

North Queensland Bulk Ports Corporation

McEwens Beach PM₁₀ Solar BAM1020 & PM_{2.5} Solar E-sampler

Ambient Air Quality Monitoring

Validated Report

1st February 2017 – 28th February 2017

Report No.: DAT11714

Report issue date: 28th March 2017

Maintenance contract: MC950

ECOTECH PTY LTD. ABN: 32005752081

1492 Ferntree Gully Rd, Knoxfield VIC. 3180. AUSTRALIA

Tel No: 1300 364 946 Fax No: 1300 668 763

Email ecotech@ecotech.com WEB www.ecotech.com

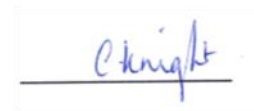
Report No: DAT11714

North Queensland Bulk Ports Corporation

| Customer Details | |
|---------------------|--|
| Customer | North Queensland Bulk Ports Corporation |
| Contact name | Nicola Stokes |
| Address | Level 1, 324 Queen Street, Brisbane QLD 4000 |
| Email | nstokes@nqbp.com.au |
| Phone | 07 4955 8105 |

| Revision History | | | |
|------------------|-----------|------------|-----------------|
| Revision | Report ID | Date | Analyst |
| 0 | DAT11714 | 28/03/2017 | Caroline Knight |

Report by: Caroline Knight



Signatory: Jon Alexander



Table of Contents

| | |
|---|----|
| Customer Details..... | 2 |
| Revision History | 2 |
| Table of Contents..... | 3 |
| List of Figures | 4 |
| List of Tables | 5 |
| Executive Summary..... | 6 |
| 1.0 Introduction | 7 |
| 2.0 Monitoring and Data Collection..... | 7 |
| 2.1. Siting Details..... | 7 |
| 2.2. Monitored Parameters | 9 |
| 2.3. Data Collection Methods | 10 |
| 2.3.1. Compliance with Standards | 11 |
| 2.3.2. Data Acquisition | 11 |
| 2.4. Data Validation and Reporting..... | 11 |
| 2.4.1. Validation | 11 |
| 2.4.2. Reporting..... | 12 |
| 3.0 Air Quality Goals | 13 |
| 4.0 Calibrations and Maintenance..... | 14 |
| 4.1. Units and Uncertainties | 14 |
| 4.2. Maintenance | 15 |
| 4.2.1. Calibration & Maintenance Summary Tables | 15 |
| 5.0 Results..... | 16 |

| | | |
|------|---|----|
| 5.1. | Data Capture | 16 |
| 5.2. | Air Quality Summary | 17 |
| 5.3. | Exceedances Discussion | 17 |
| 5.4. | Tabulated Data..... | 18 |
| 5.5. | Graphic Representations | 19 |
| 6.0 | Valid Data Exception Tables..... | 24 |
| 7.0 | Report Summary | 25 |
| | Appendix 1 - Definitions & Abbreviations..... | 26 |
| | Appendix 2 - Explanation of Exception Table | 27 |

List of Figures

| | |
|--|----|
| Figure 1: McEwens Beach Monitoring Station Location | 8 |
| Figure 2: Wind Rose for McEwens Beach station (1-hour average) – February 2017 | 19 |
| Figure 3: PM ₁₀ polar scatter plot (1-hour average) for McEwens Beach station – February 2017 | 20 |
| Figure 4: PM ₁₀ for McEwens Beach station 24-hour Averages – February 2017 | 21 |
| Figure 5: PM _{2.5} polar scatter plot (1-hour average) for McEwens Beach station – Feb 2017 | 22 |
| Figure 6: PM _{2.5} for McEwens Beach station 24-hour Averages – February 2017 | 23 |

List of Tables

Table 1: McEwens Beach monitoring site location 7

Table 2: Parameters measured at the McEwens Beach monitoring station 9

Table 3: Methods 10

Table 4: McEwens Beach Air Quality Goals 13

Table 5: Units and Uncertainties..... 14

Table 6: McEwens Beach Maintenance Table February 2017 15

Table 7: Monthly Data Capture for McEwens Beach Station Site for February 2017 16

Table 8: Exceedances Recorded for February 2017..... 17

Table 9: General statistics for February 2017 17

Table 10: McEwens Beach Station Summary Data Table February 2017 18

Table 11: McEwens Beach Solar BAM Valid Data Exception Table..... 24

Table 12: McEwens Beach Solar E-Sampler Valid Data Exception Table 24

Executive Summary

North Queensland Bulk Ports Corporation has commissioned Ecotech P/L to conduct air quality monitoring for the vicinity of the Port of Hay Point at McEwens Beach. The McEwens Beach monitoring station is currently comprised of a Solar BAM1020 and a solar E-Sampler equipped to measure PM₁₀ and PM_{2.5} respectively. A wind sensor is also installed at the air quality station.

