Port Hedland Industries Council
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**Addendum to 2017/2018 Annual Report**

**Port Hedland Ambient Air Quality Monitoring Program**

The following is an addendum to the *2017/18 Annual Report Port Hedland Ambient Air Quality Monitoring Program* prepared by Katestone Environmental Pty Ltd for the Port Hedland Industries Council.

The 2017/18 Annual Report included references to $PM_{10}$ readings at Taplin Street. The report stated that for the 2017/18 reporting period, the monitoring station at Taplin recorded nine days above the 24-hour average interim guideline for PM10 of 70 µg/m³. The interim guideline allows for ten exceedance days per year.

Since publishing the 2017/18 Annual Report, inconsistent $PM_{10}$ readings have been detected at the Taplin Street monitoring station within the Port Hedland Ambient Air Quality Monitoring Network. This was confirmed on 23 January 2020.

Investigations into the inconsistency at Taplin Street have now been completed. Because no faults could be found with the monitoring equipment, it is not possible to determine with certainty the correct readings for Taplin Street during 2017/18.

PHIC commissioned Katestone Environmental Pty Ltd to determine the commencement date of inconsistent readings, which Katestone determined to be 1 May 2018. This date is consistent with advice from investigations undertaken by the Port Hedland Ambient Air Quality Program Managers - Ecotech Pty Ltd.

Accordingly, PHIC commissioned Katestone Environmental Pty Ltd to update the 2017/18 Annual Report to exclude Taplin Street findings from 1 May – 30 June 2018.

Please note the republished 2017/18 Annual Report include the full datasets and findings from the other seven stations in the Port Hedland Ambient Air Quality Monitoring Program, namely:

1. Kingsmill
2. Richardson
3. Neptune
4. Yule
5. Wedgefield
6. Bureau of Meteorology
7. South Hedland

23 October 2020

Kind regards,

Kirsty Danby
**Port Hedland Industries Council**
**Chief Executive Officer**

PORT HEDLAND
INDUSTRIES COUNCIL

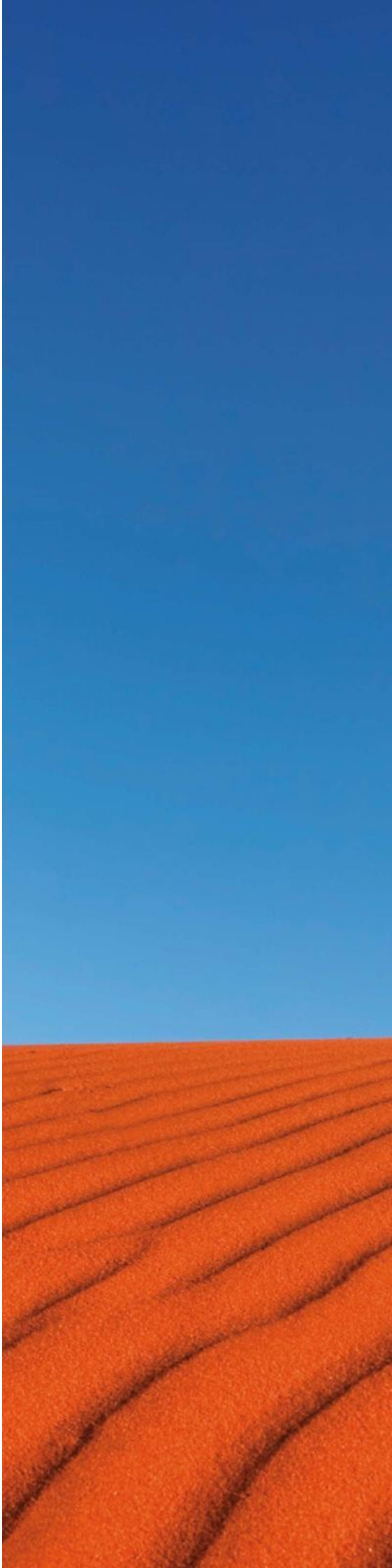
# Annual Report – FY 2017/18 Port Hedland Ambient Air Quality Monitoring Program

**FINAL**

**Port Hedland Industries Council**

**October 2020**

**Prepared by Katestone Environmental Pty Ltd**



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*October 2020 Update:*

*The $PM_{10}$ measurements from the Taplin Street monitoring station within the Port Hedland Ambient Air Quality Monitoring Network were found to be unreliable during financial year 2019/20. This was confirmed by PHIC on 23 January 2020 and affected the 2018/19 and 2019/20 data, along with Q4 of 2017/18 (April to June 2018). Accordingly, the Taplin Street $PM_{10}$ data collected during Q4 of 2017/18 have been removed from this annual report.*

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 2017/18 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 | ✓ [A] | ✓ | ✓ | ✓ |
| Wedgefield | 20.370454° | 118.584820° | Industrial | ✓ | | | ✓ |
| Yule | 20.595167° | 118.296311° | Background | ✓ | ✓ | | ✓ |

Table Note:

[A] Data recorded during Q4 of FY 2017/18 was found to be unreliable and removed from analysis

This annual report presents a summary of the Port Hedland ambient air quality monitoring network performance for FY 2017/18. 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.

***$PM_{10}$***

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

- For FY 2017/18, the monitoring station at Taplin recorded nine days above the 24-hour average interim guideline for $PM_{10}$ of 70 µg/m³. The interim guideline allows for ten exceedance days per year. However, compliance with the interim guideline could not be determined for the FY 2017/18 because of data loss in Q4 of FY 2017/18.

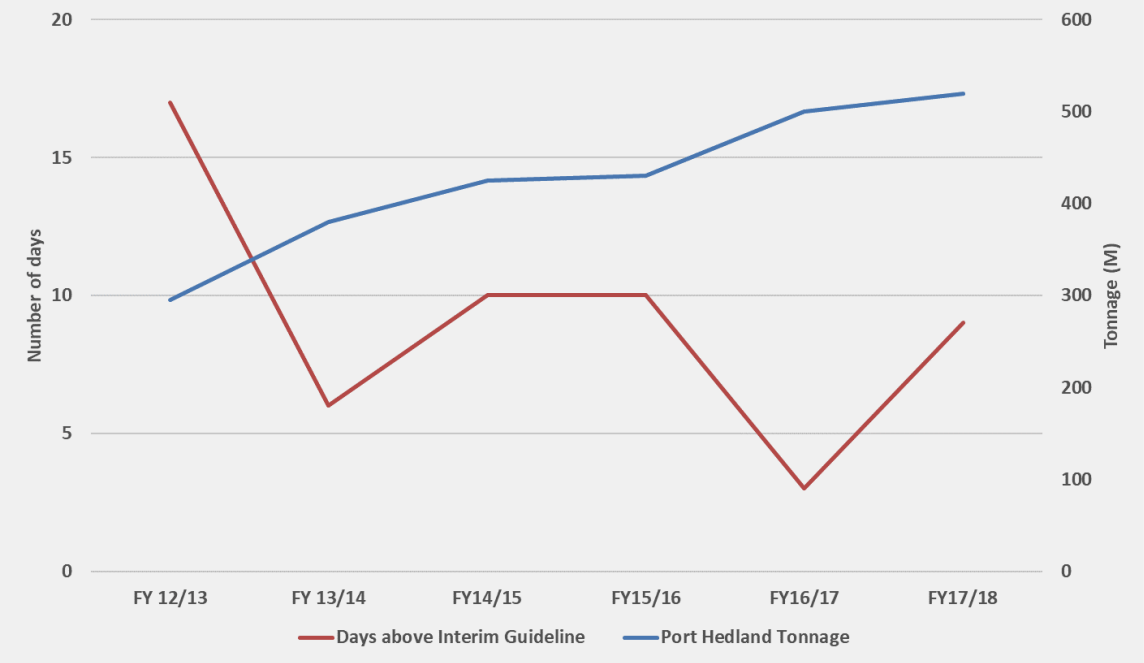
- Compared with the previous reporting year, the number of days above 70 µg/m³ has increased from three days in FY 2016/17 to nine days in FY 2017/18. The average number of days above 70 µg/m³ for the six reporting years is just over nine indicating that FY 2017/18 is consistent with the longer-term trend.

- This is in contrast to the Port Hedland export tonnage that has steadily increased over the past six reporting years (as shown in the table below).

| 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 [A] |
| 70 | 17 | 6 | 10 | 10 | 3 | 9 [A] |
| *Export Tonnage (Mt)* | 295 | 380 | 425 | 430 | 500 | 519 |

Table Note:

[A] Compliance the interim guideline could not be determined for the FY 2017/18 because of data loss in Q4 of FY 2017/18




- Detailed analysis of $PM_{10}$ data and meteorological conditions for the nine days at Taplin that were above 70 µg/m³ in FY 2017/18 indicates that:
  - On four days a local industrial source was identified as the cause
  - On three days a local industrial source combined with elevated regional levels were identified as the cause
  - On one day a local industrial source and a local non-industrial source were identified as the likely cause
  - On one day a local non-industrial source was identified as the cause.

- In FY 2017/18, there were no days above the AAQ NEPM standard for 24-hour average concentrations of $PM_{10}$ of 50 µg/m³ at South Hedland.

- At the other seven PHIC sites, 24-hour average concentrations were above the AAQ NEPM standard for $PM_{10}$ in FY 2017/18. Analysis of these events showed that:
    - Richardson and Taplin recording their highest number of concentrations above the AAQ NEPM standard compared to all previous years.
    - Kingsmill and Yule recorded a greater number of concentrations above the AAQ NEPM standard compared to the previous FY (FY 2016/17)
    - BoM, Neptune, South Hedland and Wedgefield recorded fewer concentrations above the AAQ NEPM standard compared to the previous FY (FY 2016/17).
- Considering the number of days per year above the AAQ NEPM standard for 24-hour average concentrations of $PM_{10}$ at each monitoring station over the last six years shows the following trends:
    - BoM, Kingsmill, Neptune, South Hedland, Wedgefield and Yule monitoring station's show a general decreasing trend over the past four years.
    - The Taplin monitoring station shows a steady trend over the last 6 years, with a slightly higher than the average number of exceedances this FY (2017/18).
    - The Richardson monitoring station shows an increasing trend in the number of days above the AAQ NEPM standard, especially over the last two reporting years. This may be in part due to 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 Kingsmill, Neptune, Richardson, Taplin and Wedgefield.
- The annual average concentration of $PM_{10}$ was below the AAQ NEPM standard of 25 µg/m³ at BoM, South Hedland and Yule.
- Annual average concentrations of $PM_{10}$ over the past three reporting years (FY 2015/16 to FY 2017/18) showed that:
    - Neptune, South Hedland and Wedgefield station's show a slight decreasing trend
    - Bom, Kingsmill, Taplin and Yule station's show a relatively steady trend
    - The Richardson station showed an increasing trend (It is noted that urban development changes have occurred near the Richardson station that may have contributed to the trend at this site).

***$PM_{2.5}$***

$PM_{2.5}$ was measured at four (4) stations in the Port Hedland ambient air quality monitoring network for the FY 2017/18 reporting period. Analysis of the $PM_{2.5}$ data found the following:

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

***$NO_2$***

$NO_2$ is only measured at the Taplin monitoring station in the Port Hedland ambient air quality monitoring network. Analysis of the $NO_2$ data found the following:

- 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 32% of the AAQ NEPM standard.
- The annual average concentrations of $NO_2$ were below the AAQ NEPM standard of 62 µg/m³.
- The annual average concentration of $NO_2$ corresponds to 22% of the AAQ NEPM standard.

Overall, the levels of $NO_2$ measured at Taplin in FY 2017/18 are low and consistent with the $NO_2$ levels measured in previous years.

***Data Capture***

In the FY 2017/18 the PHIC data capture criterion of 75% (per quarter and annually) was met for $NO_2$, $PM_{10}$ and $PM_{2.5}$ at all monitoring stations. For $PM_{10}$ and $PM_{2.5}$, a number of stations also met the PHIC desirable target of 95% data capture. The annual data capture rate for $PM_{10}$ was 72.6% due to data loss in Q4 of FY 2017/18.

# 1. OCTOBER 2020 UPDATE

The $PM_{10}$ measurements from the Taplin Street monitoring station within the Port Hedland Ambient Air Quality Monitoring Network were found to be unreliable during financial year 2019/20. This was confirmed by PHIC on 23 January 2020 and affected the 2018/19 and 2019/20 data, along with Q4 of 2017/18 (April to June 2018). Accordingly, the Taplin Street $PM_{10}$ data collected during Q4 of 2017/18 have been removed from this annual report.

# 2. 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 2017/18. This is the sixth annual performance report of its kind.

This report includes the following information:

- Overview of ambient air quality monitoring network and assessment methods (**Section 3**)
- Summary of Port Hedland meteorology (**Section 4**)
- Ambient air quality monitoring data summary by pollutant (**Section 5**)
- Ambient air quality monitoring data summary by monitoring station (**Section 6**)
- Summary of $PM_{10}$ trends (**Section 7**).
- Investigation of $PM_{10}$ events (**Section 8**)
- Annual report conclusions (**Section 8.6**).

# 3. AMBIENT AIR QUALITY MONITORING NETWORK OVERVIEW AND ASSESSMENT METHODS

## 3.1 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 met.

## 3.2 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 3-1 and Figure 3-1.

**Table 3-1: 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 | ✓[A] | ✓ | ✓ | ✓ |
| Wedgefield | -20.370454° | 118.584820 | Industrial | ✓ | | | ✓ |
| Yule | -20.595167° | 118.296311 | Rural Background | ✓ | ✓ | | ✓ |

Table Note:

[A] Data recorded during Q4 of FY 2017/18 was found to be unreliable and removed from analysis

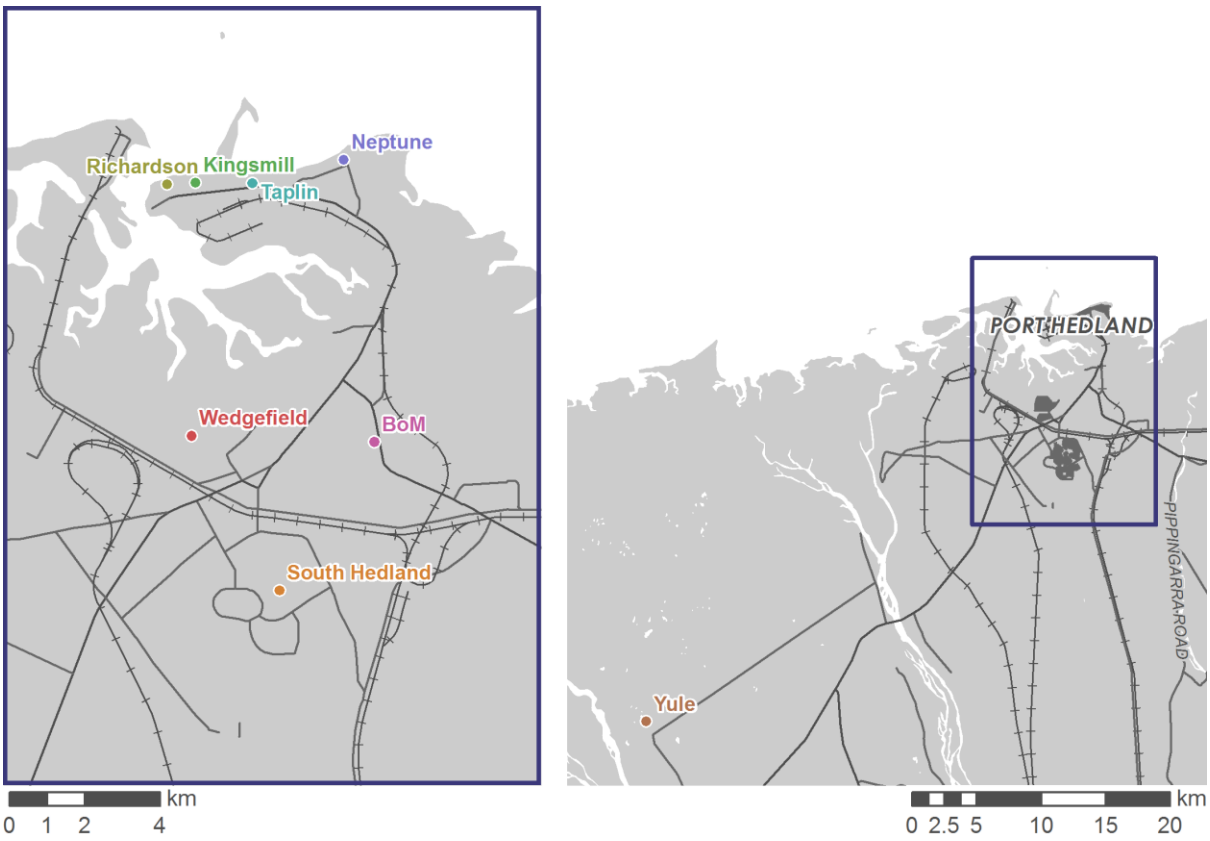



**Figure 3-1: Port Hedland Ambient Air Quality Monitoring Network**

## 3.3 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 3-2.

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 3-2: 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 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓[A] | ✓ | ✓ |
| $PM_{2.5}$ | BAM1020 | AS/NZS 3580.9.12:2013 | ✓ | | | ✓ | | ✓ | | ✓ |
| $NO_x$ | Ecotech ML9841 | AS/NZS 3580.5.1:2011 | | | | | | ✓ | | |

Table Note:

[A] Data recorded during Q4 of FY 2017/18 was found to be unreliable and removed from analysis

## 3.4 FY 2017/18 Activities

The Port Hedland ambient air quality monitoring network activities for FY 2017/18 are detailed in Table 3-3. Notable data gaps outside of the routine maintenance conducted at the site included the following:

- Unreliable $PM_{10}$ data recorded at Taplin during Q4 of 2017/18 was removed from the dataset prior to analysis.
- A cyclone warning for 10-15 January 2018 resulted in all stations (except Yule) to shut down.
- The $PM_{2.5}$ BAM1020 at Richardson Street that had faulted in the last financial year was replaced on 7 July 2017.
- The Neptune $PM_{10}$ BAM 1020 was affected by many power failures between January 2018 – June 2018.
- The Yule $PM_{10}$ and $PM_{2.5}$ BAM 1020 monitors were affected by power failures in August 2017 and intermittent tapes faults in September 2017.

