

Acciona Samsung Bouygues Joint Venture (ASBJV)

WestConnex M4-M5 Link (WCX 3A) Project

Ambient Air Quality and Weather Monitoring Validated Report

1st November 2021 – 30th November 2021

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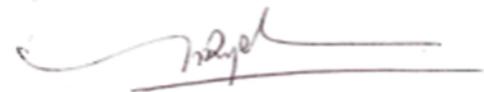
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Executive Summary

The WestConnex WCX 3A - M4_M5 Link project is being constructed in two stages:

- Stage 1: WCX 3A - M4_M5 Link Mainline Tunnels
- Stage 2: Rozelle Interchange.

This Monthly Ambient Air Quality Monitoring Report is specific to Stage 1 of the project, which generally comprises twin mainline motorway tunnels between the M4 at Haberfield and the M8 at St Peters. Each tunnel would be around 7.5 kilometres long and would generally accommodate up to four lanes of traffic in each direction.

WCX 3A - M4_M5 Link Mainline tunnels air quality is monitored by hundreds of sensors and measures various pollutants across three main areas:

- Ambient air - air quality in the areas around the WCX 3A - M4_M5 Link Mainline tunnels
- Ventilation - air quality around the ventilation stacks
- In Tunnel - air quality inside the tunnels and portals (entrances to the tunnel)

This Report details ambient air measurements. It is part of the commitment to the Minister and the community to report air quality measurements in real-time (raw data as the measurements occur) as well as validated reports. It is important to re-publish the data in reports because the raw data needs to be checked and collated by approved air quality experts and 'translated' into a format that is easy to understand and can be interpreted by both experts and laypeople.

This report details results at four external ambient air quality monitoring stations located at Albert Street, Campbell St, Ramsay Street and Wattle Street between 1st November 2021 and 30th November 2021.

Report Summary

Air quality sensors and related equipment were operating for the full month although there were some instrumentation issues (called 'Exceptions') during this time.

The data capture was below the 95% goal for some parameters in this report as shown in Table 12. The low data capture ranged from 74.6% to 94.7% for the month.

There were no exceedance of the air quality goals at the WCX 3A - M4_M5 Link Ambient Air Quality Monitoring Network for the reporting month. Please refer to Tables 13-16 in Section 5.2 – Air Quality Monthly Summary for further information.

The reasons for the exceptions are reported in Tables 18-21 and were mainly due to equipment requiring adjustment.

1.0 Introduction

Ecotech Pty Ltd was commissioned by Acciona Samsung Bouygues Joint Venture (ASBJV) to provide monitoring and data reporting for the WCX 3A - M4_M5 Link Project ambient air quality and weather monitoring network, located as detailed in Table 1. Ecotech commenced data collection in November 2021.

This report presents the available data for November 2021.

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 WCX 3A - M4_M5 Link Project monitoring network consists of six ambient air quality and weather monitoring stations. The stations' location and siting details are described below.

Table 1: WCX 3A - M4_M5 Link Project monitoring site's locations

Site Name	Geographical Coordinates	Height Above Sea Level (m)
Albert Street	33°54'52.07"S, 151°10'45.07"E	12
Campbell Street	33°54'44.71"S, 151°10'43.76"	15
Ramsay Street	33°52'26.20"S, 151°8'1.50"E	4
Wattle Street	33°52'32.88"S, 151° 8'2.67"	16

A siting audit to assess sites for compliance with *AS/NZS 3580.1.1:2016* has been completed as follows:

- Albert Street on 28/10/2021
- Campbell Street on 06/01/2021
- Ramsay Street on 17/11/2021
- Wattle Street on 02/11/2021

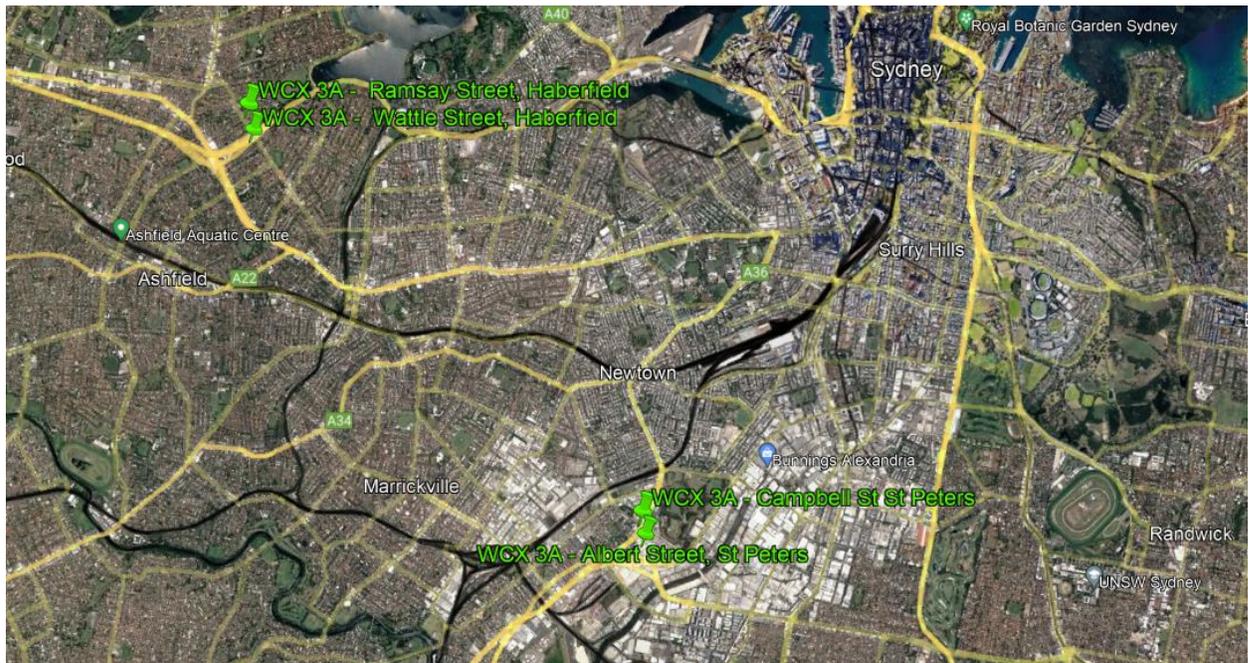


Figure 1: WCX 3A - M4_M5 Link Project Monitoring Station Locations

2.2. Monitored Parameters

Tables 2-4 below detail the parameters monitored and the instruments used at the WCX 3A - M4_M5 Link Project monitoring stations. Appendix 1 defines any abbreviated parameter names used throughout the report.

