PORT HEDLAND INDUSTRIES COUNCIL

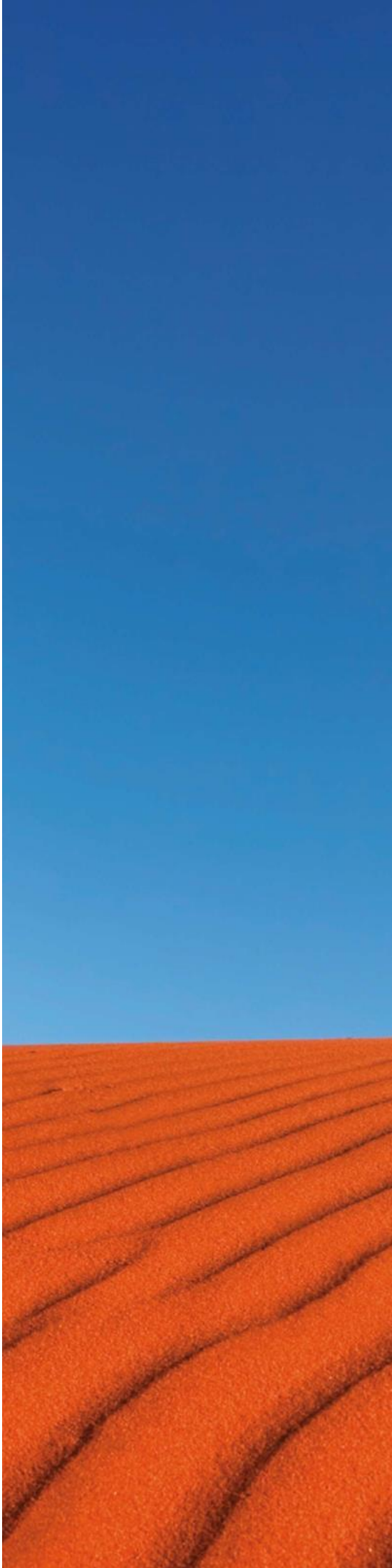
Annual Report – FY 2018/19 Port Hedland Ambient Air Quality Monitoring Program

FINAL

Port Hedland Industries Council

October 2019

Prepared by Katestone Environmental Pty Ltd



DOCUMENT CONTORL	
Deliverable Number:	D18006-9
Status:	Final
Document reference:	D18006-9 FY2018-19 Annual Monitoring Report v2.0.docx
Prepared by:	Andrew Vernon, Michael Burchill and Sarah Richardson
Reviewed by:	Simon Welchman and PHIC Dust Working Group
Approved by:	 Simon Welchman 25/10/2019

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

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 for Port Hedland by the Western Australia Government. Dust can be generated from natural sources (such as the arid landscape of the Pilbara region) and anthropogenic sources (such as urban and industrial development, including the handling and stockpiling of bulk commodities). Dust generation is also influenced by Port Hedland's arid and subtropical climate. The town experiences year-round warm to hot temperatures and low irregular rainfall.

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 in the Port Hedland region. The PHIC ambient air quality monitoring network consists of eight (8) stations distributed across the region.

The eight 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 2018/19 is provided in the table below.

Monitoring Station	Type	Parameters Measured			
		PM_{10}	$PM_{2.5}$	NO_x	Meteorology
BoM	Background	✓	✓		✓
Kingsmill	Residential	✓			✓
Neptune	Residential	✓			✓
Richardson	Residential	✓	✓		✓
South Hedland	Residential	✓			✓
Taplin	Residential	✓	✓	✓	✓
Wedgefield	Industrial	✓			✓
Yule	Background	✓	✓		✓

This annual report presents a summary of the Port Hedland ambient air quality monitoring network performance for FY 2018/19. Performance of the monitoring network has been assessed through the following:

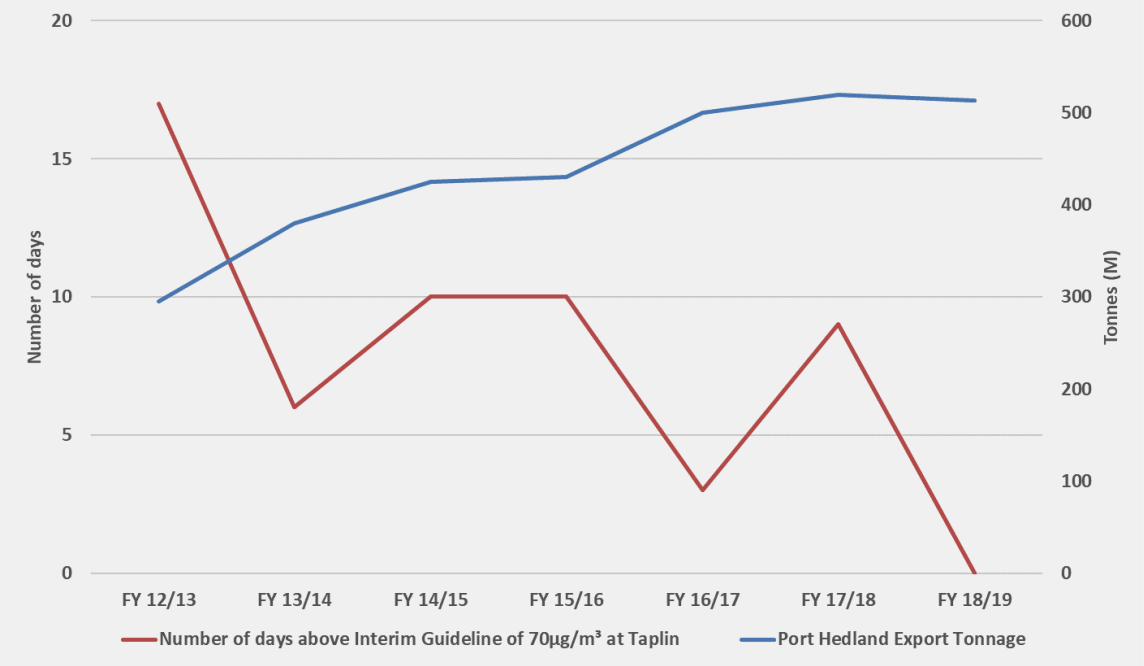
- Pollutant concentrations at each monitoring station compared with relevant air quality guidelines and standards, namely:
  - Port Hedland Dust Management Taskforce Dust Management Plan – interim guideline for PM_{10} of 70 µg/m³ (24-hour average) with ten allowable exceedances at Taplin.
  - *National 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}

Analysis of the PM_{10} data found the following:

- The Taplin monitoring station did not record any days above the 24-hour average interim guideline for PM_{10} of 70 µg/m³. Consequently, the interim guideline was met at Taplin (see figure below).
- This is the first instance of zero days above the interim guideline for a reporting period since implementation of the interim guideline.
- In FY 2018/19, Port Hedland's export tonnage was marginally (1%) lower than the previous year. Export tonnage has increased year on year for the past seven years (as shown in the table below).

Parameter	FY 12/13	FY 13/14	FY 14/15	FY 15/16	FY 16/17	FY 17/18	FY 18/19
Number of days above interim guideline of 70µg/m³ at Taplin	17	6	10	10	3	9	0
Port Hedland Export Tonnage (Mt)	295	380	425	430	500	519	513



- 24-hour average concentrations of PM_{10} were above the AAQ NEPM standard on one or more occasions at all sites in FY 2018/19. The number of days above the AAQ NEPM standard of 50 µg/m³ ranged from three days at Taplin to 167 days at Richardson.
- The number of days per year above the AAQ NEPM standard for PM_{10} at each monitoring station have been compared for the last seven years, which shows the following:
    - BoM, Kingsmill, Neptune, South Hedland, Wedgefield and Yule show a general decreasing trend over the four years prior to FY 2017/18. In FY 2017/18 and FY 2018/19, the number of days above the AAQ NEPM standard increased.
    - In the years prior to FY 2017/18, the Taplin monitoring station showed a slight downward trend in the number of days above the AAQ NEPM standard. In FY 2017/18 the number of 24-hour average concentrations above the standard was higher than the average. In FY 2018/19, the number dropped significantly to its lowest recorded level of 3.
    - The Richardson station shows an increasing trend in the number of 24-hour average concentrations above the AAQ NEPM standard, especially over the last three reporting years. This is considered to be a result of urban development changes that have occurred near the Richardson station in the past few years.
- The annual average concentration of PM_{10} was above the AAQ NEPM standard of 25 µg/m³ at BoM, Kingsmill, Neptune, Richardson and Wedgefield.
- The annual average concentration of PM_{10} was below the AAQ NEPM standard of 25 µg/m³ at South Hedland, Taplin and Yule.
- Annual average concentrations of PM_{10} over the past four years (FY 2015/16 to FY 2018/19) showed that:
    - Neptune, South Hedland and Wedgefield stations showed a slight decreasing trend to FY 2017/18, before increasing in FY 2018/19
    - BoM, Kingsmill and Yule showed a relatively steady trend to FY 2017/18, before increasing during FY 2018/19

- Taplin station showed a relatively steady trend to FY 2017/18, before decreasing significantly during FY 2018/19
- The Richardson station shows an increasing trend. Urban development changes have occurred near the Richardson station that are considered to have contributed to the increasing trend at this site. For this reason, some caution should be placed on any reliance on this data.

$PM_{2.5}$

Analysis of the $PM_{2.5}$ data found the following:

- The 24-hour average concentrations of $PM_{2.5}$ were below the AAQ NEPM standards at BoM, Taplin and Yule for all days during 2018/19.
- The 24-hour average concentration of $PM_{2.5}$ was above the AAQ NEPM standard of 25 µg/m³ on eight days at Richardson, however this land is inconsistent with other sites and suggests this may be other contributing factors.
- The annual average concentration of $PM_{2.5}$ was below the AAQ NEPM standards at Yule.
- The annual average concentration of $PM_{2.5}$ was above the AAQ NEPM standard of 8 µg/m³ at BoM, Taplin and Richardson.

NO_2

Analysis of the NO_2 data found that the concentrations of NO_2 measured at Taplin in FY 2018/19 were low and well below the AAQ NEPM standards. Concentrations were consistent with the NO_2 concentrations measured in previous years.