**Table 3-3: FY 2017/18 Port Hedland ambient air quality monitoring network activities**

| Station | Parameter | Averaging time [A] | Q1 | | | Q2 | | | Q3 | | | Q4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | July 17 | August 17 | September 16 | October 17 | November 17 | December 17 | January 18 [B] | February 18 | March 18 | April 18 | May 18 | June 18 |
| BoM | $PM_{10}$ | 10-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | $PM_{2.5}$ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Meteorology | 10-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Kingsmill | $PM_{10}$ | 10-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Meteorology | 10-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Neptune | $PM_{10}$ | 10-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓[C] | ✓[C] | ✓[C] | ✓[C] | ✓[C] | ✓[C] |
| | Meteorology | 10-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Richardson | $PM_{10}$ | 10-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | $PM_{2.5}$ | | ✓[D] | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Meteorology | 10-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| South Hedland | $PM_{10}$ | 5-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Meteorology | 5-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Taplin | $PM_{10}$ | 10-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | G | G | G |
| | $PM_{2.5}$ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | $NO_x$ | 5-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Meteorology | 10-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Wedgefield | $PM_{10}$ | 5-min / 1-hr | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Meteorology | 5-min | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Yule | $PM_{10}$ | 10-min / 1-hr | ✓ | ✓[E] | ✓[F] | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | $PM_{2.5}$ | | ✓ | ✓[E] | ✓[F] | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | 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] A cyclone warning for 10-15 January resulted in all stations (except Yule) to shut down.

[C] Power failures were experienced from January 2018 – June 2018 at Neptune $PM_{10}$ monitor which resulted in reduced data capture.

[D] $PM_{2.5}$ BAM1020 at Richardson Street that had faulted in the last financial year was replaced on 7 July 2017

[E] $PM_{10}$ and $PM_{2.5}$ BAM1020 instruments at Yule experienced power failures in August 2017 which resulted in reduced data capture.

[F] $PM_{10}$ and $PM_{2.5}$ BAM1020 instruments at Yule experienced intermittent tape faults in September 2017 which resulted in reduced data capture.

[G] $PM_{10}$ data at Taplin in Q4 of FY 2017/18 was found to be unreliable and removed from data set prior to analysis.

## 3.5 Data Processing

The FY 2017/18 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 3.3). 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 2017/18 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 exceedances 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 3.6.2) 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 8.1.

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).

## 3.6 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).

### 3.6.1 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.

### 3.6.2 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 2017/18 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 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 3-4.

**Table 3-4: 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 east of Taplin Street
[C] Maximum allowable exceedances of 1 day a year

# 4. 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.

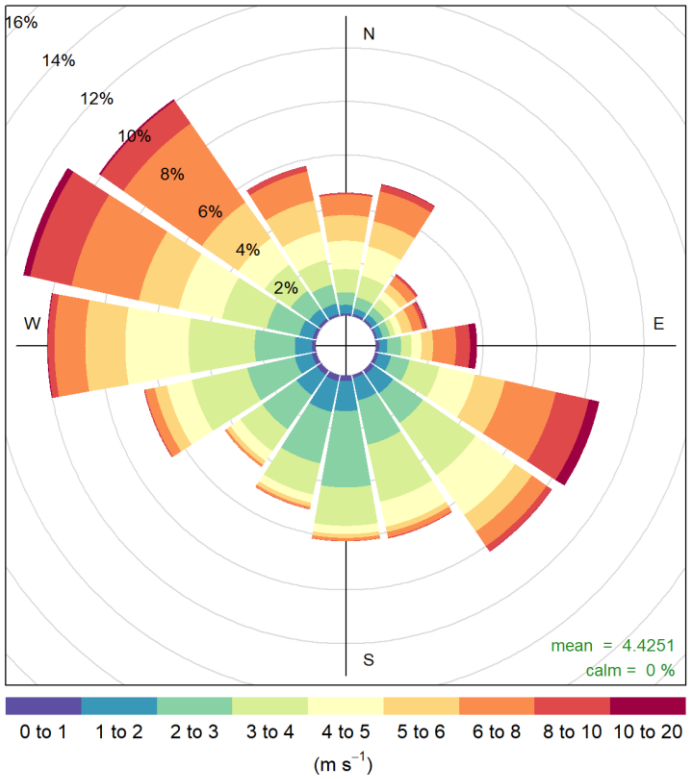
Exposed dust sources (be it from industry sources, other anthropogenic sources or natural sources), will have higher dust emissions during dry conditions and strong winds. The dust emissions will also have a greater radius of impact during periods of stronger wind speeds due to dust remaining suspended 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 2017/18 are provided in Figure 4-1, Figure 4-2 and Figure 4-3, 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 16, 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 4-1, Figure 4-2 and Figure 4-3 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 2017/18 annual average wind speeds of 4.4 m/s, 3.0 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 monitoring site 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.



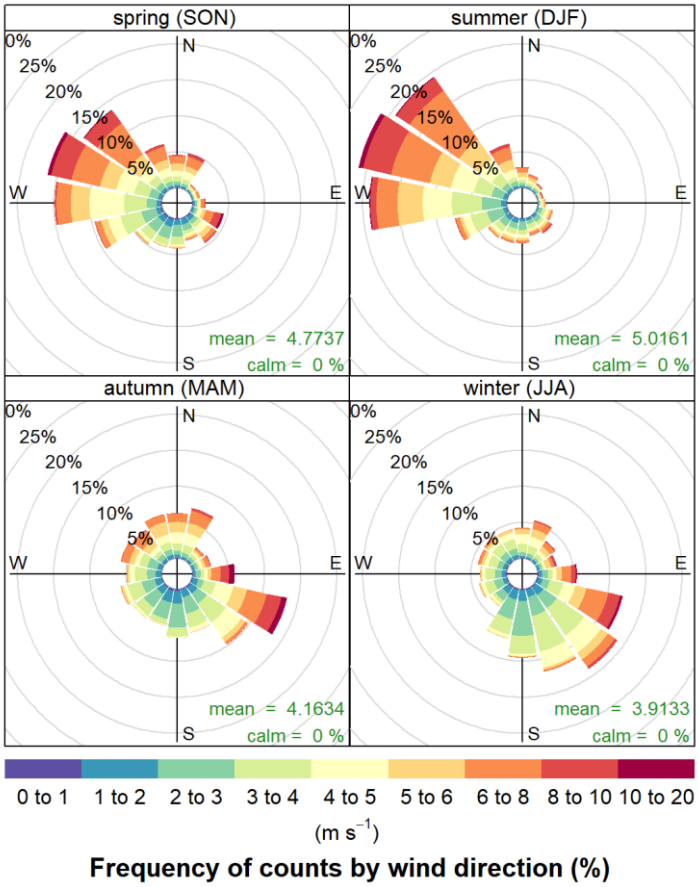
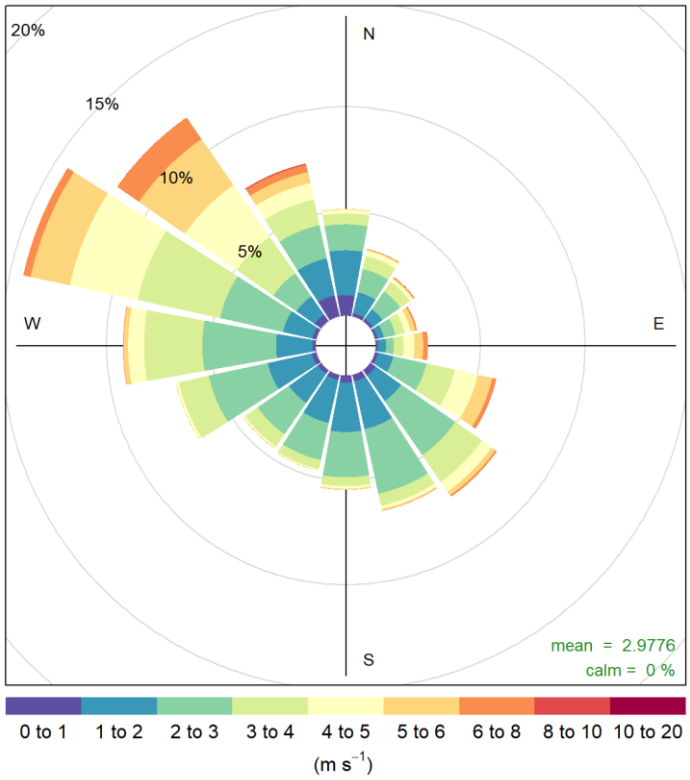




**Figure 4-1: FY 2017/18 wind roses for BoM annual (top) seasonal (bottom)**



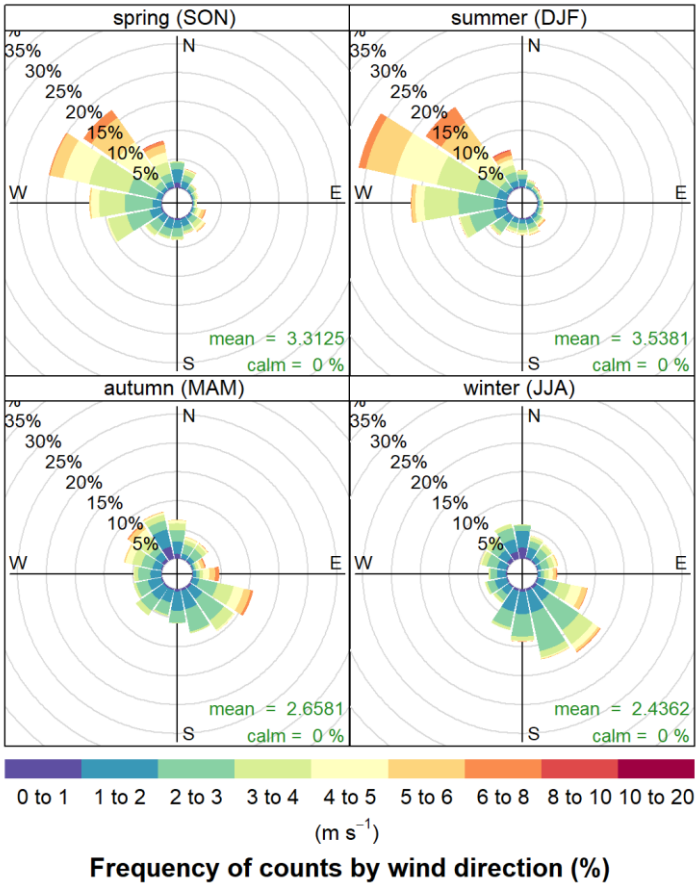
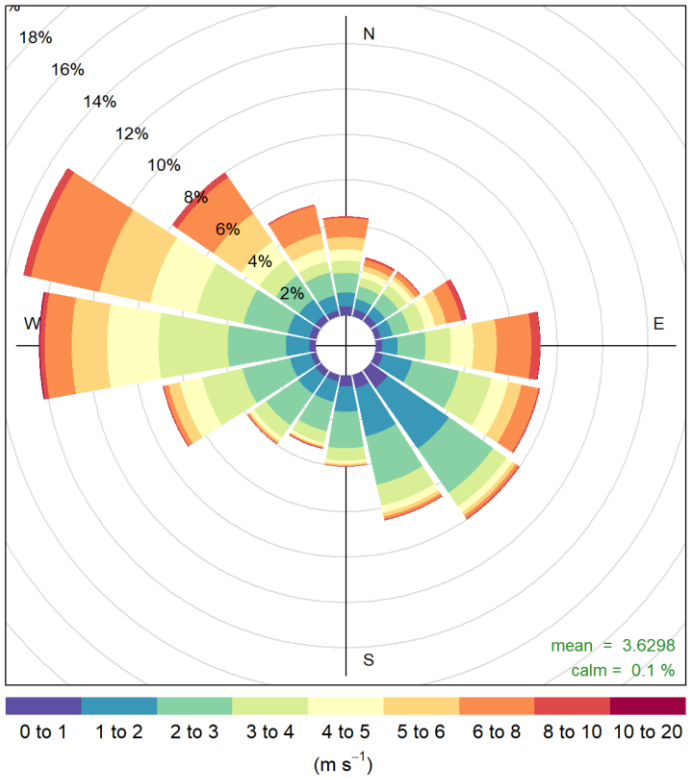




**Figure 4-2: FY 2017/18 wind roses for Taplin annual (top) seasonal (bottom)**



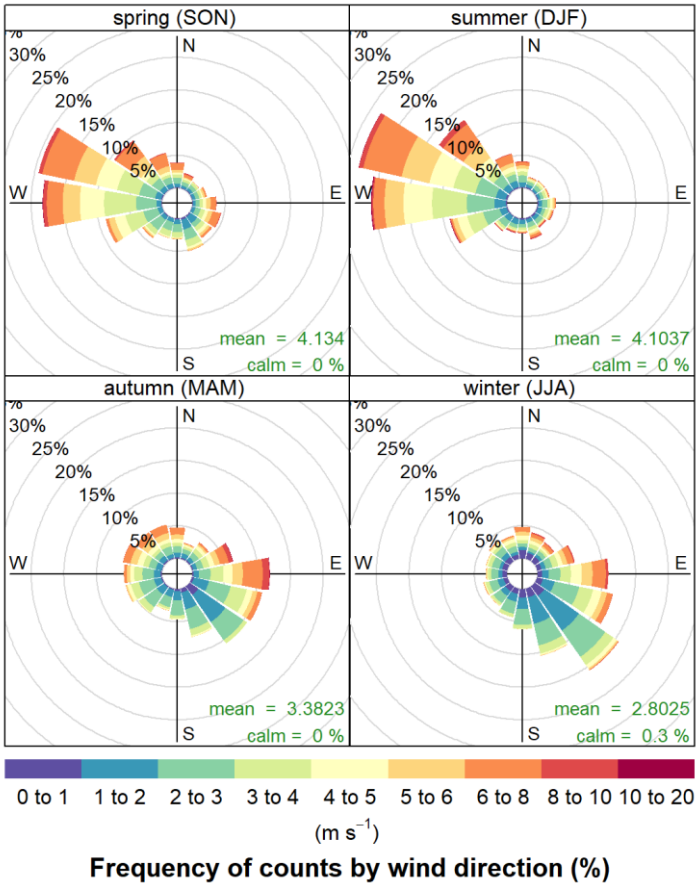




**Figure 4-3: FY 2017/18 wind roses for Yule annual (top) seasonal (bottom)**

# 5. 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.

## 5.1 $PM_{10}$

$PM_{10}$ was measured at all eight (8) monitoring stations during FY 2017/18.

### 5.1.1 Data Capture

Data capture rates for 1-hour average concentrations of $PM_{10}$ for each monitoring station in FY 2017/18 are detailed in Table 5-1. With the exception of Taplin, all stations achieved an annual capture rate for $PM_{10}$ of greater than 88% and a quarterly capture rate greater than 77%. This meets the PHIC criterion of 75% data capture. At Taplin, the $PM_{10}$ data was found to be unreliable in Q4 of 2017/18 and has been omitted from this updated annual report. Consequently, the annual data capture at Taplin was 73%, which is less than the PHIC criterion of 75%.

**Table 5-1: FY 2017/18 Data Capture Summary 1-hour average concentration of $PM_{10}$**

| Monitoring Station | $PM_{10}$ Data Capture Rate (%) | | | | | Performance |
|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Annual | |
| BoM | 99 | 100 | 95 | 95 | 97 | Met |
| Kingsmill | 96 | 98 | 92 | 84 | 93 | Met |
| Neptune | 94 | 98 | 82 | 77 | 88 | Met |
| Richardson | 98 | 100 | 94 | 99 | 98 | Met |
| South Hedland | 96 | 99 | 88 | 99 | 96 | Met |
| Taplin | 95 | 100 | 95 | 0 | 73 | Not met |
| Wedgefield | 95 | 100 | 93 | 97 | 96 | Met |
| Yule | 80 | 99 | 91 | 99 | 92 | Met |

### 5.1.2 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 5-2. The average concentration of $PM_{10}$ for FY 2017/18 for each station is detailed in Table 5-3.

The measurements of $PM_{10}$ show that for FY 2017/18:

- Performance of the Taplin site against the interim guideline could not be determined for the FY 2017/18 due to data not being available for the full twelve-month period. Considering the available $PM_{10}$ data, the monitoring station at Taplin recorded nine days above the 24-hour average interim guideline for $PM_{10}$ of 70 µg/m³. The interim guideline allows for 10 exceedance days per year.
- There were no days above the AAQ NEPM standard for 24-hour average concentrations of $PM_{10}$ of 50 µg/m³ at South Hedland.
- At the other seven PHIC sites, 24-hour average concentrations were above the AAQ NEPM standard for $PM_{10}$ in FY 2017/18. The number of days above the AAQ NEPM standard of 50 µg/m³ ranged from 4 days at BoM to 143 days at Richardson.
- The annual average concentration of $PM_{10}$ was above the AAQ NEPM standard of 25 µg/m³ at Kingsmill, Neptune, Richardson, Taplin and Wedgefield.
- The annual average concentration of $PM_{10}$ was below the AAQ NEPM standard of 25 µg/m³ at BoM, South Hedland and Yule.