Table 2: Parameters measured at the WCX 3A - Albert Street and Wattle Street monitoring stations

Station(s)	Parameter Measured	Instrument and Measurement Technique	Elevation
Albert Street Wattle Street	CO	Ecotech Serinus 30 – NDIR gas filter correlation infrared photometry	2 m
	NO, NO ₂ , NO _x	Ecotech Serinus 40 – gas phase chemiluminescence	2 m
	PM _{2.5}	Met One BAM 1020 – Beta ray attenuation	2 m
	PM ₁₀	Thermo – 1405 TEOM (Tapered Element Oscillating Microbalance)	2m
	Differential Temperature (Elevation 2m)	Ecotech E031220	2 m
	Differential Temperature (Elevation 10m)	Ecotech E031220	10 m
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10 m
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10 m
	Sigma	Calculation	-

Table 3: Parameters measured at the WCX 3A – Campbell Street monitoring station

Station(s)	Parameter Measured	Instrument and Measurement Technique	Elevation
Campbell Street	CO	Ecotech Serinus 30 – NDIR gas filter correlation infrared photometry	2 m
	NO, NO ₂ , NO _x	Ecotech Serinus 40 – gas phase chemiluminescence	2 m
	PM _{2.5}	Met One BAM 1020 – Beta ray attenuation	2 m
	PM ₁₀	Thermo – 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2m
	Differential Temperature (Elevation 2m)	Ecotech E031220	2 m
	Differential Temperature (Elevation 10m)	Ecotech E031220	10 m
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10 m
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10 m
	Sigma	Calculation	-

Table 4: Parameters measured at the WCX 3A – Ramsay Street monitoring station

Station(s)	Parameter Measured	Instrument and Measurement Technique	Elevation
Ramsay Street	CO	Ecotech Serinus 30 – NDIR gas filter correlation infrared photometry	2 m
	NO, NO ₂ , NO _x	Ecotech Serinus 40 – gas phase chemiluminescence	2 m
	PM _{2.5}	Met One BAM 1020 – Beta ray attenuation	2 m
	PM ₁₀	Thermo – 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2m
	Differential Temperature (Elevation 2m)	Met One 062MP	2 m
	Differential Temperature (Elevation 10m)	Met One 062MP	10 m
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10 m
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10 m
	Sigma	Calculation	-

2.3. Data Collection Methods

Table 5 below shows the methods used for data collection.

Table 5: Methods

Parameter Measured	Data Collection Methods Used	Description of Method
NO, NO ₂ , NO _x	AS 3580.5.1 - 2011	Methods for sampling and analysis of ambient air - Method 5.1: Determination of oxides of nitrogen-Chemiluminescence method
CO	AS 3580.7.1 - 2011	Methods for sampling and analysis of ambient air. Method 7.1: Determination of carbon monoxide—Direct-reading instrumental method
PM ₁₀ (TEOM)	AS 3580.9.8-2008	Methods for sampling and analysis of ambient air. Method 9.8: Determination of suspended particulate matter - PM ₁₀ continuous direct mass method using a tapered element oscillating microbalance analyser.
PM _{2.5} (BAM 1020)	AS/NZS 3580.9.12-2013 ¹	Methods for sampling and analysis of ambient Air - Method 9.12: Determination of suspended particulate matter—PM _{2.5} beta attenuation monitors
Vector Wind Speed (Horizontal)	AS 2923-1987 ²	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
Vector Wind Direction	AS 2923-1987 ³	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
Sigma	AS 2923-1987 ³	Methods of sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
Atmospheric Temperature	USEPA (2000) EPA 454/R-99-005 ³	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications

¹ As approved by the Department of Planning and Environment on 8th September 2017.

² Superseded by AS/NZ 3580.14 2014 but specifically referenced in ministerial conditions.

³ Superseded by AS/NZ 3580.14 2014 but specifically referenced in ministerial conditions.

Note: Two different measurement techniques are used for monitoring PM₁₀ and PM_{2.5} at the WCX 3A - M4_M5 Link Project Stations. Studies conducted in Canada, the United States and other countries have found that the Tapered Element Oscillating Microbalance (TEOM) monitors can under report concentrations compared to the Beta Attenuation Monitors (BAM), especially when the air contains a large proportion of semi-volatile particulate matter, which may be the case during cooler seasons when the air contains less coarse dust and a greater proportion of semi-volatile organic compounds such as those associated with wood smoke. As a result, it is normal to see occasional periods where PM₁₀ < PM_{2.5} and this situation does not necessarily indicate a fault with either instrument.

2.3.1. Data Acquisition

Data acquisition is performed using a PC based WinAQMS logger (using WinAQMS® Version 2.0) and Congrego logger situated at each of the monitoring sites. Each logger is equipped with a 3G modem for remote data collection. The recorded data is remotely collected from the Air Quality Monitoring Station (AQMS) loggers on a daily basis (using Airodis™ version 5.1) and stored at Ecotech's Environmental Reporting Services (ERS) department in Melbourne, Australia. Data samples are logged in 5-minute intervals.

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.

Details of all invalid or missing data are recorded in the Valid Data Exception Tables.

Validation is performed by the analyst, and the validation is reviewed. Graphs and tables are generated based on the validated five minutes and one-hour data as appropriate.

2.4.2. Reporting

Data is reported in four Microsoft Excel format files named:

- *WCX 3A - M4_M5 Link_Albert St_Monthly Data Report_November 2021.xls*
- *WCX 3A - M4_M5 Link_Campbell St_Monthly Data Report_November 2021.xls*
- *WCX 3A - M4_M5 Link_Ramsay St_Monthly Data Report_November 2021.xls*
- *WCX 3A - M4_M5 Link_Wattle St_Monthly Data Report_November 2021.xls*

Each Excel file consists of 6 worksheets:

1. Cover
2. Contents
3. 5 Minute Data
4. 1 Hour Data
5. 24-hour Data
6. Valid Data Exception Report

The data contained in this report is based on Australian Eastern Standard Time.

All averages are calculated from the five-minute and the one-hour data. Averages are based on a minimum of 75% valid readings within the averaging period. Where data capture is low for a particular parameter, summary values (e.g., monthly maximum and minimum) may be based on less than 75% valid samples. The reader should use caution when interpreting these values as they may not be representative of conditions for the entire sample 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 averages are calculated based on calendar days.

3.0 Air Quality Goals

The air quality goals and criteria for pollutants monitored at the WCX 3A - M4_M5 Link Project ambient monitoring sites are based on SSI 6307 Planning Approval Condition E9. The air quality goals and criteria are shown in Table 6 below.

Table 6: WCX 3A - M4_M5 Link Project - Air Quality Goals

Parameter	Time Period	Goal Level	Units
CO	8 hours (rolling, based on 1-hour averages)	9.0	ppm
NO ₂	1 hour	0.12	ppm
PM ₁₀	1 day	50	µg/m ³
	1 year	25	µg/m ³
PM _{2.5}	1 day	25	µg/m ³
	1 year	8	µg/m ³

Note:

This table includes all valid data points that exceed the defined air quality standards. The Ambient Air Quality NEPM includes a provision for excluding 1-day PM₁₀ or PM_{2.5} averages associated with “exceptional events” from the total exceedances of the Air Quality standard. The definition of an “exceptional event” is included below for reference. It is the responsibility of the end user of this data to evaluate whether any reported exceedances are associated with exceptional events and are eligible to be excluded from the exceedance total. Monitoring and reporting of exceedances during the operational project will be in accordance with the Planning Approval Conditions E10, E11 and E12.

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.

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 7: Units and Uncertainties

Parameter	Units	Resolution	Uncertainty	Measurement Range ⁴
NO, NO _x (S40)	ppm	0.001 ppm	± (6% of reading + 0.011 ppm) k factor of 2.0	0 to 0.5 ppm LDL = 0.0004 ppm
NO ₂ (S40)	ppm	0.001 ppm	± (6% of reading + 0.011 ppm) k factor of 2.0	0 to 0.5 ppm LDL = 0.0004 ppm
CO (S30)	ppm	0.1 ppm	± (7% of reading + 0.8 ppm) k factor of 2.0	0 to 50 ppm LDL = 0.04 ppm
PM _{2.5} (BAM1020)	µg/m ³	1 µg/m ³	24Hr: ± (5.5% of reading + 4.0 µg/m ³) (in range 0 - 100 µg/m ³) Hr: ± (8% of reading + 8.0 µg/m ³) k factor of 2.0	0 to 1000 µg/m ³ LDL _{24hr} = 1.0 µg/m ³ LDL _{hr} = 4.8 µg/m ³
PM ₁₀ (TEOM)	µg/m ³	0.1 µg/m ³	± 5.0 µg/m ³ or 3.6% of reading, whichever is the greater K factor of 2.0	0 to 1 g/m ³ LDL = 5 µg/m ³
Vector Wind Speed	m/s	0.1 m/s	± 0.4 m/s or 2 % of reading, whichever is greater K factor of 2.0	0 to 30 m/s
Vector Wind Direction	Deg	1 deg	± 4 deg K factor of 2.0	0 to 360 deg <i>Starting threshold:</i> 0 m/s

⁴ Uncertainties may not be calculated based on the full measurement range. The max measurement range for gas analysers is defined as the full scale (FS=Span/0.8).