Data Capture

In FY 2018/19, the annual data capture criterion of 75% was met for NO_2, PM_{10} and $PM_{2.5}$ at all monitoring stations. The quarterly (Q) criterion of 75% was also met for each pollutant and at all monitoring stations with the exception of PM_{10} in Q1 at Wedgefield station and in Q4 at Yule.

In August 2018, equipment faults and power supply issues at Wedgefield resulted in a Q1 capture rate of 73%. At the end of March 2019, all PHIC sites were shut down during cyclone Veronica. Due to the remoteness of Yule, was not able to be restarted until May 2019 due to access track accessibility following Cyclone Veronica, resulting in the Q4 data capture rate of 65%.

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 in Port Hedland by the Western Australian Government. Dust can be generated by natural sources (such as the arid landscape of the Pilbara region) and anthropogenic sources (such as urban and industrial development, including the handling and stockpiling of bulk commodities). Dust generation is also influenced by Port Hedland's arid and subtropical climate. The town experiences year-round warm to hot temperatures and low irregular rainfall.

In 2009, at the direction of the WA 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.

In 2017, the Taskforce released a second report to Government on its recommendations for addressing dust management in Port Hedland, including recommendations for the air quality monitoring network. In 2018, the Government issued a response that included the support of the proposed transfer of full responsibility for operating and maintaining the Port Hedland air quality monitoring network to the Department of Water and Environmental Regulation (DWER). However, at the time of writing this annual report, the transfer has not been implemented.

Accordingly, in accordance with the previous Taskforce requirements, 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 2018/19. This is the seventh 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) and again in 2018 (Environmental Technologies and Analytics, 2018) to ensure the requirements of the Taskforce were being met.

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	✓	✓		✓

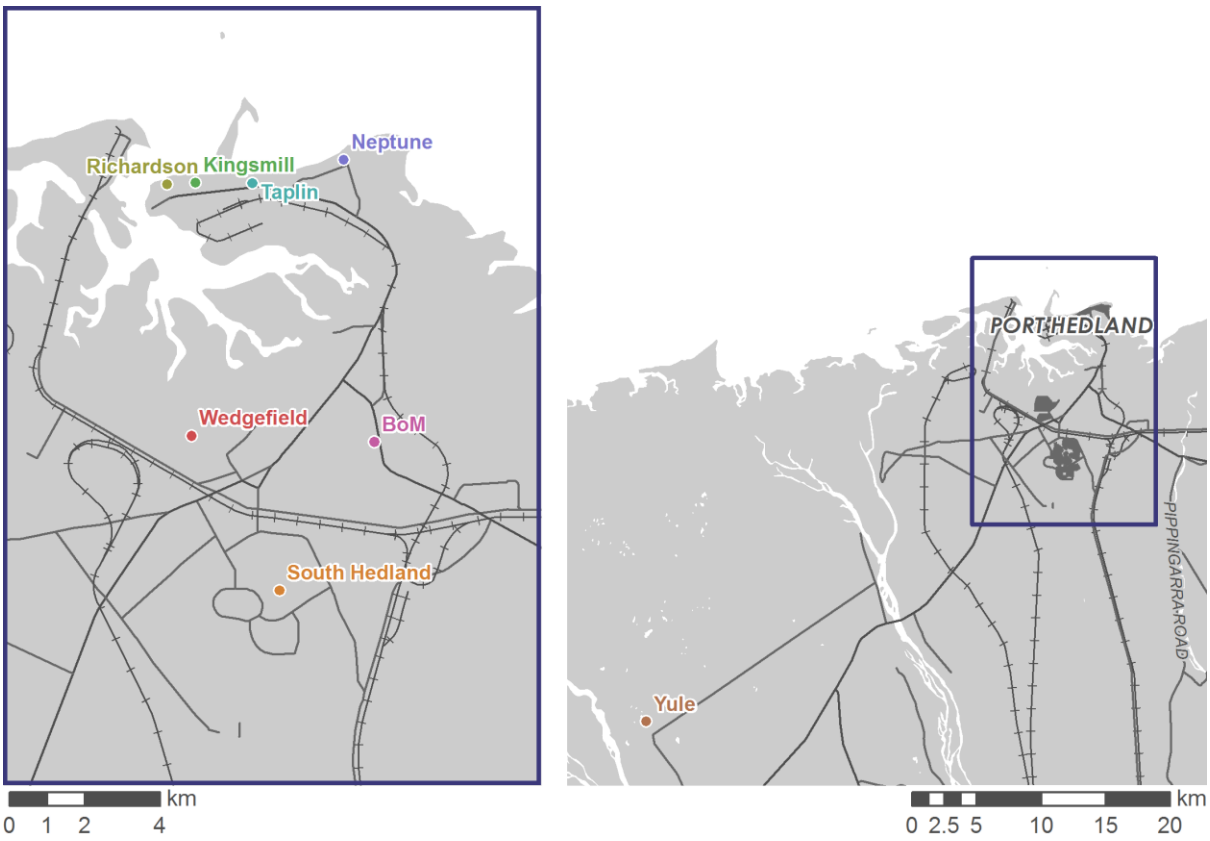


Figure 2-1: Port Hedland Ambient Air Quality Monitoring Network

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 concentrations of PM_{10} and $PM_{2.5}$ 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}	BAM1020	AS/NZS 3580.9.11:2008 & 2016	✓	✓	✓	✓	✓	✓	✓	✓
$PM_{2.5}$	BAM1020	AS/NZS 3580.9.12:2013	✓			✓		✓		✓
NO_x	Ecotech ML9841	AS/NZS 3580.5.1:2011						✓		

2.4 FY 2018/19 Activities

The Port Hedland ambient air quality monitoring network activities for FY 2018/19 are detailed in Table 2-3. Notable data gaps outside of the routine maintenance occurred due to the following:

- Power failure during July 2018 at the Yule.
- Tape fault and power failure occurred during August 2018 at the Wedgefield station.
- Intermittent power failures from January 2019 onwards at the South Hedland monitoring station.
- Tropical Cyclone Veronica affected all monitoring stations at Port Hedland area between 21 March 2019 and 27 March 2019. Following the passing of Cyclone Veronica, all stations came back online except for Wedgefield and Yule.
- The Wedgefield monitoring station experienced some communication failures following Cyclone Veronica and came back online on 11 April 2019.
- The Yule monitoring station only came back online on 2 May 2019 due to inaccessibility of site following Cyclone Veronica.
- Communication errors prevented recording of $PM_{2.5}$ data until 15 May 2019.
- Intermittent power failures occurred throughout May 2019 at the Kingsmill monitoring station.
- Intermittent power failures occurred throughout June 2019 at Neptune monitoring station.

Table 2-3: FY 2018/19 Port Hedland ambient air quality monitoring network activities

Station	Parameter	Averaging time [A]	Q1			Q2			Q3			Q4		
			July 18	August 18	September 18	October 18	November 18	December 18	January 19	February 19	March 19	April 19	May 19	June 19
BoM	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	$PM_{2.5}$	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
Kingsmill	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓[D]	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
Neptune	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓[D]
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
Richardson	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	$PM_{2.5}$	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
South Hedland	PM_{10}	5-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	Meteorology	5-min	✓	✓	✓	✓	✓	✓	✓[D]	✓[D]	✓[D,E]	✓[D,E]	✓[D]	✓[D]
Taplin	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	$PM_{2.5}$	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	NO_x	5-min	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓[E]	✓	✓	✓
Wedgefield	PM_{10}	5-min / 1-hr	✓	✓[C]	✓	✓	✓	✓	✓	✓	✓[E]	✓[F]	✓	✓
	Meteorology	10-min	✓	✓[C]	✓	✓	✓	✓	✓	✓	✓[E]	✓[F]	✓	✓
Yule	PM_{10}	10-min / 1-hr	✓	✓	✓	✓	✓	✓	✓[D]	✓	✓[E]	G	✓	✓
	$PM_{2.5}$	10-min / 1-hr	✓[B]	✓	✓	✓	✓	✓	✓[D]	✓	✓[E]	G	✓[H]	✓
	Meteorology	10-min	✓	✓	✓	✓	✓	✓	✓[D]	✓	✓[E]	G	✓	✓

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 (real time module)

[B] Power failures were experienced from 4 to 6 July 2018 and from 9 to 13 July 2018 resulting in reduced data capture of $PM_{2.5}$ at Yule.

[C] Tape fault on 13 August 2018 and power failure on 15 August 2018 resulted in reduced data capture of PM_{10} and meteorology at Wedgefield station.

[D] Intermittent data losses due to power failure.

[E] All stations experienced loss of data during tropical Cyclone Veronica that affected the entire Port Hedland area between 21 March and 27 March 2019.

[F] The Wedgefield station came back online on 11 April 2019 following the passing of Cyclone Veronica.

[G] The Yule station, it came back online in mid-May following the passing of Cyclone Veronica.

[H] Yearly maintenance and annual zero test during 10 to 13 May 2019 as well as intermittent failures throughout May 2019.

2.5 Data Processing

The FY 2018/19 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 quality assurance checks conducted by Katestone found that all FY 2018/19 data was acceptable for final processing.

Final processing included the following steps:

- All 1-hour average data were combined into a single file.
- The light scattering data were 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 exceedances of relevant air pollutant standards and guidelines
    - Time series graphs
    - Wind roses
    - Pollution polar plots.

If, in any calander day, the concentration of PM_{10} is found to be above the interim PM_{10} guideline at the Taplin monitoring station, the event is investigated further through the examination of wind roses, PM_{10} polar plots and time series plots. As there were no days the FY 2018/19 when the Taplin monitoring station recorded 24-hour average concentrations of PM_{10} above the interim guideline of 70 µg/m³ (Section 4.1.2), no further analyses were required.

Data visualisations that were used to analysis and present PHIC data were produced using the 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 2018/19 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
- Ten 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 five 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 ten exceedances) should apply to residential areas of Port Hedland. The report was advertised for public comment and then endorsed by Government of Western Australia in 2018.

