determined by methodology presented in Section 7.1)
	Taplin	BoM	Yule	
22 November 2016	**80.6**	80.3	37.3	Regional
26 November 2016	**75.8**	26.4	15.8	Industry
2 March 2017	**74.4**	11.7	7.8	Industry

7.3 22 November 2016

On the 22 November 2016, the 24-hour average PM_{10} concentration at Taplin was 80.6 µg/m³, 80.3 µg/m³ at BoM and 37.3 µg/m³ at Yule. The 24-hour average concentrations at Taplin (>70 µg/m³) and BoM (>60 µg/m³) indicate a regional event. The PM_{10} concentration at Yule was less than 60 µg/m³, however, at 37.3 µg/m³ this represents a 24-hour average concentration that is relatively elevated - in the 98th percentile range for Yule.

The 24-hour average concentrations of PM_{10} at the five other Port Hedland monitoring stations on 22 November 2016 were between 70 µg/m³ and 105 µg/m³. This provides further evidence that a regional event occurred on 22 November 2016.

A wind rose and PM_{10} polar plot of the Taplin data for 22 November 2016 is shown in Figure 7-2 and 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 indicate the following:

- Winds on 22 November 2016 were predominantly from the northwest quadrant. During the early morning, winds were strongest and from the west. As the day progressed, the winds shifted to a north-northwest and north direction and reduced in speed.
- The PM_{10} polar plot indicates the highest 10-minute concentrations of PM_{10} (red colour area) occurred when winds were from the north.
- The time series plots for the 22 November 2016 show that PM_{10} concentrations at both Taplin and BoM followed a similar pattern, increasing from around 7am to a peak at midday before decreasing in the afternoon. This suggests a regional influence.
- The highest PM_{10} concentrations were recorded when wind was from the north, outside the industry arc of influence on Port Hedland township.

Overall, on 22 November 2016, with all monitoring stations in Port Hedland township (excludes Yule) recording PM_{10} concentrations above 70 µg/m³ this event day has been classed as "Regional".

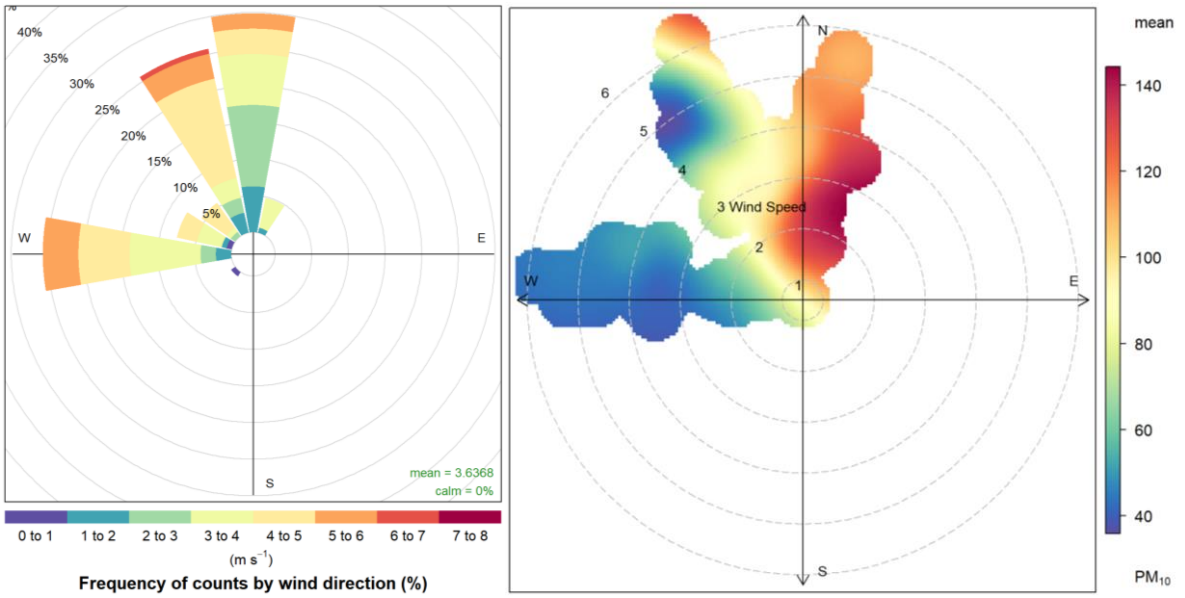


Figure 7-2: Taplin wind rose (left) and PM_{10} polar plot (right) on 22 November 2016