The air quality station was commissioned in March 2013.

This report presents the data collected from the McEwens Beach station during the month of February 2017.

Data capture for PM₁₀ and PM_{2.5} was 98.7% and 99.9% respectively for the reporting period. Data capture for wind speed and direction was 99.9%.

No exceedances were recorded for PM₁₀ or PM_{2.5} during the month.

The PM₁₀ monthly average was 14 µg/m³ with a standard deviation of 13 µg/m³. The PM_{2.5} monthly average was 5 µg/m³ with a standard deviation of 3 µg/m³.

1.0 Introduction

Ecotech Pty Ltd was commissioned by North Queensland Bulk Ports Corporation to provide monitoring and data reporting for the McEwens Beach ambient air quality monitoring station, located as detailed in Table 1. Ecotech commenced data collection from the McEwens Beach station on the 4th (Solar E-Sampler PM_{2.5}) and 5th (Solar BAM PM₁₀) April 2013.

This report presents the data from the Solar BAM and Solar E-Sampler for February 2017.

The data presented in this report:

- Describes air quality measurements;
- Compares monitoring results;
- Has been quality assured;
- Complies with NATA accreditation requirements, where applicable.

2.0 Monitoring and Data Collection

2.1. Siting Details

The McEwens Beach consists of one ambient air quality monitoring station. The station's location and siting details are described below.

Table 1: McEwens Beach monitoring site location

| Site Name | Geographical Coordinates | Height Above Sea Level (m) |
|---------------|------------------------------------|----------------------------|
| McEwens Beach | Lat: -21.249444° Long: 149.206389° | 6 |

A siting audit was conducted by Ecotech Pty Ltd on 5th January 2017 to assess compliance with AS/NZS 3580.1.1:2016 Methods for sampling and analysis of ambient air. The location was found to be compliant with the standard, with the exception of a road being located within 50m of the station. Given that this road is known to only be lightly trafficked, and the airflow in the vicinity of the sampling inlet is maintained free from restrictions independent of this proximity, these factors are not likely affect sampling results and therefore the siting of the monitoring unit is considered to be in compliance with the intent of the Standards.



Figure 1: McEwens Beach Monitoring Station Location

Report No: DAT11714

North Queensland Bulk Ports Corporation

2.2. Monitored Parameters

Table 2 below details the parameters monitored and the instruments used at the McEwens Beach monitoring station. Appendix 1 defines any abbreviated parameter names used throughout the report.

For meteorological sensors, the elevation given in the table below is the height above ground level at the monitoring station.

Table 2: Parameters measured at the McEwens Beach monitoring station

| Parameter Measured | Instrument and Measurement Technique |
|---|---|
| PM ₁₀ | Met One BAM 1020 – Beta ray attenuation |
| PM _{2.5} | Met One E-Sampler – light scatter aerosol monitor |
| Wind Speed (horizontal, elevation 3 m) | Met One 034B – cup and vane |
| Wind Direction (elevation 3 m) | Met One 034B – cup and vane |

2.3. Data Collection Methods

Table 3 shows the methods used for data collection. Any deviations from the stated methods are detailed in section 2.3.1.

Table 3: Methods

| Parameter Measured | Data Collection Methods Used | Description of Method |
|--------------------------------|------------------------------------|--|
| PM ₁₀ (BAM 1020) | AS 3580.9.11-2008 | Methods of sampling and analysis of ambient air. Method 9.11: Determination of suspended particulate matter – PM ₁₀ beta attenuation monitors |
| | Ecotech Laboratory Manual | In-house method 7.5 – Measurement of PM ₁₀ , PM _{2.5} and TSP using Beta Attenuation Monitor. |
| PM _{2.5} (E-Sampler) | Met One E-Sampler Operation Manual | Met One E-Sampler Operation Manual |
| Vector Wind Speed (Horizontal) | AS 3580.14 2014 | Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications |
| | Ecotech Laboratory Manual | In-house method 8.1 Wind speed (Horizontal) by anemometer |
| Vector Wind Direction | AS 3580.14 2014 | Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications |
| | Ecotech Laboratory Manual | In-house method 8.3 Wind direction by anemometer |

2.3.1. Compliance with Standards

Unless stated below, parameters are monitored at the McEwens Beach station according to the methods detailed in Table 3.

- Measurement of wind speed and direction is not covered by Ecotech’s NATA scope of accreditation as the sensor has not been calibrated in accordance with the requirements of AS 3580.14.2014. The sensor does not meet the performance specifications of AS 3580.14.2014
- Measurement of PM_{2.5} by E-Sampler is not covered by Ecotech’s NATA scope of accreditation.
- The monitoring location is not fully compliant with AS/NZS 3580.1.1-2007 as detailed in section 2.1.

