Ektimo

Port Authority of New South Wales

Monthly Ambient Air Quality Monitoring Report

March 2024

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Document Information

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Attention:	Miguel Frohlich
Address:	Level 4, 20 Windmill St Walsh Bay, NSW 2000
Testing Laboratory:	Ektimo Pty Ltd, ABN 86 600 381 413

Report Authorisation

Hamid Sokhan
Instrumentation Manager

NATA Accredited Laboratory
No. 14601

Please note that only numerical results pertaining to measurements conducted directly by Ektimo are covered by Ektimo's terms of NATA accreditation as described in the Test Methods table. This does not include calculations that use data supplied by third-parties, comments, conclusions, or recommendations based upon the results. Refer to 'Test Methods' for full details of testing covered by NATA accreditation.

Table of Contents

Table of Tables

Table of Figures

Executive Summary

Ektimo was engaged by Port Authority of New South Wales to commission and operate an ambient air quality monitoring station (AAQMS) at 8 By Street Eden, NSW. The air quality monitoring is required in accordance with Port Authority's State Significant Infrastructure (SSI) Approval No. 7734 for the operation of the Eden Cruise Facility.

Conditions D7 to D14 of the SSI Approval No. 7734 required the preparation of an Air Quality Operation Monitoring Program. Condition E21 of the SSI Approval No. 7734 stated the following:

"*Unless otherwise agreed with the Planning Secretary, the Operation Monitoring Program required under Condition D7 must, as a minimum, include monitoring of NO_2, SO_2 and $PM_{2.5}$ at the closest potentially impacted sensitive receiver (taking into account prevailing winds) at least two days prior to the arrival of the first three cruise ship of the season, while they are at berth and for at least two days following departure. Where there is less than two days between departure of a cruise ship and arrival of the next cruise ship, monitoring must continue until there is at least two days between ship departures and arrivals*."

In light of the conditions mentioned above, the results of the Air Quality Operation Monitoring Program are summarised below for the month of March 2024. More detailed results can be found in Section 4 of this report.

Table 1. Data Summary

Indicator/ Pollutant	Days successfully logged	Averaging Period	March 2024 Average	Regulatory Reference Criteria	% of criteria	Data Points Logged	Averaging Period Exceedances	% of Data Points Exceeding Criteria
NO_2	29 of 31 days	Hourly (1 hour)	-0.78 ppb	80 ppb	0%	691	**0**	0%
SO_2	18 of 31 days	10 minute	0.51 ppb	250 ppb	0.2%	2,697	**0**	0%
		Hourly (1 hour)	0.51 ppb	100 ppb	0.5%	447	**0**	0%
		Daily (24 hour)	0.56 ppb	20 ppb	2.8%	18	**0**	0%
$PM_{2.5}$	16 of 31 days	Daily (24 hour)	7.2 µg/m^3	25 µg/m^3	29%	16	**0**	0%

Notes:

1. Less than 75 % (<18 hours per 24 hours) of NO_2, SO_2 and $PM_{2.5}$ hourly averages available for 26/03/24 and 27/03/24 to due to logger error. Data excluded from daily averages.
2. SO_2 Data removed from 01/03/2024 to 11/03/24 due to invalid data.
3. $PM_{2.5}$ data not available from 01/03/2024 00:00 to 14/03/24 01:00.

1 Introduction

1.1 Project Background

Port Authority of New South Wales has requested Ektimo to install and operate one fixed air quality monitoring station at 8 By Street, Eden NSW to allow monitoring and management of ambient air emissions.

Table 2. AAQMS location

Site	GPS Coordinates
8 By Street, NSW	-37.073486, 149.910502

Air quality parameters to be monitored by Ektimo are concentrations of;

- Nitric oxide (NO)
- Nitrogen dioxide (NO_2)
- Nitrogen oxides (NOx)
- Sulfur dioxide (SO_2)
- Particulate matter less than 2.5µm ($PM_{2.5}$)

In addition to weather conditions recorded by Ektimo;

- Wind speed
- Wind direction
- Temperature
- Relative humidity

1.2 Project Objective

Ektimo's objective (to support Port Authority of New South Wales' objective) was to perform continuous monitoring of ambient air quality and to report these on a monthly basis for the project duration as outlined below;

Quantify, on a monthly basis (per calendar month), averages of;

- SO_2 & $PM_{2.5}$ (daily (*24hr*))
- NO, NO_2, NOx, SO_2 (hourly)
- SO_2 (10 minute)

1.3 Regulatory Reference Criteria

The air quality criteria for the project were outlined in the Eden Cruise Facility Project's Air Quality Operational Environmental Management Plan (OEMP) Sub-Plan, which predicted the most affected sensitive receiver and maximum cumulative SO_2 concentrations for 'typical operations'.

Reporting on monthly air quality includes comparison of the data against the *National Environment Protection (Ambient Air Quality) Measure 2021* **(NEPM-AAQ)** standards and the maximum cumulative SO_2 concentration at the most affected sensitive receiver as predicted in the Refined SO_2 Emission Modelling for "typical operations" **(Eden Typical Operations Criteria**), as outlined in the Air Quality OEMP Sub-Plan.

Table 3. NEPM-AAQ & Eden Typical Operations Criteria

Indicator/Pollutant	Averaging Period	Maximum Concentration Standard/Objective	Reference
NO_2	Hourly (1 hour)	0.08 ppm (80 ppb)	NEPM-AAQ
SO_2	10 minute	0.25 ppm (250 ppb)	Eden Typical Operations Criteria
	Hourly (1 hour)	0.10 ppm (100 ppb)	NEPM AAQ
	Hourly (1 hour)	0.20 ppm (200 ppb)	Eden Typical Operations Criteria
	Daily (24 hour)	0.20 ppm (20 ppb)	NEPM AAQ
	Daily (24 hour)	0.08 ppm (80 ppb)	Eden Typical Operations Criteria
$PM_{2.5}$	Daily (24 hour)	25 µg/m³	NEPM AAQ

NEPM- AAQ – https://www.legislation.gov.au/F2007B01142/latest/versions

2 Monitoring Methodology

Ambient air monitoring was carried out in accordance with the following methods;

Table 4. Monitoring Methodology

Test Method	Parameter	Description
AS3580.5.1:2023	NO, NO_2, NOx	Methods for Sampling and Analysis of Ambient Air – Determination of Oxides of Nitrogen – Direct Reading Instrumental Method.
AS 3580.4.1:2023	SO_2	Methods for Sampling and Analysis of Ambient Air – Determination of Sulfur Dioxide – Direct Reading Instrumental Method.
NA	$PM_{2.5}$	NA
AS3580.14:2014	Weather	Methods for Sampling and Analysis of Ambient Air – Part 14: Meteorological Monitoring for Ambient Air Quality Monitoring Applications
AS3580.1.1:2016	AAQMS Siting	Methods for Sampling and Analysis of Ambient Air – Guide to Siting Air Monitoring Equipment.
AS 3580.19:2020	Data Validation & Reporting	Methods for Sampling and Analysis of Ambient Air – Method 19: Ambient Air Quality Data Validation and Reporting.

**Note. Ektimo's NATA accreditation does not cover the FDS-17 $PM_{2.5}$ analyser method.*

3 Monitoring Equipment

A summary of the deployed monitoring equipment is outlined below.

Table 5. Monitoring Equipment

Parameter	Monitoring Equipment
$PM_{2.5}$	Dr Fodisch, FDS-17
NO, NO_2, NOx	Airpointer A-HTV1S070000 M100C1F1
SO_2	Airpointer 2-11A
Weather	Vaisala WXT530

Note: *Detailed Monitoring Equipment Specifications can be seen in Appendix 4.*

4 Monitoring Results, Daily

4.1 NO, NO_2, NO_x, SO_2, & $PM_{2.5}$ Results (Daily - 24-hour concentrations)

The following table details the concentrations for NO, NO_2, NOx, SO_2, $PM_{2.5}$ with the relevant NEPM-AAQ/ Eden Typical Operations Criteria. Refer to Appendix 1 for NO_2, SO_2, and $PM_{2.5}$ charts.