**Table 5-2: FY 2017/18 data summary 24-hour average concentrations of $PM_{10}$**

| Monitoring Station ID | Maximum 24-hour average $PM_{10}$ concentration (µg/m³) | Number of days >50 µg/m³ (AAQ NEPM) | Performance (AAQ NEPM) | Number of days >70 µg/m³ (Taskforce) | Performance (Taskforce) |
|---|---|---|---|---|---|
| BoM | 54.5 | 4 | Not met | - | - |
| Kingsmill | 131.8 | 103 | Not met | | |
| Neptune | 63.7 | 15 | Not met | | |
| Richardson | 110.6 | 143 | Not met | | |
| South Hedland | 47.7 | 0 | Met | | |
| Taplin | 81.0 | 64 | Not demonstrated* | 9 | Not demonstrated* |
| Wedgefield | 151.1 | 88 | Not met | - | - |
| Yule | 114.7 | 8 | Not met | | |

Table note:
* Not demonstrated due to zero data capture in Q4

**Table 5-3: FY 2017/18 data summary annual average concentrations of $PM_{10}$**

| Monitoring Station ID | Annual average $PM_{10}$ concentration (µg/m³) | Performance (AAQ NEPM of 25 µg/m³) |
|---|---|---|
| BoM | 23.8 | Met |
| Kingsmill | 43.7 | Not met |
| Neptune | 26.4 | Not met |
| Richardson | 47.3 | Not met |
| South Hedland | 16.1 | Met |
| Taplin | 39.7 | Not demonstrated* |
| Wedgefield | 42.2 | Not met |
| Yule | 17.9 | Met |

Table note:
* Not demonstrated due to zero data capture in Q4

### 5.1.3 $PM_{10}$ Timeseries Analysis

Timeseries plots of the 24-hour average concentrations of $PM_{10}$ for FY 2017/18 for each monitoring station are shown in Figure 5-1. The nine 24-hour average concentrations of $PM_{10}$ above 70 µg/m³ at Taplin are highlighted in the figure.

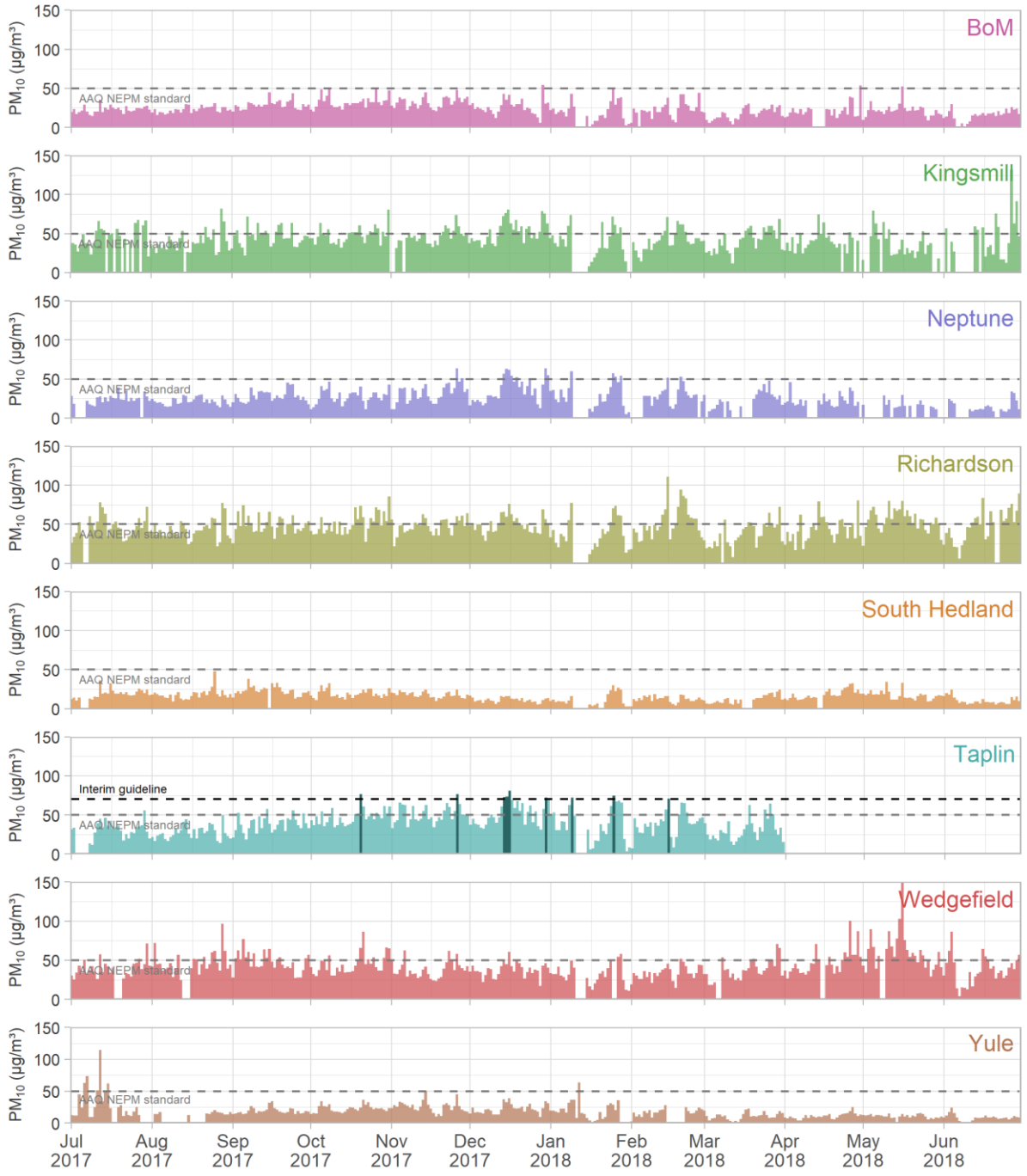



**Figure 5-1: FY 2017/18 time series plots of 24-hour average concentrations of $PM_{10}$**

## 5.2 $PM_{2.5}$

$PM_{2.5}$ was measured at four (4) monitoring stations (BoM, Richardson, Taplin and Yule) during FY 2017/18.

### 5.2.1 Data Capture

Data capture rates for 1-hour average concentrations of $PM_{2.5}$ for each monitoring station in FY 2017/18 are detailed in Table 5-4.

All stations achieved an annual capture rate for $PM_{2.5}$ of greater than 92% and a quarterly capture rate greater than 77%. This meets the PHIC criterion of 75% data capture.

**Table 5-4: FY 2017/18 data capture summary 1-hour average concentrations of $PM_{2.5}$**

| Monitoring Station ID | 2017/18 $PM_{2.5}$ Data Capture Rate (%) | | | | | Performance |
|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Annual | |
| BoM | 98 | 95 | 94 | 99 | 97 | Met |
| Richardson | 92 | 100 | 93 | 97 | 96 | Met |
| Taplin | 95 | 100 | 96 | 96 | 97 | Met |
| Yule | 77 | 99 | 91 | 99 | 92 | Met |

### 5.2.2 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 5-5. The number of days above the AAQ NEPM standard is also presented.

The $PM_{2.5}$ measurements show that for FY 2017/18:

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

**Table 5-5: FY 2017/18 data summary 24-hour and annual average concentrations of $PM_{2.5}$**

| 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 | 20.2 | 0 | Met | 6.9 | Met |
| Richardson | 27.3 | 4 | Not met | 10.1 | Not met |
| Taplin | 27.1 | 1 | Not met | 11.3 | Not met |
| Yule | 16.3 | 0 | Met | 5.8 | Met |

Table note:

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

### 5.2.3 $PM_{2.5}$ Timeseries Analysis

A timeseries plot of the 24-hour average concentration of $PM_{2.5}$ for FY 2017/18 for each monitoring station is shown in Figure 5-2.

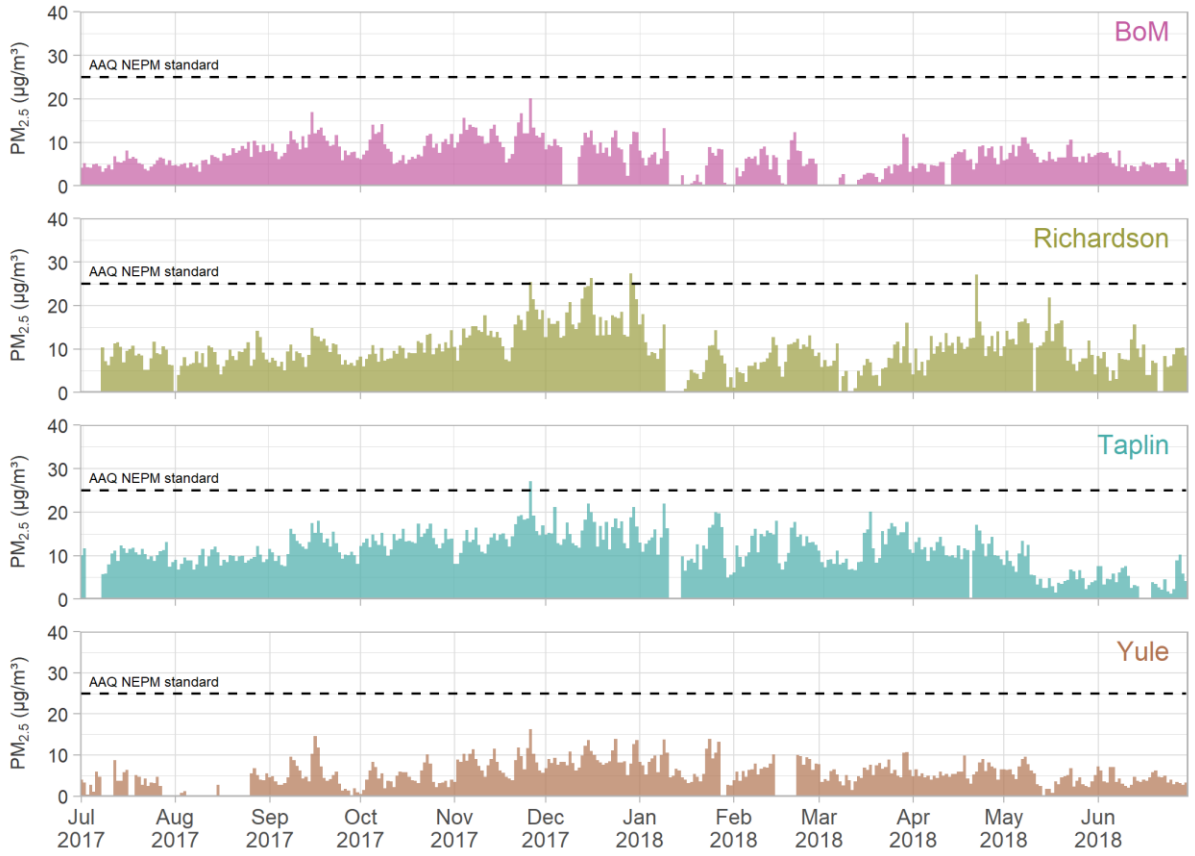



**Figure 5-2: FY 2017/18 time series plots of 24-hour average concentrations of $PM_{2.5}$**

## 5.3 Oxides of Nitrogen

$NO_x$ was measured at the Taplin monitoring station during FY 2017/18. $NO_x$ monitoring included nitrogen dioxide ($NO_2$), nitric oxide (NO) and total $NO_x$ (reported as $NO_2$).

### 5.3.1 Data Capture

Data capture rates for 1-hour average concentrations of $NO_x$ for the Taplin monitoring station are detailed in Table 5-6. Taplin monitoring station achieved quarterly and annual $NO_x$ capture rates greater than 92%, which meets the PHIC criterion of 75% data capture.

**Table 5-6: FY 2017/18 data capture summary 1-hour average concentrations of $NO_x$**

| Monitoring Station ID | 2017/18 $NO_x$ Data Capture Rate (%) | | | | | Performance |
|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Annual | |
| Taplin | 96 | 92 | 92 | 95 | 94 | Met |

### 5.3.2 Comparison to Air Quality Standards

The maximum measured 1-hour average and annual average concentrations of $NO_2$ at Taplin are detailed in Table 5-7. The $NO_2$ measurements show that for FY 2017/18:

- 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 32% of the AAQ NEPM standard.
- The annual average concentrations of $NO_2$ were below the AAQ NEPM standard of 62 µg/m³.
- The annual average concentration of $NO_2$ corresponds to 22% 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 5-7: FY 2017/18 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 | 77.5 | Met | 13.8 | Met |

### 5.3.3 $NO_2$ Time Series Analysis

A timeseries plot of the 1-hour average concentrations of $NO_2$ for FY 2017/18 at Taplin monitoring station is shown in Figure 5-3. Note that the AAQ NEPM standard is 246 µg/m³ and is not shown on Figure 5-3 due to the low levels measured at the station.

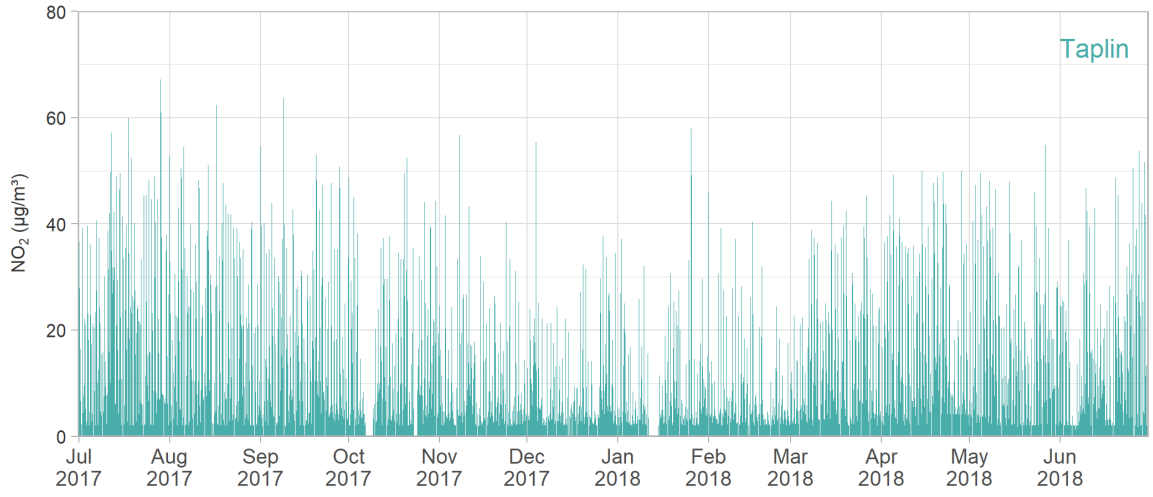



**Figure 5-3: FY 2017/18 time series plot of 1-hour average concentrations of $NO_2$ for Taplin**

# 6. 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 2017/18.

## 6.1 Taplin

The Taplin monitoring station is located in Port Hedland (Figure 3-1) 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.

Taplin 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 $PM_{10}$.

The $PM_{10}$ measurements from the Taplin Street monitoring station were found to be unreliable during financial year 2019/20. This was confirmed by PHIC on 23 January 2020 and affected the 2018/19 and 2019/20 data, along with Q4 of 2017/18 (April to June 2018). Accordingly, the Taplin Street $PM_{10}$ data collected during Q4 of 2017/18 have been removed from this annual report.

A summary of the air pollutant performance of the Taplin monitoring station is detailed in Table 6-1.

**Table 6-1: 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 | 9 | Met |
| | | 50 | 24-hour | 64 | Not demonstrated[B] |
| | | 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
[B] Not demonstrated due to zero data capture in Q4

## 6.2 BoM

The BoM monitoring station is located at Port Hedland Airport (Figure 3-1) 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 6-2.

**Table 6-2: 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 | 4 | Not met |
| | | 25 | Annual | 0 | Met |
| $PM_{2.5}$ | Met | 25 | 24-hour | 0 | Met |
| | | 8 | Annual | 0 | Met |

## 6.3 Kingsmill

The Kingsmill monitoring station is located in Port Hedland (Figure 3-1) 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 6-3.

**Table 6-3: 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 | 103 | Not met |
| | | 25 | Annual | 1 | Not met |

## 6.4 Neptune

The Neptune monitoring station is located at Port Hedland (Figure 3-1) 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 6-4.

**Table 6-4: 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 | 15 | Not met |
| | | 25 | Annual | 1 | Not met |

## 6.5 Richardson

The Richardson monitoring station is located at Port Hedland (Figure 3-1) 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 6-5.

**Table 6-5: 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 | 143 | Not met |
| | | 25 | Annual | 1 | Not met |
| $PM_{2.5}$ | Not met | 25 | 24-hour | 4 | Not met |
| | | 8 | Annual | 1 | Not met |

## 6.6 South Hedland

The South Hedland monitoring station is located in the South Hedland township (Figure 3-1) 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 6-6.

**Table 6-6: 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 | 0 | Met |
| | | 25 | Annual | 0 | Met |

## 6.7 Wedgefield

The Wedgefield monitoring station is located within light industrial and residential areas (Figure 3-1) 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 6-7.

**Table 6-7: 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 | 88 | Not met |
| | | 25 | Annual | 1 | Not met |

## 6.8 Yule

The Yule monitoring station is located 30 km away from Port Hedland (Figure 3-1) 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 6-8.

**Table 6-8: 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 | 8 | Not met |
| | | 25 | Annual | 0 | Met |
| $PM_{2.5}$ | Met | 25 | 24-hour | 0 | Met |
| | | 8 | Annual | 0 | Met |

# 7. $PM_{10}$ TRENDS

This section presents analysis of trends in concentrations of $PM_{10}$ measured by the Port Hedland ambient air quality monitoring network data for the six years from FY 2012/13 to FY 2017/18.

## 7.1 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 last six reporting years is presented in Table 7-1 and Figure 7-1.