2.3.2. Data Acquisition

Data acquisition is performed using a PC based WinAQMS logger (using WinAQMS® Version 2.0) situated at the monitoring site. The logger is equipped with a 3G modem for remote data collection. The recorded data is remotely collected from the WinAQMS logger on a daily basis (using Airodis™ version 5.1.0) and stored at Ecotech’s Environmental Reporting Services (ERS) department in Melbourne, Australia. Data samples are logged in 5 minute intervals for the E-Sampler and hourly for the BAM1020.

2.4. Data Validation and Reporting

2.4.1. Validation

The Ecotech ERS department performs daily data checks to ensure maximum data capture rates are maintained. Any equipment failures are communicated to the responsible field engineers for urgent rectification. Ecotech ERS maintains two distinct databases containing non-validated and validated data respectively.

The validated database is created by duplicating the non-validated database and then flagging data affected by instrument faults, calibrations and other maintenance activities. The data validation software requires the analyst to supply a valid reason (e.g. backed by maintenance notes, calibration sheets etc) in the database for flagging any data as invalid.

Report No: DAT11714

North Queensland Bulk Ports Corporation

Validation is performed by the Ecotech ERS operator, and the validation is reviewed. All data is checked and graphs and reports are generated based on the verified five minute data for the E-Sampler and on the hourly data for the BAM1020.

2.4.2. Reporting

The reported data is in a Microsoft Excel format file named “NQBP McEwens Beach Data Report February 2017.xls”.

The Excel file consists of six worksheets:

1. Cover
2. 5 Min Averages
3. 15 Min Averages
4. 1 Hour Averages
5. 24 Hour Averages
6. Valid Data Exception Tables

The data contained in these reports is based on Australian Eastern Standard Time. Data is for all parameters measured continuously.

All averages are calculated from the five minute data for the E-Sampler and from hourly data for the BAM1020. Averages are based on a minimum of 75% valid readings within the averaging period.

Averaging periods of eight hours or less are reported for the end of the period, i.e. the hourly average 02:00am is for the data collected from 1:00am to 2:00am. One hour averages are calculated based on a clock hour. One day and one year averages are calculated based on calendar days.

Wind Data Reporting

Wind speed, wind speed gust and wind direction data associated with calm wind conditions are reported in accordance with the requirements of AS 3580.14-2014 Method for sampling and analysis of ambient air – Meteorological monitoring for ambient quality monitoring applications. Calm wind conditions are defined as wind speeds below the starting threshold of the wind speed / direction sensors. Sensor starting thresholds are given in Table 5 under “Measurement Range”.

In this report, calm wind speed and wind speed gust readings in tabulated data are reported as 0 m/s. Wind direction readings during calm periods are excluded from the tabulated data (reported as nulls).

Calm readings are excluded from wind roses; however the percentage of calm data is indicated at the bottom of the graph. In all other graphic representations of the data, wind speed, gust and direction values are reported as logged, without calm filters applied.

3.0 Air Quality Goals

The air quality goals for pollutants monitored at the McEwens Beach Station monitoring network site are based on the Australian National Environmental Council (NEPC) Ambient Air Quality NEPM. The air quality goals are shown in Table 4 below.

Table 4: McEwens Beach Air Quality Goals

| Parameter | Time Period | Exceedance Level | Units | Maximum allowable exceedances |
|-------------------|-------------|------------------|-------------------|-------------------------------|
| PM ₁₀ | 1 day | 50 | µg/m ³ | None |
| PM ₁₀ | 1 year | 25 | µg/m ³ | None |
| PM _{2.5} | 1 day | 25 | µg/m ³ | None |
| PM _{2.5} | 1 year | 8 | µg/m ³ | None |

Note:

Exceptional events are excluded from this standard. As per the Ambient Air Quality NEPM, **Exceptional event** means a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedance of 1 day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust.

Ecotech will include any valid data identified as being associated with an exceptional event in all report tables and graphic representations. However 1 day averages associated with exceptional events will not be counted as exceedances of the Air Quality standard.

4.0 Calibrations and Maintenance

4.1. Units and Uncertainties

The uncertainties for each parameter have been determined by the manufacturer’s tolerance limits of the equipment’s parameters, and by the data collection standard method.

The reported uncertainties are expanded uncertainties, calculated using coverage factors which give a level of confidence of approximately 95%.

Table 5: Units and Uncertainties

| Parameter | Units | Resolution | Uncertainty | Measurement Range ¹ |
|----------------------------------|-------------------|---------------------|--|--|
| PM ₁₀ (BAM 1020) | µg/m ³ | 1 µg/m ³ | 3.57% of reading K factor of 1.98 | 0 to 1000 µg/m ³ |
| PM _{2.5} (E-Sampler) | µg/m ³ | 1 µg/m ³ | ± 10% to gravimetric method ² K factor of 1.32 | 0 to 65,530 µg/m ³ |
| Vector Wind Speed | m/s | 0.1 m/s | ±0.22 m/s or 3.0% of reading, whichever is greater K factor of 1.96 | 0.4 m/s to 15 m/s |
| Vector Wind Direction | Deg | 1 deg | ±4 deg K factor of 2.11 | 0 deg to 360 deg Starting threshold: 0.4 m/s |

¹ Uncertainties may not be calculated based on the full measurement range.