Parameter	Units	Resolution	Uncertainty	Measurement Range ⁴
Ambient Temperature	°K	0.1°K	± 0.6°K K factor of 2.0	263.15°C to 323.15°C

4.2. Maintenance

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 further validation, 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.

Tables 8-11 indicate when the particulate and gas and meteorological equipment were last maintained/calibrated.

Table 8: WCX 3A - Albert Street Maintenance Table November 2021

Parameter	Date of Last Scheduled Maintenance	Maintenance Type ⁵	Date of Last Calibration	Calibration Cycle
NO, NO ₂ , NO _x	28/10/21	Commissioning	03/11/21	Monthly
CO	28/10/21	Commissioning	28/10/21	Monthly
PM ₁₀	27/10/21	Commissioning	27/10/21	Yearly
PM _{2.5}	27/10/21	Commissioning	27/10/21	Yearly
WS/WD/Sigma	27/10/21	Commissioning	16/06/21 ⁶	2 Yearly
Differential Temperature 2m	27/10/21	Commissioning	27/10/21	6 Monthly
Differential Temperature 10m	27/10/21	Commissioning	27/10/21	6 Monthly

⁵ Additional visits may have been made as required.

⁶ Wind sensor calibrated on 16/06/21 and installed at this site on 27/10/21.

Table 9: WCX 3A - Campbell Street Maintenance Table November 2021

Parameter	Date of Last Scheduled Maintenance	Maintenance Type ⁷	Date of Last Calibration	Calibration Cycle
NO, NO ₂ , NO _x	19/11/21	Monthly	19/11/21	Monthly
CO	19/11/21	Monthly	19/11/21	Monthly
PM ₁₀	19/11/21	Monthly	25/01/21	Yearly
PM _{2.5}	19/11/21	2 Monthly	06/01/21	Yearly
WS/WD/Sigma	19/11/21	Monthly	23/03/21 ⁸	2 Yearly
Differential Temperature 2m	19/11/21	Monthly	10/06/21	6 Monthly
Differential Temperature 10m	19/11/21	Monthly	10/06/21	6 Monthly

⁷ Additional visits may have been made as required.

⁸ Wind sensor calibrated on 23/03/21 and installed at this site on 10/06/21.

Table 10: WCX 3A - Ramsay Street Maintenance Table November 2021

Parameter	Date of Last Scheduled Maintenance	Maintenance Type ⁹	Date of Last Calibration	Calibration Cycle
NO, NO ₂ , NO _x	16/11/21	Yearly	16/11/21	Monthly
CO	16/11/21	Yearly	16/11/21	Monthly
PM ₁₀	16/11/21	Yearly	16/11/21	Yearly
PM _{2.5}	16/11/21	Yearly	16/11/21	Yearly
WS/WD/Sigma	17/11/21	Yearly	18/12/19 ¹⁰	2 Yearly
Differential Temperature 2m	17/11/21	Yearly	17/11/21	6 Monthly
Differential Temperature 10m	17/11/21	Yearly	17/11/21	6 Monthly

⁹ Additional visits may have been made as required.

¹⁰ Wind sensor calibrated on 18/12/19 and installed at this site on 14/01/20.

Table 11: WCX 3A - Wattle Street Maintenance Table November 2021

Parameter	Date of Last Scheduled Maintenance	Maintenance Type ¹¹	Date of Last Calibration	Calibration Cycle
NO, NO ₂ , NO _x	02/11/21	Commissioning	24/11/21	Monthly
CO	02/11/21	Commissioning	02/11/21	Monthly
PM ₁₀	01/11/21	Commissioning	01/11/21	Yearly
PM _{2.5}	01/11/21	Commissioning	01/11/21	Yearly
WS/WD/Sigma	01/11/21	Commissioning	15/06/21 ¹²	2 Yearly
Differential Temperature 2m	01/11/21	Commissioning	01/11/21	6 Monthly
Differential Temperature 10m	01/11/21	Commissioning	01/11/21	6 Monthly

¹¹ Additional visits may have been made as required.

¹² Wind sensor calibrated on 15/06/21 and installed at this site on 01/11/21.

5.0 Results

5.1. Data Capture

Valid data capture refers to the amount of valid data collected during the report period. It is based on 5-minute data, for gaseous and meteorological parameters and 1-hour data for particulate parameters.

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

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

Where:

- Reported air quality data = Number of samples (instrument readings) which have been validated through a quality assured process and excludes all data errors, zero data collection due to calibration, equipment failures, planned and unplanned maintenance.
- Total data = Total number of samples (instrument readings) expected for the sampling period. Total data is calculated based on the same averaging period as “reported air quality data” and the duration of the corresponding report period. e.g., for 5-minute data collected over a month of 31 days, the total data would be equal to 12 (5-minute samples in an hour) x 24 (hours in a day) x 31 (days in a month) = 8928 samples.

Table 12 below displays data capture statistics for November 2021. **Bold** values in the table indicate data capture below 95%.

Details of all invalid or missing data affecting data capture are included in the Valid Data Exception Tables, see section 6.0.

Table 12: Data Capture for WCX 3A - M4_M5 Link Project Ambient Air Quality Network

Parameter	Data Capture (%)			
	Albert Street	Campbell Street	Ramsay Street	Wattle Street
PM _{2.5}	94.7	99.6	96.0	85.1
PM ₁₀	74.7	99.6	95.8	74.6
CO	96.8	92.1	96.2	91.8
NO, NO ₂ , NO _x	89.7	96.2	97.1	95.2
WS, WD, Sigma	96.7	99.7	98.8	97.8
AT 2m	99.7	99.7	98.8	97.8
AT 10m	99.7	99.7	98.8	97.8

5.2. Air Quality Monthly Summary

Tables 13-16 below include a summary of any exceedances recorded at the WCX 3A - M4_M5 Link Project stations during the reported period¹³.

Table 13: WCX 3A - Albert Street Exceedances Recorded for November 2021

Parameter	Time Period	Value of Exceedance	Date of Exceedance
NO ₂ (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM ₁₀ (µg/m ³)	24-hour	-	-
	Annual ¹⁴	-	-
PM _{2.5} (µg/m ³)	24-hour	-	-
	Annual ¹⁵	-	-

¹³ Exceedances are based on the decimal places reported.