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

- Maximum concentration of 50 µg/m³ for 24-hour average concentration of PM_{10}
- Maximum concentration of 25 µg/m³ for annual average concentration of PM_{10}
- Maximum concentration of 25 µg/m³ for 24-hour average concentration of $PM_{2.5}$
- Maximum concentration of 8 µg/m³ for annual average concentration of $PM_{2.5}$
- Maximum concentration of 246 µg/m³ for 24-hour average concentration of NO_2 with maximum allowable exceedances of 1 day a year
- Maximum concentration of 62 µg/m³ for annual average concentration of 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] Ten exceedance days allowed per year due to industry
[B] Applies to residential areas east of Taplin Street
[C] Maximum allowable exceedances of 1 day a year

3. SUMMARY OF FY2018/19 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.

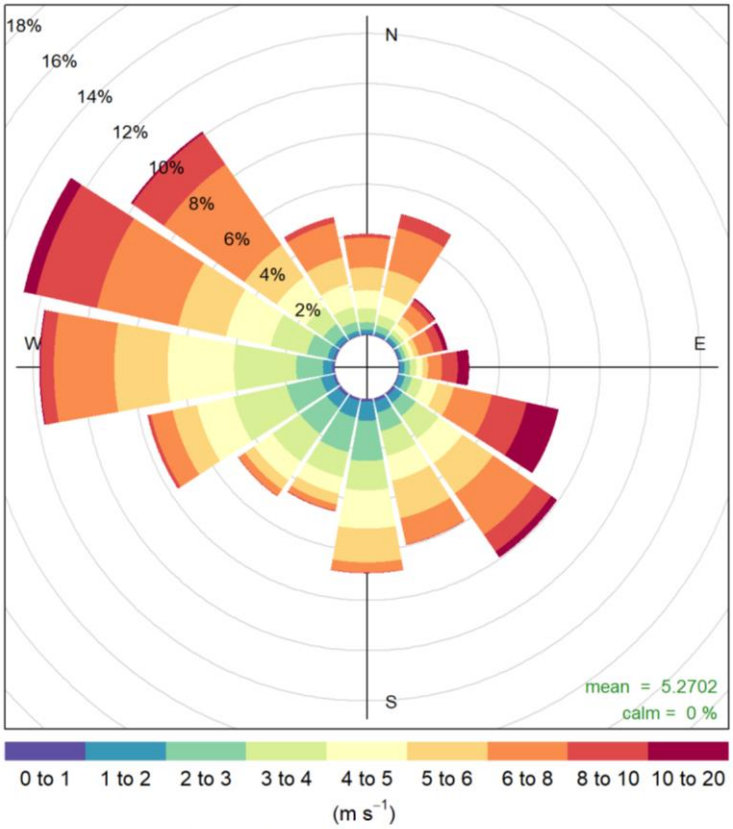
Exposed dust sources (be it from industry sources, other anthropogenic sources or natural sources), will have higher dust emissions during dry conditions and strong winds. The dust emissions will also have a greater radius of impact during periods of stronger wind speeds due to dust remaining suspended 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 BoM, Taplin and Yule during FY 2018/19 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 and its location on the WA coastline.
- The predominant wind direction at all three sites is the northwest quadrant (west to northwest).
- All three sites also show frequent winds from the southeast quadrant.
- Winds from the southwest and northeast quadrants are less common but do occur on occasion at all sites.
- Wind speeds measured at all three monitoring stations are relatively strong (important for dust generation and dispersion) with FY 2018/19 annual average wind speeds of 5.3 m/s, 2.6 m/s and 3.6 m/s at BoM, Taplin and Yule, respectively.
- Wind speeds are highest at BoM due to the exposed nature of the BoM monitoring station near Port Hedland Airport.
- Yule has stronger winds than Taplin due to the Yule being located in an open area that is more exposed to winds than 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.



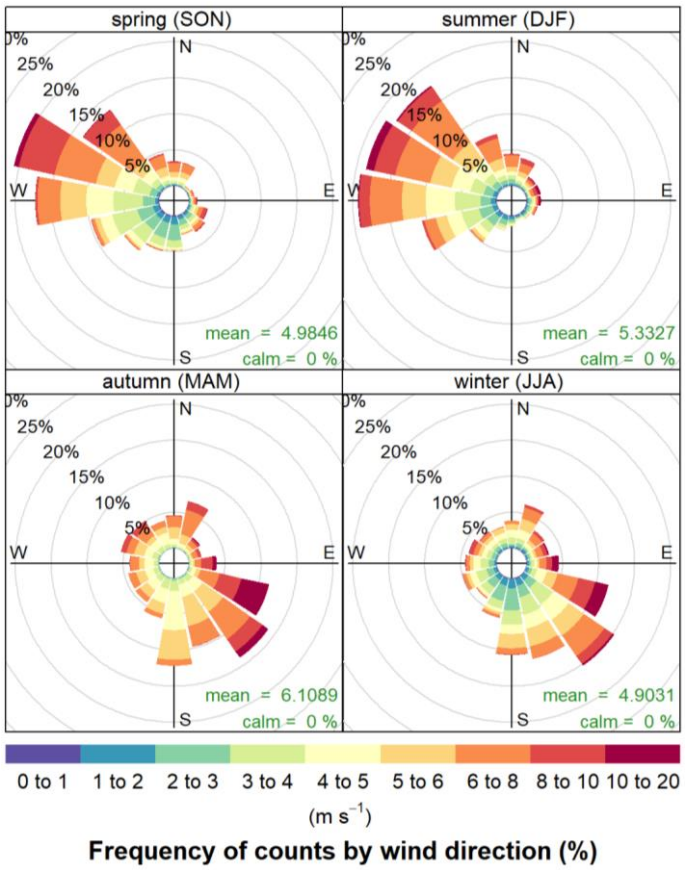
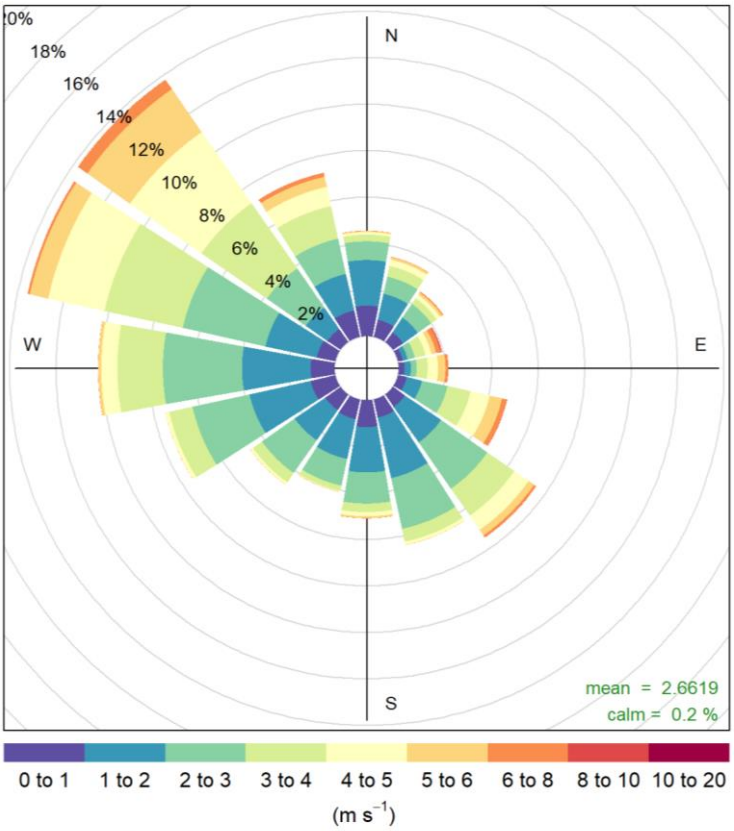


Figure 3-1: FY 2018/19 wind roses for BoM annual (top) seasonal (bottom)



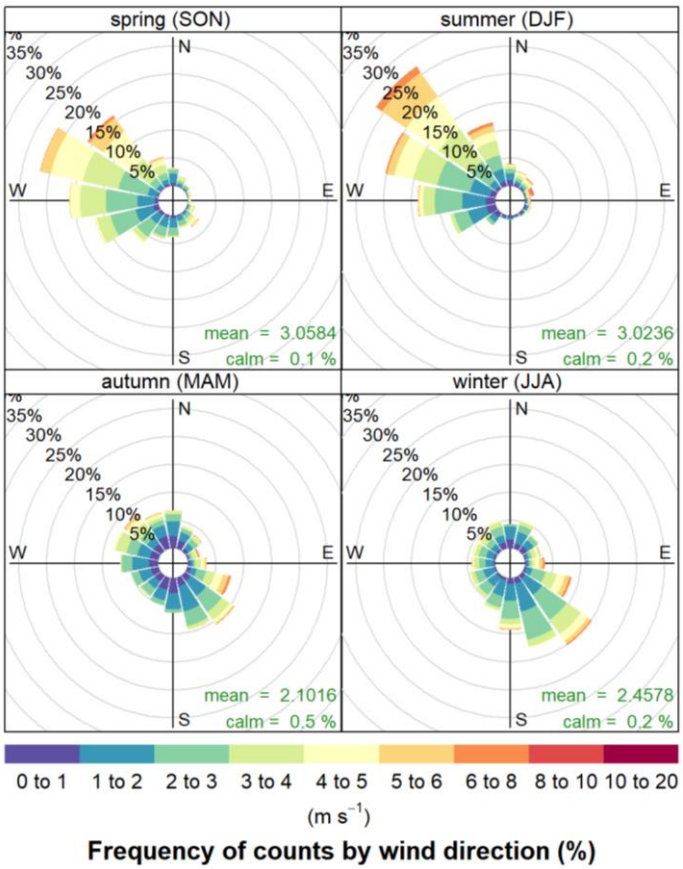
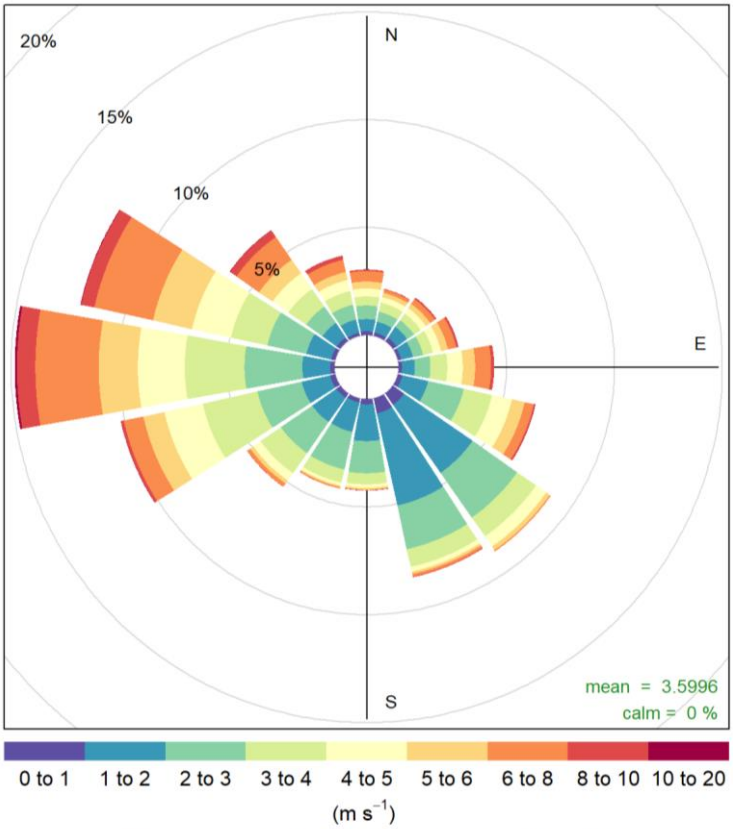