Table 6. NO, NO_2, NO_x, SO_2, $PM_{2.5}$ Results

Date/Time	NO (ppb)	NO_2 (ppb)	NOx (ppb)	SO_2 (ppb)	$PM_{2.5}$ (µg/m³)
1/03/2024	-1.52	-0.93	-2.45	---	---
2/03/2024	-1.7	-1.5	-3.2	---	---
3/03/2024	-1.7	-1.3	-3.0	---	---
4/03/2024	-1.8	-1.3	-3.1	---	---
5/03/2024	-1.2	-0.5	-1.7	---	---
6/03/2024	-0.9	0.1	-0.8	---	---
7/03/2024	-1.6	-1.0	-2.6	---	---
8/03/2024	-0.6	-0.5	-1.1	---	---
9/03/2024	-1.4	-1.1	-2.6	---	---
10/03/2024	-1.0	-0.4	-1.4	---	---
11/03/2024	0.2	0.8	1.1	---	---
12/03/2024	7.4	3.6	10.9	2.08	---
13/03/2024	-0.8	-0.1	-0.9	1.04	---
14/03/2024	-1.6	-0.8	-2.4	0.4	8.2
15/03/2024	-1.3	-0.9	-2.1	0.5	6.8
16/03/2024	-1.39	-1.1	-2.5	0.44	5.2
17/03/2024	-1.3	-0.9	-2.2	0.33	5.1
18/03/2024	-0.36	-0.74	-1.09	0.36	7.8
19/03/2024	-1.3	-0.9	-2.2	0.55	15.1
20/03/2024	-1.73	-0.8	-2.6	0.24	6.3
21/03/2024	-1.70	-1.1	-2.8	0.49	5.2
22/03/2024	-1.35	-0.9	-2.3	0.28	4.9
23/03/2024	-1.90	-0.9	-2.8	0.47	5.5
24/03/2024	-1.92	-0.9	-2.8	0.49	4.9
25/03/2024	-1.94	-0.8	-2.7	0.50	6.1
26/03/2024	---	---	---	---	---
27/03/2024	---	---	---	---	---
28/03/2024	-2.0	-1.5	-3.5	0.3	5.0
29/03/2024	-1.8	-1.6	-3.5	0.3	7.2
30/03/2024	-1.8	-1.7	-3.5	0.7	8.3
31/03/2024	-1.9	-1.6	-3.5	0.6	12.8
Maximum	**7.36**	**3.6**	**10.9**	**2.08**	**15**
Minimum	**-2.00**	**-1.68**	**-3.51**	**0.24**	**5**
Average	**-1.10**	**-0.73**	**-1.83**	**0.56**	**7.2**
Standard Deviation	**1.68**	**0.97**	**2.61**	**0.409**	**2.8**
NEPM-AAQ Criteria (Daily average)				20	25
Exceedances				0	0
Eden Typical Operations Criteria (Daily average)				80	
Exceedances				0	

Notes:

1. Dates highlighted in yellow correspond to days "Cruise Vessels" in port.
   Red highlighting indicates days "Non-Cruise" Vessels in port
   Blue highlighting indicates both vessel types in port.
2. $PM_{2.5}$ results corrected to 0°C and 101.3 kPa as per AS3580.9.12:2022
3. Please note, hourly and 10-minute average concentrations are reported separately in Excel® format.
4. Data corrections, if required, were performed during the data validation process as per AS methods (see section 2 for methodology).
5. Less than 75 % (<18 hours per 24 hours) of NO_2, SO_2 and $PM_{2.5}$ hourly averages available for 26/03/24 and 27/03/24 to due to logger error. Data excluded from daily averages.
6. SO_2 Data removed from 01/03/2024 to 11/03/24 due to invalid data.
7. $PM_{2.5}$ data not available from 01/03/2024 to 14/03/24 01:00.

5 Hourly and 10-minute Monitoring Results

Results in the following tables may include values below the formal detection limit of the analyser. These values are raw statistical calculations.

5.1 NO, NO_2, NOx, SO_2 (Hourly average concentrations)

Table 7. NO, NO_2, NOx, SO_2 (Hourly concentrations)

	NO (ppb)	NO_2 (ppb)	NOx (ppb)	SO_2 (ppb)
Maximum	**27.5**	**21.6**	**45.8**	**4.14**
Minimum	**-2.9**	**-3.2**	**-5.8**	**-1.19**
Average	**-1.3**	**-0.78**	**-2.0**	**0.51**
Standard Deviation	**2.05**	**1.70**	**3.6**	**0.63**
NEPM-AAQ Criteria (Hourly average)		80		100
Exceedances		0		0
Eden Typical Operations Criteria (Hourly average)				200
Exceedances				0

5.2 SO_2 (10-minute average concentrations)

Table 8. SO_2 (10-minute concentrations)

	SO_2 (ppb)
Maximum	**9.7**
Minimum	**-1.31**
Average	**0.51**
Standard Deviation	**0.67**
Eden Typical Operations Criteria (10 minute average)	250
Exceedances	0

6 Weather Results

The following table details the weather daily averages.

Table 9. Daily (24 hour) Weather Results

Date/Time	Wind speed (m/sec)	Wind Direction (°)	Temperature at 2m (°C)	Relative humidity %
1/03/2024	1.1	194.9	21.1	74.8
2/03/2024	3.3	7.4	20.0	65.2
3/03/2024	2.3	6.7	19.5	57.6
4/03/2024	2.3	6.8	17.4	53.9
5/03/2024	2.1	195.3	17.9	67.3
6/03/2024	0.2	269.5	20.5	76.1
7/03/2024	1.7	7.5	21.0	63.5
8/03/2024	2.4	199.8	21.7	80.8
9/03/2024	3.8	190.9	23.7	75.8
10/03/2024	2.7	186.8	22.9	72.0
11/03/2024	1.8	187.5	21.2	75.4
12/03/2024	0.5	356.0	22.0	70.8
13/03/2024	1.2	192.3	21.5	81.5
14/03/2024	1.5	5.9	19.5	82.9
15/03/2024	0.4	7.3	18.3	72.4
16/03/2024	1.4	193.5	18.1	70.0
17/03/2024	1.6	184.7	19.0	77.6
18/03/2024	2.6	200.1	19.9	83.1
19/03/2024	3.4	188.1	21.2	82.1
20/03/2024	3.3	10.3	17.1	68.7
21/03/2024	0.4	336.8	15.5	60.5
22/03/2024	0.9	196.5	15.5	74.9
23/03/2024	0.7	4.0	17.1	69.9
24/03/2024	0.2	340.8	16.9	70.8
25/03/2024	0.4	342.0	17.7	70.4
26/03/2024	---	---	---	---
27/03/2024	---	---	---	59.3
28/03/2024	0.9	3.8	17.6	68.5
29/03/2024	1.6	193.8	18.8	76.1
30/03/2024	0.2	302.7	18.9	80.2
31/03/2024	0.2	242.4	18.9	77.2
Maximum	**3.8**	**-**	**24**	**83**
Minimum	**0.17**	**-**	**15**	**54**
Average	**1.6**	**-**	**19**	**72**
Standard Deviation	**1.1**	**-**	**2.1**	**7.6**

Wind speed averages calculated using vector averaging.

Notes:

1. Dates highlighted in yellow correspond to days “Cruise Vessels” in port.
   Red highlighting indicates days “Non-Cruise” Vessels in port.
   Blue highlighting indicates both vessel types in port.
2. Less than 75 % (<18 hours per 24 hours) hourly averages available for 26/03/24 and 27/03/24 to due to logger error. Data excluded from daily averages.
3. Refer to Appendix 2 for weather charts.

7 SO_2, NO_2 & $PM_{2.5}$ levels compared with Vessel Movements

Port Authority provided vessel movement records for the monthly monitoring period covered by this report. Vessel movements were compared with measured analyte concentrations and prevailing wind direction to identify possible links between elevated analyte concentrations and vessel movement.

Table 10 below shows the arrival/departure times for each vessel along with the corresponding 10-minute average SO_2 concentration. Additionally, it includes the 10-minute average SO_2 concentrations for the 10 minutes preceding and following each arrival/departure.

Figure 1 details the continuous 1-minute and 10-minute average SO_2 concentrations measured compared with the recorded times of vessel arrivals/departures, as indicated in Table 10.

There was a spike in SO_2 from 12/03/2024 08:30 to 12/03/2024 19:00 with the 10-minute average peaking at 9.73 ppb between 08:30 and 08:40.

This coincides with the time “Grand Princess” was in port.

As can be seen in section 4 & 5, SO_2 levels were lower than all the relevant criteria for the entire testing period.

Average NO_2 and $PM_{2.5}$ concentrations were also below the relevant criteria during the entire duration of the testing period.

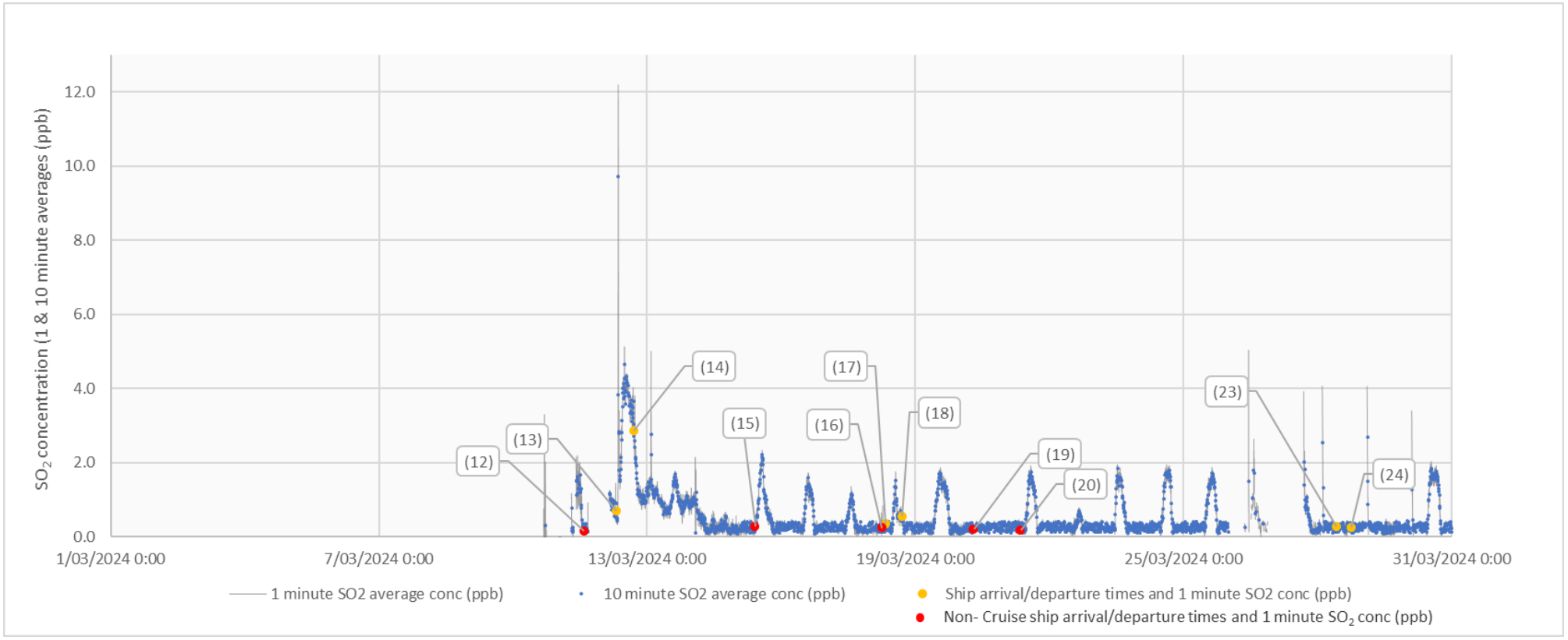
As shown in Image 2, Appendix 5, the Eden Cruise Wharf is situated West of the AQMS Station. Considering this, Section 9.2, Daily Windroses details the 24-hour Windrose for each day that vessels were active in the Port along with corresponding daily average SO_2 concentration.