² Manufacturer’s stated accuracy for nephelometer when calibrated for local particulate type.

4.2. Maintenance

Scheduled maintenance is completed quarterly by Ecotech for the BAM1020, E-sampler and Wind Sensor. E-Sampler maintenance for the intervening months is completed by a customer-nominated third party.

4.2.1. Calibration & Maintenance Summary Tables

The last calibrations for the following parameters were performed on the indicated dates. Data supplied after this time is subject to verification, to be performed at the next calibration cycle.

Note: Maintenance and calibration dates may differ, as calibrations may be less frequent than scheduled maintenance visits.

Table 6 indicates when the particulate and meteorological equipment were last maintained/calibrated.

Table 6: McEwens Beach Maintenance Table February 2017

| Parameter | Date of Last Maintenance | Maintenance Type | Date of Last Calibration |
|-------------------|--------------------------|----------------------|--------------------------|
| PM ₁₀ | 05/01/2017 | 2 Monthly, 3 Monthly | 05/01/2017 |
| PM _{2.5} | 05/01/2017 | Monthly, 2 Monthly | 14/11/2016 |
| Wind Speed | 05/01/2017 | 6 Monthly | 05/01/2017 |
| Wind Direction | 05/01/2017 | 6 Monthly | 05/01/2017 |

*Note: wind sensor date of yearly maintenance refers to onsite calibration.

5.0 Results

5.1. Data Capture

Data capture is based on 1 hour averages, calculated from 5 minute data, and refers to the amount of available data collected during the report period.

The percentage of data captured is calculated using the following equation:

$$\text{Data capture} = (\text{Reported air quality data} / \text{Total data}) \times 100\%$$

Where:

- Reported air quality data = Number of instrument readings which have been verified through a quality assured process and excludes all data errors, zero data collection due to calibration, failures and planned and unplanned maintenance.
- Total data = Total number of instrument readings since the start of the term assuming no maintenance, errors, loss of data or calibration.

Table 7 below displays data capture statistics for February 2017. **Bold** values in the table indicate data capture below 95%.

Table 7: Monthly Data Capture for McEwens Beach Station Site for February 2017

| Parameter | Data Capture (%) |
|-------------------|------------------|
| PM ₁₀ | 98.7 |
| PM _{2.5} | 99.9 |
| WS, WD | 99.9 |

Report No: DAT11714

North Queensland Bulk Ports Corporation

5.2. Air Quality Summary

Table 8 below summarises any exceedances of the air quality goals recorded in the month of December 2016.

Table 8: Exceedances Recorded for February 2017

| Parameter | Time Period | Value of Exceedance ($\mu\text{g}/\text{m}^3$) | Date of Exceedance |
|-------------------|-------------|--|--------------------|
| PM _{2.5} | 24 Hour | No exceedance | N/A |
| PM ₁₀ | 24 Hour | No exceedance | N/A |

Table 9 below presents some statistical parameters for February 2017. The standard deviation is calculated based on the hourly averaged data.

Table 9: General statistics for February 2017

| Parameter | Time Period | Average ($\mu\text{g}/\text{m}^3$) | Standard Deviation ($\mu\text{g}/\text{m}^3$) |
|-------------------|-------------|--------------------------------------|---|
| PM ₁₀ | 1 month | 14 | 13 |
| PM _{2.5} | 1 month | 5 | 3 |

5.3. Exceedances Discussion

- There were no exceedances over the PM_{2.5} limits during February 2017.
- There were no exceedances over the PM₁₀ limits during February 2017.

5.4. Tabulated Data

Table 10 details the daily averages for PM₁₀, PM_{2.5} and meteorological parameters measured at McEwens Beach station during February 2017.