Figure 3-2: FY 2018/19 wind roses for Taplin annual (top) seasonal (bottom)



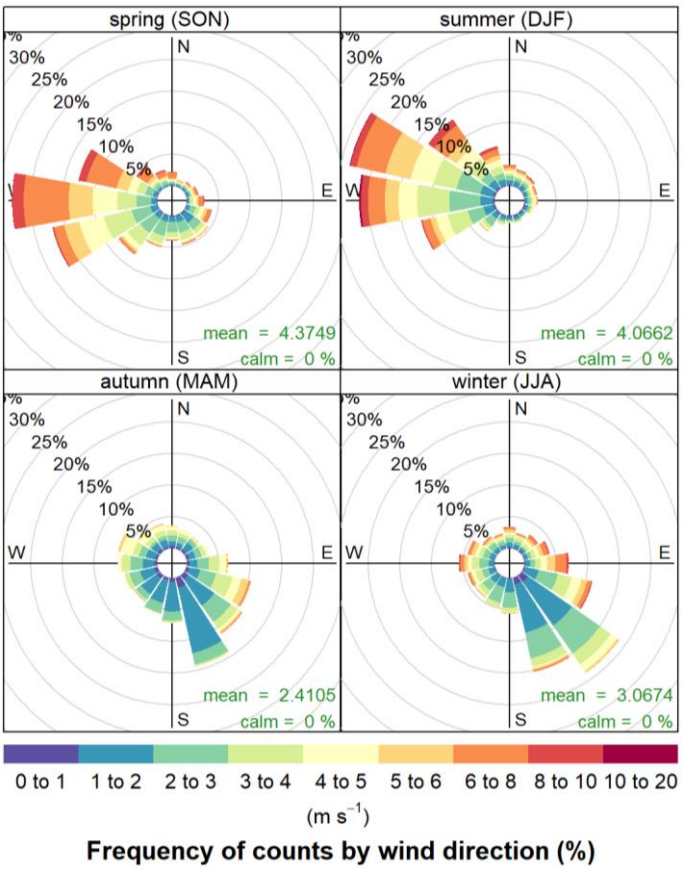


Figure 3-3: FY 2018/19 wind roses for Yule annual (top) seasonal (bottom)

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 2018/19.

4.1.1 Data Capture

Data capture rates for 1-hour average concentrations of PM_{10} for each monitoring station in FY 2018/19 are detailed in due to access track accessibility for some time after heavy rainfall associated with Cyclone Veronica.

Table 4-1. All stations achieved an annual capture rate for PM_{10} of greater than 85%. This meets the PHIC criterion of 75% data capture. The BoM, Kingsmill, Neptune, Richardson, South Hedland and Taplin sites all achieved quarterly capture rates greater than 83%, satisfying the PHIC criterion of 75% data capture.

As tape fault and power failure at the Wedgefield monitoring station during August 2018, caused the Q1 capture rate of 73%, which does not meet the PHIC criterion of 75% data capture.

The Q4 data capture rate at Yule was 65%, which does not meet the PHIC criterion of 75% data capture due to access track accessibility for some time after heavy rainfall associated with Cyclone Veronica.

Table 4-1: FY 2018/19 Data Capture Summary 1-hour average concentration of PM_{10}

Monitoring Station	2018/19 PM_{10} Data Capture Rate (%)					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	100	100	94	99	98	Met
Kingsmill	90	100	91	83	91	Met
Neptune	95	100	91	89	94	Met
Richardson	100	100	91	100	98	Met
South Hedland	98	100	90	100	97	Met
Taplin	99	100	95	99	98	Met
Wedgefield	73	99	79	88	85	Not Met
Yule	97	99	80	65	85	Not Met

4.1.2 Comparison to Air Quality Standards and Guideline

The maximum measured 24-hour average concentration of PM_{10} (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 concentration of PM_{10} for FY 2018/19 for each station is detailed in Table 4-3.

The measurements of PM_{10} show that for FY 2018/19:

- The Taplin monitoring station did not record any days above the 24-hour average interim guideline for PM_{10} of 70 µg/m³. Consequently, the interim guideline was met at Taplin.
- 24-hour average concentrations of PM_{10} were above the AAQ NEPM standard on one or more days at all sites in FY 2018/19. The number of days above the AAQ NEPM standard of 50 µg/m³ ranged from three days at Taplin to 167 days at Richardson.
- The annual average concentration of PM_{10} was above the AAQ NEPM standard of 25 µg/m³ at BoM, Kingsmill, Neptune, Richardson and Wedgefield.
- The annual average concentration of PM_{10} was below the AAQ NEPM standard of 25 µg/m³ at South Hedland, Taplin and Yule.

Table 4-2: FY 2018/19 data summary 24-hour average concentrations of PM_{10}

Monitoring Station ID	Maximum 24-hour average concentration of PM_{10} (µg/m³)	Number of days >50 µg/m³ (AAQ NEPM)	Performance (AAQ NEPM)	Number of days >70 µg/m³ (Taskforce)	Performance (Taskforce)
BoM	107.1	25	Not met	-	-
Kingsmill	111.6	155	Not met		
Neptune	108.4	102	Not met		
Richardson	132.0	167	Not met		
South Hedland	90.6	11	Not met		
Taplin	66.9	3	Not met	0	Met
Wedgefield	178.9	165	Not demonstrated due to data capture	-	-
Yule	108.8	15	Not demonstrated due to data capture		

Table 4-3: FY 2018/19 data summary annual average concentrations of PM_{10}

Monitoring Station ID	Annual average concentration of PM_{10} (µg/m³)	Performance (AAQ NEPM of 25 µg/m³)
BoM	31.5	Not met
Kingsmill	51.0	Not met
Neptune	40.2	Not met
Richardson	51.4	Not met
South Hedland	24.4	Met
Taplin	23.8	Met
Wedgefield	55.0	Not demonstrated due to data capture
Yule	22.2	Not demonstrated due to data capture

4.1.3 PM_{10} Timeseries Analysis

Timeseries plots of the 24-hour average concentrations of PM_{10} for FY 2018/19 for each monitoring station are shown in Figure 4-1. The timeseries plot for Taplin monitoring station shows that the 24-hour average concentrations of PM_{10} did not go above the interim guideline of 70 µg/m³.

Figure 4-1: FY 2018/19 time series plots of 24-hour average concentrations of PM_{10}

4.2 $PM_{2.5}$

$PM_{2.5}$ was measured at four (4) monitoring stations (BoM, Richardson, Taplin and Yule) during FY 2018/19.

4.2.1 Data Capture

Data capture rates for 1-hour average concentrations of $PM_{2.5}$ for each monitoring station in FY 2018/19 are detailed in Table 4-4. All stations achieved an annual capture rate for $PM_{2.5}$ of greater than 81%. This meets the PHIC criterion of 75% data capture. The BoM, Richardson and Taplin monitoring stations all achieved quarterly capture rates greater than 91%, satisfying the PHIC criterion of 75% data capture.

The Q4 data capture rate at Yule was 51%, not meeting the PHIC criterion of 75% data capture, due to access track accessibility for some time after heavy rainfall associated with Cyclone Veronica..

Table 4-4: FY 2018/19 data capture summary 1-hour average concentrations of $PM_{2.5}$

Monitoring Station ID	2018/19 $PM_{2.5}$ Data Capture Rate (%)					Performance
	Q1	Q2	Q3	Q4	Annual	
BoM	100	100	93	99	98	Met
Richardson	100	100	91	100	97	Met
Taplin	99	100	94	99	98	Met
Yule	92	99	81	51	81	Not Met

4.2.2 Comparison to Air Quality Standards

The maximum 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 2018/19:

- The 24-hour average concentrations of $PM_{2.5}$ were below the AAQ NEPM standards at BoM, Taplin and Yule.
- The 24-hour average concentration of $PM_{2.5}$ was above the AAQ NEPM standard of 25 µg/m³ on eight days at Richardson monitoring station.
- The annual average concentration of $PM_{2.5}$ was below the AAQ NEPM standards at Yule.
- The annual average concentration of $PM_{2.5}$ was above the AAQ NEPM standard of 8 µg/m³ at BoM, Taplin and Richardson monitoring stations.