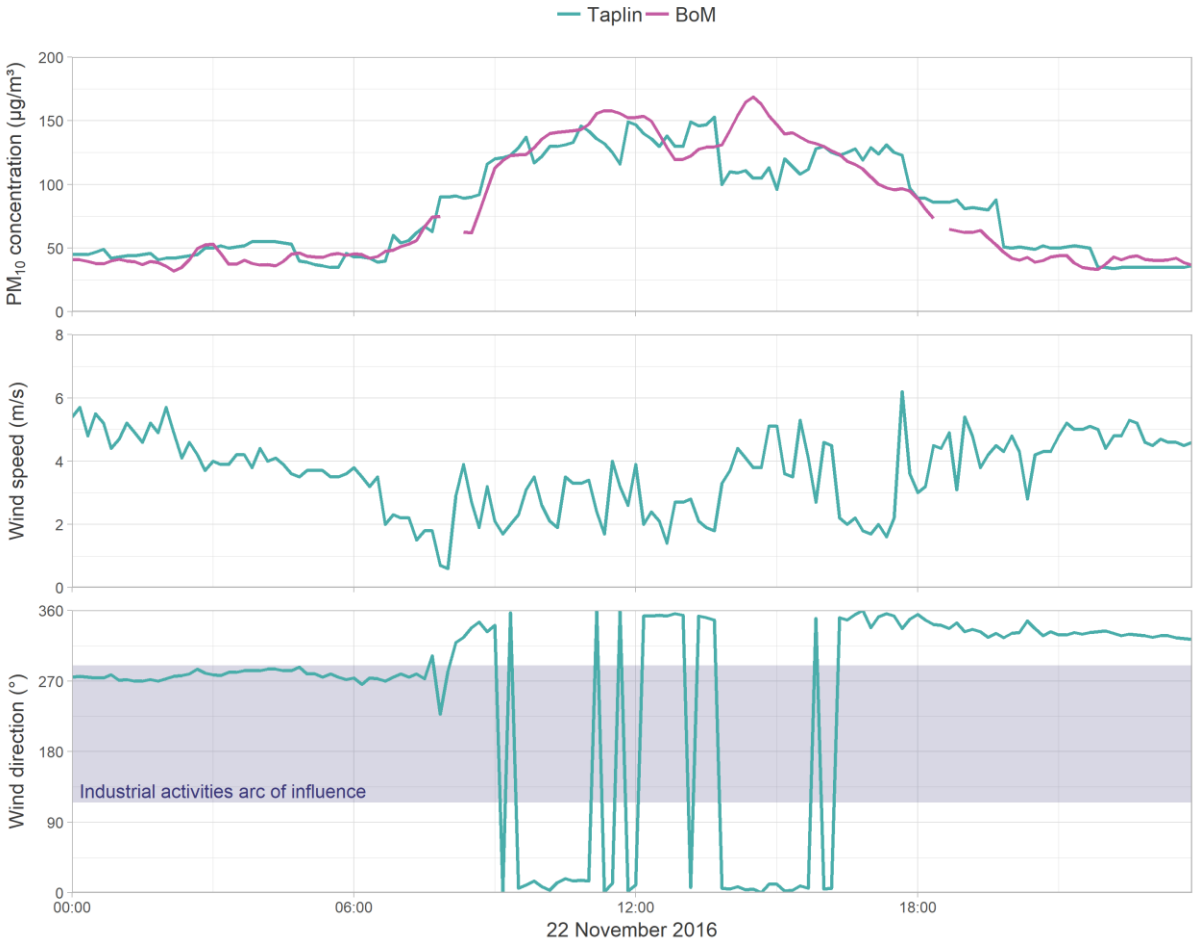


Figure 7-3: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 22 November 2016

7.4 26 November 2016

On the 26 November 2016, the 24-hour average PM_{10} concentration at Taplin was 75.8 µg/m³, 26.4 µg/m³ at BoM and 15.8 µg/m³ at Yule, which indicates a local event occurring at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for 26 November 2016 is shown in Figure 7-4 and a timeseries of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-5.

The figures indicate the following:

- Winds on the 26 November 2016 were relatively light (<4 m/s) and occurred from either the northwest or southwest sector.
- The PM_{10} polar plot indicates the highest average 10-minute PM_{10} concentrations (red and orange areas) occurred when winds were light (shown close to the centre of the polar plot). These light winds occurred from the southwest.
- The time series plots for the 26 November 2016 shows that elevated PM_{10} concentrations occurred at Taplin in the evening (between 19:00 and 23:00) with a peak 10-minute average concentration of 400 µg/m³. Winds during this time were between 1 and 2 m/s (light) and from within the Port Hedland industry arc of influence. PM_{10} concentrations at BoM during this time were not elevated.

Overall, on 26 November 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 24-hour average PM_{10} concentration to be above 70 µg/m³.