The data shows the following:

- Compared with the previous reporting year, the number of days at Taplin above 70 µg/m³ has increased from three days in FY 2016/17 to nine days in FY 2017/18.
- The average number of days above 70 µg/m³ for the six reporting years is just over nine indicating that FY 2017/18 is consistent with the longer-term trend.
- This is in contrast to the Port Hedland export tonnage that has steadily increased over the past six reporting years (as shown in Figure 7-1).

**Table 7-1: 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 [B] |
| Taplin | 70[A] | 17 | 6 | 10 | 10 | 3 | 9 [B] |

Table note:
[A] 10 exceedances of 24-hour average allowed per year due to industry
[B] The number of exceedances days not available for FY 2017/18

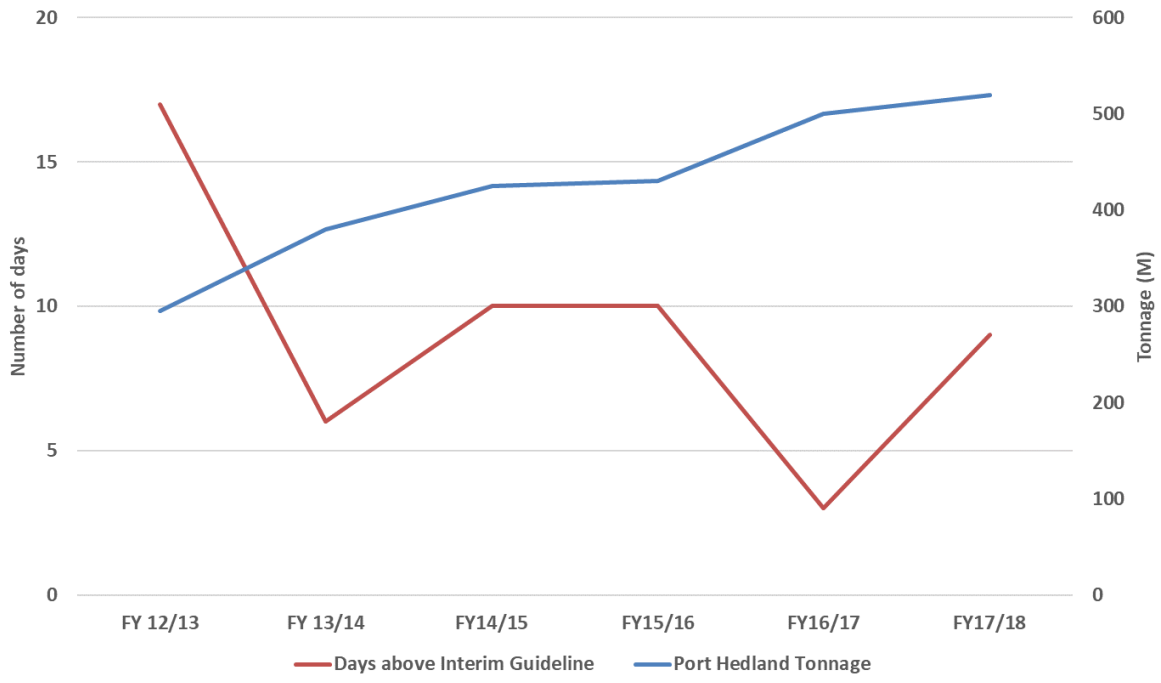



**Figure 7-1: Number of 24-hour average concentrations of $PM_{10}$ above the interim guideline and Port Hedland export tonnage for each year from FY 2012/13 to FY 2017/18**

## 7.2 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 7-2 and Figure 7-2.

The data shows the following:

- In FY 2017/18:
  - There were no 24-hour average concentrations of $PM_{10}$ above the AAQ NEPM standard of 50 µg/m³ at South Hedland.
  - Richardson and Taplin recorded more 24-hour average concentrations above the AAQ NEPM standard compared to all previous years.
  - Kingsmill and Yule recorded more 24-hour average concentrations above the AAQ NEPM standard compared to the previous FY (FY 2016/17)
  - BoM, Neptune, South Hedland and Wedgefield recorded fewer 24-hour average concentrations above the AAQ NEPM standard than the previous FY (FY 2016/17).
- Over the six 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 monitoring stations show a general decreasing trend over the past four years.
  - In years prior to FY 2016/17, the Taplin monitoring station showed a relatively steady trend in the number of 24-hour average concentrations above the AAQ NEPM standard. In FY 2016/17, the number was lower than average, whereas in FY 2017/18 the number of 24-hour average concentrations above the standard was higher than the average.
  - The Richardson monitoring station shows an increasing trend in the number of 24-hour average concentrations above the AAQ NEPM standard, especially over the last two reporting years. This may be in part due to urban development changes that have occurred near the Richardson station in the past few years.

**Table 7-2: Summary of 24-hour average concentrations of $PM_{10}$ above the AAQ NEPM standard for the last six 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 |
| BoM | 50 | 24 | 10 | 17 | 12 | 7 | 4 |
| Kingsmill | | 89 | 98 | 156 | 112 | 83 | 103 |
| Neptune | | 25 | 25 | 67 | 43 | 29 | 15 |
| Richardson | | 74 | 50 | 79 | 39 | 90 | 143 |
| South Hedland | | 23 | 13 | 19 | 12 | 8 | 0 |
| Taplin | | 48 | 48 | 55 | 48 | 27 | 64 |
| Wedgefield | | 157 | 148 | 169 | 150 | 99 | 88 |
| Yule | | 24 | 8 | 18 | 5 | 1 | 8 |

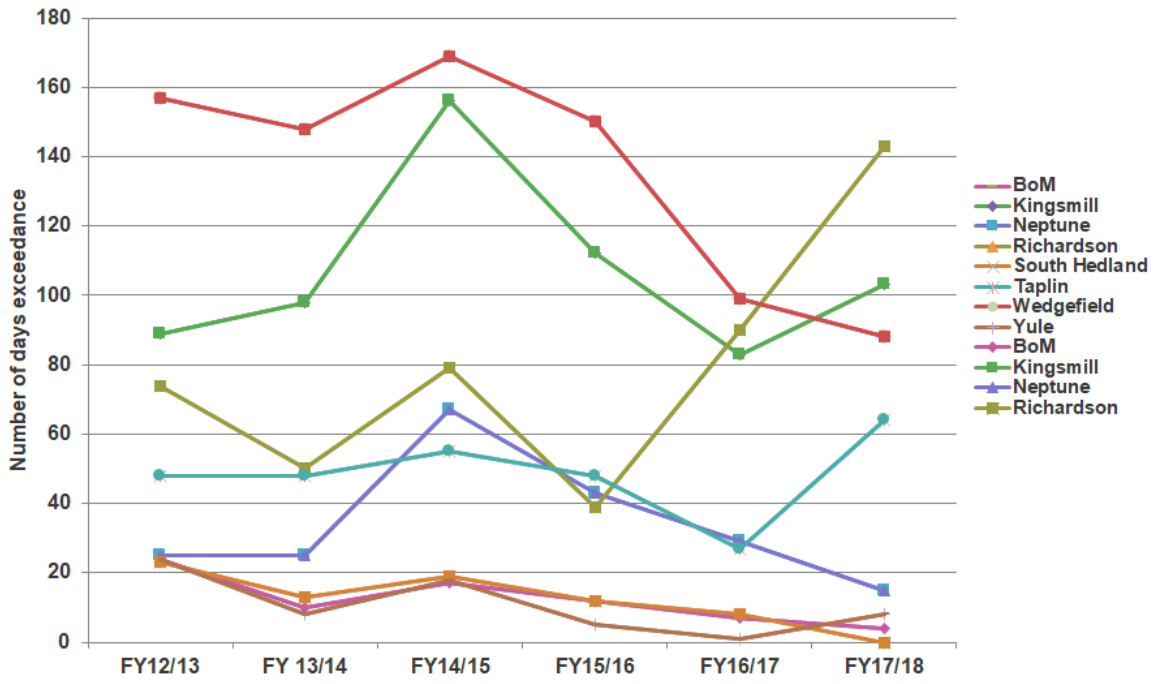



**Figure 7-2: Number of the 24-hour average concentration of $PM_{10}$ above the AAQ NEPM standard for each reporting year**

## 7.3 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 three reporting years have been compared with the standard in Table 7-3 and Figure 7-3.

The data shows the following in relation to annual average concentrations of $PM_{10}$ over the past three reporting years (FY 2015/16 to FY 2017/18):

- Neptune, South Hedland and Wedgefield stations show a slight decreasing trend
- Bom, Kingsmill, Taplin and Yule stations show a relatively steady trend
- The Richardson station showed an increasing trend. It is noted that urban development changes have occurred near the Richardson station that may have contributed to the trend at this site.

**Table 7-3: Summary of annual average concentrations of $PM_{10}$ for the last three 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 |
| BoM | 25 | Not required to be reported | | | 25.4 | 21.4 | 23.8 |
| Kingsmill | | | | | 44.7 | 40.4 | 43.7 |
| Neptune | | | | | 32.3 | 27.4 | 26.4 |
| Richardson | | | | | 35.2 | 40.0 | 47.3 |
| South Hedland | | | | | 26.5 | 22.2 | 16.1 |
| Taplin | | | | | 35.6 | 31.3 | 39.7 |
| Wedgefield | | | | | 51.1 | 43.1 | 42.2 |
| Yule | | | | | 18.5 | 15.4 | 17.9 |

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

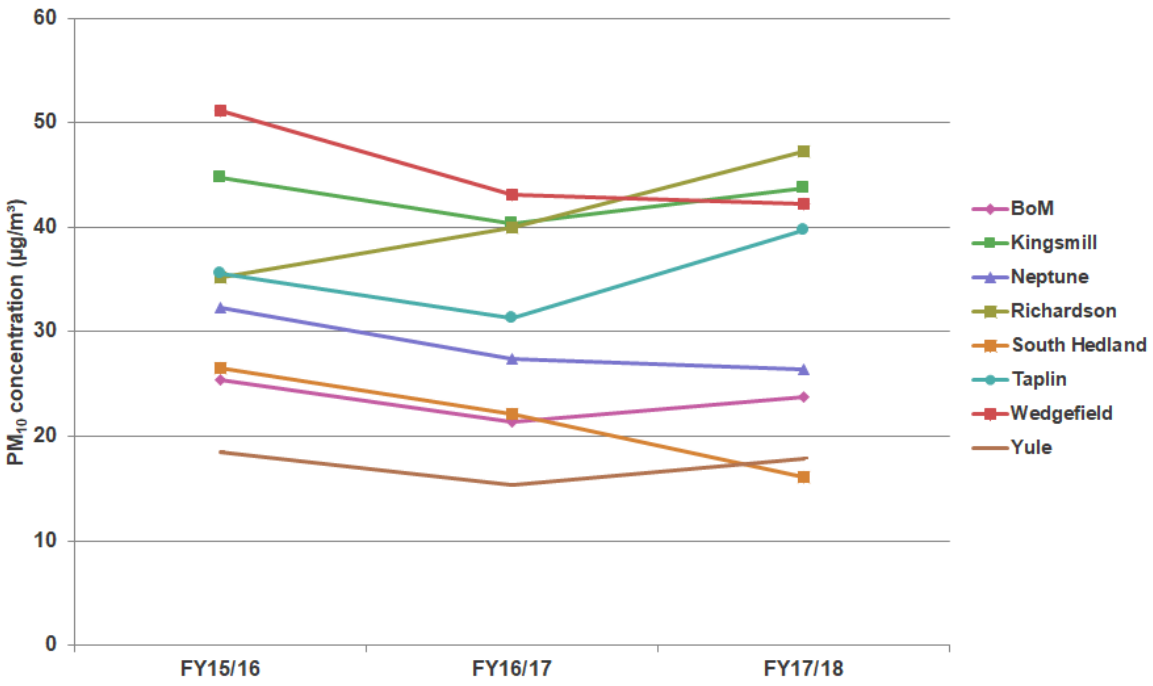



**Figure 7-3: Annual average concentrations of $PM_{10}$ for the last three financial years**

## 7.4 $PM_{10}$ Statistics

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

- maximum
- 99$^{th}$ percentile
- 98$^{th}$ percentile
- 95$^{th}$ percentile
- 50$^{th}$ 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
- 99$^{th}$, 98$^{th}$ and 95$^{th}$ percentile 24-hour average concentrations of $PM_{10}$ show a slightly decreasing or stable trend at all monitoring stations over the six reporting years
- 50$^{th}$ percentile 24-hour average concentration of $PM_{10}$ exhibit a generally stable trend at all monitoring stations over the six reporting years.

# 8. INVESTIGATION OF $PM_{10}$ EVENTS

## 8.1 Investigation methodology

The Taskforce interim guideline for 24-hour average concentrations of $PM_{10}$ allows for ten days above 70 µg/m³ at Taplin as a result of industry. The following methodology is used to determine whether an exceedance of the Taskforce interim guideline at Taplin was caused by industry. Under the methodology, an event day is not counted where it can be demonstrated to be a result of regional dust or a local dust source other than industry.

Step 1. Determine whether the event is likely to be "regional" or "local"

a) A "regional" event occurs when the 24-hour average concentration of $PM_{10}$ at Taplin is **greater** than 70 µg/m³ and the 24-hour average concentration of $PM_{10}$ at BoM monitoring station is **greater** than 60 µg/m³. Regional events are not caused by industry and so are not counted as an exceedance of the Taskforce interim guideline. The background monitoring station at Yule is also considered when determining regional events.

b) A "local" event occurs when the 24-hour average concentration of $PM_{10}$ at Taplin is greater than 70 µg/m³ and the 24-hour concentration of $PM_{10}$ at BoM monitoring station is less than 60 µg/m³.

c) Further identification of “local” versus “regional” events considers the percentile range of the value measured at BoM and Yule compared to the FY 2017/18 dataset. Concurrent 24-hour average concentrations at the other PHIC monitoring stations are also extracted to investigate a regional component to the event.

Step 2. For each "local" event, the likelihood that Port Hedland industry contributed to the concentration of $PM_{10}$ above 70µg/m³ has been investigated through analysis with meteorological conditions (using wind roses, polar frequency plots and time series – discussed in Section 7.1.1) and the Port Hedland industry 'arc of influence'.

a) The Port Hedland industry arc of influence is defined as any wind direction that has the potential to carry emissions from industry to the Taplin monitoring station. The Port Hedland industry arc of influence at Taplin is shown in Figure 8-1 (shaded area) and represents wind directions between 115° and 290°.

It is possible for events to occur due regional influences like bushfires, local activities such as industry or local activities that are not related to industry. It is also possible that a combination of the above may occur during one event.

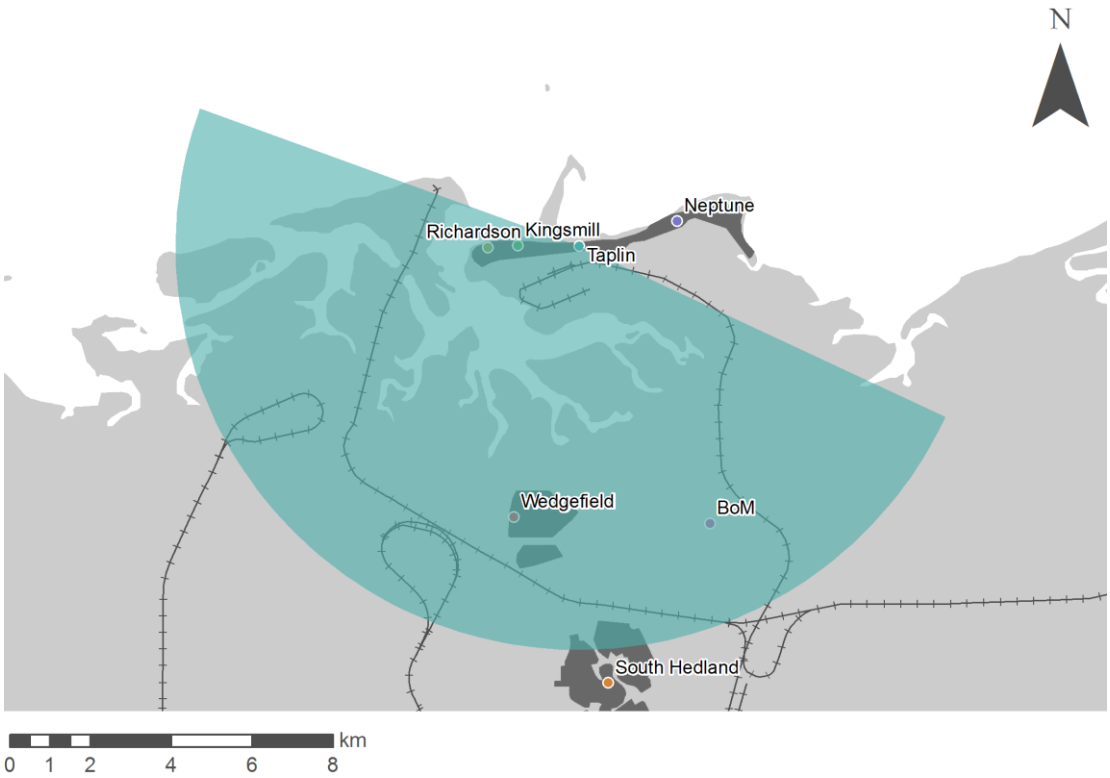



**Figure 8-1: Port Hedland industry arc of influence (shaded area) at Taplin monitoring station**

### 8.1.1 Graphical presentation of event days

The likelihood that Port Hedland industry contributed to the concentration of $PM_{10}$ above 70µg/m³ has been investigated through analysis with meteorological conditions. The 10-minute average data has been used to provide the best resolution. The following types of graphs have been used:

- Wind roses
- Polar frequency plots
- Time series.

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 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. All wind rose graphs have the same wind speed scale and colours.