Table 4-5: FY 2018/19 data summary 24-hour and annual average concentrations of $PM_{2.5}$

Monitoring Station ID	Maximum 24-hour average concentration of $PM_{2.5}$ (µg/m³)	Number of days >25 µg/m³ (AAQ NEPM)	Performance (AAQ NEPM of 25 µg/m³)	Annual average concentration of $PM_{2.5}$ (µg/m³)	Performance (AAQ NEPM of 8 µg/m³)
BoM	22.2	0	Met	8.9	Not met
Richardson	30.4	8	Not met	12.3	Not met
Taplin	23.6	0	Met	9.6	Not met
Yule	20.1	0	Not demonstrated due to data capture	7.8	Not demonstrated due to data capture

4.2.3 $PM_{2.5}$ Timeseries Analysis

A timeseries plot of the 24-hour average concentration of $PM_{2.5}$ for FY 2018/19 for each monitoring station is shown in Figure 4-2.

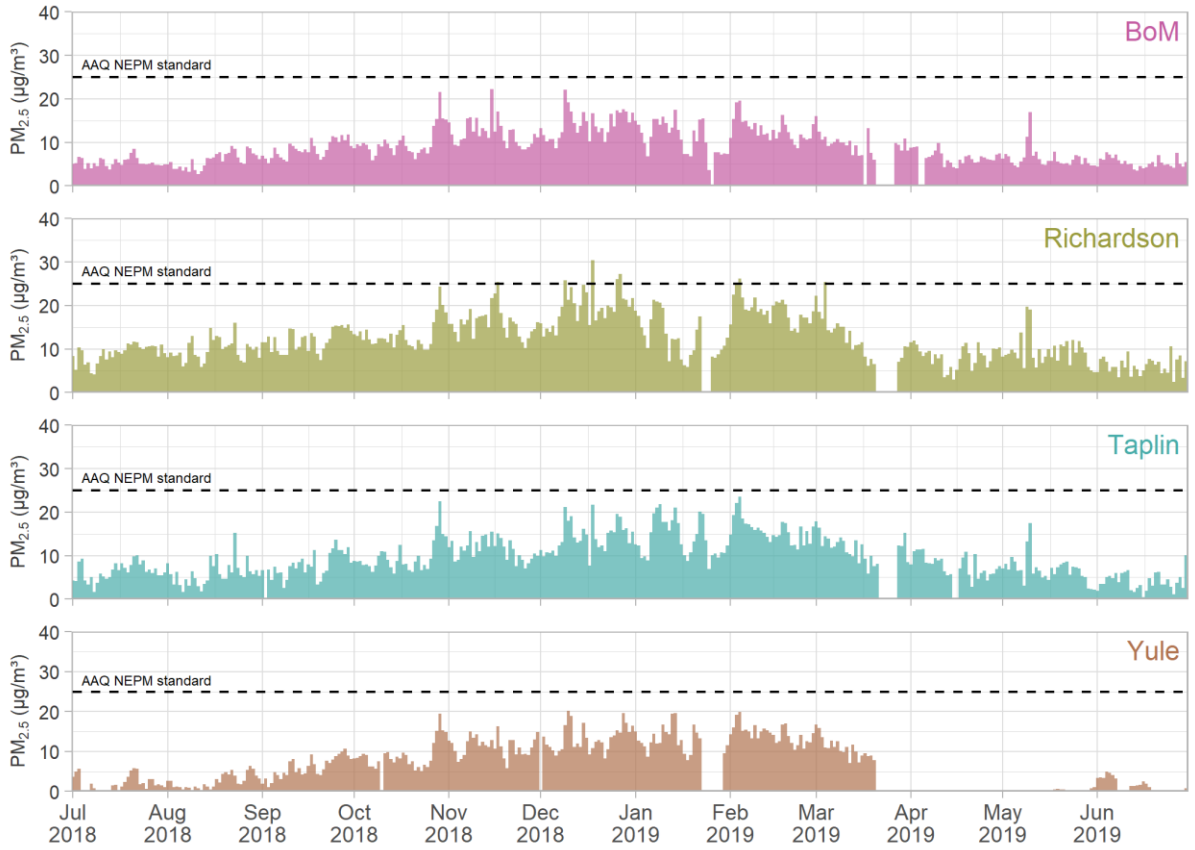


Figure 4-2: FY 2018/19 time series plots of 24-hour average concentrations of $PM_{2.5}$

4.3 Oxides of Nitrogen

NO_x was measured at the Taplin monitoring station during FY 2018/19. 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 rates greater than 79%, which meets the PHIC criterion of 75% data capture.

Table 4-6: FY 2018/19 data capture summary 1-hour average concentrations of NO_x

Monitoring Station ID	2018/19 NO_x Data Capture Rate (%)					Performance
	Q1	Q2	Q3	Q4	Annual	
Taplin	95	95	79	95	91	Met

4.3.2 Comparison to Air Quality Standards

The maximum measured 1-hour average and annual average concentrations of NO_2 at Taplin monitoring station are detailed in Table 4-7. The NO_2 measurements show that for FY 2018/19:

- The 1-hour average concentrations of NO_2 were below the AAQ NEPM standard of 246 µg/m³.
- The highest 1-hour average concentration of NO_2 corresponds to 27% of the AAQ NEPM standard.
- The annual average concentration of NO_2 was below the AAQ NEPM standard of 62 µg/m³.
- The annual average concentration of NO_2 corresponds to 20% of the AAQ NEPM standard.

The levels of NO_2 measured at Taplin are low and consistent with the NO_2 levels measured in previous years.

Table 4-7: FY 2018/19 data summary 1-hour average and annual average concentrations of NO_2

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	65.3	Met	12.6	Met

4.3.3 NO_2 Time Series Analysis

A timeseries plot of the 1-hour average concentrations of NO_2 for FY 2018/19 at Taplin monitoring station is shown in Figure 4-3. Note that the AAQ NEPM standard is 246 µg/m³ and is not shown on Figure 4-3 due to the low levels measured at the station.

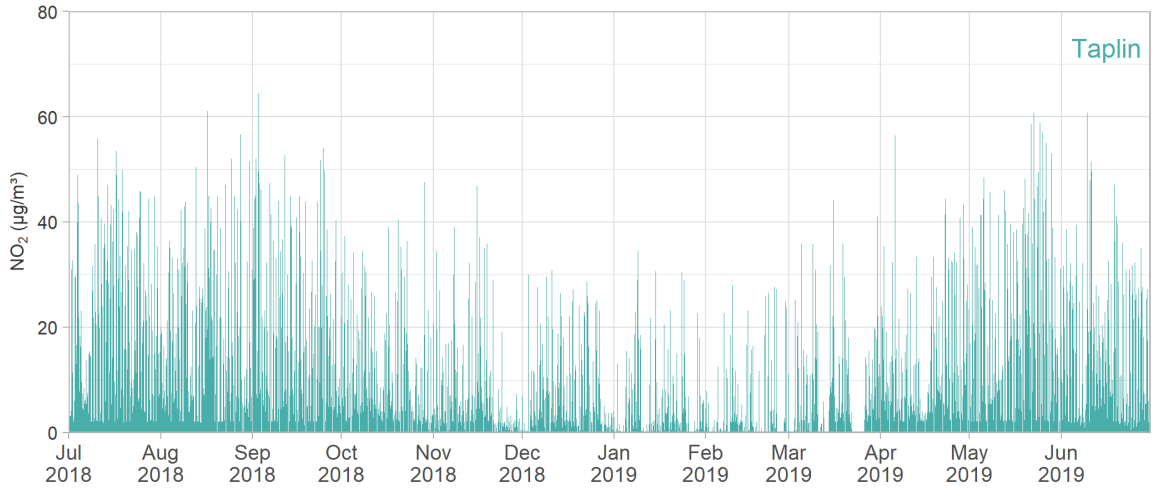


Figure 4-3: FY 2018/19 time series plot of 1-hour average concentrations of NO_2 for Taplin

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 2018/19.

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.

The Taplin monitoring station is the only PHIC monitoring network 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	0	Met
		50	24-hour	3	Not met
		25	Annual	0	Met
$PM_{2.5}$	Met	25	24-hour	0	Met
		8	Annual	0	Met
NO_2	Met	246	1-hour	0	Met
		62	Annual	0	Met

Table note:
[A] Ten 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 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	25	Not met
		25	Annual	1	Not met
$PM_{2.5}$	Met	25	24-hour	0	Met
		8	Annual	1	Not 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	155	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 location in the eastern part of Port Hedland township. Parameters measured at the Neptune monitoring 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	102	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 monitoring 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	167	Not met
		25	Annual	1	Not met
$PM_{2.5}$	Met	25	24-hour	8	Not met
		8	Annual	1	Not met

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	11	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}	Not Met	50	24-hour	165	Not demonstrated due to data capture
		25	Annual	1	Not demonstrated due to data capture

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 Yule 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}	Not Met	50	24-hour	15	Not demonstrated due to data capture
		25	Annual	0	Not demonstrated due to data capture
$PM_{2.5}$	Not Met	25	24-hour	0	Not demonstrated due to data capture
		8	Annual	0	Not demonstrated due to data capture

6. PM_{10} TRENDS

This section presents analysis of trends in concentrations of PM_{10} measured by the Port Hedland ambient air quality monitoring network for the seven years from FY 2012/13 to FY 2018/19.

6.1 24-hour average concentrations of 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 past seven years is presented in Table 6-1 and Figure 6-1.

The data shows the following:

- The number of days above the interim guideline at the Taplin monitoring station has shown a gradual downward trend over the past seven years.
- In FY 2018/19, there were zero days above the 24-hour average interim guideline for PM_{10} of 70 µg/m³.
- This is the first time since implementation of the interim guideline when zero days above the interim guideline has occurred.
- In FY 2108/19, Port Hedland's export tonnage was marginally (1%) lower than the previous year. In the past six years, export tonnage has increased year on year (as shown in Figure 6-1).