Table 10: McEwens Beach Station Summary Data Table February 2017

| Daily Data – PM ₁₀ , PM _{2.5} , WS, WD | | | | |
|--|--|----------|----------|---------------------------------------|
| Date | PM _{2.5} (µg/m ³) | WS (m/s) | WD (deg) | PM ₁₀ (µg/m ³) |
| 1/02/2017 | 7 | 3.3 | 103 | 20 |
| 2/02/2017 | 6 | 1.9 | 104 | 13 |
| 3/02/2017 | 5 | 2.5 | 101 | 10 |
| 4/02/2017 | 6 | 3.5 | 99 | 10 |
| 5/02/2017 | 8 | 4.6 | 98 | 21 |
| 6/02/2017 | 7 | 4.1 | 107 | 17 |
| 7/02/2017 | 9 | 4.6 | 108 | 25 |
| 8/02/2017 | 9 | 5.4 | 112 | 28 |
| 9/02/2017 | 6 | 4.0 | 123 | 23 |
| 10/02/2017 | 7 | 2.6 | 112 | 25 |
| 11/02/2017 | 4 | 0.4 | 57 | 7 |
| 12/02/2017 | 4 | 1.0 | 324 | 5 |
| 13/02/2017 | 5 | 1.2 | 314 | 7 |
| 14/02/2017 | 4 | 1.0 | 91 | 9 |
| 15/02/2017 | 5 | 0.9 | 129 | 20 |
| 16/02/2017 | 8 | 3.0 | 92 | 24 |
| 17/02/2017 | 4 | 0.7 | 81 | 12 |
| 18/02/2017 | 3 | 0.4 | 49 | 7 |
| 19/02/2017 | 2 | 0.7 | 346 | 4 |
| 20/02/2017 | 3 | 0.5 | 78 | 2 |
| 21/02/2017 | 1 | 1.7 | 92 | 1 |
| 22/02/2017 | 4 | 3.5 | 116 | 9 |
| 23/02/2017 | 10 | 3.3 | 122 | 31 |
| 24/02/2017 | 5 | 2.5 | 127 | 13 |
| 25/02/2017 | 4 | 3.1 | 115 | 7 |
| 26/02/2017 | 3 | 3.7 | 112 | 9 |
| 27/02/2017 | 5 | 2.8 | 120 | 11 |
| 28/02/2017 | 3 | 2.7 | 115 | 11 |

5.5. Graphic Representations

Validated data for PM₁₀, PM_{2.5}, WS and WD were used to construct the following monthly graphic representations.