¹⁴ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

¹⁵ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

Table 14: WCX 3A - Campbell Street Exceedances Recorded for November 2021

Parameter	Time Period	Value of Exceedance	Date of Exceedance
NO ₂ (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM ₁₀ (µg/m ³)	24-hour	-	-
	Annual ¹⁶	-	-
PM _{2.5} (µg/m ³)	24-hour	-	-
	Annual ¹⁷	-	-

¹⁶ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

¹⁷ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

Table 15: WCX 3A - Ramsay Street Exceedances Recorded for November 2021

Parameter	Time Period	Value of Exceedance	Date of Exceedance
NO ₂ (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM ₁₀ (µg/m ³)	24-hour	-	-
	Annual ¹⁸	-	-
PM _{2.5} (µg/m ³)	24-hour	-	-
	Annual ¹⁹	-	-

¹⁸ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

¹⁹ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

Table 16: WCX 3A - Wattle Street Exceedances Recorded for November 2021

Parameter	Time Period	Value of Exceedance	Date of Exceedance
NO ₂ (ppm)	1 hour		
CO (ppm)	8-hour rolling	-	-
PM ₁₀ (µg/m ³)	24-hour	-	-
	Annual ²⁰	-	-
PM _{2.5} (µg/m ³)	24-hour	-	-
	Annual ²¹	-	-

²⁰ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

²¹ Insufficient data to report annual average in 2021, any exceedances will be included in December 2022 report.

5.3. Tabulated data

5.3.1. Annual average

Table 17 displays monthly averages of the PM_{2.5} and PM₁₀ parameters collected at WCX 3A - M4_M5 Link ambient air monitoring stations for 2021. Averages shown are for the 2021 calendar year, up to the current reported month. Table requires at least 75% valid data to display a monthly average. Footer values are based on all available data for 2021 rather than the average of individual months. This gives an indication of performance against the annual objectives.

Table 17: PM₁₀ and PM_{2.5} averages at the WCX 3A – M4_M5 Link ambient air monitoring stations 2021

Month	Albert Street		Campbell Street		Ramsay Street		Wattle Street	
	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)
Jan-21	-	-	-	-	-	-	-	-
Feb-21	-	-	-	-	-	-	-	-
Mar-21	-	-	-	-	-	-	-	-
Apr-21	-	-	-	-	-	-	-	-
May-21	-	-	-	-	-	-	-	-
Jun-21	-	-	-	-	-	-	-	-
Jul-21	-	-	-	-	-	-	-	-
Aug-21	-	-	-	-	-	-	-	-
Sep-21	-	-	-	-	-	-	-	-
Oct-21	-	-	-	-	-	-	-	-
Nov-21	-	5.7	15.4	5.1	14.0	4.2	-	5.3
Dec-21	-	-	-	-	-	-	-	-
Average	-	5.7	15.4	5.1	14.0	4.2	-	5.3

5.4. Graphic Representations

This section displays graphs of the pollutants and meteorological parameters monitored at the WCX 3A - M4_M5 Link Project for November 2021. The graphs are based on validated 5 minutes or 1-hour data as appropriate.

CO 8-Hour (Rolling, based on 1-Hour Averages)

November 2021

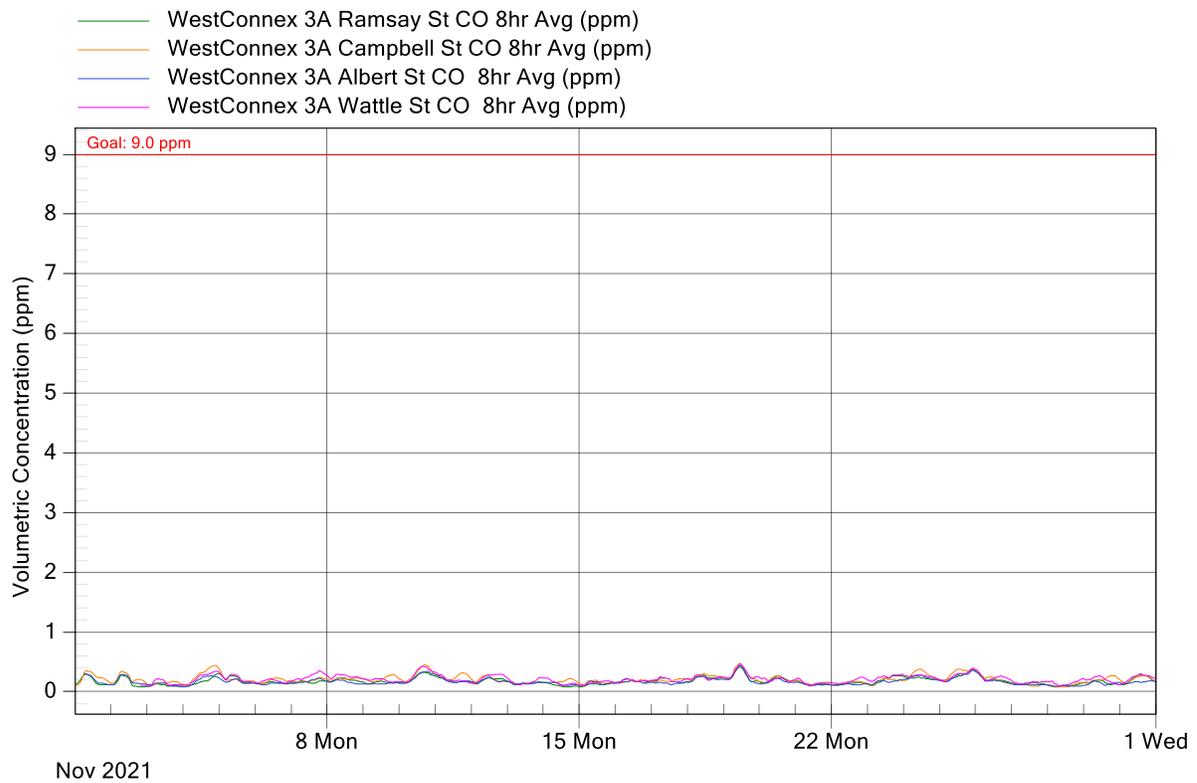


Figure 2: WCX 3A - M4_M5 Link Project Air Monitoring Stations - CO 8-Hour Rolling Graph for November 2021