Table 6-1: Number of 24-hour average concentrations of PM_{10} 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	FY 2017/18	FY 2018/19
Taplin	70[A]	17	6	10	10	3	9	0

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

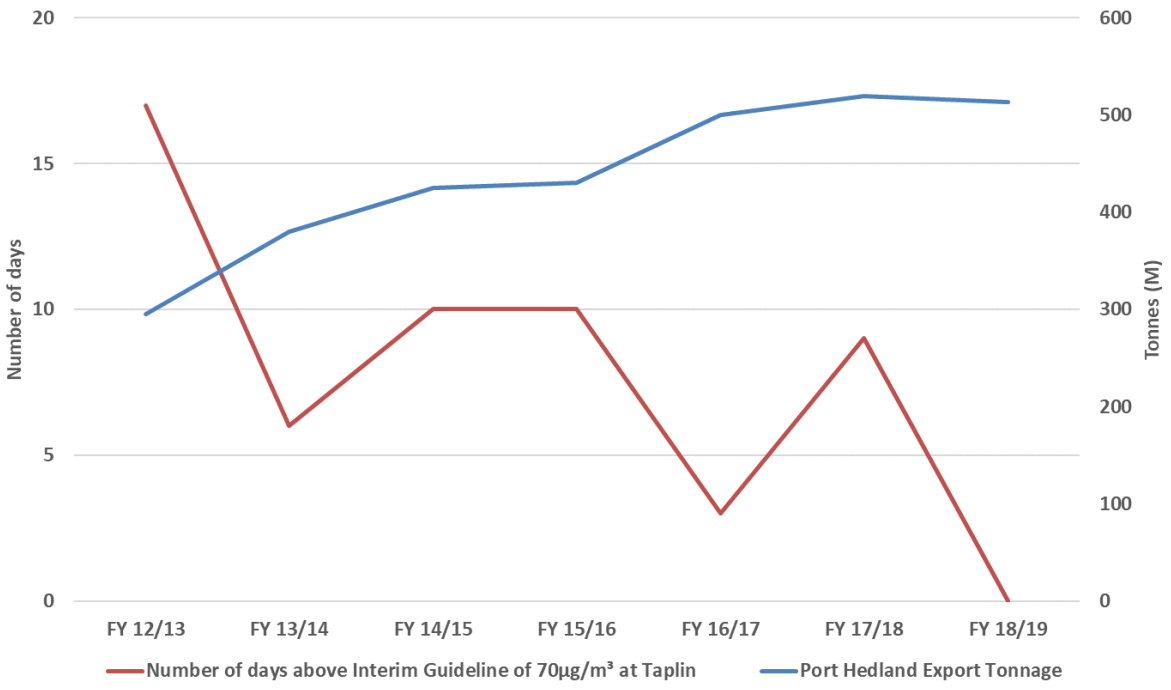


Figure 6-1: Number of 24-hour average concentrations of PM_{10} above the interim guideline at Taplin and the Port Hedland export tonnage for each year from FY 2012/13 to FY 2018/19

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

The number of 24-hour average concentrations of PM_{10} at each Port Hedland monitoring station 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:

- In FY 2018/19:
  - Kingsmill, Neptune, Richardson and Wedgefield monitoring stations recorded a greater number of 24-hour average concentrations above the AAQ NEPM standard compared to the three years prior.
  - Neptune and Richardson monitoring stations recorded their highest number of concentrations above the AAQ NEPM standard in FY 2018/19.
  - BoM recorded slightly more 24-hour average concentrations above the AAQ NEPM standard compared to the six years prior.
  - The number of 24-hour average concentrations above the AAQ NEPM standard at the South Hedland and Yule stations were similar to the six years prior.
  - Taplin monitoring station recorded fewer 24-hour average concentrations above the AAQ NEPM standard than the six years prior.
- Over the seven years, the number of 24-hour average concentration of PM_{10} above the AAQ NEPM standard at each monitoring station show the following trends:
  - BoM, Kingsmill, Neptune, South Hedland, Wedgefield and Yule show a general decreasing trend over the four years prior to FY 2017/18. In FY 2017/18 and FY 2018/19, the number of days above the AAQ NEPM standard increased.
  - In the years prior to FY 2017/18, the Taplin monitoring station showed a slight downward trend in the number of days above the AAQ NEPM standard. In FY 2017/18 the number of 24-hour average concentrations above the standard was higher than the average. In FY 2018/19, the number dropped significantly to its lowest recorded level of 3.
  - Richardson shows an increasing trend in the number of 24-hour average concentrations above the AAQ NEPM standard, especially over the last three reporting years. This may be in part due to urban development changes that have occurred near Richardson in the past few years.

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

Monitoring Station	AAQ NEPM Standard (µg/m³)	Number of days above the AAQ NEPM standard						
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17	FY 2017/18	FY 2018/19
BoM	50	24	10	17	12	7	4	25
Kingsmill		89	98	156	112	83	103	155
Neptune		25	25	67	43	29	15	102
Richardson		74	50	79	39	90	143	167
South Hedland		23	13	19	12	8	0	11
Taplin		48	48	55	48	27	65	3
Wedgefield		157	148	169	150	99	88	165
Yule		24	8	18	5	1	8	15

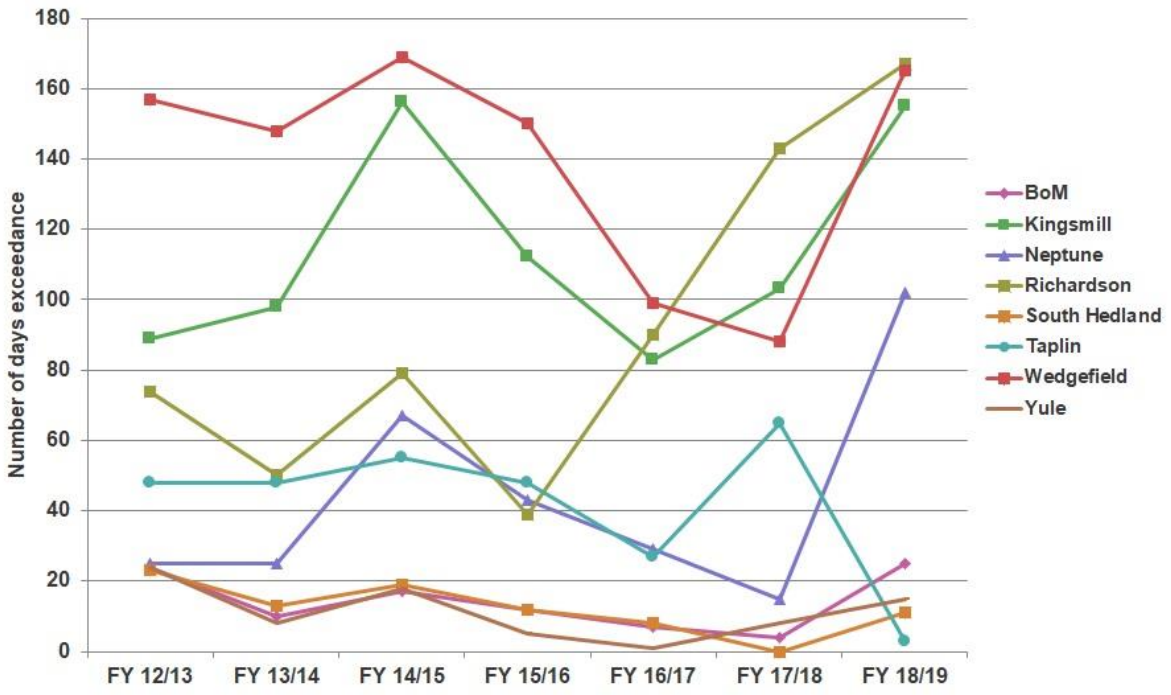


Figure 6-2: Number of the 24-hour average concentration of PM_{10} above the AAQ NEPM standard for each reporting year

6.3 Annual average concentration of PM_{10} – AAQ NEPM Standard

An annual average standard for PM_{10} was introduced into the AAQ NEPM in 2016. Accordingly, the annual average concentrations of PM_{10} at each Port Hedland monitoring station for the last four reporting years (FY 2015/16 to FY 2018/19) have been compared with the standard in Table 6-3 and Figure 6-3.

The data shows the following:

- Neptune, South Hedland and Wedgefield monitoring stations show a slight decreasing trend to FY 2017/18, before increasing during FY 2018/19.
- Bom, Kingsmill and Yule show a relatively steady trend to FY 2017/18, before increasing during FY 2018/19.
- Taplin monitoring station show a relatively steady trend to FY 2017/18, before decreasing significantly during FY 2018/19.
- Richardson monitoring station shows an increasing trend. It is mainly attributed to urban development changes that have occurred near the Richardson monitoring station.

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

Monitoring Station	AAQ NEPM Standard (µg/m³)	Annual average concentration of PM_{10} (µg/m³)						
		FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16[A]	FY 2016/17	FY 2017/18	FY 2018/19
BoM	25	Not required to be reported			25.4	21.4	23.8	31.5
Kingsmill					44.7	40.4	43.7	51.0
Neptune					32.3	27.4	26.4	40.2
Richardson					35.2	40.0	47.3	51.4
South Hedland					26.5	22.2	16.1	24.4
Taplin					35.6	31.3	34.4	23.8
Wedgefield					51.1	43.1	42.2	55.0
Yule					18.5	15.4	17.9	22.2