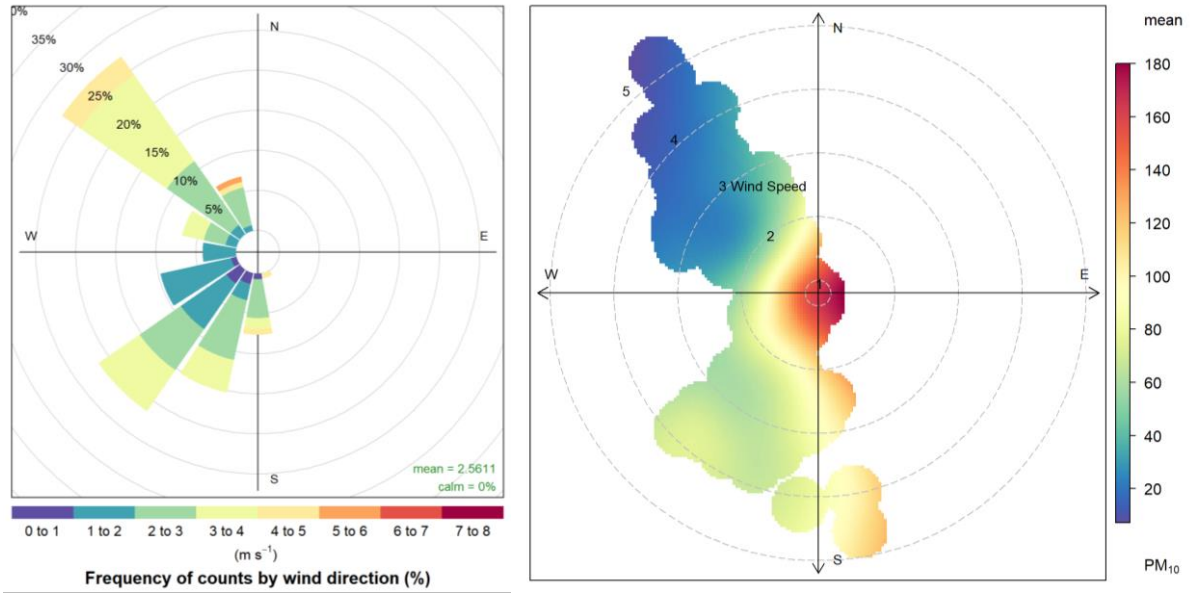


Figure 7-4: Taplin wind rose (left) and PM_{10} rose (right) on 26 November 2016

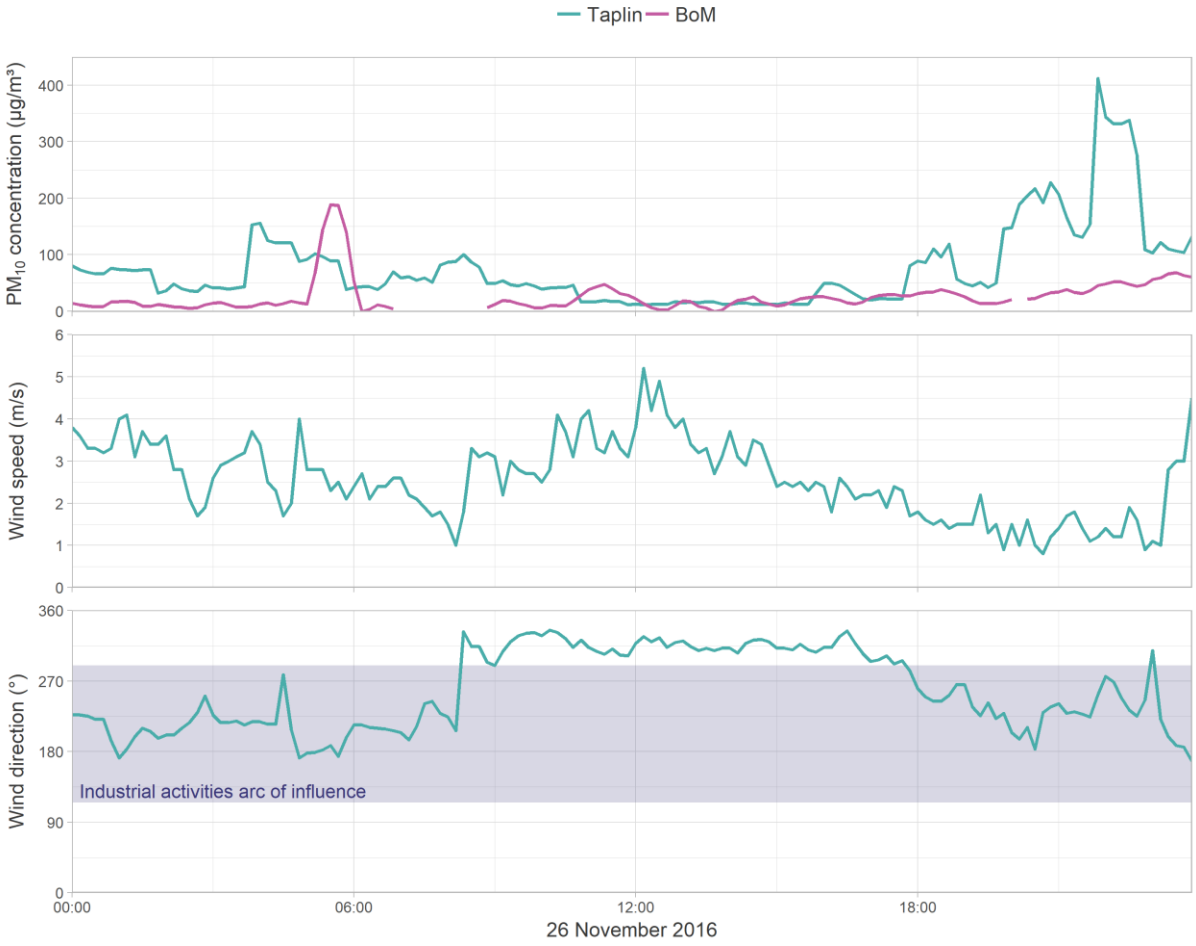


Figure 7-5: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 26 November 2016

7.5 2 March 2017

On the 2 March 2017, the 24-hour average PM_{10} concentration at Taplin was 74.4 µg/m³, 11.7 µg/m³ at BoM and 7.8 µg/m³ at Yule, which indicates a local event occurring at Taplin.