NO₂ 1-Hour Averages

November 2021

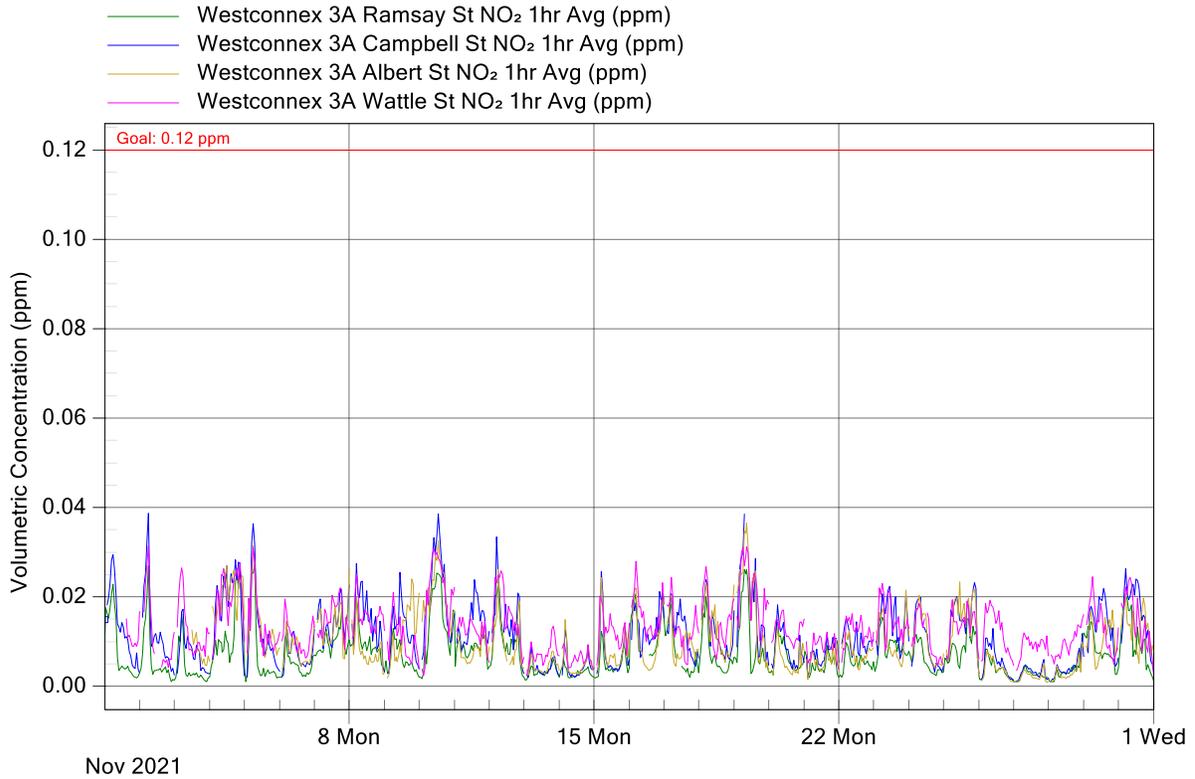


Figure 3: WCX 3A - M4_M5 Link Project Air Monitoring Stations - NO₂ 1-Hour Averages Graph for November 2021

PM₁₀ 24-Hour Averages

November 2021

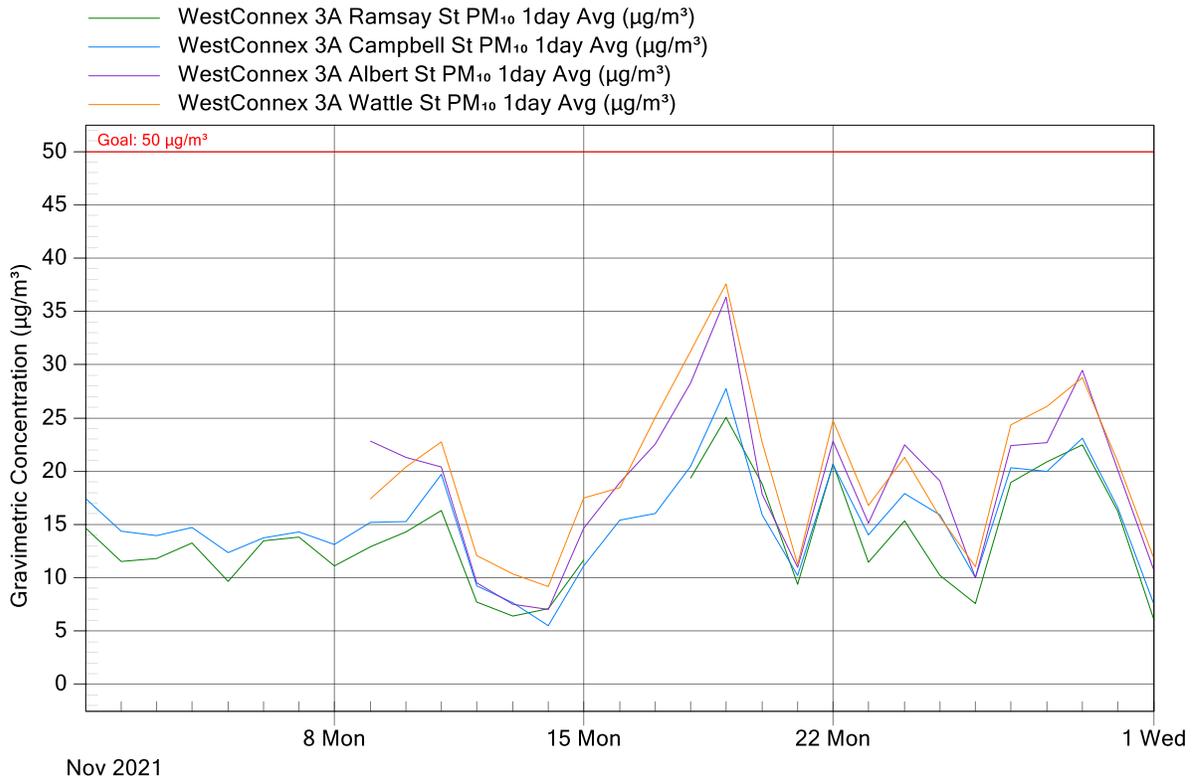


Figure 4: WCX 3A - M4_M5 Link Project Air Monitoring Stations - PM₁₀ 24-Hour Averages Graph for November 2021

PM_{2.5} 24-Hour Averages

November 2021

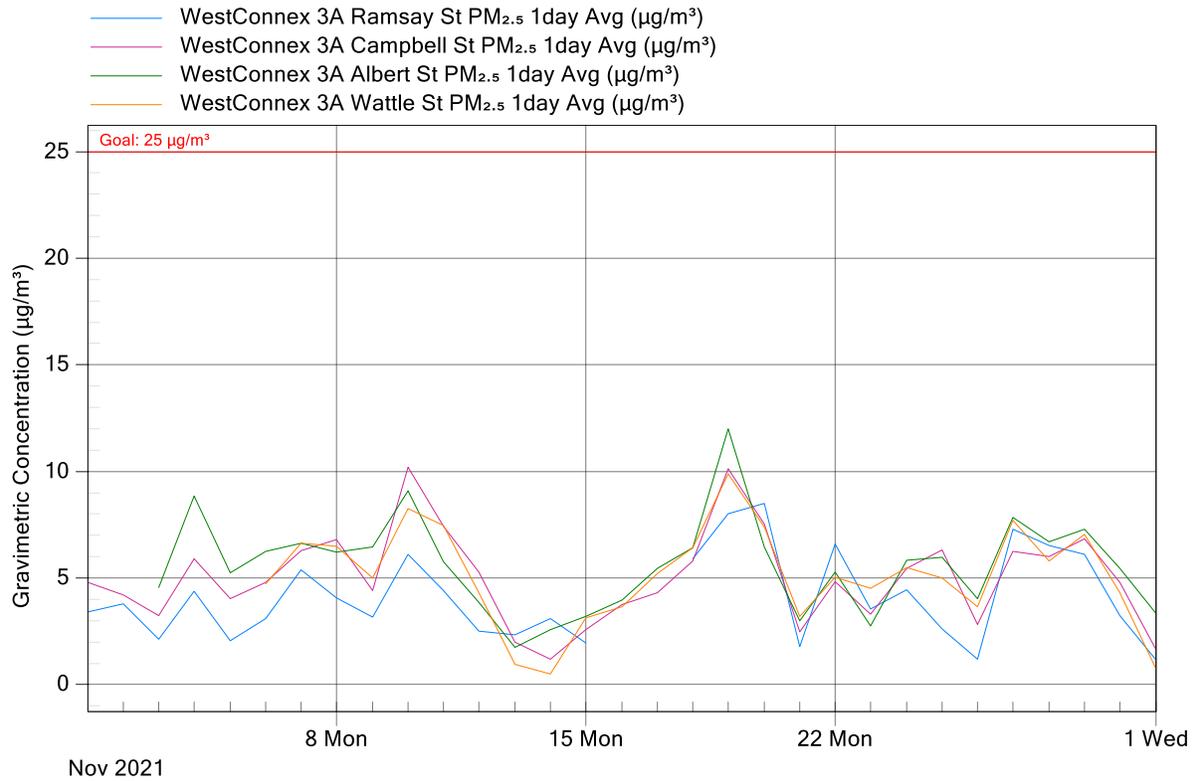
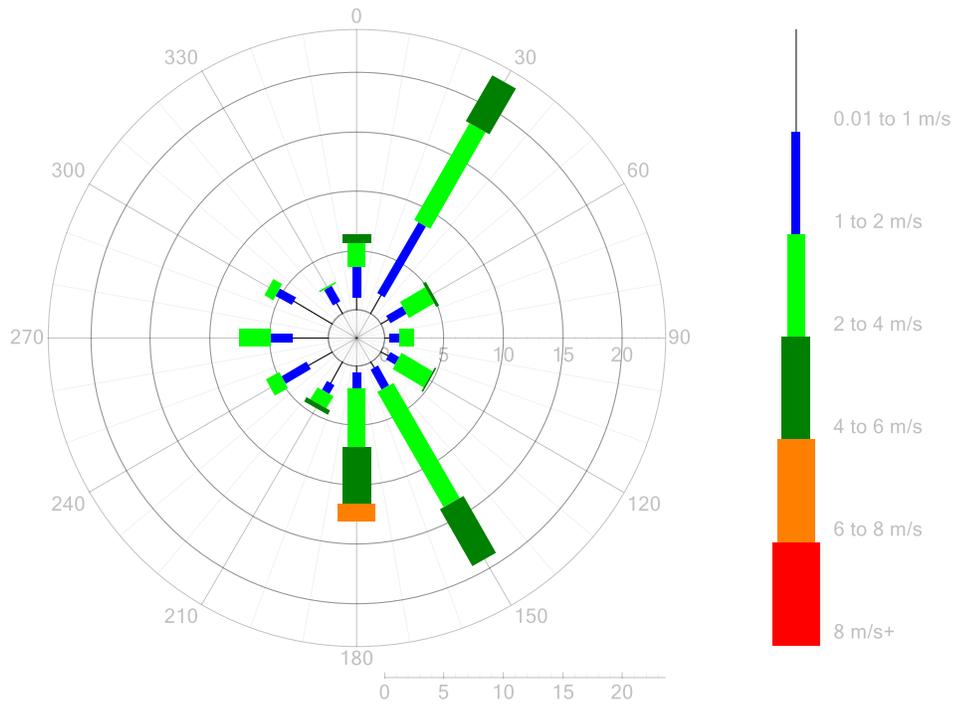