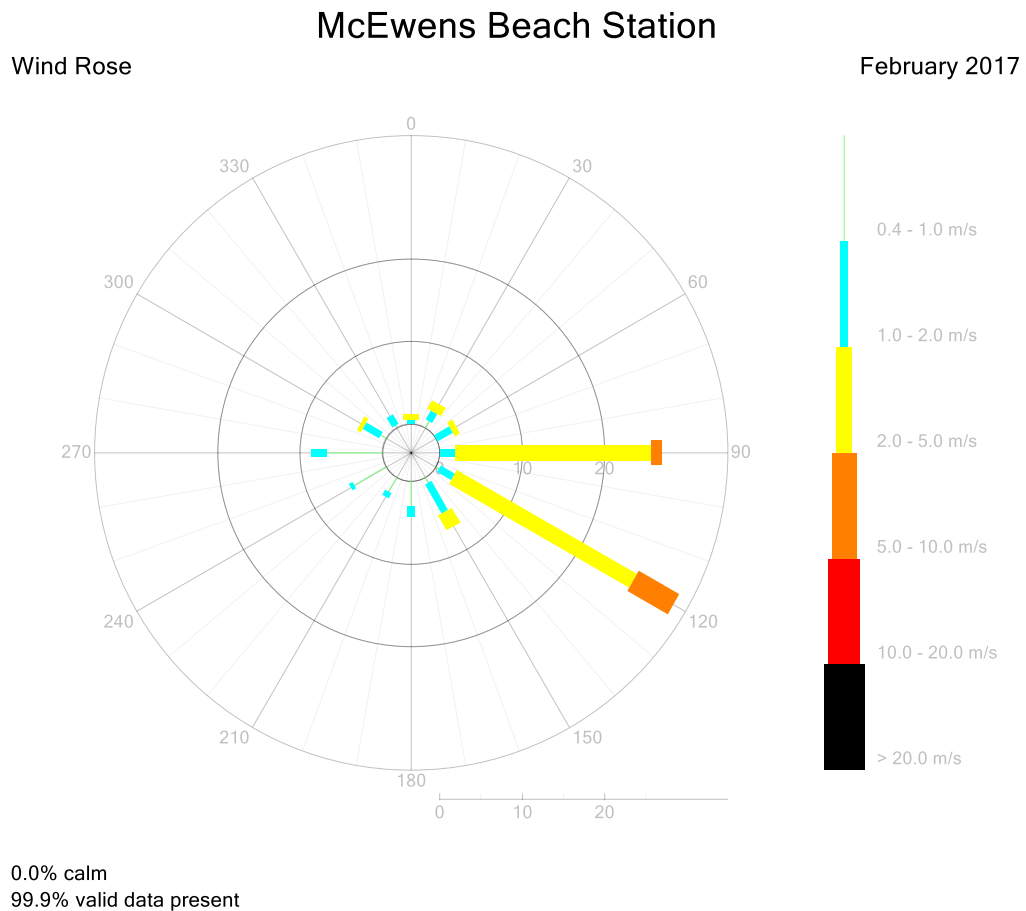


Figure 2: Wind Rose for McEwens Beach station (1-hour average) – February 2017

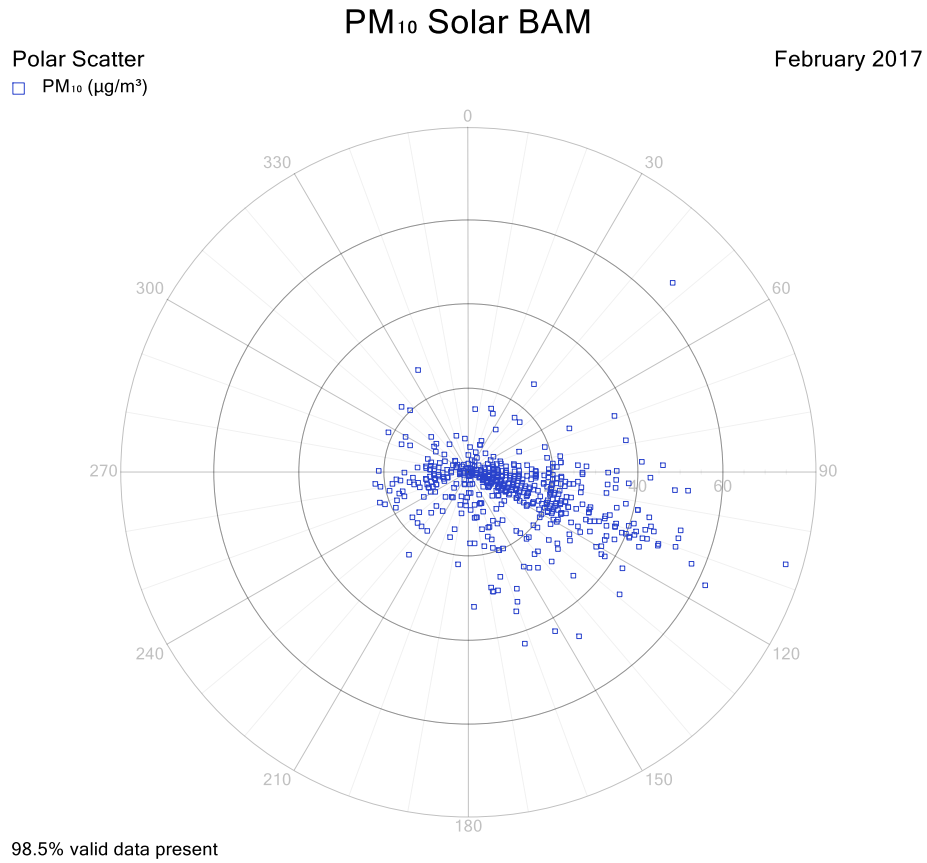


Figure 3: PM₁₀ polar scatter plot (1-hour average) for McEwens Beach station – Feb 2017