A polar plot shows the dependence of concentrations of $PM_{10}$ 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 concentrations higher than 200 µg/m³ shown in red graduating to lower concentrations, which are shown in orange, yellow, green and then blue. All polar plots have the $PM_{10}$ colour scale for ease of comparison. 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 and each event day plot has the same scale.

## 8.2 Overview

Table 8-1 details the nine days when the 24-hour average concentration of $PM_{10}$ was above 70 µg/m³ at Taplin during FY 2017/18. Concentrations of $PM_{10}$ at BoM and Yule for the same time period are also displayed. The likely cause of the $PM_{10}$ event day is detailed in Table 8-1 as determined by the methodology in Section 8.1. The analysis shows for the following for the nine event days in FY 2017/18:

- Four days were the result of local (industry) sources
- Three days were the result of both a local (industry) source and a regional event
- One day was the result of both local (industry) and local (non-industry) sources
- One day was the result of local (non-industry) sources.

**Table 8-1 Summary of 24-hour average concentrations of $PM_{10}$ 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 | |
| 20 October 2017 | **76.8** | 33.1 | 24.2 | Local (industry) |
| 26 November 2017 | **76.5** | 47.8 | 45.0 | Local (industry) and Regional |
| 14 December 2017 | **73.1** | 43.0 | 37.3 | Local (industry) and Regional |
| 15 December 2017 | **73.5** | 35.5 | 33.0 | Local (non-industry) |
| 16 December 2017 | **81.0** | 41.6 | 38.8 | Local (industry) and Regional |
| 30 December 2017 | **71.9** | 30.2 | 34.0 | Local (industry) |
| 9 January 2018 | **71.9** | 42.8 | 36.4 | Local (industry) |
| 25 January 2018 | **74.6** | 49.2 | 29.1 | Local (industry) |
| 15 February 2018 | **71.0** | 37.9 | no data | Local (industry and non-industry) |

## 8.3 20 October 2017

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 20 October 2017 | **76.8** | 33.1 | 24.2 | Local (industry) |

On the 20 October 2017, the 24-hour average concentration of $PM_{10}$ at Taplin was 76.8 µg/m³, 33.1 µg/m³ at BoM and 24.2 µg/m³ at Yule, which indicates a local event occurring at Taplin.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 20 October 2017 is shown in Figure 8-2 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-3.

The figures indicate the following:

- Winds on 20 October 2017 were mainly from the southeast, southwest and northwest quadrants.
- Winds were strongest (5 – 7 m/s) from the southeast quadrant.
- The $PM_{10}$ polar frequency plot indicates that the highest 10-minute average concentrations of $PM_{10}$ (red and orange areas) occurred when the wind was relatively light (<3 m/s) and from either the west-northwest or southwest (within the industry arc of influence).
- The time series plots for the 20 October 2017 show that concentrations of $PM_{10}$ at Taplin were elevated in the early morning (between 02:00 and 06:00) and in the evening (between 18:00 and 20:00). A very large 10-minute average spike (>500 µg/m³) occurred at 23:00.
- Concentrations of $PM_{10}$ at BoM were lower than at Taplin on 20 October 2017, especially during the elevated periods at Taplin described above.
- During the early morning, winds were from the southwest (within the industry arc of influence) and less than 3 m/s. As the morning progressed, the winds shifted to a southeast and increased in speed to between 4 and 6 m/s. In the afternoon and evening the winds shifted from the southeast to the north and then to the southwest and gradually decreased in speed to less than 2 m/s.

Overall on 20 October 2017, winds were from the direction of industry at the times when concentrations of $PM_{10}$ at Taplin were elevated. At the same time, low concentrations of $PM_{10}$ were measured at BoM. Therefore, this has been classified as a local industry event.

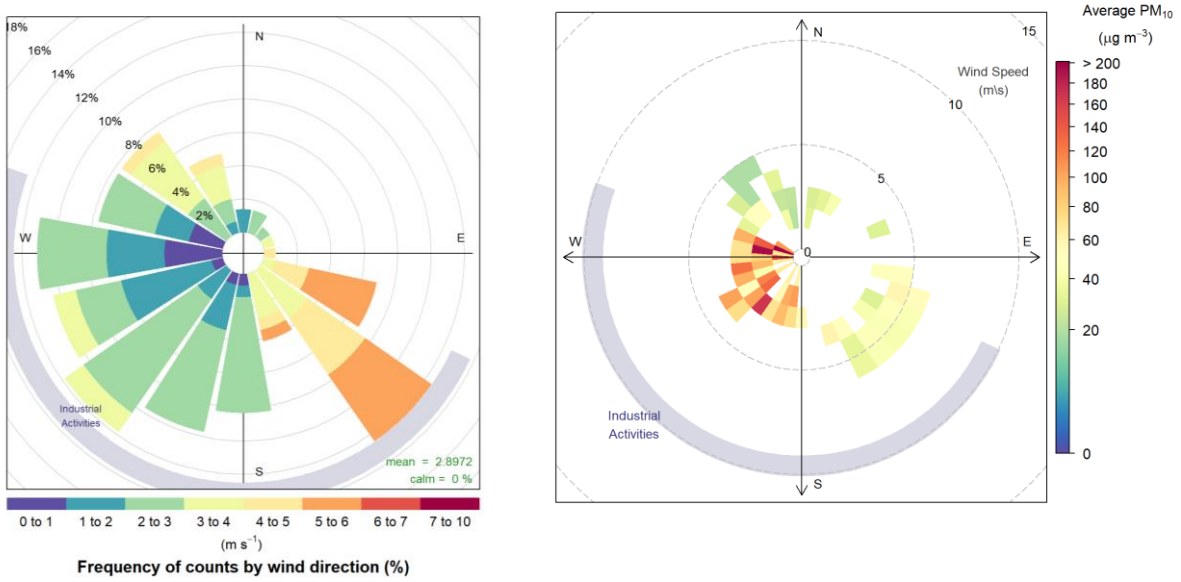



**Figure 8-2: Wind rose (left) and $PM_{10}$ polar plot (right) on 20 October 2017 at Taplin**


**Figure 8-3: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 20 October 2017**

## 8.4 26 November 2017

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 26 November 2017 | **76.5** | 47.8 | 45.0 | Local (industry) and Regional |

On the 26 November 2017, the 24-hour average concentration of $PM_{10}$ at Taplin was 76.5 µg/m³, 47.8 µg/m³ at BoM and 45.0 µg/m³ at Yule. The relatively high concentration at Taplin compared to the other two sites suggests a potential local event occurring at Taplin. It is also relevant to note that the concentrations at BoM and Yule were relatively elevated being in the 95$^{th}$ percentile range for each site's FY 2017/18 dataset. This indicates a regional component to dust levels on the 26 November 2017.

Further to this, 24-hour average concentrations of $PM_{10}$ on 26 November 2017 at Kingsmill, Neptune, Richardson Street, South Hedland and Wedgefield (the other PHIC network sites) were 73.8 µg/m³, 63.7 µg/m³, 60.3 µg/m³, 24.0 µg/m³, 58.1 µg/m³, respectively. With the exception of South Hedland, the data from the other PHIC sites indicates elevated concentrations of $PM_{10}$ across the region.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 26 November 2017 is shown in Figure 8-4 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-5.

The figures indicate the following:

- Winds on 26 November 2017 were only from the west to north-northeast.
- Winds were strongest (5 – 7 m/s) from the west-northwest to north-northwest.
- The $PM_{10}$ polar frequency plot indicates that 10-minute average concentrations of $PM_{10}$ were relatively elevated all day (mostly orange coloured areas) and occurred when winds were from the west (within the industry arc of influence) and the northwest.
- The time series plots for the 26 November 2017 show that concentrations of $PM_{10}$ at Taplin were above 50 µg/m³ for the whole day. Concentrations gradually increased in the early morning with a sharp increase around 05:00, which corresponds with wind direction shifting into the arc of industry. Concentrations then remained relatively constant in the middle of the day before gradually decreasing over the course of the evening except for short term peaks around 15:00 and 18:00. Winds were from outside the arc of influence during the day and evening.
- Concentrations of $PM_{10}$ at BoM showed a similar pattern on 26 November 2017 but there was no sharp increase around dawn (05:00) and the magnitude was generally lower.
- Wind speeds were highest in the early morning and early afternoon, reaching approximately 6 m/s, and were lowest in the middle of the day.

Overall on 26 November 2017, both local industry sources and a regional dust component contributed to the elevated 24-hour average concentration of $PM_{10}$ at Taplin and the event has been classified accordingly.

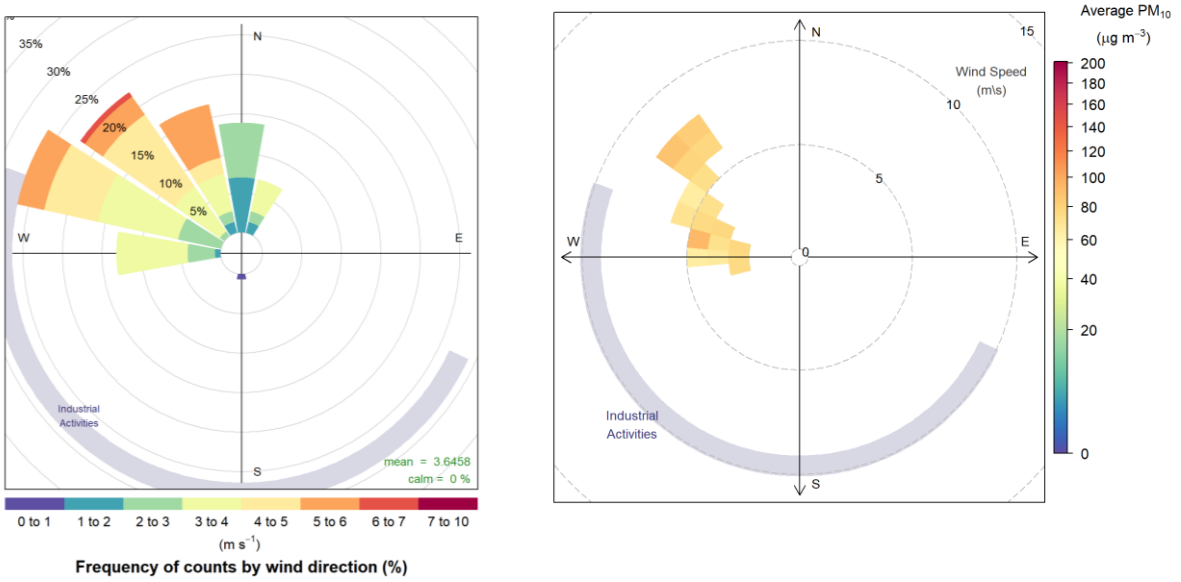



**Figure 8-4:** **Wind rose (left) and $PM_{10}$ rose (right) on 26 November 2017 at Taplin**

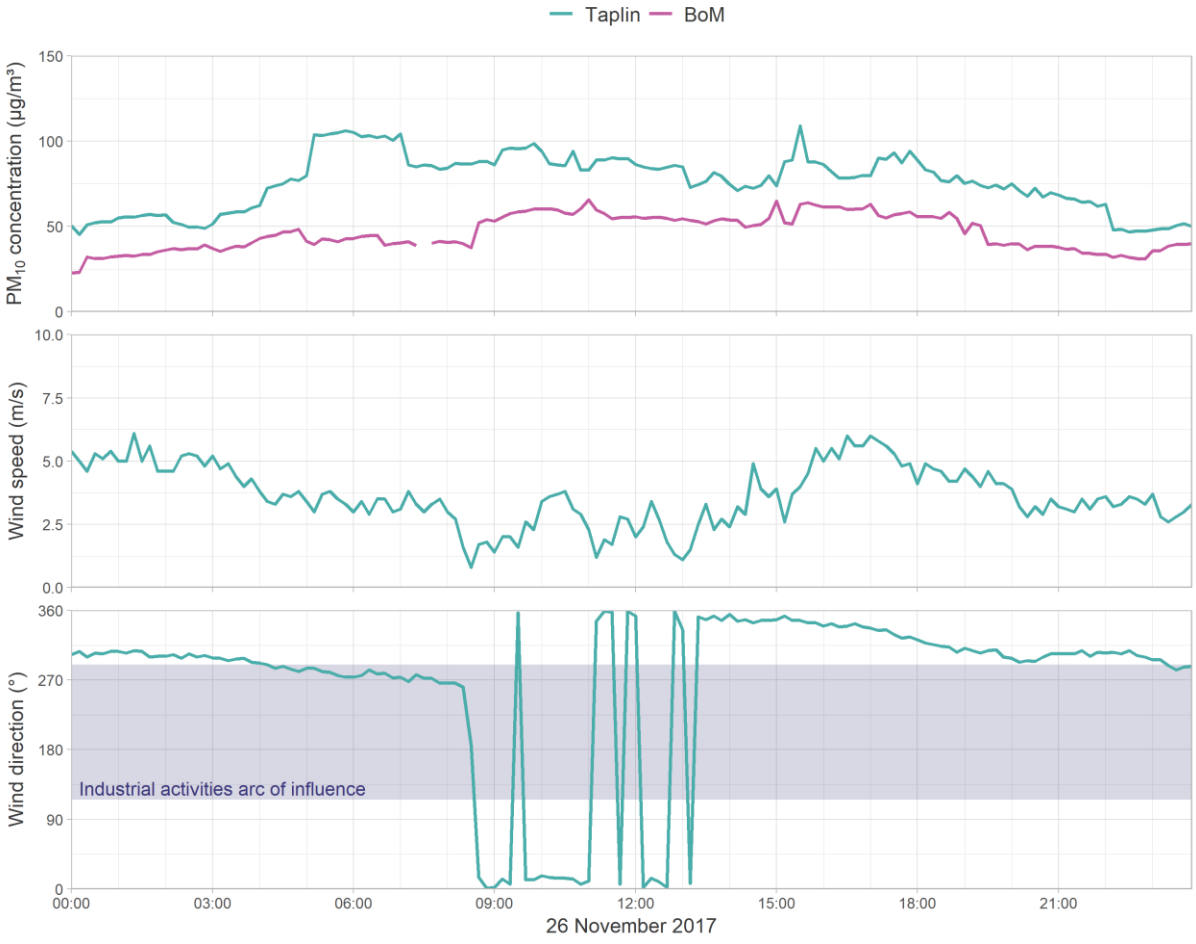



**Figure 8-5:** **Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 26 November 2017**

## 8.5 14 December 2017

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 14 December 2017 | **73.1** | 43.0 | 37.3 | Local (industry) and Regional |

On the 14 December 2017, the 24-hour average concentration of $PM_{10}$ at Taplin was 73.1 µg/m³, 43.0 µg/m³ at BoM and 37.3 µg/m³ at Yule. The relatively high concentration at Taplin compared to the other two sites suggests a potential local event occurring at Taplin. It is also relevant to note that the concentrations of $PM_{10}$ at BoM and Yule were relatively elevated. The concentration at BoM is in the 90$^{th}$ percentile range for the FY 2017/18 dataset and Yule is in the 95$^{th}$ percentile range. Similar to the event of 26 November 2017, this indicates that there was likely to be a regional component to the event on 14 December 2017.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 14 December 2017 is shown in Figure 8-6 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-7.

The figures indicate the following:

- Winds on 14 December 2017 were mainly from the west-northwest.
- Winds were greater than 4 m/s for the majority of hours from 06:00 to 18:00.
- The $PM_{10}$ polar frequency plot indicates that 10-minute average concentrations of $PM_{10}$ were relatively elevated all day (mostly orange coloured areas) and occurred when winds were from the west to west-northwest (inside industry arc of influence).
- The time series plots for the 14 December 2017 show that concentrations of $PM_{10}$ at Taplin steadily increased over the day, peaking around 13:00 before gradually decreasing.
- Concentrations of $PM_{10}$ at BoM show a similar pattern to Taplin but at a lower magnitude.
- The wind speeds on 14 December 2017 were stronger during the middle part of the day than during the early morning and evening, with the highest wind speed (6 m/s) occurring at the same time as the highest concentration of $PM_{10}$. Winds were from the edge of the industry arc during the day.

Overall on 14 December 2017, both local industry sources and a regional dust component contributed to the elevated 24-hour average concentration of $PM_{10}$ at Taplin and the event has been classified accordingly.