A wind rose and PM_{10} polar plot of the Taplin station data for 2 March 2017 is shown in Figure 7-6 and a timeseries of PM_{10} at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 7-7.

The figures indicate the following:

- Winds on the 2 March 2017 were relatively light (<4 m/s) and occurred from between the southeast to northwest and, in particular, from either the southwest or the northwest.
- The PM_{10} polar plot indicates the highest average 10-minute PM_{10} concentrations (red and orange areas) occurred when winds were between 1 m/s and 3 m/s and from the southwest.
- The time series plots for the 2 March 2017 shows that PM_{10} at Taplin peaked to around 150 µg/m³ (10-minute average) during the morning and the late evening.
- The winds during the morning and evening peaks of PM_{10} at Taplin were within the Port Hedland industry arc of influence.
- PM_{10} concentrations at BoM on 2 March were below 25µg/m³ for the duration of the day.

Overall, on 2 March 2017, with winds from the direction of the industry for the times when PM_{10} at Taplin was elevated and low concentrations at BoM, it is likely that industry caused the 24-hour average PM_{10} concentration to be above 70 µg/m³.

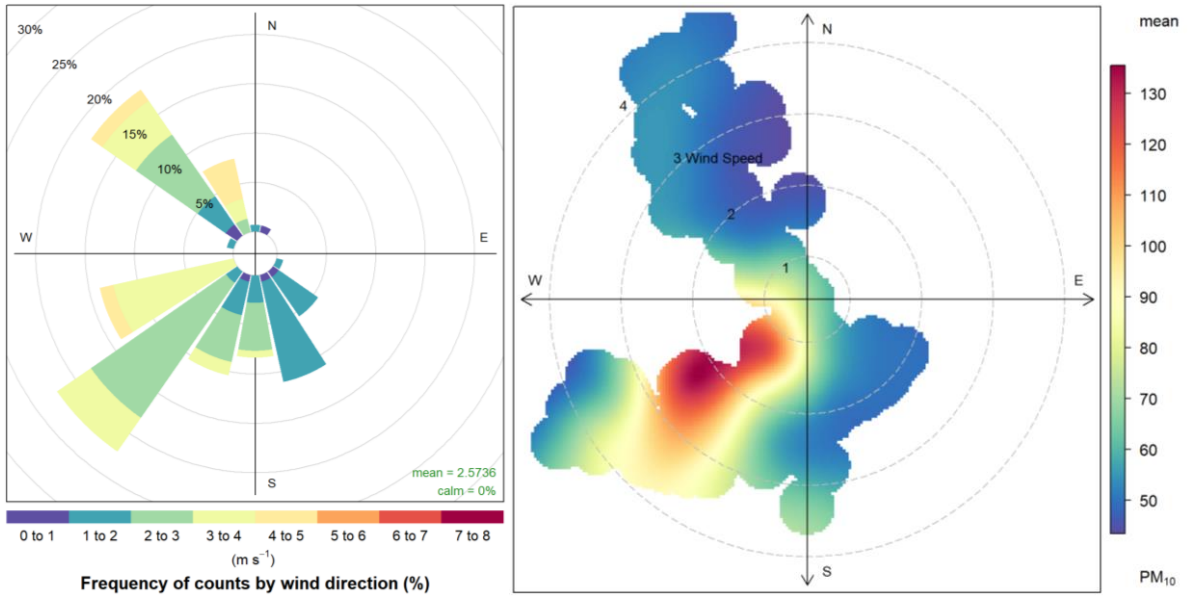


Figure 7-6: Taplin wind rose (left) and PM_{10} rose (right) on 2 March 2017

Figure 7-7: Time series of PM_{10} concentrations at Taplin and BoM (top) and Taplin wind speed (middle) and wind direction (bottom) on 2 March 2017

8. CONCLUSIONS

8.1 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 Taskforce interim guideline for 24-hour average PM_{10} is 70 µg/m³ with 10 exceedances allowed per year. In FY 2016/17 there were 3 days at Taplin when the concentration of PM_{10} exceeded 70 µg/m³.
    - Compared with previous reporting years, this is the lowest number of days in one year when the 24-hour average concentration of PM_{10} was above the interim guideline (as shown in the table below). This trend is in contrast to the Port Hedland export tonnage that has steadily increased over the past five reporting years.

Interim Guideline (µg/m³)	Number of days above interim guideline				
	FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17
70	17	6	10	10	3
Export Tonnage (Mt)	295	380	425	430	500