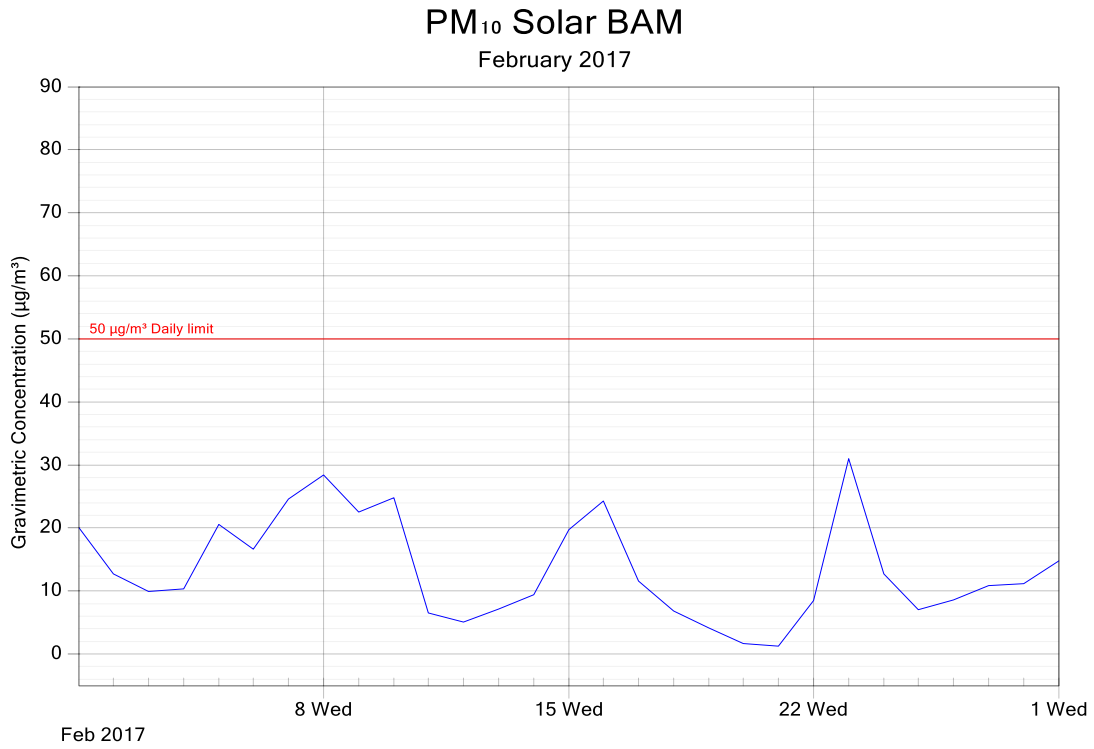


Figure 4: PM₁₀ for McEwens Beach station 24-hour Averages – February 2017

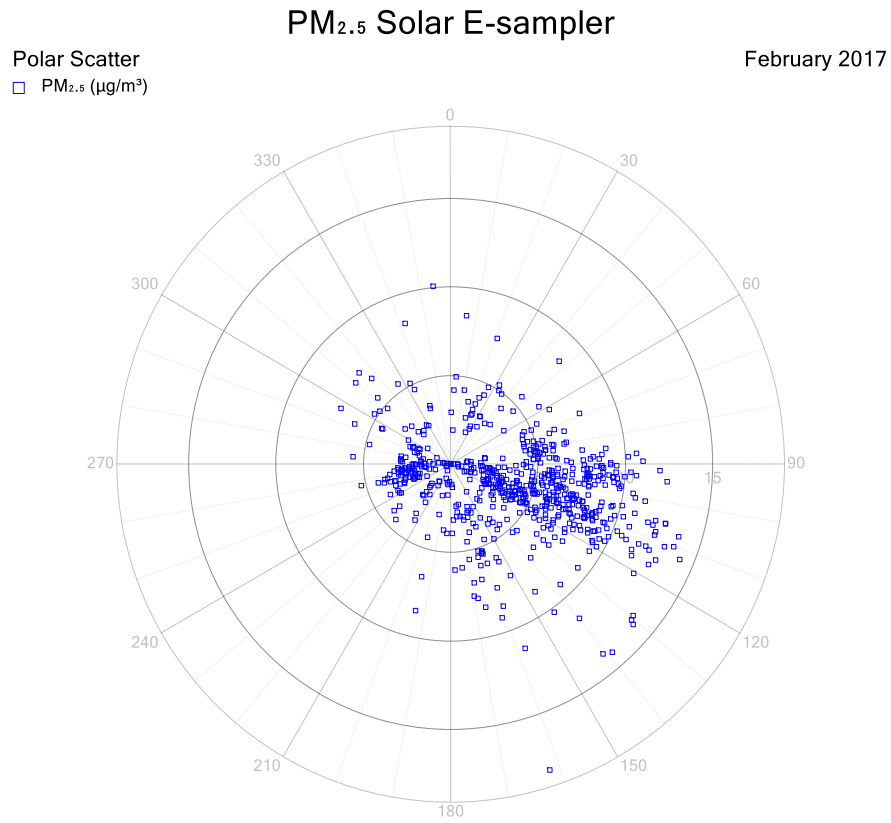


Figure 5: PM_{2.5} polar scatter plot (1-hour average) for McEwens Beach station – Feb 2017