Table 10. Recorded Vessel movement times March 2024 (provided by Port Authority NSW) compared to monitoring data.

	Date/Time	Arrival /Departure	Vessel	10 minute average period SO_2 value (ppb)	Previous 10 minute average period SO_2 value (ppb)	Post 10 minute average period SO_2 value (ppb)
(1)	03/03/2024, 10:24	Arrival	NORWEGIAN SPIRIT	No data	No data	No data
(2)	03/03/2024, 16:30	Departure	NORWEGIAN SPIRIT	No data	No data	No data
(3)	04/03/2024, 07:54	Arrival	P T FORTITUDE	No data	No data	No data
(4)	04/03/2024, 07:54	Arrival	BOUGAINVILLE	No data	No data	No data
(5)	05/03/2024, 07:22	Arrival	NORWEGIAN SPIRIT	No data	No data	No data
(6)	05/03/2024, 15:30	Departure	NORWEGIAN SPIRIT	No data	No data	No data
(7)	06/03/2024, 06:12	Departure	P T FORTITUDE	No data	No data	No data
(8)	06/03/2024, 06:23	Departure	BOUGAINVILLE	No data	No data	No data
(9)	08/03/2024, 08:42	Arrival	CELEBRITY EDGE	No data	No data	No data
(10)	08/03/2024, 16:44	Departure	CELEBRITY EDGE	No data	No data	No data
(11)	08/03/2024, 19:20	Arrival	HMAS DIAMANTINA	No data	No data	No data
(12)	11/03/2024, 14:20	Departure	HMAS DIAMANTINA	0.24	0.28	0.15
(13)	12/03/2024, 07:18	Arrival	GRAND PRINCESS	0.91	0.92	0.62
(14)	12/03/2024, 16:52	Departure	GRAND PRINCESS	2.71	3.04	2.58
(15)	15/03/2024, 10:10	Arrival	HMAS DIAMANTINA	0.25	0.21	0.27
(16)	18/03/2024, 06:10	Departure	HMAS DIAMANTINA	0.34	0.31	0.13
(17)	18/03/2024, 08:15	Arrival	CRYSTAL SERENITY	*0.37*	*0.26*	*0.36*
(18)	18/03/2024, 16:50	Departure	CRYSTAL SERENITY	0.54	0.54	0.45
(19)	20/03/2024, 07:25	Arrival	ALLANKAY	0.18	0.28	0.22
(20)	21/03/2024, 08:40	Departure	ALLANKAY	*0.24*	*0.35*	*0.19*
(21)	27/03/2024, 10:20	Arrival	NORWEGIAN SPIRIT	No data	No data	No data
(22)	27/03/2024, 16:28	Departure	NORWEGIAN SPIRIT	No data	No data	No data
(23)	28/03/2024, 10:20	Arrival	RESILIENT LADY	*0.18*	*0.13*	*0.28*
(24)	28/03/2024, 17:53	Departure	RESILIENT LADY	*0.22*	*0.36*	*0.24*

Notes:

1. *Vessels highlighted in red are 'Non-Cruise' ships*
2. *“No data” above indicates less than 75% (<8 minutes per 10 minutes) available for the averaging period.*



Numbers in chart above correspond to Table 10 (previous page), indicating Vessel name and departure/arrival time.

Figure 1. Vessel Arrival/Departure VS SO_2 Concentrations

8 Quality Assurance & Quality Control (QA/QC)

Ektimo is accredited by the National Association of Testing Authorities (NATA) for the sampling and analysis of air pollutants. Unless otherwise stated test methods used are accredited with the National Association of Testing Authorities. For full details, search for Ektimo at NATA's website www.nata.com.au.

Ektimo is accredited by NATA to ISO/IEC 17025 - Testing. ISO/IEC 17025 - Testing requires that a laboratory have adequate equipment to perform the testing, as well as laboratory personnel with the competence to perform the testing. This quality assurance system is administered and maintained by the Quality Director. NATA is a member of APAC (Asia Pacific Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through mutual recognition arrangements with these organisations, NATA accreditation is recognised worldwide.

8.1 Maintenance Checks and Calibrations

Maintenance checks and calibrations for the period can be seen in the table below.

Table 11. Maintenance Checks and Calibrations

Monitoring Equipment	Parameter	Equipment ID (or SN)	Type of Calibration/ Check	Date of Calibration(s)/ Check(s)
FDS-17	$PM_{2.5}$	19015	NA	NA
NOx Analyser	NOx	EKT0135	Monthly	11/03/2024
SO_2 Analyser	SO_2	EKT0135	Monthly	11/03/2024

NOTES:

1. The span drift of the NOx readings during post span check on the 11/03/2024 at 8:36 was -3.3% FS. A linear adjustment between pre (29/02/2024 16:33) and post span drift checks was performed accordingly.

2. The span drift of the NOx readings during post span check on the 01/05/2024 at 11:46 was +38.8% FS . A linear adjustment between pre (11/03/2024 9:39) and post span drift checks was performed accordingly.

3. The NO_2 values were also adjusted using the same linear factors as NO_2 is calculated by the difference between NOx and NO.

4. The span drift of the SO_2 readings during the post span check on the 26/03/2024 10:51 was +4.75% FS. A conservative approach was taken by not adjusting the SO_2 values down.

8.2 Monthly Data Capture

The station is equipped with a local data logger to collect data from the AAQMS and weather station and store it in the logger memory. Data is automatically transferred to a secure cloud-based service every 1 minute. This cloud-based platform is known as '*Ektimo Live'* and it enables real time access and visualisation of the data collected.

Calculated Data Capture is the proportion of data periods successfully logged out of the theoretical maximum during the period. In a monthly period, you might expect the following maximum (in a 30-day month);

- 720 Hourly Averages
- 30 Daily Averages

Data capture is calculated before data validation.

Table 12. NO, NO_2, NO_x, SO_2, $PM_{2.5}$, Monthly Data Capture

	NO, NO_2, NOx (%)	SO_2 (%)	PM2.5 (%)
Data Capture	95.7	95.9	61.4

Table 13. Weather Monthly Data Capture

	Wind speed (%)	Wind Direction (%)	Relative humidity (%)	Temperature at 2m (%)
Data Capture	92.6	92.6	95.8	95.8

8.3 Data Validation & Exceptions

Data validation is performed as per *AS 3580.19:2020 Methods for Sampling and Analysis of Ambient Air – Method 19: Ambient Air Quality Data Validation and Reporting*.

Periods where data has been deemed invalid and removed from all calculations can be seen below.

Individual daily and hourly averages are also automatically invalid if there has been data loss due to equipment malfunction, calibration and/or maintenance which results in less than 75% of data for any averaging period.