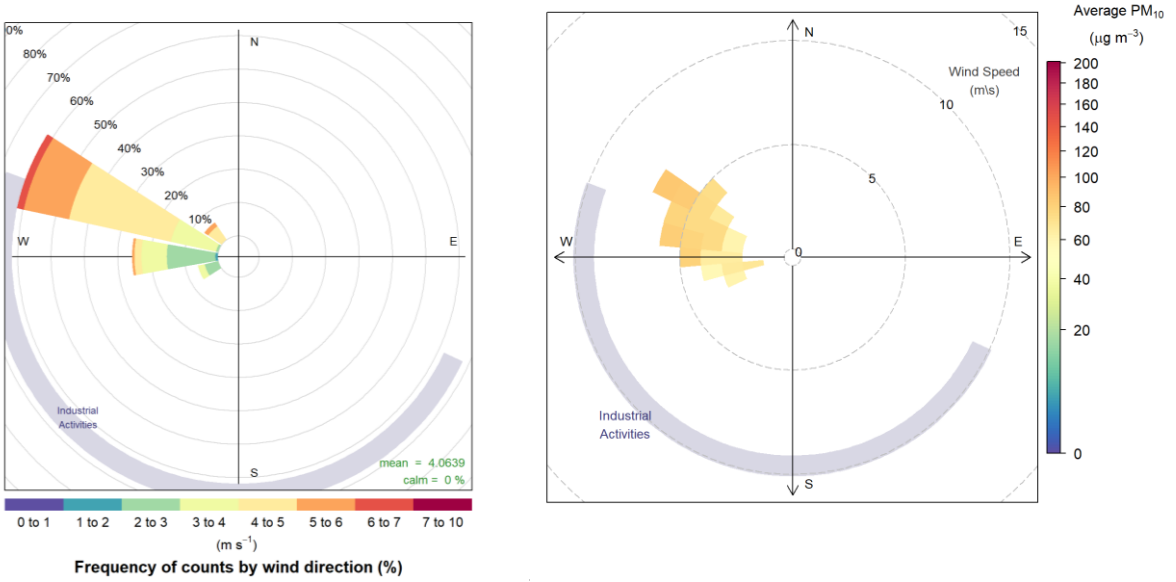



**Figure 8-6: Wind rose (left) and $PM_{10}$ rose (right) on 14 December 2017 at Taplin**

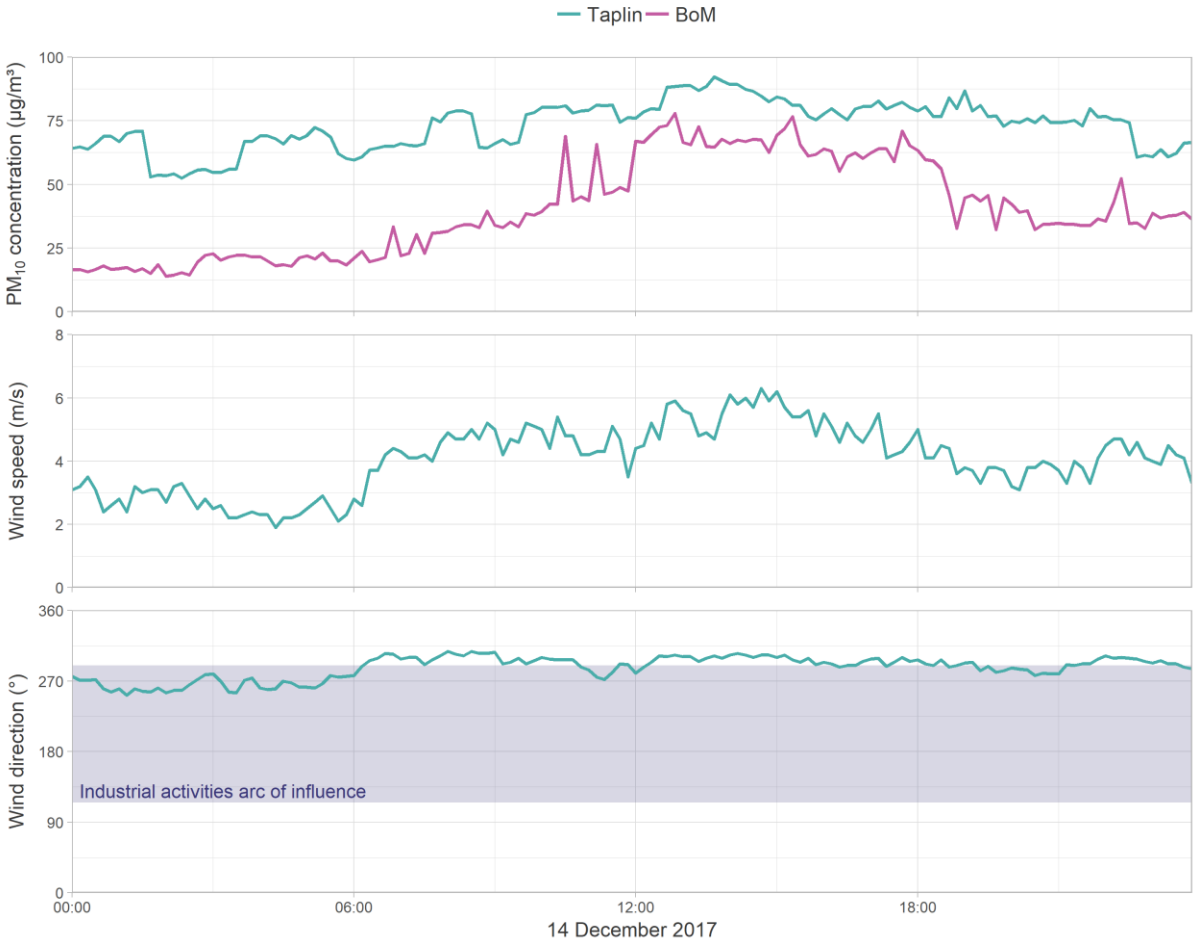



**Figure 8-7: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 14 December 2017**

## 8.6 15 December 2017

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 15 December 2017 | **73.5** | 35.5 | 33.0 | Local (non-industry) |

On the 15 December 2017, the 24-hour average concentration of $PM_{10}$ at Taplin was 73.5 µg/m³, 33.5 µg/m³ at BoM and 33.0 µg/m³ at Yule, which indicates a local event occurring at Taplin.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 15 December 2017 is shown in Figure 8-8 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-9.

The figures indicate the following:

- Winds on 15 December 2017 were mainly from the west to northwest.
- Winds were greater than 4 m/s for most of the day with strong winds (6 m/s) occurring from the northwest.
- The $PM_{10}$ polar frequency plot indicates that 10-minute average concentrations of $PM_{10}$ were relatively elevated all day (mostly orange coloured areas)
- The time series plots for the 15 December 2017 show that concentrations of $PM_{10}$ at Taplin were between 50 – 75 µg/m³ for most of the morning. At around 15:00 the concentrations of $PM_{10}$ reached a low of 40 µg/m before gradually increasing to a peak at 19:00 when winds were outside the industry arc.
- Concentrations of $PM_{10}$ at BoM show a similar increase during the afternoon but concentrations at other times were lower than measured at Taplin.
- The wind speeds on 15 December 2017 were strong. Winds increased over the morning to a sustained peak of greater than 6 m/s in the later afternoon and early evening. Winds were from just within the industry arc of influence in the early morning and just outside the industry arc of influence during the day and evening.

Overall on 15 December 2017, a local source outside of the industry arc of influence contributed to elevated concentrations of $PM_{10}$ at Taplin.

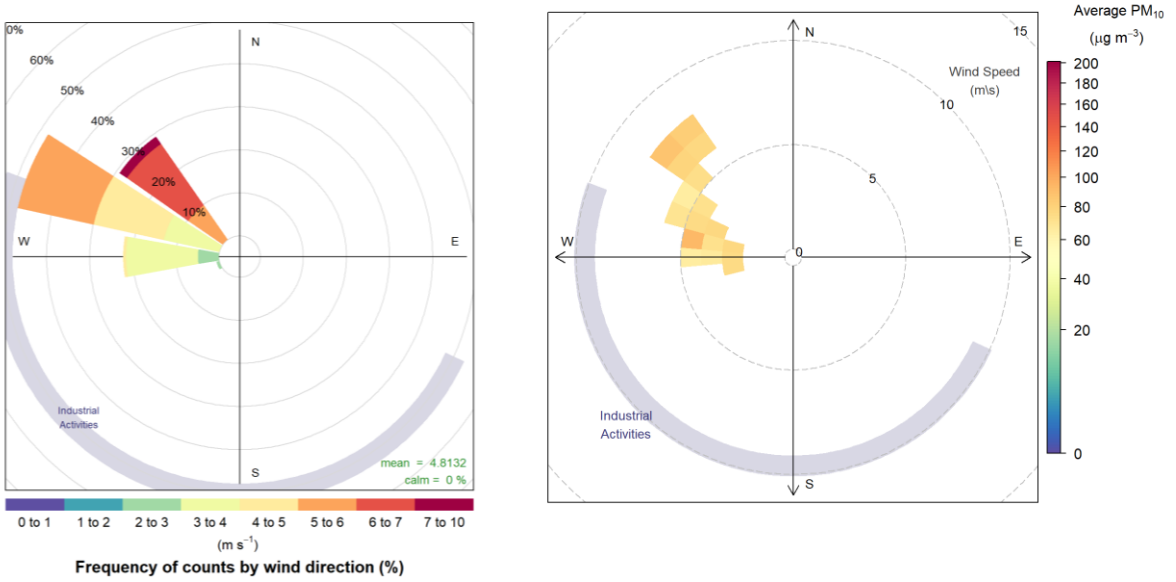



**Figure 8-8:** **Wind rose (left) and $PM_{10}$ rose (right) on 15 December 2017 at Taplin**

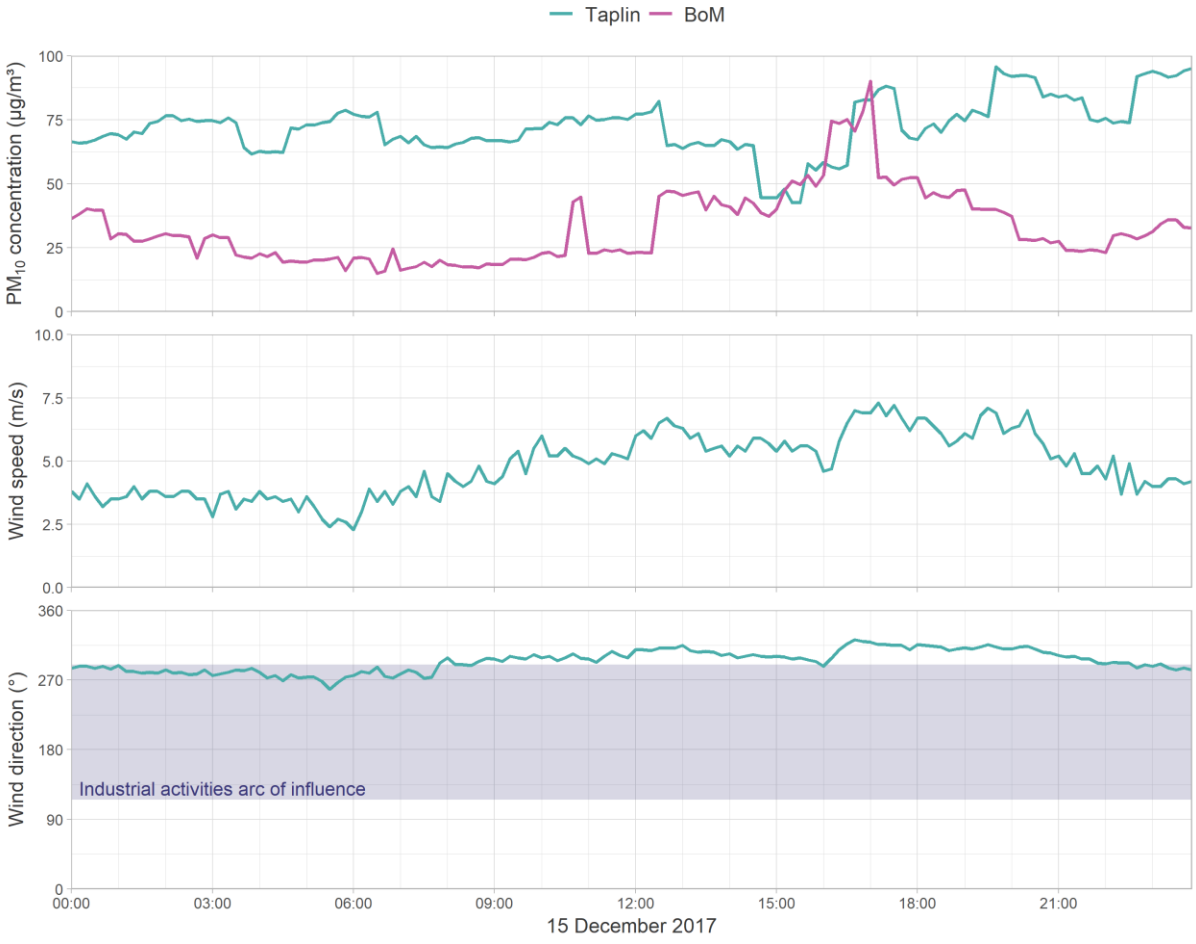



**Figure 8-9:** **Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 15 December 2017**

## 8.7 16 December 2017

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 16 December 2017 | **81.0** | 41.6 | 38.8 | Local (industry) and Regional |

On the 16 December 2017, the 24-hour average concentration of $PM_{10}$ at Taplin was 81.0 µg/m³, 41.6 µg/m³ at BoM and 38.8 µg/m³ at Yule. The relatively high concentration at Taplin compared to the other two sites suggests a potential local event occurring at Taplin. It is also relevant to note that the concentrations at BoM and Yule are relatively elevated being in the 90$^{th}$ and 95$^{th}$ percentile range for each site's dataset, respectively. This indicates a regional component to dust on the 16 December 2017.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 16 December 2017 is shown in Figure 8-10 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-11.

The figures indicate the following:

- Winds on 16 December 2017 were mainly from the northwest and west-northwest.
- Winds were generally strong for most of the day (>4 m/s) with strongest winds (6 m/s) occurring from the northwest.
- The $PM_{10}$ polar frequency plot indicates that 10-minute average concentrations of $PM_{10}$ were relatively elevated all day (mostly orange coloured areas)
- The time series plots for the 16 December 2017 show that concentrations of $PM_{10}$ at Taplin were high (90 -125 µg/m³) in the morning (00:00 to 10:00). Concentrations of $PM_{10}$ gradually decreased during the day before trending upwards again in the evening including a spike around 19:00.
- Concentrations of $PM_{10}$ at BoM show similar levels during the day (11:00 – 15:00) and a spike in the evening (19:00) but concentrations at other times (morning and late evening) were lower than measured at Taplin.
- The wind speeds on 16 December 2017 were strong. Winds were consistent and between 3-4 m/s in the morning, strengthened during the day to over 6 m/s before reducing back to around 4 m/s in the evening. Winds were consistently from either just within the industry arc of influence (early morning and late evening) and just outside the arc of influence during the late morning, day and afternoon.

Overall on 16 December 2017, both industry and a regional component contributed to 24-hour average concentration of $PM_{10}$ at Taplin.

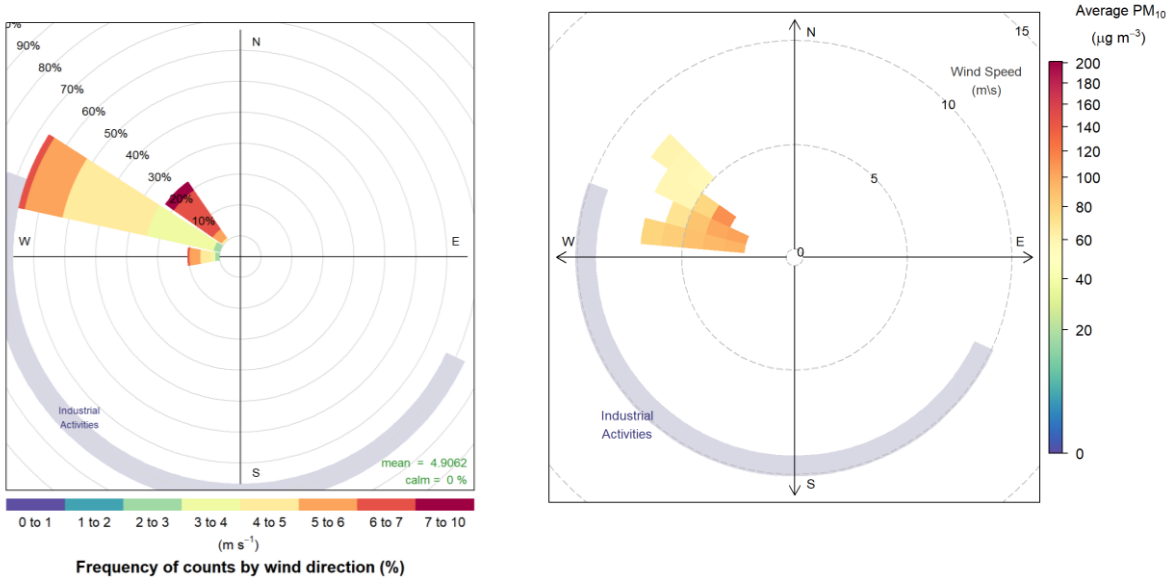



**Figure 8-10: Wind rose (left) and $PM_{10}$ rose (right) on 16 December 2017 at Taplin**

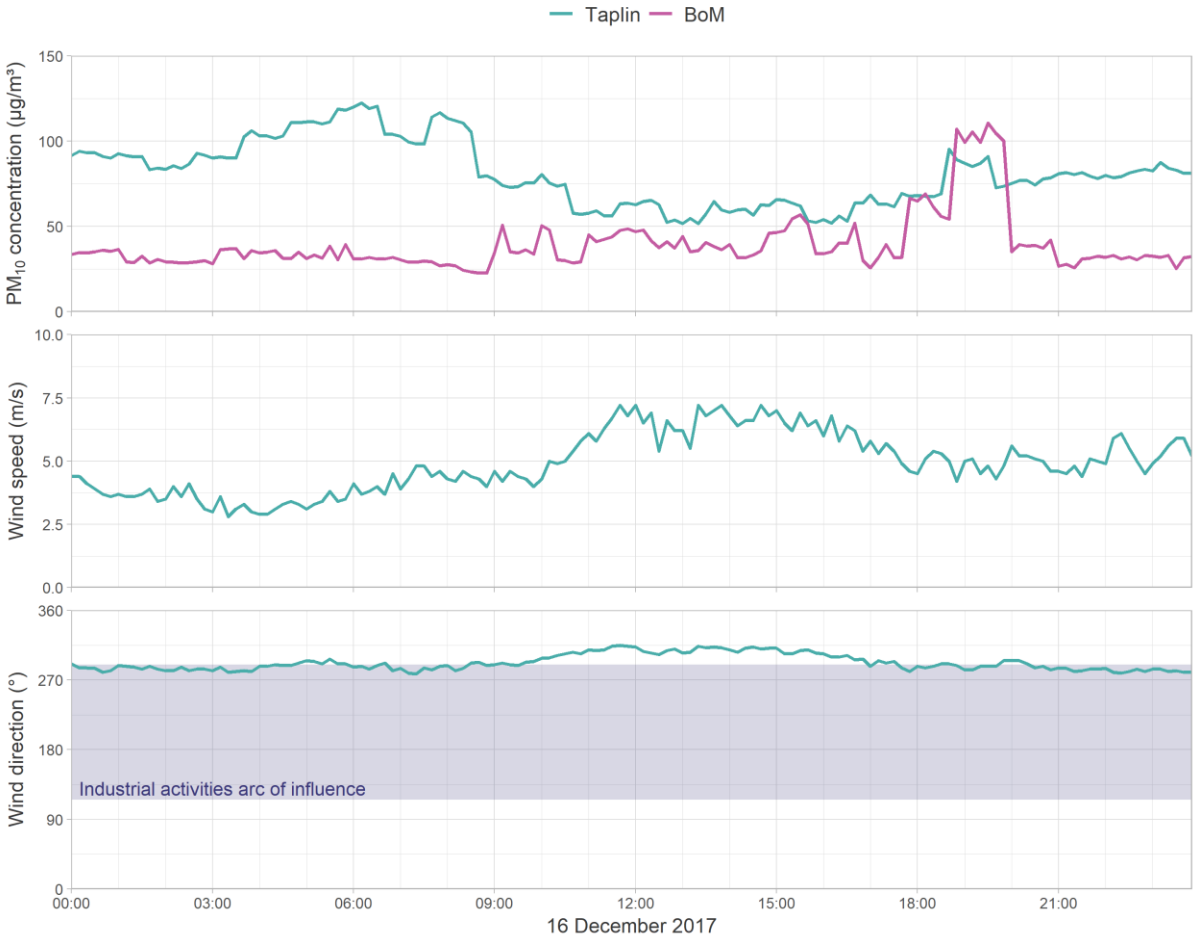



**Figure 8-11: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 16 December 2017**

## 8.8 30 December 2017

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 30 December 2017 | **71.9** | 30.2 | 34.0 | Local (industry) |

On the 30 December 2017, the 24-hour average concentration of $PM_{10}$ at Taplin was 71.9 µg/m³, 30.2 µg/m³ at BoM and 34.0 µg/m³ at Yule, which indicates a local event occurring at Taplin.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 30 December 2017 is shown in Figure 8-12 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-13.