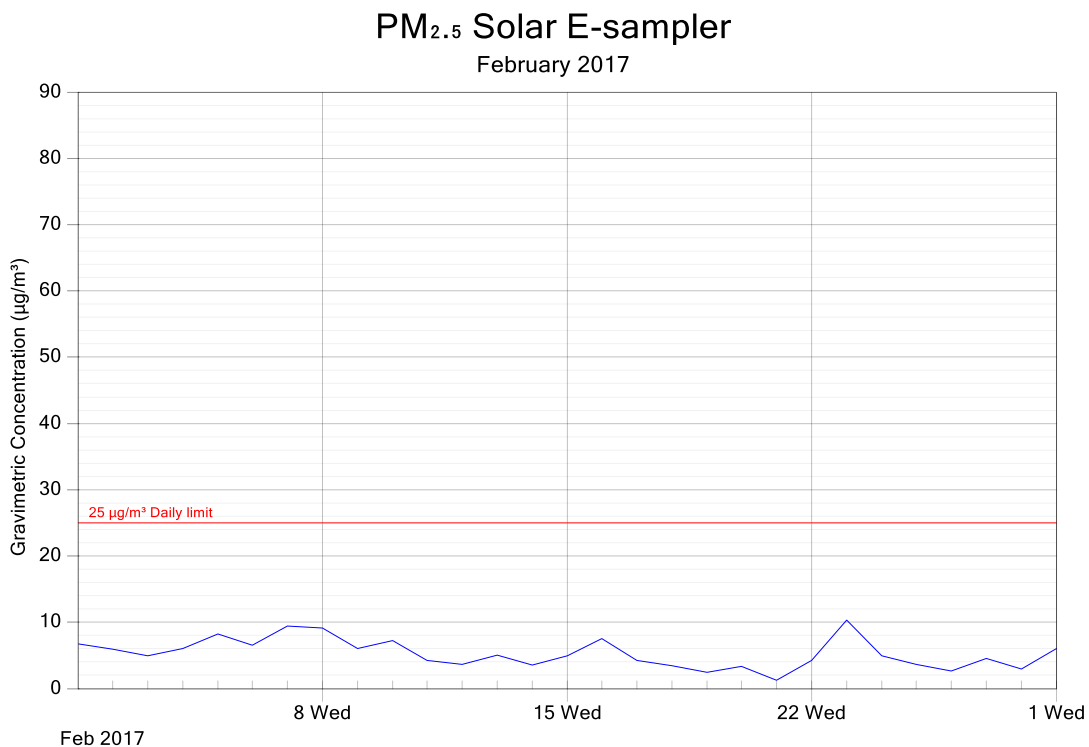


Figure 6: PM_{2.5} for McEwens Beach station 24-hour Averages – Feb 2017

6.0 Valid Data Exception Tables

The tables below detail all changes made to the raw data set during the validation process. An explanation of reasons given in the table can be found in Appendix 2.

Table 11: McEwens Beach Solar BAM Valid Data Exception Table

| Start Date | End Date | Reason | Change Details | User Name | Change Date |
|------------------|------------------|--------------------------------|------------------|-----------|-------------|
| 13/02/2017 00:00 | 28/02/2017 00:00 | Intermittent beta count errors | PM ₁₀ | CK | 20/03/2017 |

Table 12: McEwens Beach Solar E-Sampler Valid Data Exception Table

| Start Date | End Date | Reason | Change Details | User Name | Change Date |
|------------------|------------------|----------|-------------------|-----------|-------------|
| 10/02/2017 16:50 | 10/02/2017 17:45 | Data gap | PM _{2.5} | CK | 20/03/2017 |

7.0 Report Summary

- Data capture for PM₁₀ was 98.7% during February 2017 due to intermittent tape fault during the month.
- Data capture for PM_{2.5} was 99.9% for the reporting period.
- Data capture for wind speed and direction was 99.9% during February 2017.
- No exceedances were recorded for PM₁₀ or PM_{2.5}.
- The PM₁₀ monthly average was 14 µg/m³ with a standard deviation of 13 µg/m³.
- The PM_{2.5} monthly average was 5 µg/m³ with a standard deviation of 3 µg/m³.
- Some data in this report does not comply with Australian Standard requirements and is not covered by Ecotech's NATA scope of accreditation. Refer to section 2.3.1 for further details.

-----END OF REPORT-----

Appendix 1 - Definitions & Abbreviations

| | |
|--------------------------|--|
| $\mu\text{g}/\text{m}^3$ | Micrograms per cubic metre at standard temperature and pressure (0°C and 101.3 kPa) |
| calm | Wind conditions where the wind speed is below the operating range of the wind sensor |
| deg | Degrees (True North) |
| m/s | Metres per second |
| PM ₁₀ | Particulate less than 10 microns in equivalent aerodynamic diameter |
| PM _{2.5} | Particulate less than 2.5 microns in equivalent aerodynamic diameter |
| WD | Vector Wind Direction |
| WS | Vector Wind Speed |

Appendix 2 - Explanation of Exception Table

Commissioning refers to the initial setup and calibration of the instrument when it is first installed. For some instruments there may be a stabilisation period before normal operation commences.

Data affected by environmental conditions – wind speed/wind speed gust spike refers to when a one-off high reading occurs due to a natural occurrence such as a bird sitting on the wind sensor, or some other event causing the readings to spike.

Data transmission error refers to a period of time when the instrument could not transmit data. This may be due to interference, or a problem with the phone line or modem.

Equipment malfunction/instrument fault refers to a period of time when the instrument was not in the normal operating mode and did not measure a representative value of the existing conditions.

Gap in data/data not available refers to a period of time when either data has been lost or could not be collected.

Instrument Alarm refers to an alarm produced by the instrument. A range of alarms can be produced depending on how operation of the instrument is being affected.

Instrument out of service refers to a lack of data due to an instrument being shut down for repair, maintenance, or factory calibration.

Linear offset or multiplier refers to when an offset or multiplier has been applied between two points where the values of the offset or multiplier are different and the correction is interpolated between the two points.

Logger error refers to when an error occurs and instrument readings are not correctly recorded by the logger.

Maintenance refers to a period of time when the logger/instrument was switched off due to maintenance.

Power Interruption refers to no power to the station therefore no data was collected at this time.

Tape break refers to the breaking of the EBAM/BAM sample tape during operation.

Warm up after power interruption refers to the startup period of an instrument after power has been restored.