Table 14. Data Exceptions

Start Date/Time	End Date/Time	Parameter	Comments	Details of Outage or Required Change	Person Making Changes
1/03/2024 0:00	10/03/2024 16:26	SO_2	Reocurring Pattern of gradual increase and decrease each 24 hours, suggesting compromised data	SO_2 removed	ADo
1/03/2024 0:00	11/03/2024 17:51	$PM_{2.5}$	no data available	no $PM_{2.5}$	ADo
1/03/2024 0:26	11/03/2024 14:21	Relative humidity and temperature	151 instances of zero readings	151 minutes of Relative humidity and temperature removed	ADo
1/03/2024 13:49	1/03/2024 14:05	NOx	Erroneous spike (fault)	NOx removed	ADo
3/03/2024 8:40	3/03/2024 9:36	NOx	6 minutes of Suddent negative spike (~ -3000ppb)	NOx removed 6 minutes removed	ADo
3/03/2024 8:40	3/03/2024 8:42	Wind speed, Relative humidity and temperature	Sudden extreme values deemed impossible	Wind speed, Relative humidity and temperature removed	ADo
3/03/2024 9:04	3/03/2024 9:06	Wind speed, Relative humidity and temperature	Sudden extreme values deemed impossible	Wind speed, Relative humidity and temperature removed	ADo
3/03/2024 9:34	3/03/2024 9:36	Wind speed, Relative humidity and temperature	Sudden extreme values deemed impossible	Wind speed, Relative humidity and temperature removed	ADo
3/03/2024 9:35	3/03/2024 9:37	NOx	Spike in NO with large negative spike in NO_2	NOx removed	ADo
3/03/2024 10:08	3/03/2024 10:15	NOx	Null value recorded	NOx removed	
3/03/2024 10:08	3/03/2024 10:16	Wind speed, Relative humidity and temperature	6 minutes of Sudden extreme values deemed impossible	6 minutes of Wind speed, Relative humidity and temperature removed	ADo
3/03/2024 16:46	3/03/2024 17:01	NOx	Erroneous spike (fault)	NOx removed	ADo
11/03/2024 2:36	11/03/2024 7:18	SO_2	After calibration elevated SO2 concentrations, reliablilty questioned	SO_2 removed	ADo
11/03/2024 8:18	11/03/2024 11:36	Relative humidity and temperature	Anomalous values logged	Relative humidity and temperature removed	ADo
11/03/2024 8:18	11/03/2024 11:36	Windspeed	repeating value, logger error	Windspeed removed	ADo
11/03/2024 8:27	11/03/2024 9:49	NOx & SO_2	Onsite maintenance	Nox/SO_2 removed	ADo
11/03/2024 8:29	11/03/2024 8:30	NOx	Spike in No with large negative spike in NO2	NOx removed	ADo
11/03/2024 9:23	11/03/2024 9:25	NOx	spike in NO with large negative spike in NO_2	NOx removed	ADo
11/03/2024 16:15	12/03/2024 3:39	SO_2	Sudden step change in SO2 levels deemed not valid	SO_2 removed	ADo
11/03/2024 17:51	14/03/2024 1:56	PM2.5	large gradual peak after installation of FDS-17 (data deemed unstable)	$PM_{2.5}$ removed	ADo

Continued overpage

Start Date/Time	End Date/Time	Parameter	Comments	Details of Outage or Required Change	Person Making Changes
12/03/2024 3:38	12/03/2024 3:43	Wind speed, Relative humidity and temperature	3 minutes of Sudden extreme values deemed impossible	3 minutes of Wind speed, Relative humidity and temperature removed	ADo
12/03/2024 3:39	12/03/2024 3:46	NOx	Erroneous spike (fault)	NOx removed	ADo
12/03/2024 8:14	12/03/2024 8:39	NOx	Spike in No with large negative spike in NO_2	NOx removed	ADo
12/03/2024 13:00	12/03/2024 17:03	NOx	Progressive spike up to 5,000ppb (13:00-14:13), followed by progressive negative spike down to -3,000ppb (14:14-17:03))	Nox removed	ADo
12/03/2024 19:12	12/03/2024 19:51	NOx	Constant negative NO_2 concentrations (less than -2ppb contributing to -2ppb hourly average -screening criteria)	NOx removed	ADo
13/03/2024 1:46	13/03/2024 1:56	NOx	spike in No with large negative spike in NO_2	NOx removed	ADo
13/03/2024 5:35	13/03/2024 5:46	All data	Repeated null value	all data removed	ADo
13/03/2024 15:15	13/03/2024 17:09	NOx	Constant negative NO_2 concentrations (less than -2ppb contributing to -2ppb hourly average -screening criteria)	NOx removed	ADo
21/03/2024 12:13	21/03/2024 12:14	All data	Repeated null value	all data removed	ADo
26/03/2024 9:06	26/03/2024 9:09	Temperature	Dropped to zero for 2 minutes	2 minutes of relative temperature data removed	ADo
26/03/2024 9:18	26/03/2024 11:00	NOx & SO_2	Analysers unstable (jumping between high positive and negative values)	NOx & SO_2 removed	ADo
26/03/2024 9:27	26/03/2024 10:15	Wind speed, Relative humidity and temperature	3 minutes of Sudden extreme values deemed impossible	4 minutes of Wind speed, Relative humidity and temperature removed	ADo
26/03/2024 13:27	26/03/2024 13:29	Relative humidity	Dropped to zero for 2 minutes	2 minutes of relative humidity data removed	ADo
26/03/2024 13:46	26/03/2024 13:47	NOx	Spike in NO with negative spike in NO_2	NOx removed	ADo
26/03/2024 13:58	26/03/2024 14:03	NOx	3 minutes removed (spike in NO with negative spike in NO_2)	NOx removed	ADo
26/03/2024 23:47	27/03/2024 14:19	All	Data taker error	All values removed	ADo
26/03/2024 23:47	27/03/2024 16:36	SO_2	Repeated values (logger error)	SO_2 removed	ADo
26/03/2024 23:47	27/03/2024 11:49	All weather data: Wind speed, wind direction, relative humidity and temperature	Consecutive identical values	Weather data removed	ADo
27/03/2024 14:14	27/03/2024 16:26	NOx	After logger restarted elevated values logged	NOx removed	ADo

9 Definitions

The following symbols and abbreviations may be used in this test report:

<	Less than
>	Greater than
≥	Greater than or equal to
% v/v	Volume to volume ratio, dry or wet basis
~	Approximately
<	Less than
>	Greater than
≥	Greater than or equal to
µg/m³	Micrograms per cubic meter
AAQMS	Ambient air quality monitoring station
AS	Australian Standard
BAM	Beta attenuation monitor for measuring PM10 & PM2.5
Data Capture	The proportion of data periods successfully logged out of the theoretical maximum possible number (100%)
Data Exception	Missing or invalid data as per AS3580.19:2020.
EPA	Environment Protection Authority
NA	Not applicable
NATA	National Association of Testing Authorities
NEPM-AAQ	National Environment Protection (Ambient Air Quality) Measure
NO	Nitric oxide
NO_2	Nitrogen dioxide
CO	Carbon monoxide
O_3	Ozone
SO_2	Sulfur dioxide
$PM_{2.5}$	Particulate matter with an equivalent aerodynamic diameter less than 2.5 microns (PM2.5)
PM_{10}	Particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM10)
VOC	Volatile organic compound. A carbon-based chemical compound with a vapour pressure of at least 0.010 kPa at 25°C or having a corresponding volatility under the given conditions of use. VOCs may contain oxygen, nitrogen and other elements. VOCs do not include carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
ppb	Parts per billion
ppm	Parts per million
STP	Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0 °C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa.
TM	Test method