- Detailed analysis of the 3 days at Taplin when the 24-hour average PM_{10} concentration was above 70 µg/m³ determined that:
    - On 22 November 2016, dust concentrations were elevated across the region and, therefore, industry was not the cause of the event.
    - On 26 November 2016 and 2 March 2017, industry was identified as likely to have caused the event.
- In FY 2016/17 the 24-hour average AAQ NEPM standard for PM_{10} of 50 µg/m³ was not met at any of the Port Hedland ambient air quality monitoring stations. The following points are relevant:
    - The past five reporting years show a stable or decreasing trend in the number of days when the 24-hour average concentration of PM_{10} is above the AAQ NEPM standard at all sites except for Richardson.
    - At Richardson, the number of days above the AAQ NEPM standard was significantly increased in Q4 during FY 2016/17. This is consistent with a local source such as urban development that has a localised effect but does not influence levels at the other monitoring sites.
- In FY 2016/17 the annual average AAQ NEPM standard for PM_{10} of 25 µg/m³ was not met at five of the monitoring stations, namely: Kingsmill (40.4 µg/m³), Richardson (40.0 µg/m³), Taplin (31.3 µg/m³), Neptune (27.4 µg/m³) and Wedgefield (43.1 µg/m³).
- In FY 2016/17 the annual average AAQ NEPM standard for PM_{10} of 25 µg/m³ was met at BoM (21.4 µg/m³), South Hedland (22.2 µg/m³) and Yule (15.4 µg/m³).
- The annual average concentrations of PM_{10} in FY 2016/17 decreased compared to FY 2015/16 at all sites except for Richardson.
- The urban development near to Richardson that occurred in Q4 of FY 2016/17 also resulted in higher annual average concentrations of $PM_{2.5}$ than in FY 2015/16.

8.2 $PM_{2.5}$

$PM_{2.5}$ was measured at four (4) stations in the Port Hedland ambient air quality monitoring network for the FY 2016/17 reporting period. 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 at BoM (24.2 µg/m³) and Yule (17.3 µg/m³) monitoring stations.

- The 24-hour average AAQ NEPM standard for $PM_{2.5}$ was exceeded at Taplin (28.3 µg/m³) on one day, 22 November 2016, a day when the 24-hour PM_{10} concentration at Taplin was above 70 µg/m³ due to a regional dust event.
- The annual average AAQ NEPM standard for $PM_{2.5}$ of 8 µg/m³ was met at all stations except for Taplin.
- The annual average $PM_{2.5}$ concentration at Taplin was 10.7 µg/m³.
- $PM_{2.5}$ concentrations measured at Richardson were not assessed against the AAQ NEPM standard due to the data capture rate being below 75%.

8.3 NO_2

NO_2 was only measured at the Taplin monitoring station in the Port Hedland ambient air quality monitoring network for the FY 2016/17 reporting period. The performance assessment found the following:

- Taplin monitoring station met the 1-hour average AAQ NEPM standard of 246 µg/m³.
- The highest 1-hour average concentration corresponds to 29% of the AAQ NEPM standard.
- Taplin monitoring station met the annual average AAQ NEPM standard of 62 µg/m³.
- The annual average concentration corresponds to 21 % of the AAQ NEPM standard.

Overall, the levels of NO_2 measured at Taplin in FY 2016/17 are low and consistent with the NO_2 levels measured in previous years, including at the now decommissioned sites, as detailed in the Pilbara Ports Authority (PPA) monitoring data analysis report (PEL, 2015).

8.4 Data Capture

The PHIC data capture criterion was met for NO_2 and PM_{10}, with greater than 75% data capture per quarter and annually at all monitoring stations. The PHIC data capture criterion was also met for $PM_{2.5}$ at Taplin and Yule monitoring stations, with greater than 75% data capture achieved per quarter and annually.

$PM_{2.5}$ data capture at the BoM monitoring station met the annual PHIC criterion of 75%. However, during Q3 $PM_{2.5}$ data capture did not meet the 75% criterion due to an instrument fault.

$PM_{2.5}$ data capture at the Richardson monitoring station did not meet the annual PHIC criterion of 75% due to an instrument fault that required significant repairs between March and July 2017.

9. REFERENCES

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Appendix A SUMMARY OF PM_{10} DURING TAPLIN INSTRUMENT FAULT

The Taplin PM_{10} BAM1020 was offline for a period of 6 consecutive days between 27 January 2017 and 1 February 2017 due to water ingress following a weather event. Whilst the instrument fault did not reduce the data capture rate to below the PHIC criterion (92% data capture was achieved in Q3) it was not possible to demonstrate compliance against the PM_{10} interim guideline during this time.

To understand PM_{10} concentrations in Port Hedland during this time, Table 9-1 and Figure A-1 detail the 24-hour average PM_{10} concentrations at the seven other monitoring stations. The data shows that:

- 24-hour average PM_{10} concentrations were below the interim guideline of 70 µg/m³ at all stations during the period Taplin was offline.
- 24-hour average PM_{10} concentrations were below the AAQ NEPM standard of 50 µg/m³ at all stations during the period Taplin was offline except for Kingsmill and Wedgefield.
- Kingsmill marginally exceeded the AAQ NEPM standard of 50 µg/m³ on 28 and 29 January 2017.
- Wedgefield exceeded the AAQ NEPM standard of 50 µg/m³ on 1 February 2017.