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

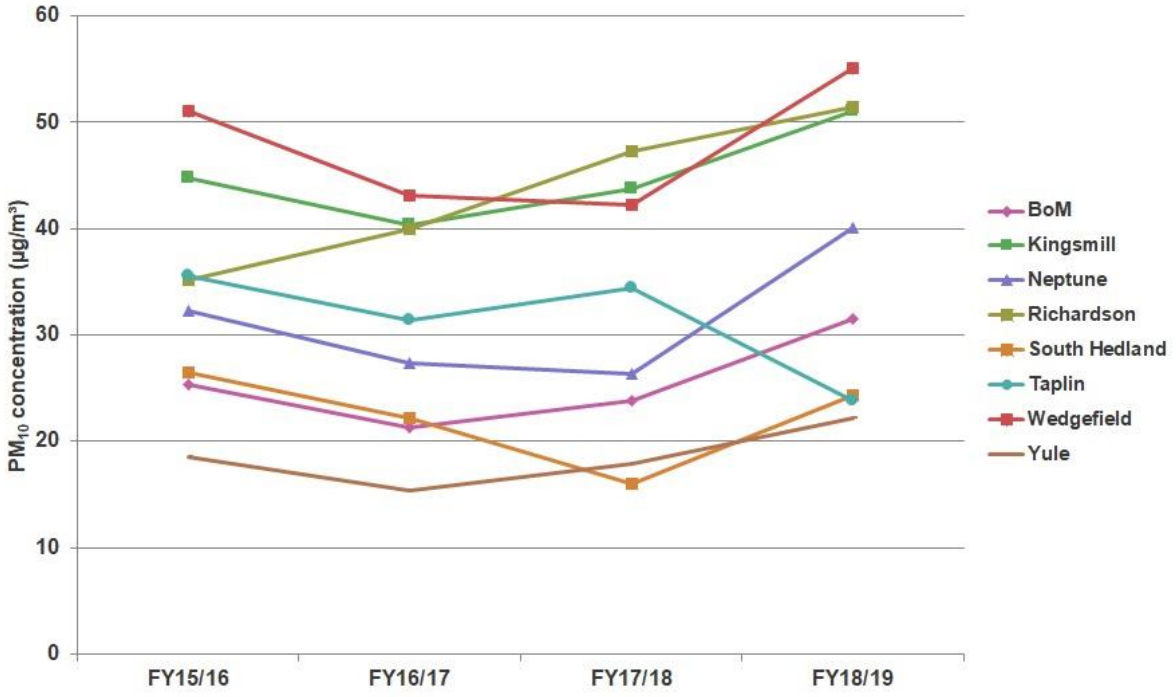


Figure 6-3: Annual average concentrations of PM_{10} for the last four years

6.4 PM_{10} Statistics

The following summary statistics for 24-hour average concentrations of PM_{10} are displayed graphically in Appendix A for the past seven reporting years:

- Maximum
- 99th percentile
- 98th percentile
- 95th percentile
- 50th percentile.

The graphs in Appendix A show the following:

- Maximum 24-hour average concentrations of PM_{10} show a decreasing trend at all monitoring stations over the six reporting years to FY 2017/18, with an increase in FY 2018/19 with the exception of a slight decrease at Kingsmill, Taplin and Yule
- 99th, 98th and 95th percentile 24-hour average concentrations of PM_{10} show a slightly decreasing or stable trend at all monitoring stations over the six reporting years to FY 2017/18, with a slight increase during FY 2018/19 with the exception of a decrease at the Taplin monitoring station
- 50th percentile 24-hour average concentration of PM_{10} exhibit a generally stable trend at all monitoring stations over the seven reporting years, with a slight increase during FY 2018/19 with the exception of a decrease at the Taplin monitoring station.

7. INVESTIGATION OF PM_{10} EVENTS

The Taskforce interim guideline for 24-hour average concentrations of PM_{10} allows for ten days above 70 µg/m³ at Taplin monitoring station as a result of industry. During periods exceeding the 24-hour Taskforce interim guideline, source contribution analyses are carried out to demonstrate whether the event day is likely to be a result of industry, regional dust or a local dust source other than industry.

As there were no 24-hour average concentrations of PM_{10} at the Taplin station above the 70 µg/m³ Taskforce interim guideline during the FY 2018/19, source contribution analysis is not required.

8. CONCLUSIONS

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 in the Port Hedland region. The PHIC ambient air quality monitoring network consists of eight (8) stations distributed across the region.

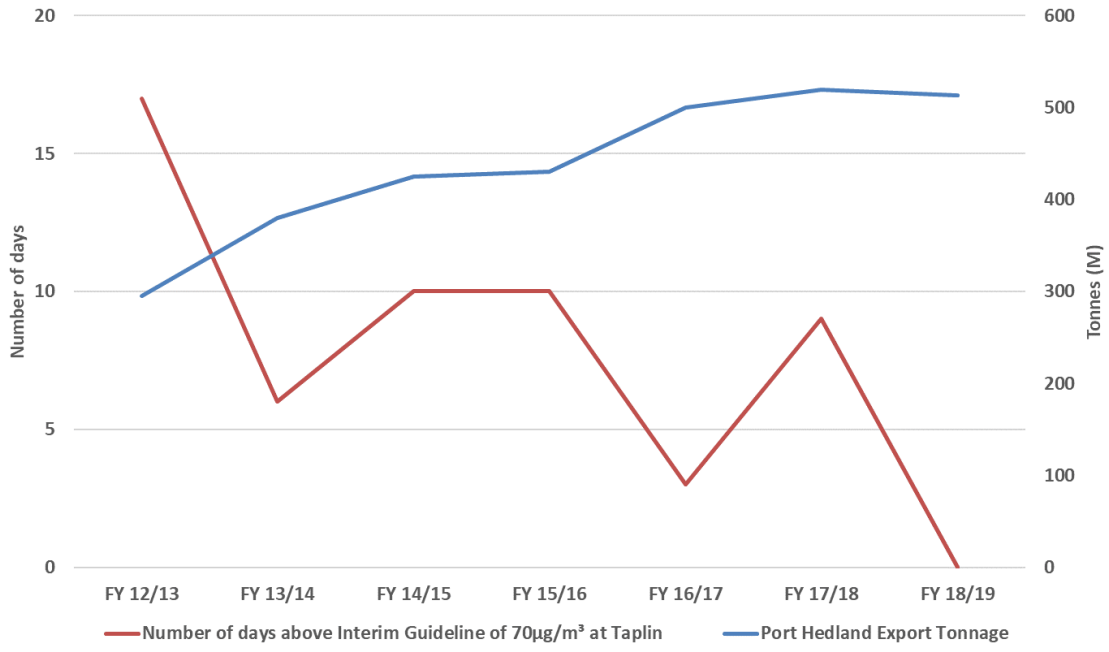
This annual report presents a summary of the Port Hedland ambient air quality monitoring network performance for FY 2018/19.

8.1 PM_{10}

Analysis of the PM_{10} data found the following:

- The Taplin monitoring station did not record any days above the 24-hour average interim guideline for PM_{10} of 70 µg/m³. Consequently, the interim guideline was met at Taplin (see figure below).
- This is the first instance of zero days above the interim guideline for a reporting period since implementation of the interim guideline.
- In FY 2018/19, Port Hedland's export tonnage was marginally (1%) lower than the previous year. Export tonnage has increased year on year for the past seven years (as shown in the table below).

Parameter	FY 12/13	FY 13/14	FY 14/15	FY 15/16	FY 16/17	FY 17/18	FY 18/19
Number of days above interim guideline of 70µg/m³ at Taplin	17	6	10	10	3	9	0
Port Hedland Export Tonnage (Mt)	295	380	425	430	500	519	513



- 24-hour average concentrations of PM_{10} were above the AAQ NEPM standard on one or more occasions at all sites in FY 2018/19. The number of days above the AAQ NEPM standard of 50 µg/m³ ranged from three days at Taplin to 167 days at Richardson.
- The number of days per year above the AAQ NEPM standard for PM_{10} at each monitoring station have been compared for the last seven years, which shows the following:
    - BoM, Kingsmill, Neptune, South Hedland, Wedgefield and Yule show a general decreasing trend over the four years prior to FY 2017/18. In FY 2017/18 and FY 2018/19, the number of days above the AAQ NEPM standard increased.
    - In the years prior to FY 2017/18, the Taplin monitoring station showed a slight downward trend in the number of days above the AAQ NEPM standard. In FY 2017/18 the number of 24-hour

average concentrations above the standard was higher than the average. In FY 2018/19, the number dropped significantly to its lowest recorded level of 3.
    - The Richardson station shows an increasing trend in the number of 24-hour average concentrations above the AAQ NEPM standard, especially over the last three reporting years. This is considered to be a result of urban development changes that have occurred near the Richardson station in the past few years.
- The annual average concentration of PM_{10} was above the AAQ NEPM standard of 25 µg/m³ at BoM, Kingsmill, Neptune, Richardson and Wedgefield.
- The annual average concentration of PM_{10} was below the AAQ NEPM standard of 25 µg/m³ at South Hedland, Taplin and Yule.
- Annual average concentrations of PM_{10} over the past four years (FY 2015/16 to FY 2018/19) showed that:
    - Neptune, South Hedland and Wedgefield stations showed a slight decreasing trend to FY 2017/18, before increasing in FY 2018/19
    - BoM, Kingsmill and Yule showed a relatively steady trend to FY 2017/18, before increasing during FY 2018/19
    - Taplin station showed a relatively steady trend to FY 2017/18, before decreasing significantly during FY 2018/19
    - The Richardson station shows an increasing trend. Urban development changes have occurred near the Richardson station that are considered to have contributed to the increasing trend at this site. For this reason, some caution should be placed on any reliance on this data.

8.2 $PM_{2.5}$

Analysis of the $PM_{2.5}$ data found the following:

- The 24-hour average concentrations of $PM_{2.5}$ were below the AAQ NEPM standards at BoM, Taplin and Yule.
- The 24-hour average concentration of $PM_{2.5}$ was above the AAQ NEPM standard of 25 µg/m³ on eight days at Richardson.
- The annual average concentration of $PM_{2.5}$ was below the AAQ NEPM standards at Yule.
- The annual average concentration of $PM_{2.5}$ was above the AAQ NEPM standard of 8 µg/m³ at BoM, Taplin and Richardson.

8.3 NO_2

Analysis of the NO_2 data found that the concentrations of NO_2 measured at Taplin in FY 2018/19 were low and well below the AAQ NEPM standards. Concentrations were consistent with the NO_2 concentrations measured in previous years.

8.4 Data Capture

In FY 2018/19, the annual data capture criterion of 75% was met for NO_2, PM_{10} and $PM_{2.5}$ at all monitoring stations. The quarterly (Q) criterion of 75% was also met for each pollutant and at all monitoring stations with the exception of PM_{10} in Q1 at Wedgefield station and in Q4 at Yule.

In August 2018, equipment faults and power supply issues at Wedgefield resulted in a Q1 capture rate of 73%. At the end of March 2019, all PHIC sites were shut down during cyclone Veronica. Due to the remoteness of Yule, access to site was not possible until May 2019 resulting in the Q4 data capture rate of 65%.