Appendix 1. NO_2, CO, SO_2, $PM_{2.5}$ Charts

Daily (24 hourly) Average $PM_{2.5}$

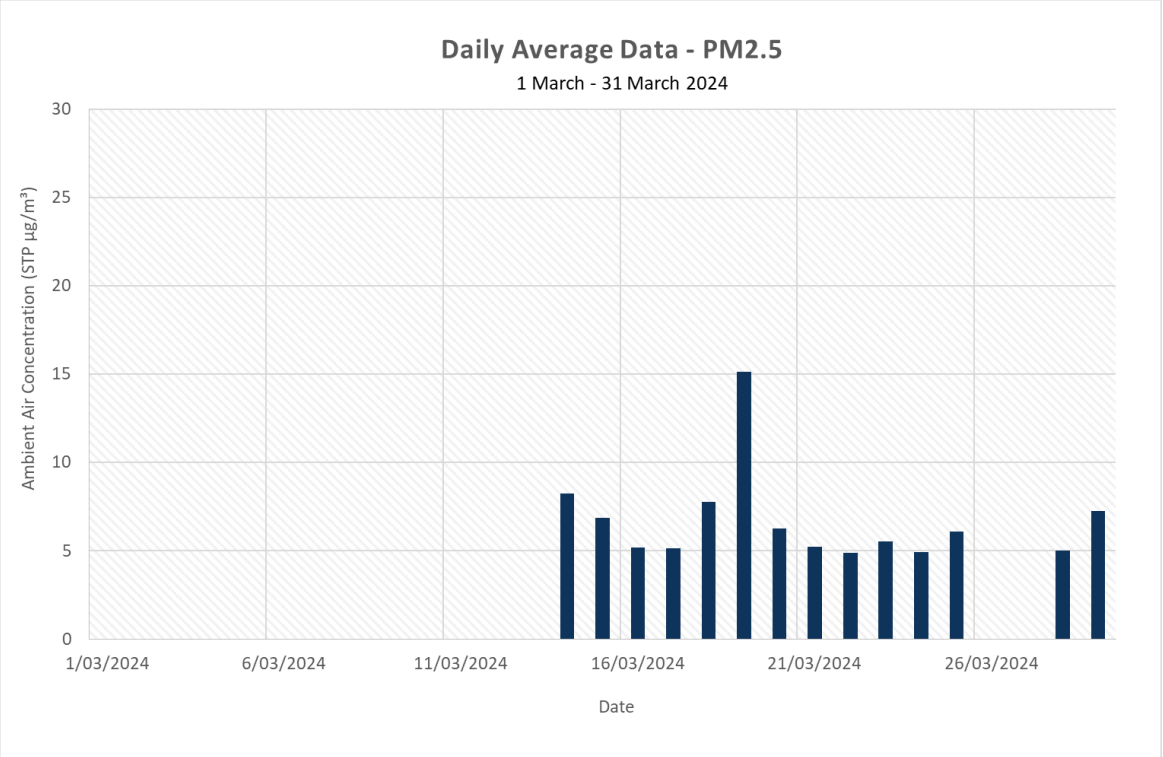


Figure 2. Daily (24 Hour) Average $PM_{2.5}$

Hourly Average NO_2

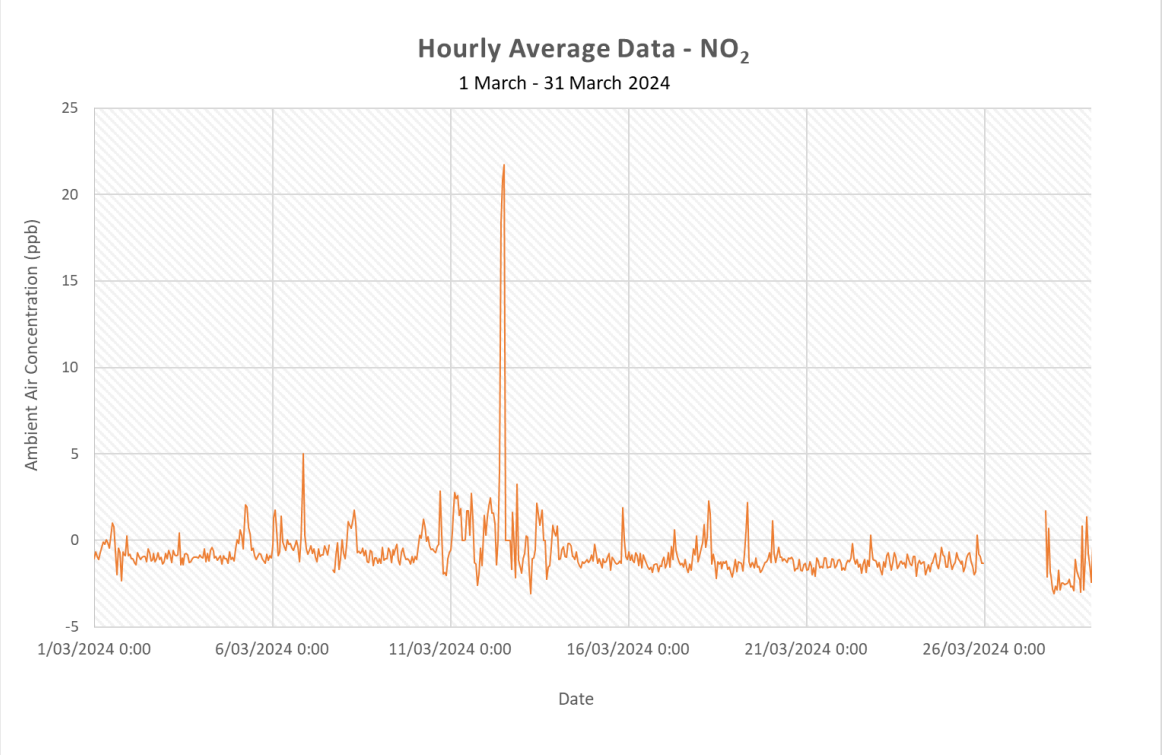


Figure 3. Hourly Average NO_2

10 Minute Average SO_2

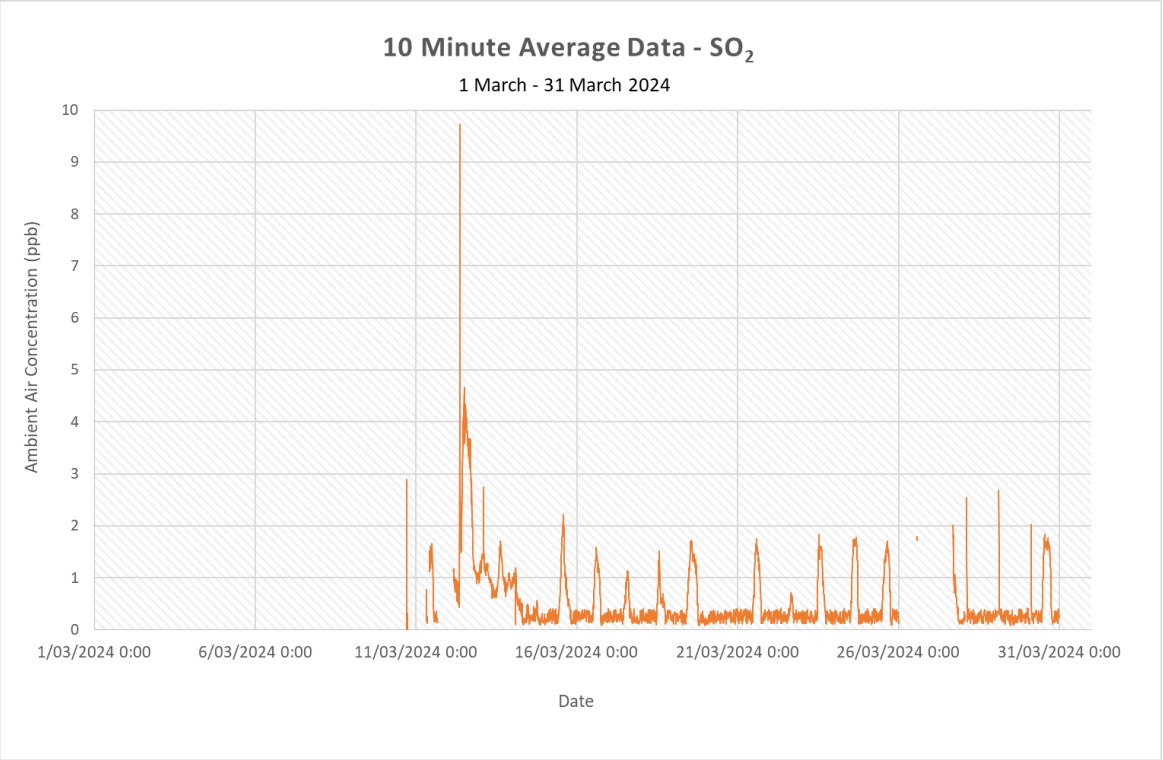


Figure 4. 10 Minute Average SO_2

Hourly Average SO_2

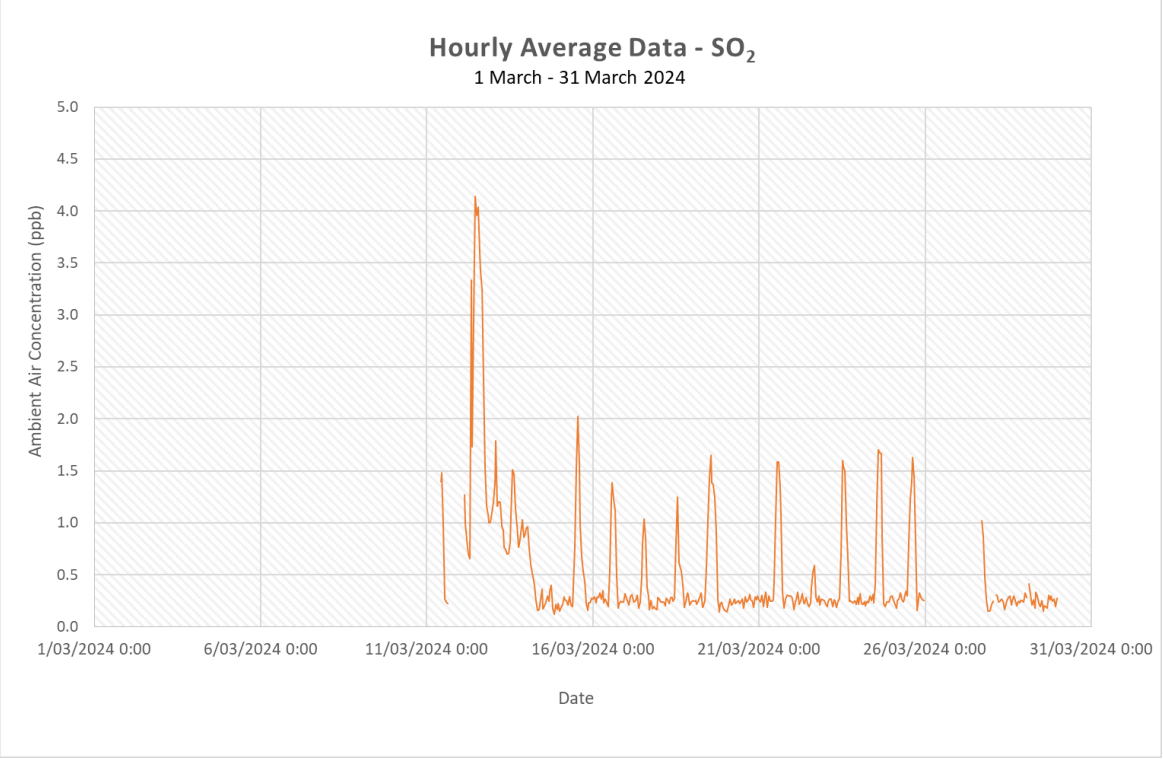


Figure 5. Hourly Average SO_2

Daily (24 Hourly) SO_2

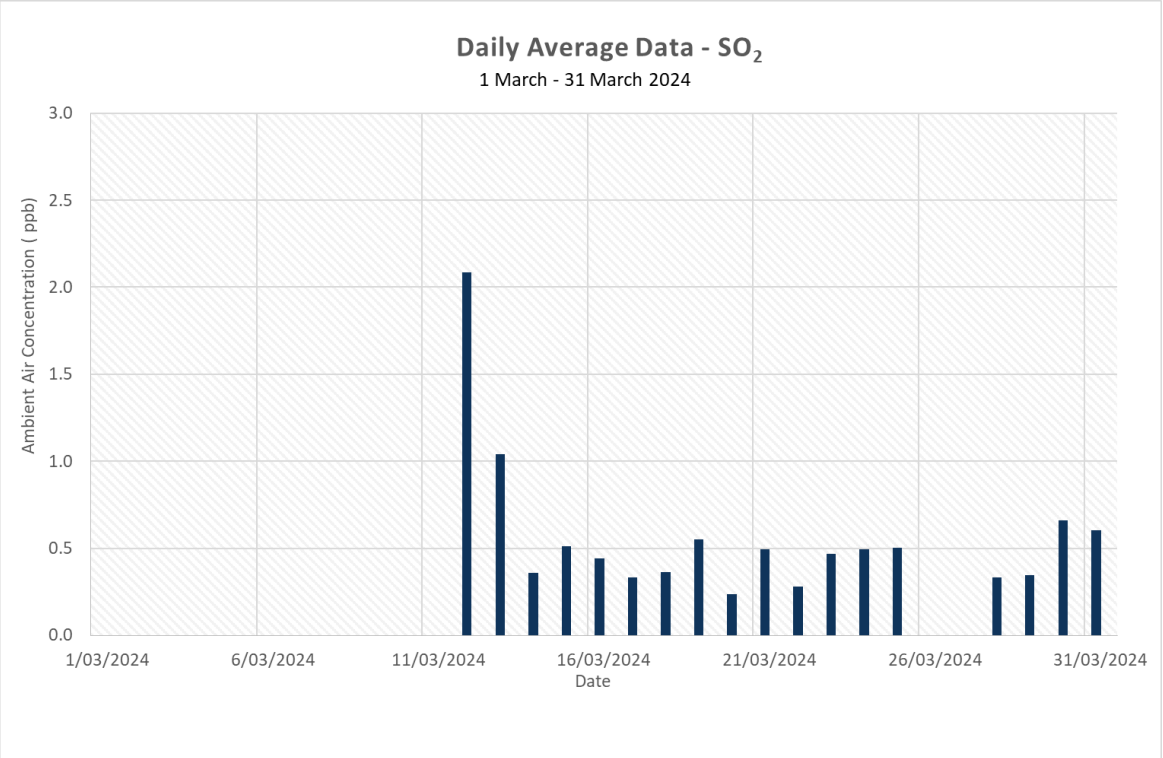


Figure 6. Daily (24 Hour) Average SO_2

Appendix 2. Weather Charts

9.1 Monthly Windrose