Table 9-1: 24-hour average PM_{10} concentration during Taplin instrument fault

Date	BoM	Kingsmill	Neptune	Richardson	South Hedland	Wedgefield	Yule
27 Jan	10.7	19.7	6.3	9.2	6.5	20.1	8.0
28 Jan	16.8	51.5	45.0	22.7	11.9	19.1	12.8
29 Jan	14.2	52.0	31.7	13.6	11.7	14.9	12.9
30 Jan	11.5	22.0	15.0	9.0	10.1	16.3	9.0
31 Jan	12.7	27.1	9.8	23.4	13.6	16.7	10.6
1 Feb	18.7	42.7	17.4	29.0	13.7	59.8	28.7

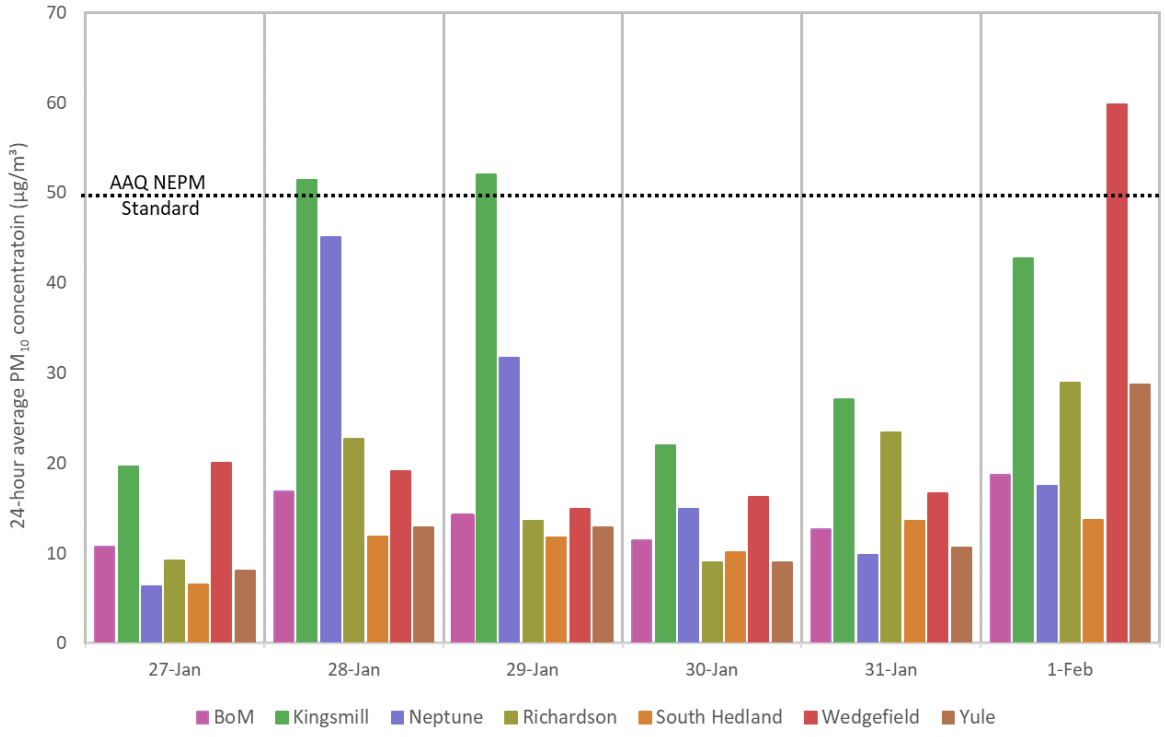