Figure 5: WCX 3A - M4_M5 Link Project Air Monitoring Stations - PM_{2.5} 24-Hour Averages Graph for November 2021

Albert St - Wind Rose (1-Hour Averages)

Wind Rose

November 2021



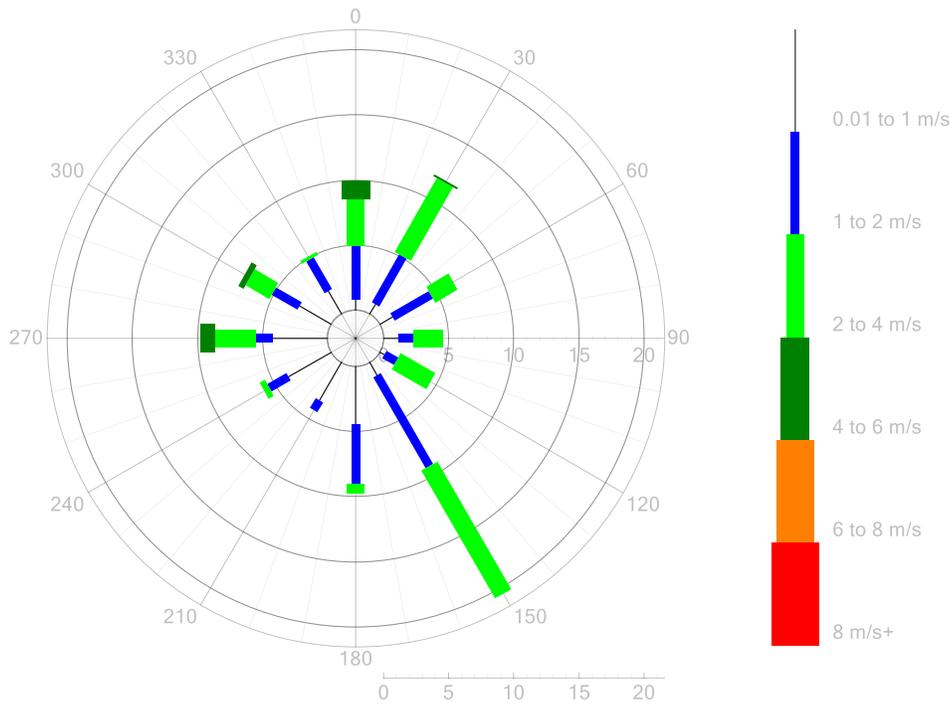
0.0% calm
96.5% valid data present

Figure 6: WCX 3A - Albert Street – Wind Rose for November 2021

Campbell St - Wind Rose (1-Hour Averages)

Wind Rose

November 2021



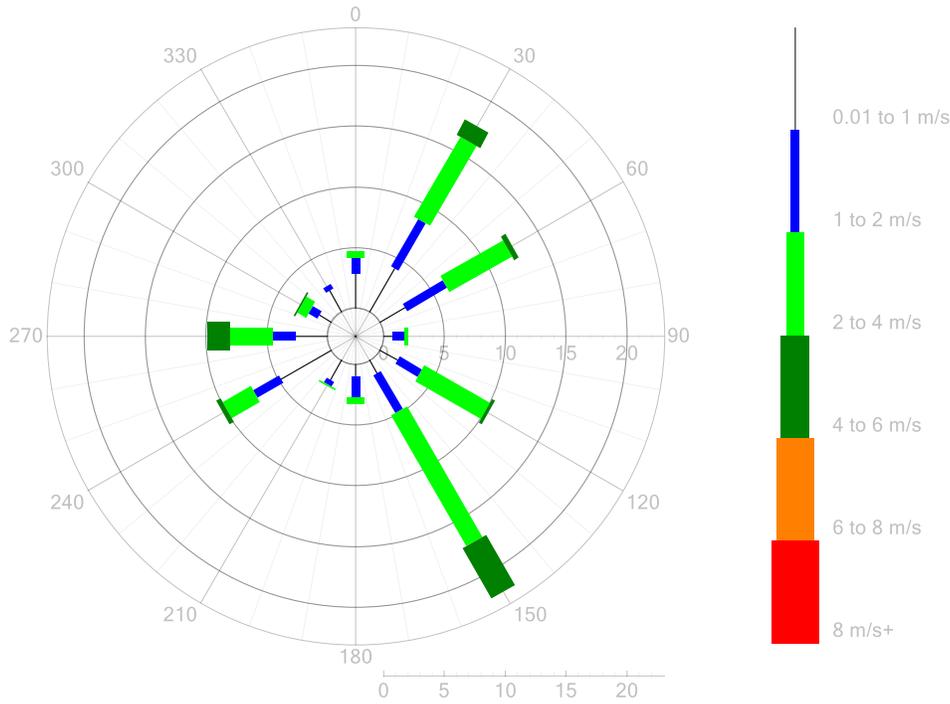
0.0% calm
98.3% valid data present

Figure 7: WCX 3A - Campbell Street – Wind Rose for November 2021

Ramsay St - Wind Rose (1-Hour Averages)