9. REFERENCES

Port Hedland Dust Management Taskforce, 2010, Port *Hedland Air Quality and Noise Management Plan*, Government of Western Australia Department of State Development (DSD)

Carslaw, D.C. and K. Ropkins, (2012). Openair - an R package for air quality data analysis. Environmental Modelling & Software. Volume 27-28, pp. 52-61

Carslaw, D.C. (2015). The Openair manual - open-source tools for analysing air pollution data. Manual for version 1.1-4, King's College London

National Environmental Protection Council, 1998, *National Environment Protection Ambient Air Quality Measure*

National Environmental Protection Council, 2003, *Variation to National Environment Protection Ambient Air Quality Measure*

National Environmental Protection Council, 2016, *Variation to the National Environment Protection Ambient Air Quality Measure*

PEL (2013) Audit of Ambient Air Quality Monitoring Stations – Port Hedland. Report prepared by Pacific Environment Limited for Port Hedland Industries Council, June 2013

PEL (2016) Audit of Ambient Air Quality Monitoring Stations – Port Hedland. Report prepared by Pacific Environment Limited for Port Hedland Industries Council

Port Hedland Industry Council, 2013, 2012/13 Port Hedland Ambient Air Quality Monitoring Report, accessed online at: http://www.phic-hedland.com.au/phic/Annual_Report.htm

Port Hedland Industry Council, 2014, 2013/14 Port Hedland Ambient Air Quality Monitoring Report, accessed online at: http://www.phic-hedland.com.au/phic/Annual_Report.htm

Port Hedland Industry Council, 2015, 2014/15 Port Hedland Ambient Air Quality Monitoring Report, accessed online at: http://www.phic-hedland.com.au/phic/Annual_Report.htm

Port Hedland Industry Council, 2016, 2015/16 Port Hedland Ambient Air Quality Monitoring Report, accessed online at: http://www.phic-hedland.com.au/phic/Annual_Report.htm

Port Hedland Industry Council, 2017, 2016/17 Port Hedland Ambient Air Quality Monitoring Report, accessed online at: http://www.phic-hedland.com.au/phic/Annual_Report.htm

Peer Review Committee, 2001, National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 5 – Data Collection and Handling, report prepared by for the National Environmental Protection Council

Peer Review Committee, 2002, National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 8 – Annual Reports, report prepared by for the National Environmental Protection Council

R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

H. Wickham. GGPlot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2009

Claus O. Wilke (2016). Cowplot: Streamlined Plot Theme and Plot Annotations for 'ggplot2'. R package version 0.6.2. https://CRAN.R-project.org/package=cowplot

Appendix A PM10 TREND SUMMARY GRAPHS

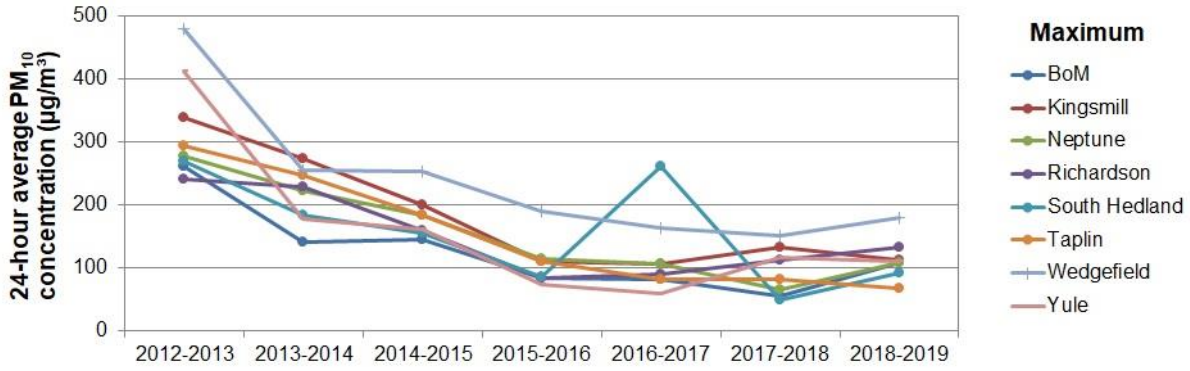


Figure A-1: Maximum 24-hour average PM10 Trends

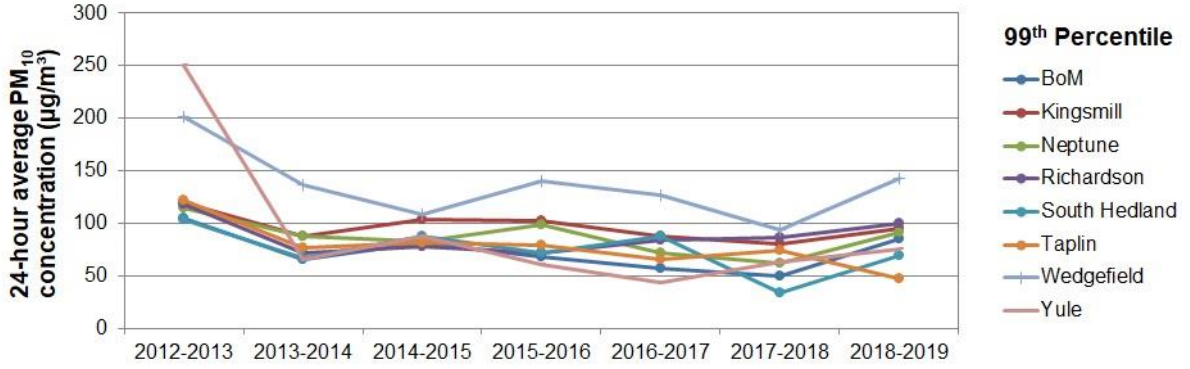


Figure A-2: 99th percentile 24-hour average PM10 Trends

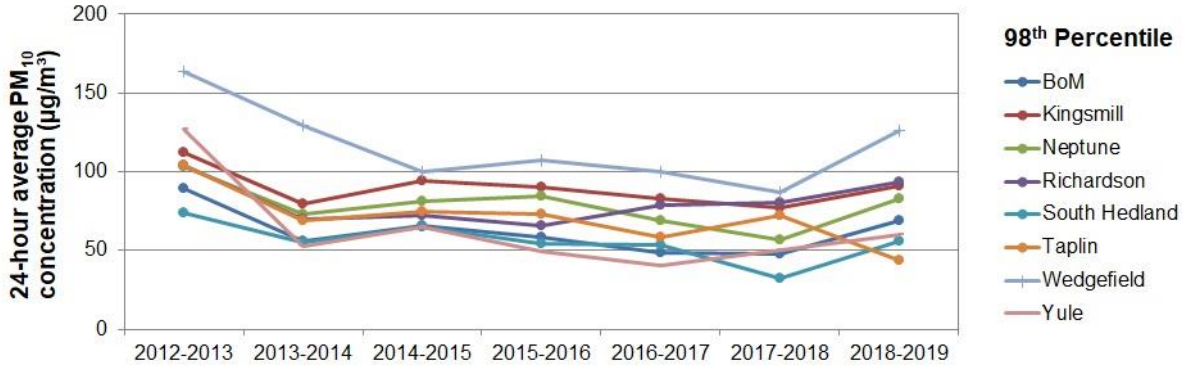


Figure A-3: 98th percentile 24-hour average PM10 Trends

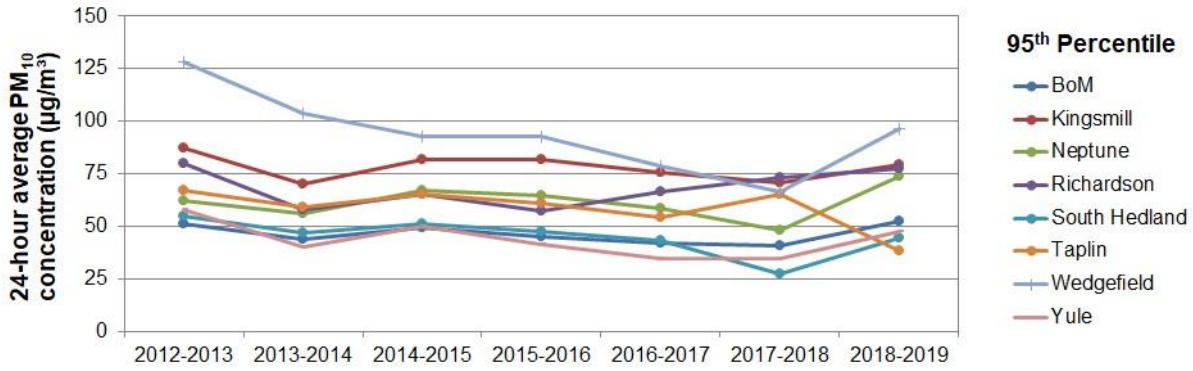


Figure A-4: 95th percentile 24-hour average PM_{10} Trends

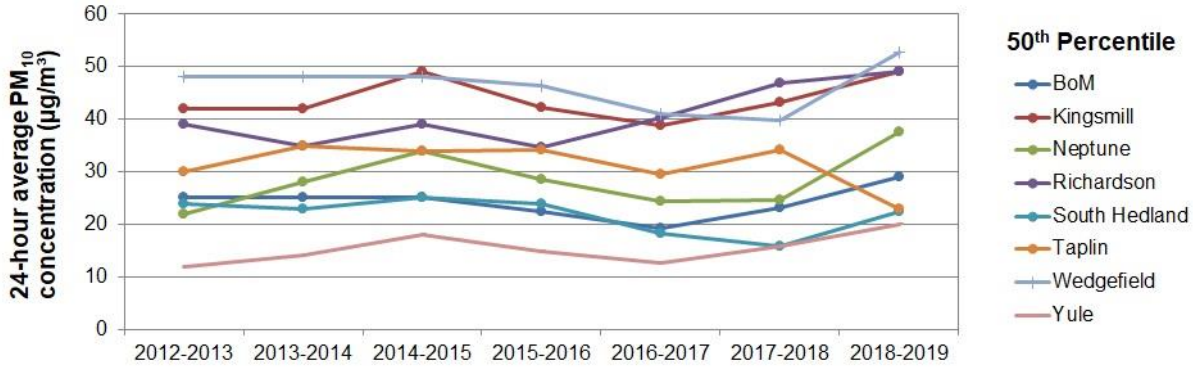


Figure A-5: 50th percentile 24-hour average PM_{10} Trends