Figure A-1: 24-hour average PM_{10} concentration during Taplin instrument fault

Appendix B PM$_{10}$ TREND SUMMARY GRAPHS

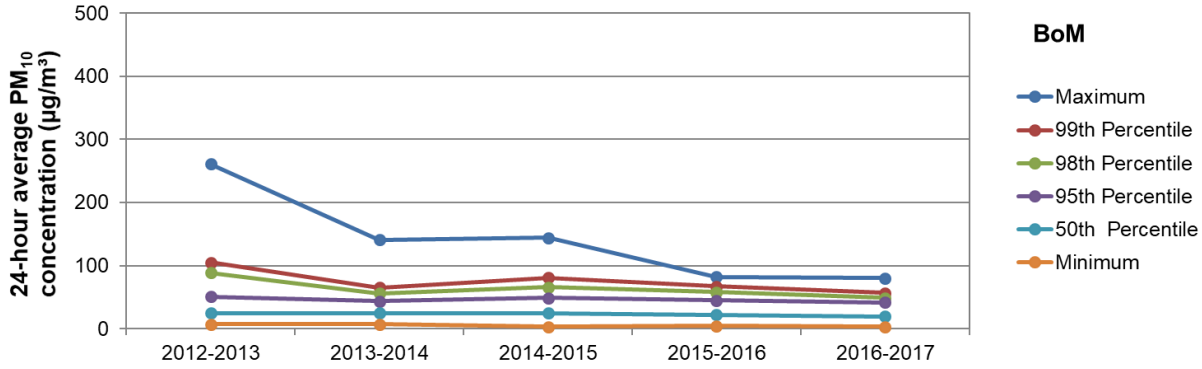

Figure B-1: 24-hour average PM$_{10}$ Trends at BoM

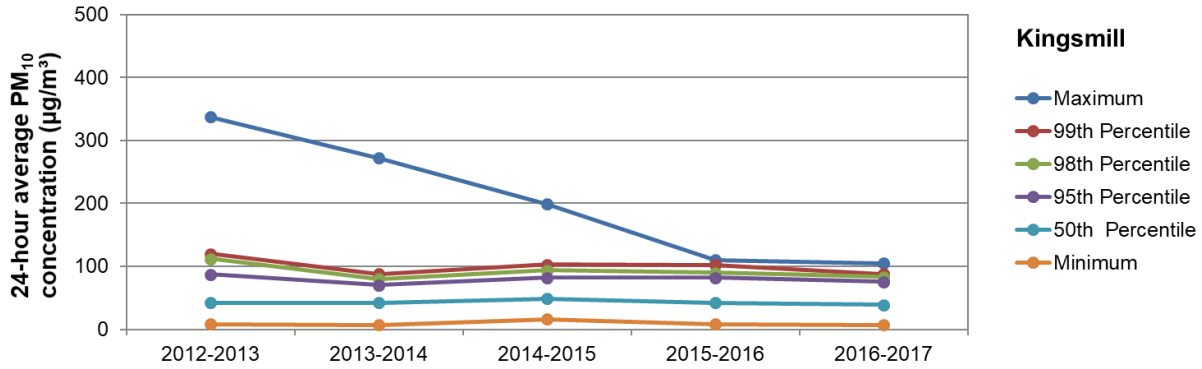

Figure B-2: 24-hour average PM$_{10}$ Trends at Kingsmill

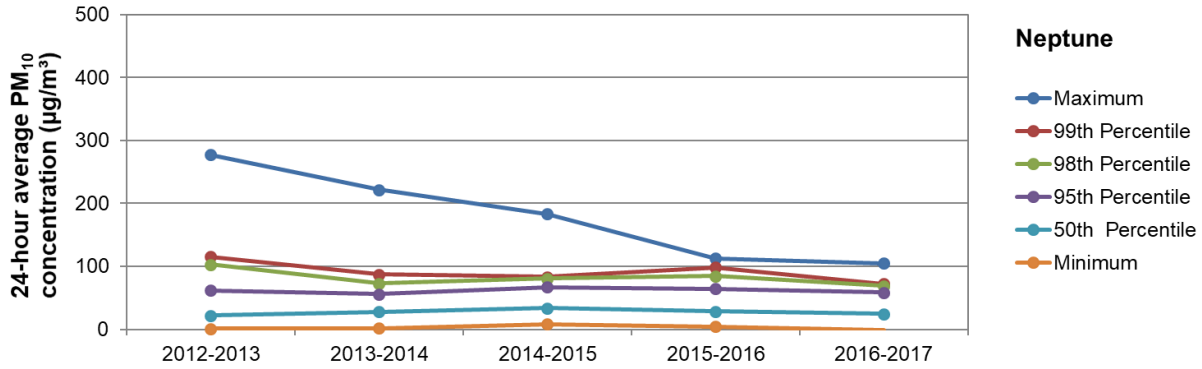

Figure B-3: 24-hour average PM$_{10}$ Trends at Neptune

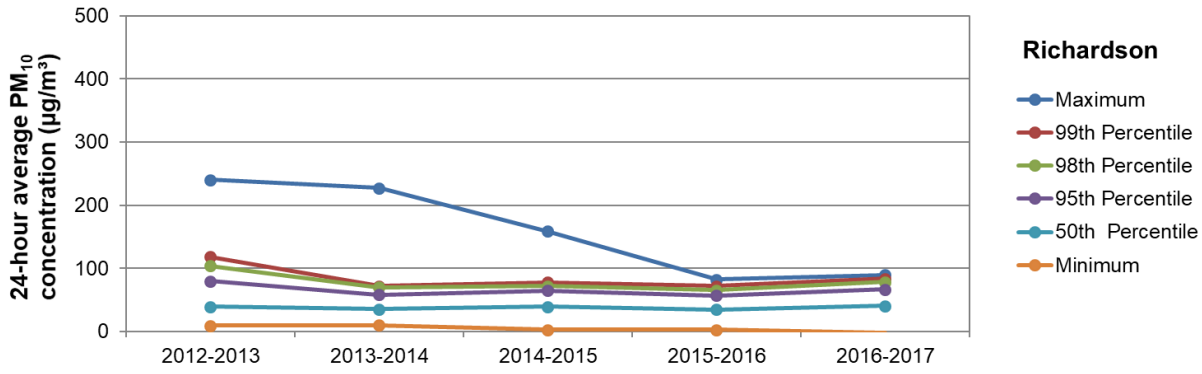