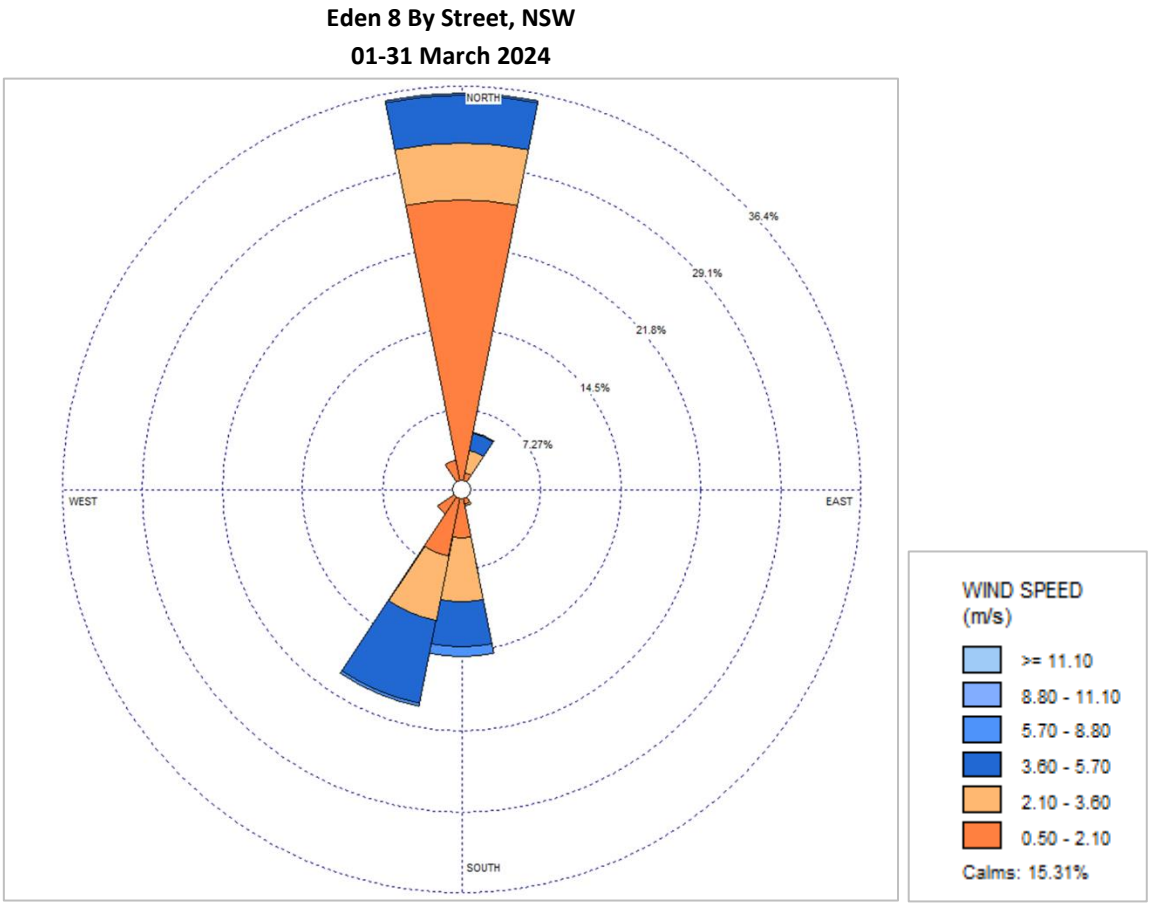
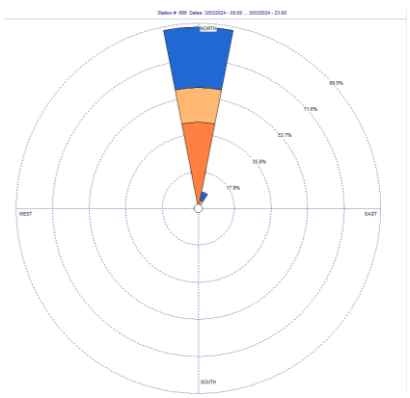


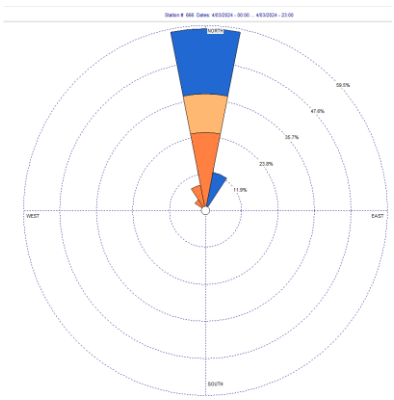
Figure 7. Monthly Wind Rose

9.2 Daily Windroses

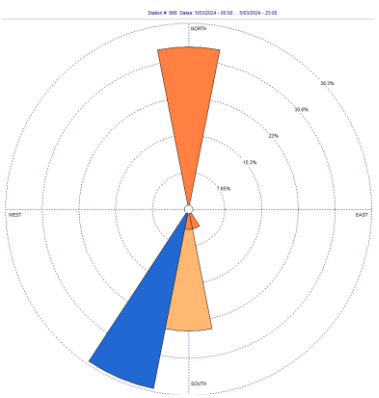
The following Daily windroses correspond to days Ships were berthed at port of Eden.
The daily average concentration of SO_2 (ppb) is also noted in brackets for each day.



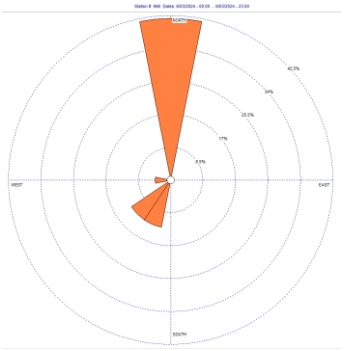
03/03/24 (NA)



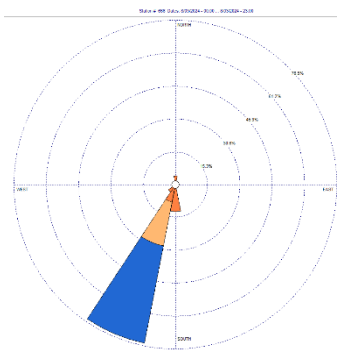
04/03/24 (NA)



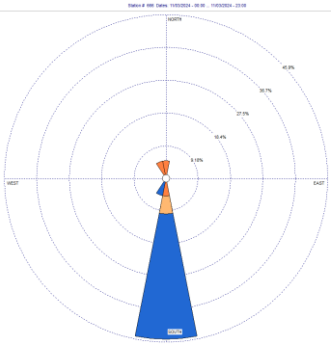
05/03/24 (NA)



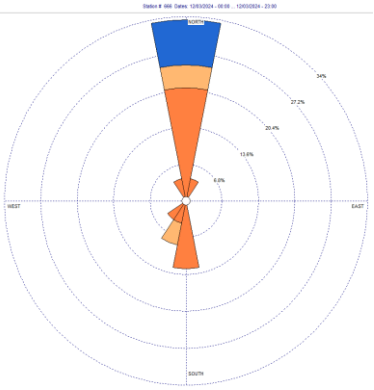
06/03/24 (NA)