Wind Rose

November 2021



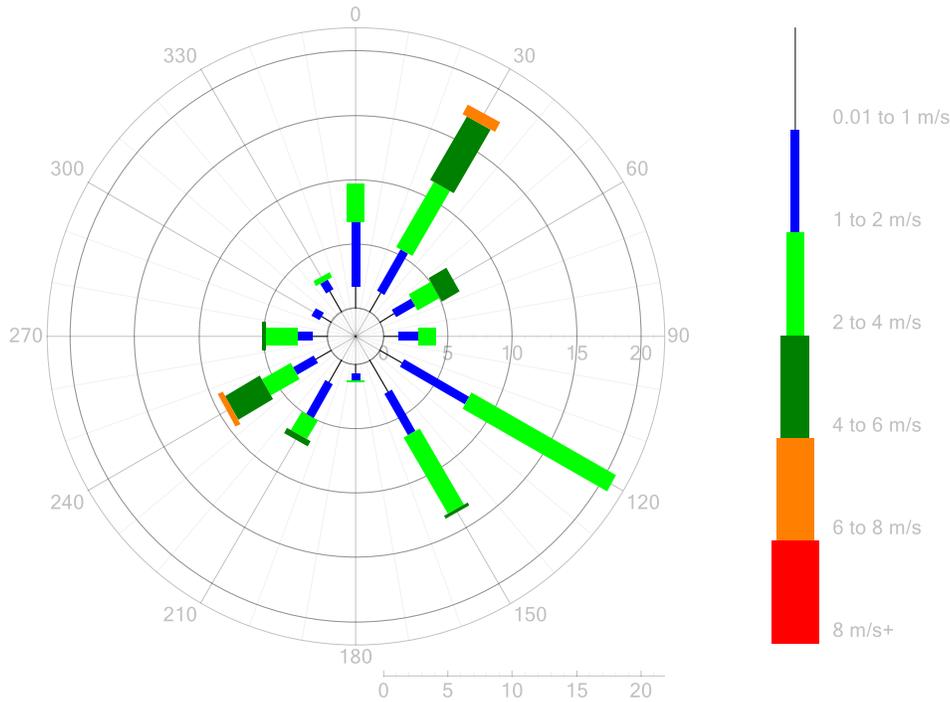
0.0% calm
98.8% valid data present

Figure 8: WCX 3A - Ramsay Street – Wind Rose for November 2021

Wattle St - Wind Rose (1-Hour Averages)

Wind Rose

November 2021



0.0% calm
97.8% valid data present

Figure 9: WCX 3A - Wattle Street – Wind Rose for November 2021

6.0 Valid Data Exception Tables

Tables 18–21 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 18: WCX 3A - Albert Street Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/11/21 00:00	02/11/21 11:00	72 hours Background check performed	PM _{2.5}	DL	14/12/21
01/11/21 00:00	03/11/21 11:20	Station commissioning followed by calibration check outside tolerance	NO, NO ₂ , NO _x	DL	14/12/21
01/11/21 00:00	08/11/21 11:10	Instrument fault - Main flow not logging in volumetric flow	PM ₁₀	DL	14/12/21
01/11/21 01:00	30/11/21 01:25	Automatic span and zero checks, once daily from 01:00 to 01:25 followed by instrument stabilisation	CO, NO, NO ₂ , NO _x	DL	14/12/21
01/11/21 01:30	30/11/21 23:45	Intermittent linear offsets applied as required to correct unstable baseline <i>A values range from 0.00 ppm to 0.10 ppm and B values range from -0.10 ppm to +0.05 ppm</i>	CO	DL	14/12/21
01/11/21 23:50	30/11/21 23:55	Background checks, once daily for 5 to 10 minutes followed by instrument stabilisation	CO	DL	14/12/21
02/11/21 12:00	02/11/21 14:10	Non-scheduled maintenance - New background values applied to the instrument	All parameters	DL	14/12/21
03/11/21 11:25	03/11/21 11:55	Remote maintenance - NO _x instrument re-calibrated	NO, NO ₂ , NO _x	DL	14/12/21
05/11/21 12:05	22/11/21 10:35	Intermittent unrealistic negative readings	NO, NO ₂ , NO _x	DL	14/12/21
07/11/21 13:30	08/11/21 11:10	Instrument fault - Data flatline	WS, WD, Sigma	DL	14/12/21
08/11/21 11:15	08/11/21 13:40	Non-scheduled maintenance - Fixing wind sensor fault and TEOM flow changed to volumetric flow	AT 2m, AT 10m, PM ₁₀ , WS, WD, Sigma	DL	14/12/21
09/11/21 11:00	15/11/21 08:25	Intermittent data transmission errors	AT 2m, AT 10m, PM ₁₀ , CO, NO, NO ₂ , NO _x	DL	14/12/21
11/11/21 08:10	11/11/21 08:10	Non-scheduled maintenance - Logger restarted	AT 2m, AT 10m, PM ₁₀ , CO, NO, NO ₂ , NO _x	DL	14/12/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
12/11/21 00:00	27/11/21 00:55	Intermittent static offsets applied as required to correct unstable baseline <i>Values range from +0.03 ppm to +0.05 ppm</i>	CO	DL	14/12/21
12/11/21 13:15	12/11/21 13:30	Non-scheduled maintenance - Logger and modem restarted	AT 2m, AT 10m, PM ₁₀ , CO, NO, NO ₂ , NO _x , WS, WD, Sigma	DL	14/12/21
26/11/21 16:55	26/11/21 17:00	Unrealistic data - WS spike	WS, WD, Sigma	DL	14/12/21

Table 19: WCX 3A - Campbell Street Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/11/21 00:00	20/11/21 23:55	Intermittent static offsets applied as required to correct unstable baseline <i>Values range from -0.70 ppm to -0.25 ppm</i>	CO	DL	14/12/21
01/11/21 01:00	30/11/21 01:45	Automatic span and zero checks, once daily from 01:00 to 01:45 followed by instrument stabilisation	CO, NO, NO ₂ , NO _x	DL	14/12/21
01/11/21 01:50	30/11/21 23:40	Intermittent linear offsets applied as required to correct unstable baseline <i>A values range from -0.75 ppm to -0.20 ppm and B values range from -1.00 ppm to +0.10 ppm</i>	CO	DL	14/12/21
01/11/21 20:40	30/11/21 16:45	Intermittent instrument fault - Status errors	CO	DL	14/12/21
01/11/21 23:45	30/11/21 23:50	Background checks, once daily for 5 to 10 minutes followed by instrument stabilisation	CO	DL	14/12/21
03/11/21 09:15	03/11/21 09:15	Data transmission error	AT 2m, AT 10m, PM ₁₀ , CO, NO, NO ₂ , NO _x , WS, WD, Sigma	DL	14/12/21
03/11/21 16:25	20/11/21 18:15	Intermittent unrealistic data - Possible moisture interference	PM ₁₀	DL	14/12/21
13/11/21 01:50	13/11/21 23:40	Unrealistic data - Readings not tracking with other sites	CO	DL	14/12/21
19/11/21 08:00	19/11/21 10:30	Scheduled 2 monthly maintenance - Instrument calibrations followed by instrument stabilisation	All parameters	DL	14/12/21