Figure B-4: 24-hour average PM_{10} Trends at Richardson

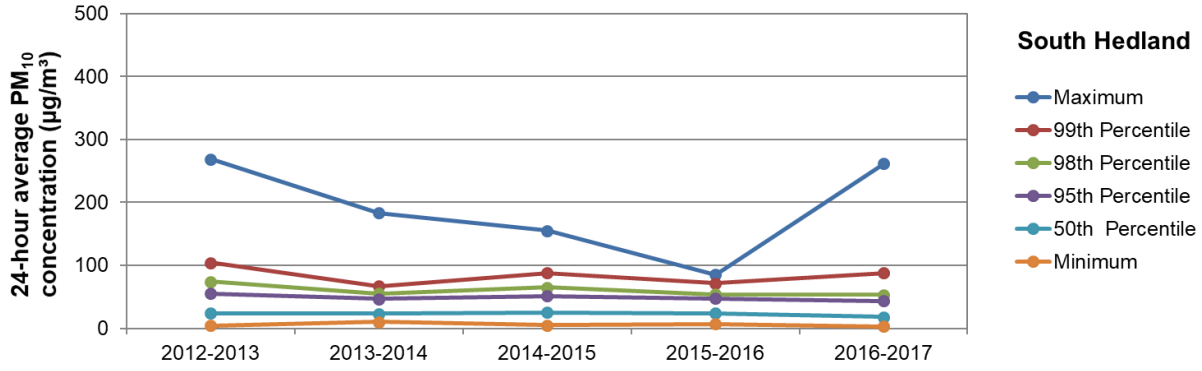

Figure B-5: 24-hour average PM_{10} Trends at South Hedland

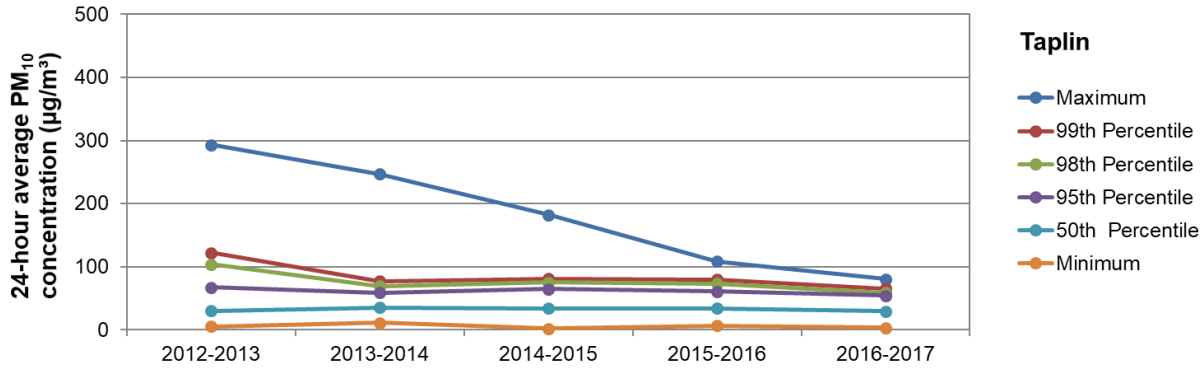

Figure B-6: 24-hour average PM_{10} Trends at Taplin

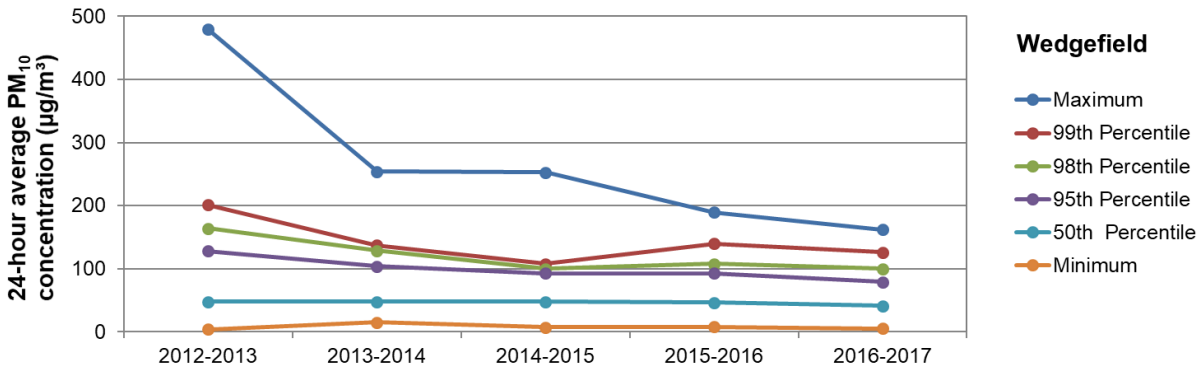

Figure B-7: 24-hour average PM_{10} Trends at Wedgefield

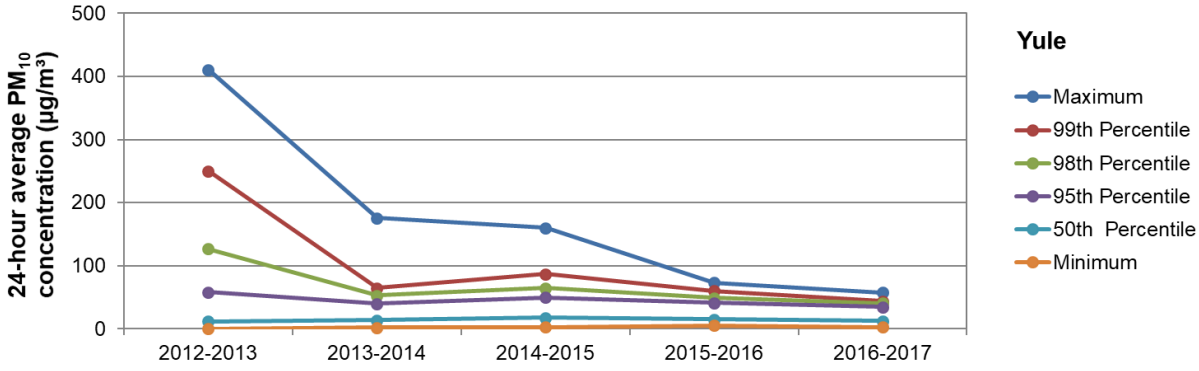

Figure B-8: 24-hour average PM_{10} Trends at Yule