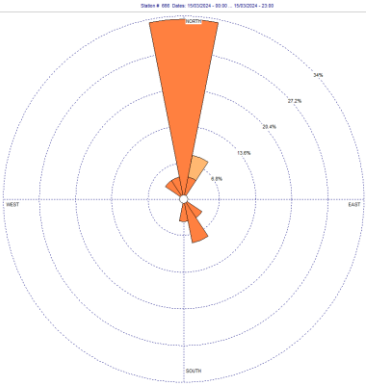
08/03/24 (NA)



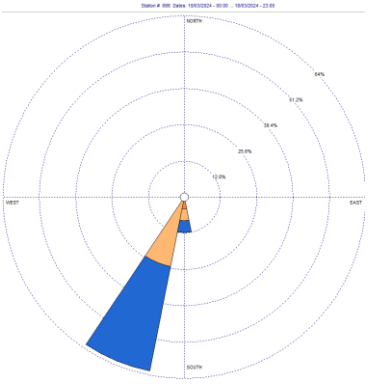
11/03/24 (NA)



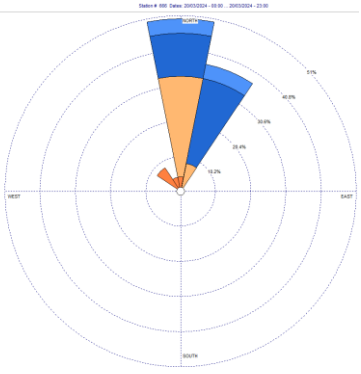
12/03/24 (SO2 2.08 ppb)



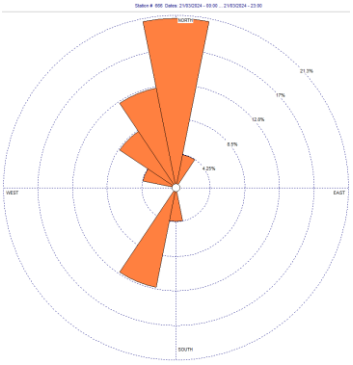
15/03/24 (SO2 0.5 ppb)



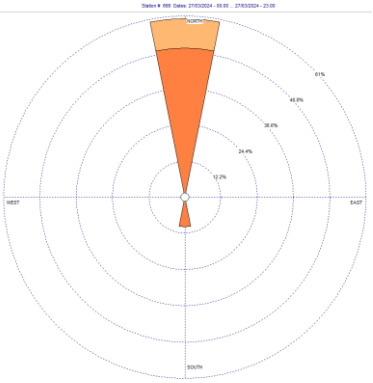
18/03/2/24 (SO2 0.36 ppb)



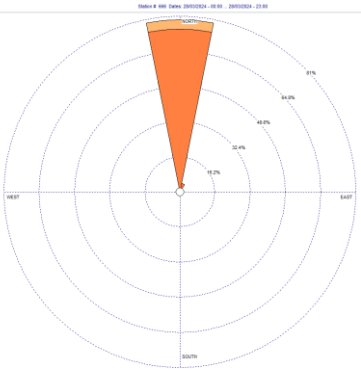
20/03/2/24 (SO2 0.24 ppb)



21/03/2/24 (SO2 0.49 ppb)



27/03/2/24 (NA)



28/03/2/24 (SO2 0.3ppb)

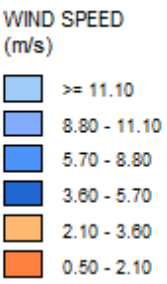


Figure 8. Daily Wind Roses

9.3 Weather Charts

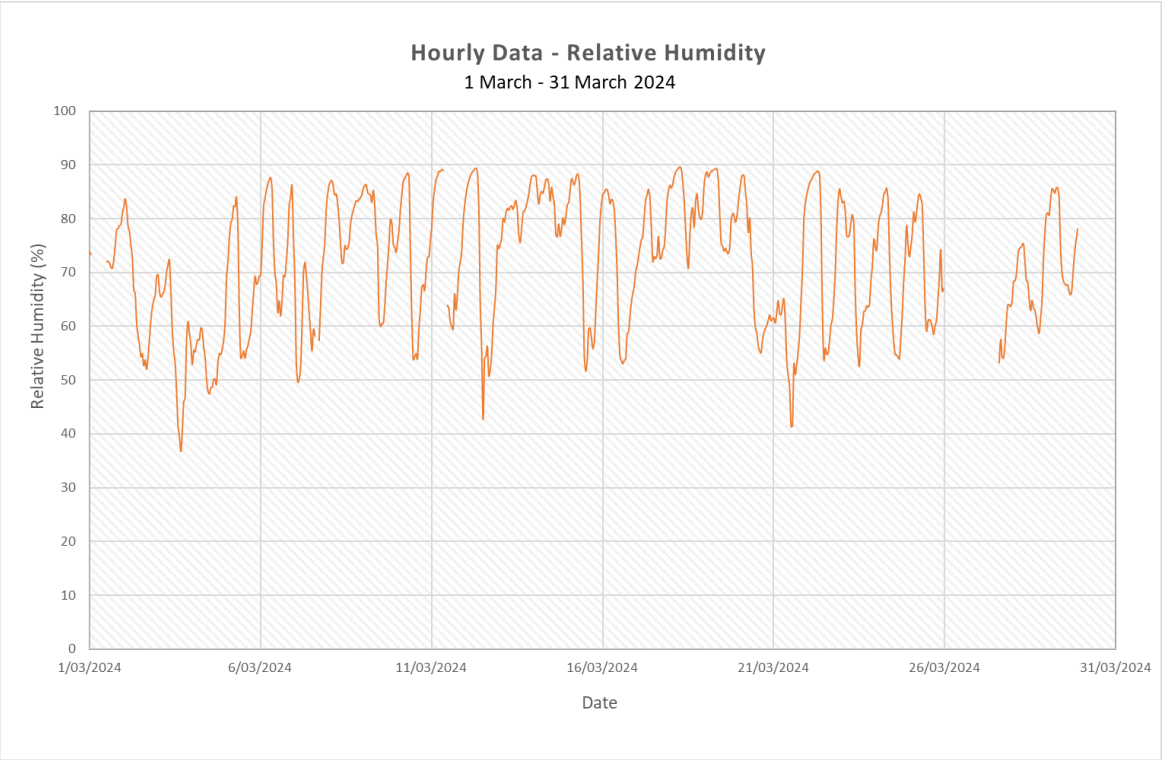


Figure 9. Hourly Relative Humidity

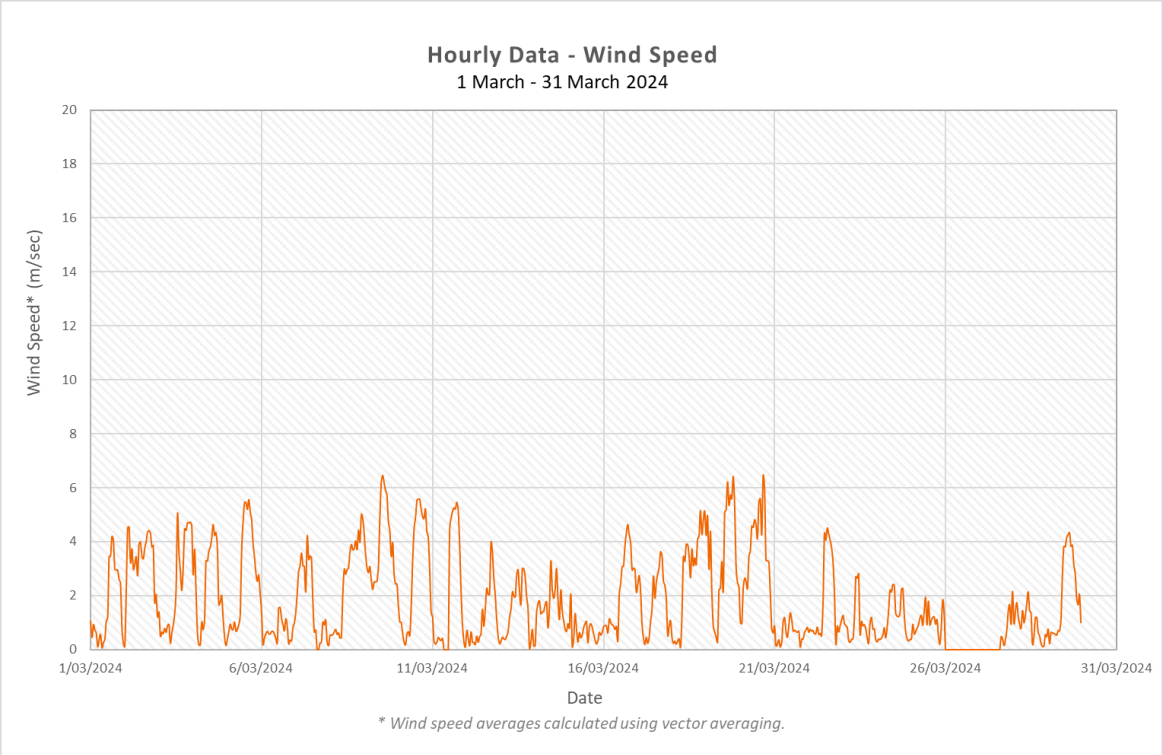


Figure 10. Hourly Wind Speed.