Table 20: WCX 3A - Ramsay Street Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/11/21 00:45	30/11/21 01:10	Automatic span and zero checks, once daily from 00:45 to 01:05 followed by instrument stabilisation	CO, NO, NO ₂ , NO _x	DL	14/12/21
01/11/21 23:50	30/11/21 23:50	Background checks, once daily for 5 to 10 minutes followed by instrument stabilisation	CO	DL	14/12/21
06/11/21 14:15	24/11/21 23:45	Intermittent static offsets applied as required to correct unstable baseline <i>Values range from -0.20 ppm to +0.10 ppm</i>	CO	DL	14/12/21
07/11/21 07:25	30/11/21 00:40	Intermittent linear offsets applied as required to correct unstable baseline <i>A values range from -0.15 ppm to 0.10 ppm and B values range from -0.20 ppm to +0.25 ppm</i>	CO	DL	14/12/21
16/11/21 08:00	16/11/21 13:55	Scheduled yearly maintenance (1 st Visit) - Instrument calibrations followed by instrument stabilisation	All parameters	DL	14/12/21
16/11/21 14:00	17/11/21 08:50	Zero check performed	PM _{2.5} , PM ₁₀	DL	14/12/21
17/11/21 08:55	17/11/21 12:30	Scheduled yearly maintenance (2 nd Visit) - Zero filters removed, AT sensors calibrated	All parameters	DL	14/12/21
18/11/21 04:10	24/11/21 11:50	Intermittent unrealistic data - Possible moisture interference	PM ₁₀	DL	14/12/21

Table 21: WCX 3A - Wattle Street Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/11/21 06:15	01/11/21 15:20	Station commissioning	AT 2m, AT 10m, PM _{2.5} , PM ₁₀ , WS, WD, Sigma	DL	14/12/21
01/11/21 06:15	02/11/21 14:50	Station commissioning	CO, NO, NO ₂ , NO _x	DL	14/12/21
01/11/21 15:25	02/11/21 11:50	Zero check performed	PM ₁₀	DL	14/12/21
01/11/21 16:00	05/11/21 08:00	72 hours background check performed	PM _{2.5}	DL	14/12/21
02/11/21 11:55	02/11/21 14:25	Non-scheduled maintenance - Zero filter removed	PM ₁₀	DL	14/12/21
02/11/21 14:30	08/11/21 13:55	Instrument fault - Main flow not logging in volumetric flow	PM ₁₀	DL	14/12/21
02/11/21 14:55	28/11/21 00:55	Intermittent linear offsets applied as required to correct unstable baseline <i>A values range from -0.10 ppm to 0.00 ppm and B values range from -0.15 ppm to +0.00 ppm</i>	CO	DL	14/12/21
02/11/21 23:45	30/11/21 23:50	Background checks, once daily for 5 to 10 minutes followed by instrument stabilisation	CO	DL	14/12/21
03/11/21 01:00	30/11/21 01:25	Automatic span and zero checks, once daily from 01:00 to 01:25 followed by instrument stabilisation	CO, NO, NO ₂ , NO _x	DL	14/12/21
05/11/21 09:00	05/11/21 09:00	Non-scheduled maintenance - Zero filter removed and Background value applied to the instrument	PM _{2.5}	DL	14/12/21
06/11/21 00:10	29/11/21 00:55	Intermittent static offsets applied as required to correct unstable baseline <i>Values range from -0.10 ppm to -0.05 ppm</i>	CO	DL	14/12/21
08/11/21 14:00	08/11/21 14:15	Non-scheduled maintenance - TEOM flow changed to volumetric flow	PM ₁₀	DL	14/12/21
14/11/21 19:20	24/11/21 18:30	Intermittent unrealistic negative readings	NO, NO ₂ , NO _x	DL	14/12/21
15/11/21 01:30	24/11/21 12:35	Linear multiplier of A = 1.046 and B = 1.066 applied to correct NO span drift. NO ₂ readings re-calculated accordingly	NO ₂ , NO	DL	14/12/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
15/11/21 01:30	24/11/21 12:35	Linear multiplier of A = 1.042 and B = 1.068 applied to correct NO _x span drift. NO ₂ readings re-calculated accordingly	NO ₂ , NO _x	DL	14/12/21
24/11/21 12:00	24/11/21 13:05	Remote maintenance - NO _x instrument calibrated	All parameters	DL	14/12/21

7.0 Report Summary

- Percentage availability for most parameters at WCX 3A - Albert Street station was above 95% during the reporting month, except for PM₁₀, PM_{2.5}, NO, NO₂ and NO_x due to commissioning.
- Percentage availability for most parameters at WCX 3A - Campbell Street station was above 95% during the reporting month, except for CO due to intermittent status error and unrealistic data.
- Percentage availability for all parameters at WCX 3A - Ramsay Street station was above 95% during the reporting month.
- Percentage availability for most parameters at WCX 3A - Wattle Street station was above 95% during the reporting month, except for PM_{2.5}, PM₁₀ and CO due to commissioning.
- Refer to Table 12, and Tables 18-21 for details.
- There were no exceedance of the air quality goals at the WCX 3A - M4_M5 Link Ambient Air Quality Monitoring Network for the reporting month. Please refer to Tables 13-16 in Section 5.2 – Air Quality Monthly Summary for further information.

Appendix 1 - Definitions & Abbreviations

ERS	Environmental Reporting Services
AQMS	Air Quality Monitoring Station
AQM	Air Quality Monitor
BAM	Beta Attenuation Monitors
TEOM	Tapered Element Oscillating Microbalance
°	Degrees (True North)
K	Kelvin
LDL	Lower Detectable Limit
$\mu\text{g}/\text{m}^3$	Micrograms per cubic metre at standard temperature and pressure (0°C and 101.3 kPa)
AT	Ambient Temperature
calm	Wind conditions where the wind speed is below the operating range of the wind sensor
CO	Carbon monoxide
mg/m^3	Milligrams per cubic metre at standard temperature and pressure (0°C and 101.3 kPa)
mm	Millimeters
NO	Nitric oxide
NO ₂	Nitrogen dioxide
NO _x	Oxides of nitrogen
PM ₁₀	Particulate less than 10 microns in equivalent aerodynamic diameter
PM _{2.5}	Particulate less than 2.5 microns in equivalent aerodynamic diameter

ppb	Parts per billion
ppm	Parts per million
RH	Relative Humidity
WD	Vector Wind Direction
WS	Vector Wind Speed

Appendix 2 - Explanation of Exception Table

Automatic filter tape advance refers to the movement of the filter paper by the analyser to an unused spot.

Automatic background check refers to when analyser samples zero air and measures the level of the concentration voltage. This voltage is taken as the zero signal level and this value is subtracted from any subsequent readings as an active zero compensation. This is the analyser's fine zero measurement.

Automatic span/zero check. The E-Sampler is programmed to perform a zero calibration check whereby air is passed through filter element, removing particulates, before entering the sensor in the analyser. Data is invalidated when these checks occur.

Beta count failure refers to a fault in the functioning of the EBAM. A one minute beta count was less than the maximum acceptable counts during operation.

Calibration check outside tolerance refers to when the calibration values are outside the tolerance limits set for the precision check.

Calibration correction factor applied to data refers to an offset or multiplier applied to the data. This operation may be performed for a number of reasons including: (a) when a clear trend / drift outside the tolerance limit can be demonstrated by repeated operation precision checks, (b) when a correction is required on previously logged data due to a calibration check being outside the allowable tolerance

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 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.

Overnight span/zero out of tolerance refers to when the span/zero reading measured by the analyser during an automatic precision check falls outside of the expected concentration limits.

Overnight zero out of tolerance refers to when the automatic zero reading measured by the analyser falls outside the expected limits.

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

Remote Calibration refers to when a technician remotely connects to the station and manually performs a span check.

Static offset or multiplier refers to when a single offset or multiplier has been applied to the data between two points either to increase or decrease the measured value.

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.