The figures indicate the following:

- Winds on 30 December 2017 were predominantly from the northwest.
- Winds were strongest (5 – 7 m/s) from the northwest. Infrequent lighter winds (<3m/s) occurred from the southeast to west.
- The $PM_{10}$ polar frequency plot indicates 10-minute average concentrations of $PM_{10}$ were elevated all day (mostly orange coloured areas) and occurred when winds were from the southeast to west (within the industry arc of influence) and the wind speed was less than 4 m/s.
- The time series plots for the 30 December 2017 show that concentrations of $PM_{10}$ at Taplin were highest during the early morning (between 02:00 and 06:00) and consistently above 50 µg/m³.
- Concentrations of $PM_{10}$ at BoM on 30 December 2017 were consistently less than 50 µg/m³.
- During the early morning, winds were from the southwest to southeast (within the industrial activity arc of influence) and relatively light. As the morning progressed, the winds shifted to the northwest and strengthened to 6 m/s. In the afternoon and into evening the winds stayed in the same direction but gradually decreased in speed.

Overall on 30 December 2017, winds were from the direction of the industry at the times when concentrations of $PM_{10}$ at Taplin were elevated. At the same time, low concentrations of $PM_{10}$ were measured at BoM. It is therefore likely that industry contributed to 24-hour average concentration of $PM_{10}$ on 30 December 2017 at Taplin.

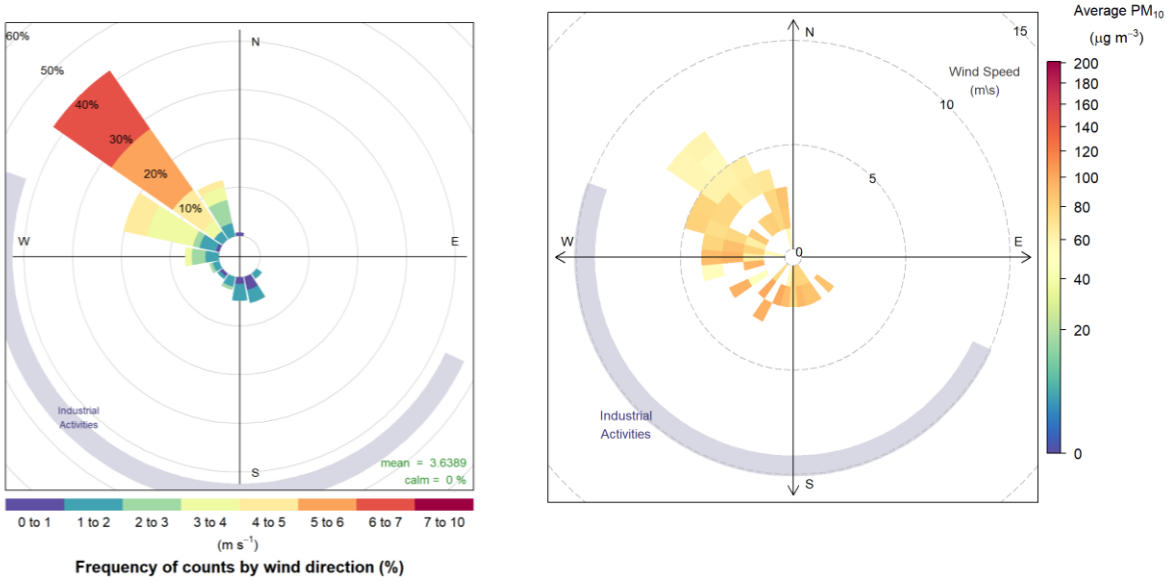



**Figure 8-12: Wind rose (left) and $PM_{10}$ rose (right) on 30 December 2017 at Taplin**

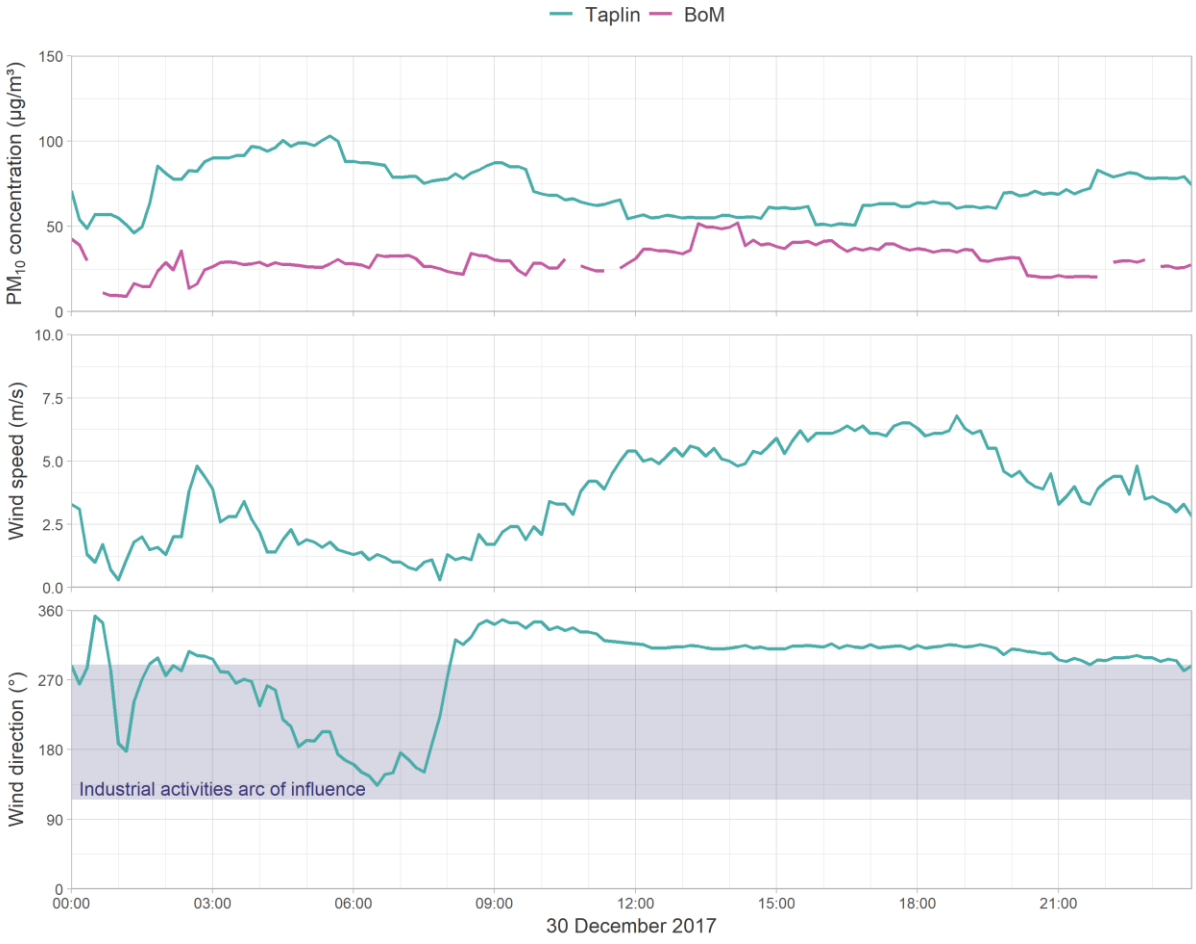



**Figure 8-13: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 30 December 2017**

## 8.9 9 January 2018

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 9 January 2018 | **71.9** | 42.8 | 36.4 | Local (industry) |

On the 9 January 2018, the 24-hour average concentration of $PM_{10}$ at Taplin was 71.9 µg/m³, 42.8 µg/m³ at BoM and 36.4 µg/m³ at Yule. The relatively high concentration at Taplin compared to the other two sites suggests a potential local event occurring at Taplin. It is also relevant to note that the concentrations at BoM and Yule are relatively elevated being in the 90$^{th}$ percentile range for each site's dataset. This indicates a regional component to dust on the 9 January 2018.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 9 January 2018 is shown in Figure 8-14 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-15.

The figures indicate the following:

- Winds on 9 January 2018 were generally from the west-southwest to northwest. Infrequent winds also occurred from most other directions.
- Winds were strongest (5 - 7 m/s) from the northwest. Lighter winds (<3m/s) occurred from the west and west-southwest.
- The $PM_{10}$ polar frequency plot indicates the highest 10-minute average concentrations of $PM_{10}$ (darker orange coloured areas) occurred when winds were from the south and west-southwest (within the industry arc of influence).
- The time series plots for 9 January 2018 show that concentrations of $PM_{10}$ at Taplin were highest during the early morning (between 02:00 and 06:00) and in the evening (between 18:00 and 21:00).
- Concentrations of $PM_{10}$ at BoM on 9 January 2018 showed a similar trend to Taplin except for lack of elevated early morning concentrations and a generally lower magnitude.
- During the early morning, winds were relatively light (between 2-4 m/s) from the west-southwest to south (within the industrial activity arc of influence). Winds increased in speed during the day up to 6 m/s and shifted to a northwest. In the afternoon and into evening the winds shift back towards the south and west and decreased in speed.

Overall on 9 January 2018, winds were from the direction of industry at the times when concentrations of $PM_{10}$ at Taplin was elevated (early morning and evening). It is therefore likely that industry contributed to the 24-hour average concentration of $PM_{10}$ on 9 January 2018 at Taplin.

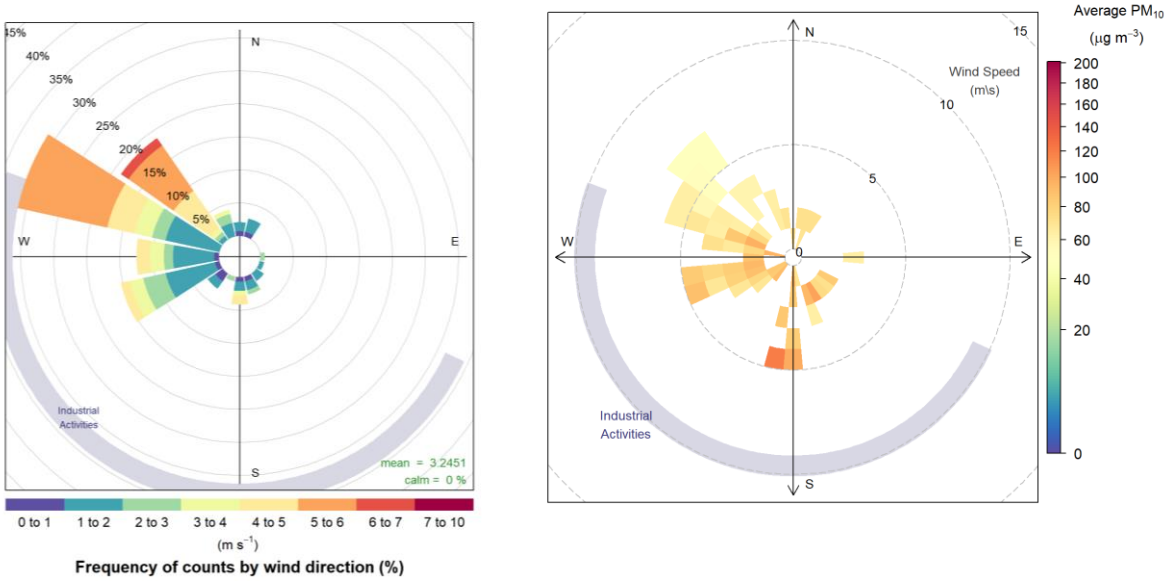



**Figure 8-14: Wind rose (left) and $PM_{10}$ rose (right) on 9 January 2018 at Taplin**


**Figure 8-15: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 9 January 2018**

## 8.10 25 January 2015

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 25 January 2018 | **74.6** | 49.2 | 29.1 | Local (industry) |

On the 25 January 2018, the 24-hour average concentration of $PM_{10}$ at Taplin was 74.6 µg/m³, 49.2 µg/m³ at BoM and 29.1 µg/m³ at Yule. The relatively high concentration at Taplin compared to the other two sites suggests a potential local event occurring at Taplin. It is also relevant to note that the concentration at BoM is relatively elevated being in the 95$^{th}$ range for the dataset. This indicates a regional component to dust on the 25 January 2018.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 25 January 2018 is shown in Figure 8-16 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-17.

The figures indicate the following:

- Winds on 25 January 2018 were predominantly from the west-northwest. Frequent winds also occurred from the northeast and southwest.
- Winds were strongest (5->7 m/s) from the northeast and northwest. Lighter winds (<3m/s) occurred from the southeast and southwest.
- The $PM_{10}$ polar frequency plot indicates that the highest 10-minute average concentrations of $PM_{10}$ (dark orange coloured areas) occurred when winds were from the south (within the industry arc of influence).
- The time series plots for the 25 January 2018 show that concentrations of $PM_{10}$ at Taplin were highest during the morning (around 06:00) but were consistently above 50 µg/m³ throughout the day.
- Concentrations of $PM_{10}$ at BoM on 25 January 2018 were elevated in the early morning (03:00 and 04:00) and around midday.
- During the early morning (03:00), strong winds were observed from the northeast. As the morning progressed, the wind speed dropped to around 3 m/s and shifted to the south (within the industrial activity arc of influence). The wind speeds continued to increase as the day progressed to around 5-6 m/s and shifted to a northwest by midday.

Overall on 25 January 2018, with winds were from the direction of industry at the times when concentrations of $PM_{10}$ at Taplin were elevated. It is therefore likely that industry contributed to the 24-hour average concentration of $PM_{10}$ on 25 January 2018 at Taplin.

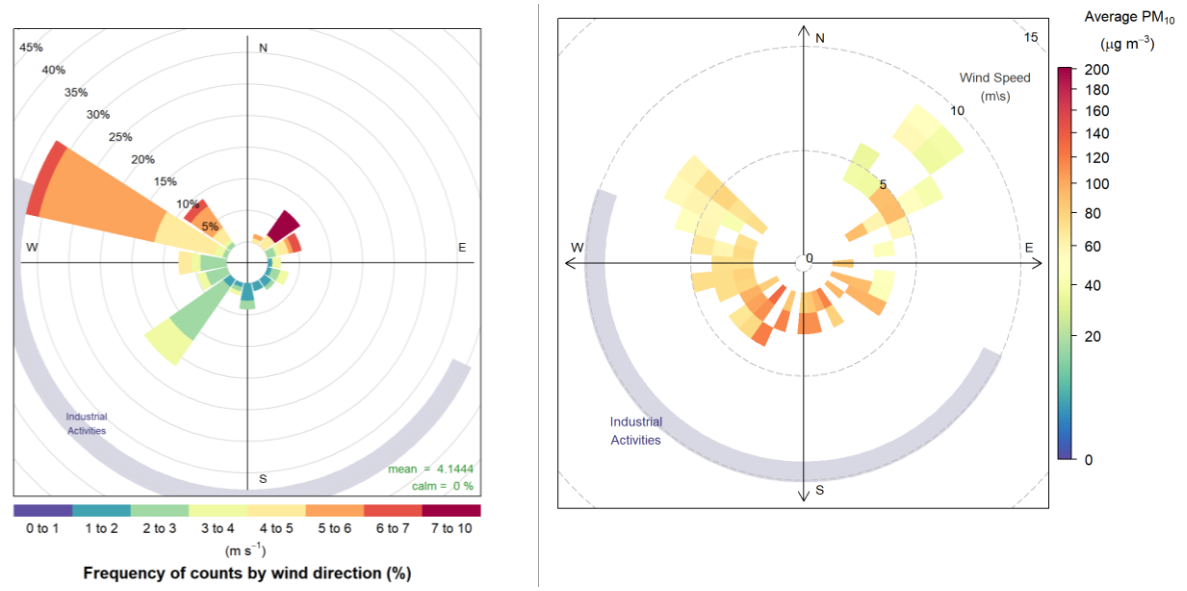



**Figure 8-16: Wind rose (left) and $PM_{10}$ rose (right) on 25 January 2018 at Taplin**


**Figure 8-17: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 25 January 2018**

## 8.11 15 February 2018

| Date | 24-hour average $PM_{10}$ (µg/m³) | | | Likely cause (as determined by methodology presented in Section 7.1) |
|---|---|---|---|---|
| | Taplin | BoM | Yule | |
| 15 February 2018 | **71.0** | 37.9 | no data | Local (industry and non-industry) |

On the 15 February 2018, the 24-hour average concentration of $PM_{10}$ at Taplin was 71.0 µg/m³ and 37.9 µg/m³ at BoM (no data available for Yule due to a cyclone shutdown), which indicates a local event occurring at Taplin.