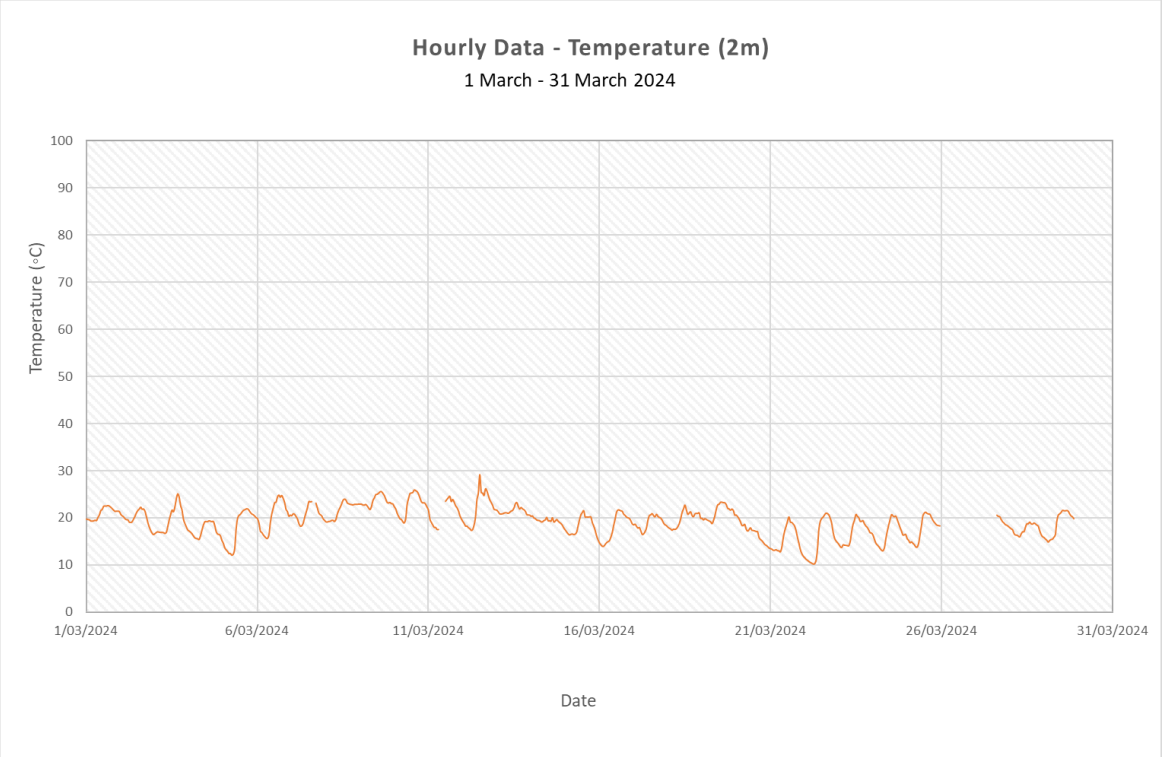


Figure 11. Hourly Temperature (2m)

Ektimo

Appendix 4. Monitoring Equipment Specifications

Table 15. Monitoring Equipment Specifications

Parameter	Manufacturer	Model	Specification Units	Operating Range	Accuracy	Detection Threshold	Resolution	Error / Drift	Sample rate
$PM_{2.5}$	Dr Fodisch	FDS-17	µg/m3	2...2000 µg/m³.	For concentrations greater than 100 µg/m³, the accuracy is ±15%. less than 100 µg/m³, the accuracy is ±15 µg/m³	2 µg/m³	NA	NA	(2 l/min).
NOx	Airpointer	A-HTV1S070000 M100C1F1	ppb	up to 20ppm	1%of read ingor1ppb (whichever is greater) @<500ppb	0.4ppb	NA	<0.4ppb (zero) 1% of reading >100ppb (span) 24hrs	1000ml/min
SO_2	FPI	AQMS-500	ppb	0 - 500 ppb	< 1% Linearity: <1% F.S.	0.5 ppb	NA	≤1 ppb for Zero (24hours) ≤5 ppb for Span (24hours)	350-1000 sccm
Wind direction	Vaisala	WXT530	degree (°)	0 - 360°	±3.0° at 10 m/s	NA	1°	NA	NA
Wind speed	Vaisala	WXT530	m/s	0 - 60 m/s	±3 % at 10 m/s	NA	0.1 m/s	NA	NA
Relative Humidity	Vaisala	WXT530	%	0 - 100 %RH	±3 %RH at 0 - 90 %RH ±5 %RH at 90 - 100 %RH	0.1 %RH	0.1 %RH	NA	NA
Temperature	Vaisala	WXT530	°C	-52 - 60 °C	±0.3 °C	NA	0.1 °C	NA	NA

Appendix 5. Ambient Air Quality Monitoring Station (AAQMS) Locations and Siting.

AAQMS & Weather Station Location

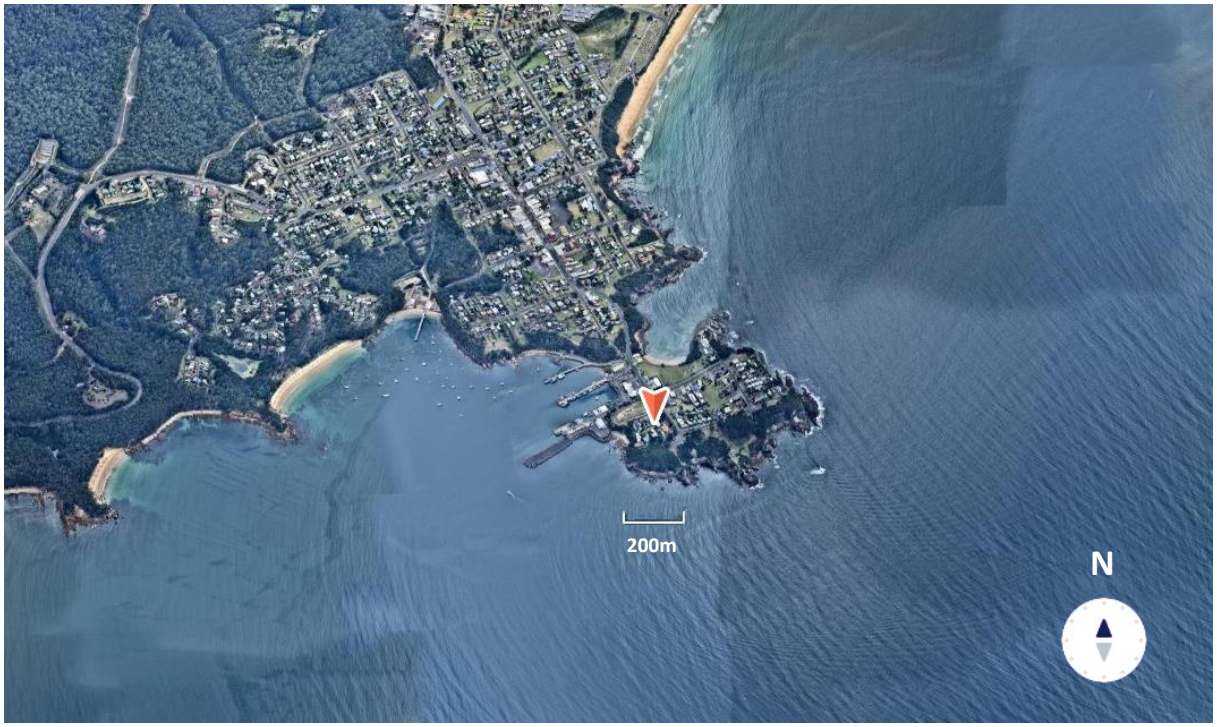


Image 1. Port Eden AAQMS Location, 8 By Street

Image 2. Port Eden AAQMS Location, 8 By street (zoomed in)

Appendix 6. AAQMS Image.

Image 3. AAQMS, 8 by Street Port Eden

Appendix 7. Location Siting and Compliance

AAQMS were assessed in accordance with the siting requirements of AS3580.1.1.

Compliance with the siting requirements of AS3580.1.1 are summarised in the following tables.

Table 16. Location Siting Assessment

Ektimo	Initial Station Siting
Client name	Port Authority of New South Wales
Job number	R016315
Date of Installation	18/01/2024
Ektimo Staff	Hamid Sokhan
Site Location	8 By St, Eden NSW 2551
Latitude	-37.073486
Longitude	149.910502
Equipment type	Ambient Air Quality Monitoring System
Station type	Neighbourhood
Australian Standard AAQMS Siting Criteria Compliance	**(✓,✗ or na)**
Inlet height above ground level 2 m - 5 m	✓
Twice the height of nearby obstacle above the inlet ≤ Dw	✗
Inlet 10 m from drip line of trees	✓
Greater than 50 m from road (≤ 10,000 vehicles/day)	✗
10 m from object with height exceeding 2 m below the inlet height	✗
Clear sky angle 120° above inlet	✓
Unrestricted 270° airflow around inlter	✓
No extraneaous sources nearby	✓
Wind speed and wind direction	
Anemometer height above ground level 10 m	✗
Distance obstruction (≥ 10 times obstruction height)	✗
Temperature & relative humidity	
Sensor height above ground level 2 m	✓
Distance to obstruction (≥ 4 times obstruction height)	✗

Ektimo

ektimo.com.au
1300 364 005

MELBOURNE (Head Office)
26 Redland Drive
Mitcham
VIC 3132
AUSTRALIA

SYDNEY
6/78 Reserve Road
Artarmon
NSW 2064
AUSTRALIA

WOLLONGONG
1/251 Princes Highway
Unanderra
NSW 2526
AUSTRALIA

PERTH
52 Cooper Road
Cockburn Central
WA 6164
AUSTRALIA

BRISBANE
3/109 Riverside Place
Morningside
QLD 4170
AUSTRALIA