A wind rose and $PM_{10}$ polar frequency plot of the Taplin data for 15 February 2018 is shown in Figure 8-18 and a time series plot of concentrations of $PM_{10}$ at Taplin and BoM and wind speed and wind direction at Taplin is shown in Figure 8-19.

The figures indicate the following:

- Winds on 15 February 2018 were predominantly from the west-northwest. Frequent winds also occurred from the northeast, west and west-southwest.
- Winds were strongest from the west-northwest and northwest. Lighter winds (<3m/s) occurred from other directions.
- The $PM_{10}$ polar frequency plot indicates that the highest 10-minute average concentrations of $PM_{10}$ (dark orange and orange coloured areas) occurred when winds were from the southwest (within industry arc of influence) and the northwest to north-northeast (outside the industry arc).
- The time series plots for the 15 February 2018 shows that concentrations of $PM_{10}$ at Taplin were high in the early morning and gradually decreased to approximately 50 µg/m³ before spiking around 13:00 and then dropping back to approximately 50 µg/m³ for the rest of the day.
- Concentrations of $PM_{10}$ at BoM on 15 February 2018 show a similar pattern but with a lesser magnitude than Taplin.
- During the morning, winds were from the industrial activity arc of influence and less than 2 m/s. As the day progressed, the winds increased in speed to around 6 m/s and shifted to be from the north and northwest.

Overall on 15 February 2018, it is likely that both local industry and non-industry sources contributed to 24-hour average concentration of $PM_{10}$ at Taplin.

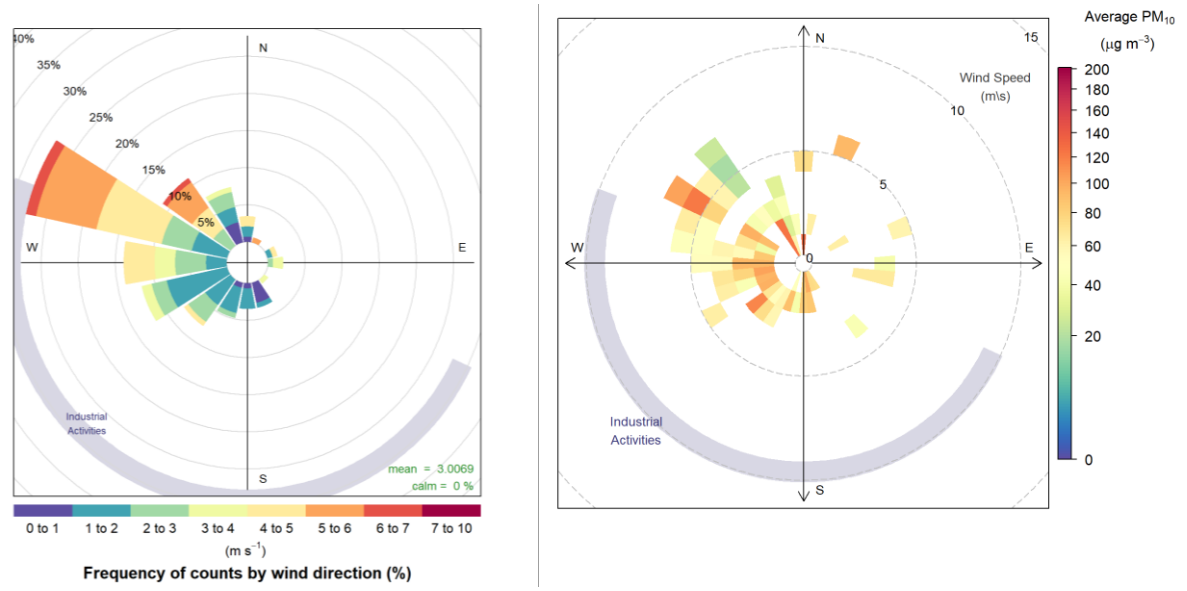



**Figure 8-18: Wind rose (left) and $PM_{10}$ rose (right) on 15 February 2018 at Taplin**


**Figure 8-19: Time series of concentrations of $PM_{10}$ at Taplin and BoM (top) and wind speed at Taplin (middle) and wind direction at Taplin (bottom) on 15 February 2018**

# 9. CONCLUSIONS

## 9.1 $PM_{10}$

$PM_{10}$ was measured at eight (8) stations in the Port Hedland monitoring network; however, the $PM_{10}$ data at Taplin was found to be unreliable for Q4 of FY 2017/18 and has been omitted from this updated annual report.

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

- For FY 2017/18, the monitoring station at Taplin recorded nine days above the 24-hour average interim guideline for $PM_{10}$ of 70 µg/m³. The interim guideline allows for ten exceedance days per year; however, as data from this site was not available for the full twelve months, performance of this site against the interim guideline could not be determined for the FY 2017/18.
- Compared with the previous reporting year, the number of days above 70 µg/m³ has increased from three days in FY 2016/17 to nine days in FY 2017/18. The average number of days above 70 µg/m³ for the six reporting years is just over nine indicating that FY 2017/18 is consistent with the longer-term trend.
- This is in contrast to the Port Hedland export tonnage that has steadily increased over the past six reporting years (as shown in the table below).

| 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 |
| 70 | 17 | 6 | 10 | 10 | 3 | 9 |
| *Export Tonnage (Mt)* | 295 | 380 | 425 | 430 | 500 | 519 |

- Detailed analysis of $PM_{10}$ data and meteorological conditions for the nine days at Taplin that were above 70 µg/m³ in FY 2017/18 indicated that:
  - On four days a local industrial source was identified as the cause
  - On three days a local industrial source combined with elevated regional levels were identified as the cause
  - On one day a local industrial source and a local non-industrial source were identified as the likely cause
  - On one day a local non-industrial source was identified as the cause.
- In FY 2017/18, there were no days above the AAQ NEPM standard for 24-hour average concentrations of $PM_{10}$ of 50 µg/m³ at South Hedland.
- At the other seven PHIC sites, 24-hour average concentrations were above the AAQ NEPM standard for $PM_{10}$ in FY 2017/18. Analysis of these events showed that:
  - Richardson and Taplin recording their highest number of concentrations above the AAQ NEPM standard compared to all previous years.
  - Kingsmill and Yule recorded a greater number of concentrations above the AAQ NEPM standard compared to the previous FY (FY 2016/17)
  - BoM, Neptune, South Hedland and Wedgefield recorded fewer concentrations above the AAQ NEPM standard compared to the previous FY (FY 2016/17).
- Considering the number of days per year above the AAQ NEPM standard for 24-hour average concentrations of $PM_{10}$ at each monitoring station over the last six years shows the following trends:
  - BoM, Kingsmill, Neptune, South Hedland, Wedgefield and Yule monitoring station's show a general decreasing trend over the past four years.
  - The Taplin monitoring station shows a steady trend over the last 6 years, with a slightly higher than the average number of exceedances this FY (2017/18).
  - The Richardson monitoring station shows an increasing trend in the number of days above the AAQ NEPM standard, especially over the last two reporting years. This may be in part due to 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 Kingsmill, Neptune, Richardson, Taplin and Wedgefield.
- The annual average concentration of $PM_{10}$ was below the AAQ NEPM standard of 25 µg/m³ at BoM, South Hedland and Yule.
- Annual average concentrations of $PM_{10}$ over the past three reporting years (FY 2015/16 to FY 2017/18) showed that:
    - Neptune, South Hedland and Wedgefield station's show a slight decreasing trend
    - Bom, Kingsmill, Taplin and Yule station's show a relatively steady trend
    - The Richardson station showed an increasing trend (It is noted that urban development changes have occurred near the Richardson station that may have contributed to the trend at this site).

## 9.2 $PM_{2.5}$

$PM_{2.5}$ was measured at four (4) stations in the Port Hedland ambient air quality monitoring network for the FY 2017/18 reporting period. Analysis of the $PM_{2.5}$ data found the following:

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

## 9.3 $NO_2$

$NO_2$ is only measured at the Taplin monitoring station in the Port Hedland ambient air quality monitoring network. Analysis of the $NO_2$ data found the following:

- 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 32% of the AAQ NEPM standard.
- The annual average concentrations of $NO_2$ were below the AAQ NEPM standard of 62 µg/m³.
- The annual average concentration of $NO_2$ corresponds to 22% of the AAQ NEPM standard.

Overall, the levels of $NO_2$ measured at Taplin in FY 2017/18 are low and consistent with the $NO_2$ levels measured in previous years.

## 9.4 Data Capture

With the exception of Taplin $PM_{10}$ data, in the FY 2017/18 the PHIC data capture criterion of 75% (per quarter and annually) was met for $NO_2$, $PM_{10}$ and $PM_{2.5}$ at all monitoring stations. For $PM_{10}$ and $PM_{2.5}$, a number of stations also met the PHIC desirable target of 95% data capture.

# 10. REFERENCES

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# Appendix A PM$_{10}$ TREND SUMMARY GRAPHS

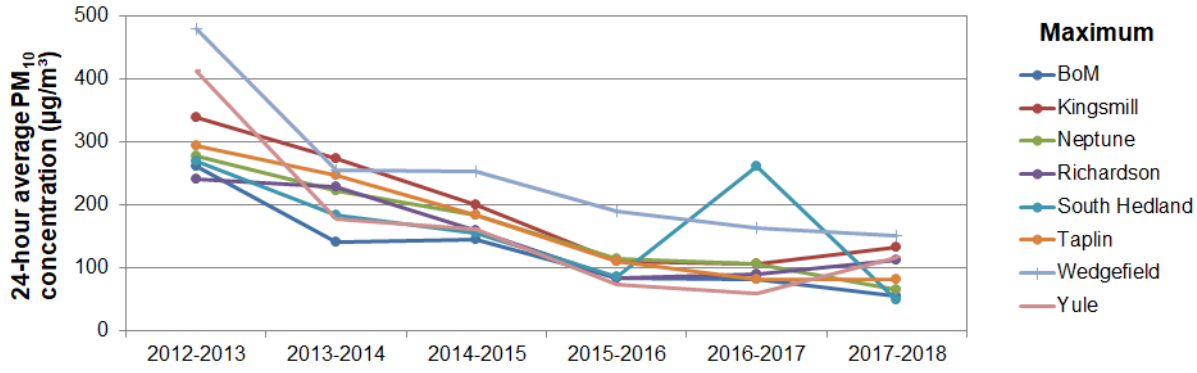


**Figure A-1: Maximum 24-hour average PM$_{10}$ Trends**

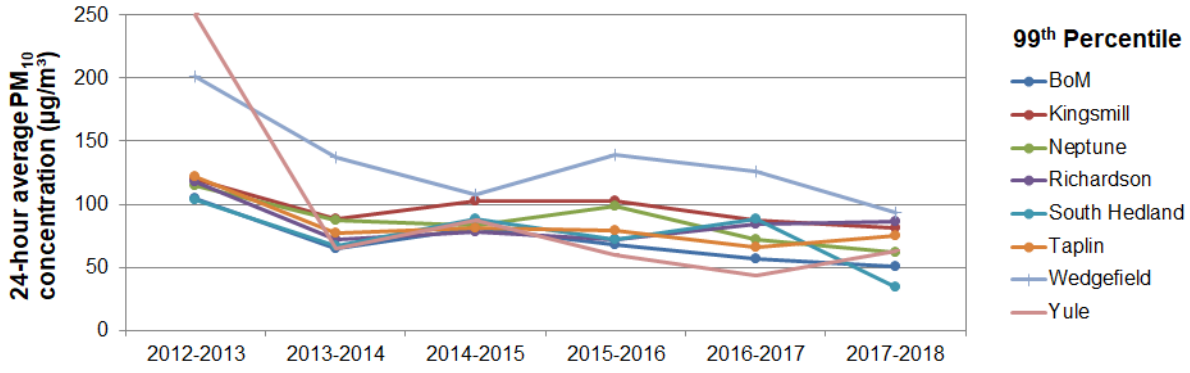


**Figure A-2: 99$^{th}$ percentile 24-hour average PM$_{10}$ Trends**

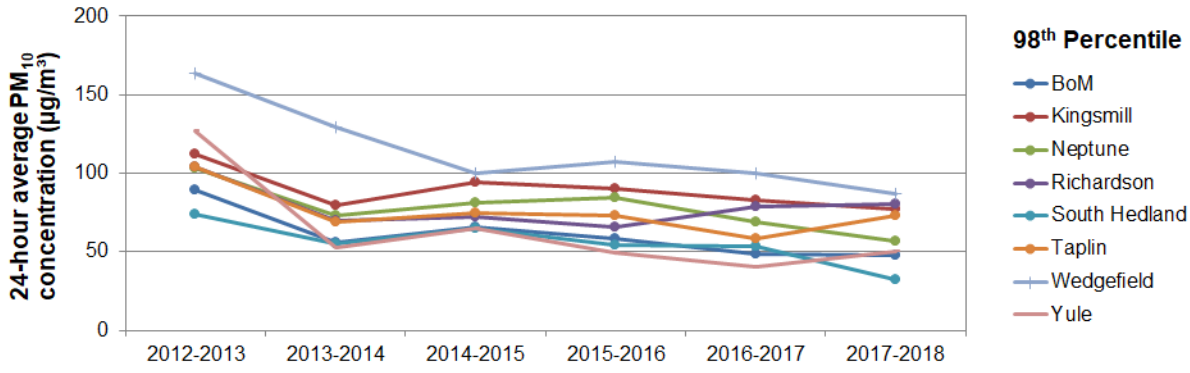


**Figure A-3: 98$^{th}$ percentile 24-hour average PM$_{10}$ Trends**

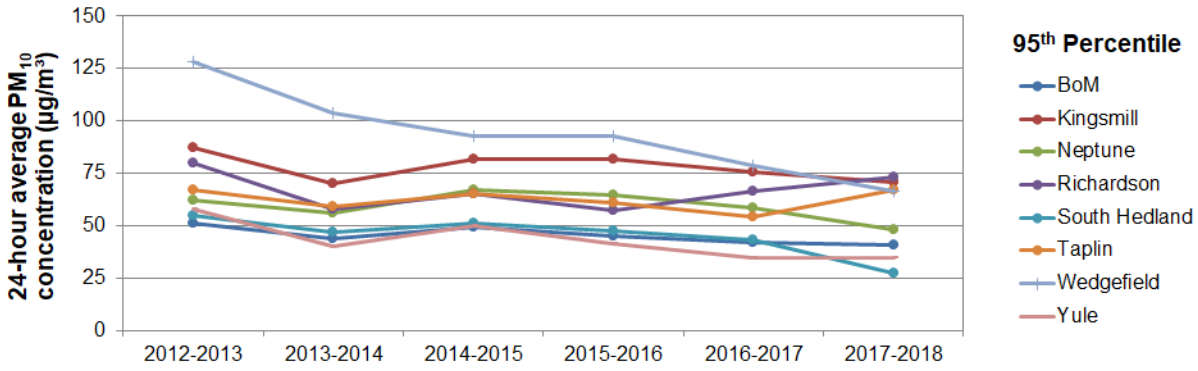


**Figure A-4: 95th percentile 24-hour average $PM_{10}$ Trends**

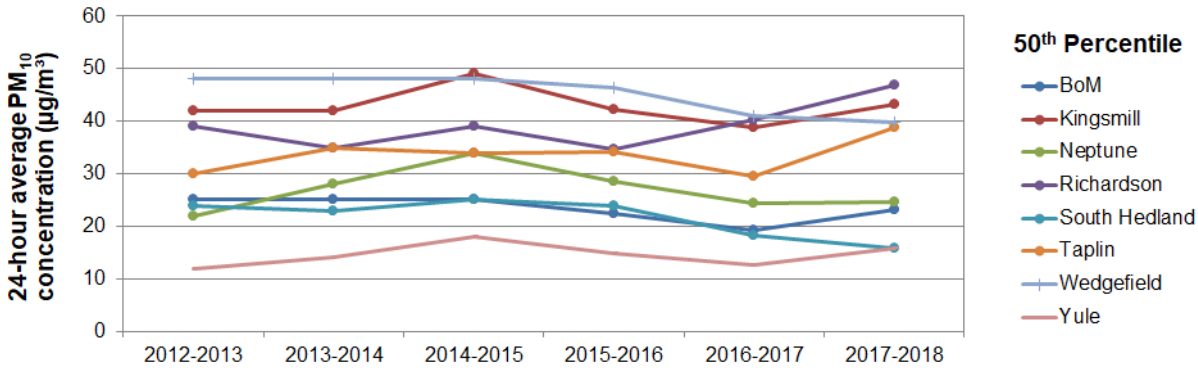


**Figure A-5: 50th percentile 24-hour average $PM_{10}$ Trends**