



## REPORT

### *EastLink Ventilation Stack Emission Monitoring Report April - June 2021*

Submitted to:

#### **Ventia Pty Ltd**

EastLink Operations Centre  
2 Hillcrest Avenue  
Ringwood VIC 3134

Submitted by:

#### **Golder Associates Pty Ltd**

Building 7, Botanicca Corporate Park 570 – 588 Swan Street Richmond, Victoria 3121  
Australia

+61 3 8862 3500

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Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in  
this document are traceable to Australian / national standards.

## Record of Issue

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## Distribution List

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**APPENDICES**

**APPENDIX A**

Important Information Relating to this Report

## 1.0 INTRODUCTION

EastLink is a 39 kilometre motorway running between Donvale in Melbourne's north-east to Frankston in Melbourne's south-east with two tunnels under the Mullum Mullum Valley. Broadspectrum Pty Ltd, who are responsible for operation and maintenance of the road, commissioned Golder Associates Pty. Ltd. to provide continuous emission monitoring services for the EastLink motorway project. The services provided include:

- Operations and maintenance services for the EastLink ventilation stack continuous emission monitoring systems (CEMS)
- NATA endorsed emission monitoring reports.

Monitoring commenced on the 29<sup>th</sup> June 2008 with the opening of the EastLink motorway. Results for the sampling period 1<sup>st</sup> April 2021 to 30<sup>th</sup> June 2021 inclusive are contained in the following report.

The work was conducted under the following Broadspectrum Pty Ltd Work Order numbers:

Month	Western Stack	Eastern Stack
April	1226728	1226484
May	1231282	1230964
June	1234228	1233792

Note: TBA – To be advised

Your attention is drawn to the document - "Important Information Relating to this Report" (LEG04, RL2), which is included in Appendix A of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. We would be pleased to answer any questions the reader may have regarding this document.

## 2.0 DISCHARGES TO AIR

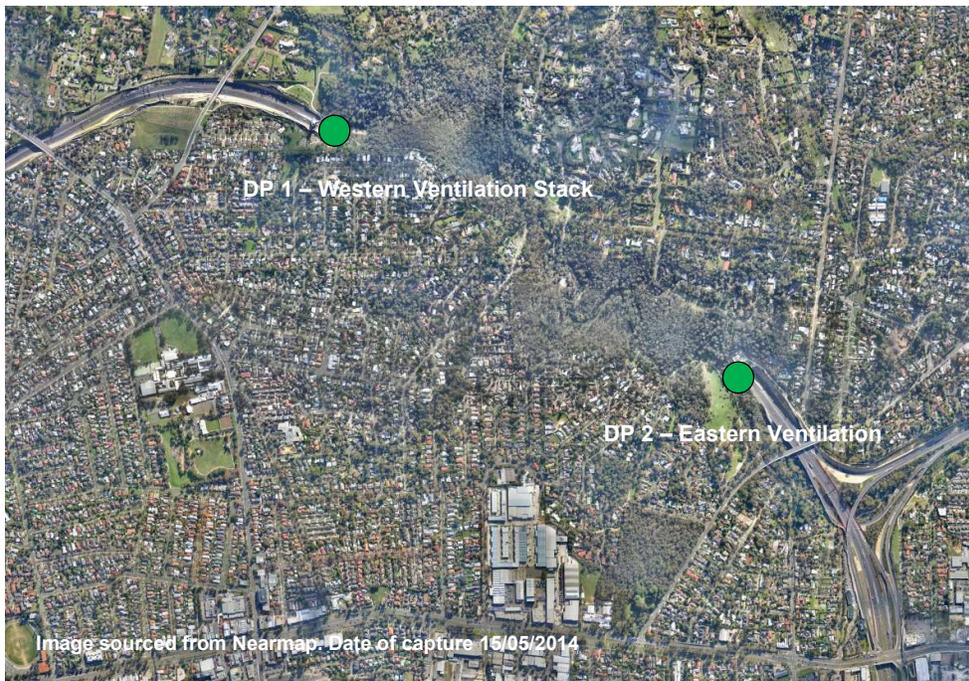
EastLink has discharges to air servicing two road tunnels. Discharge Point No. 1 (DP1) services the inbound (Melba) tunnel and Discharge Point No. 2 (DP2) services the outbound (Mullum Mullum) tunnel.

The locations of the discharges to air are described in Table 1 and presented in Figure 1.

**Table 1: Discharges to Air**

Discharge Point No.	Station Name	Location
1	Western ventilation stack	Western end of inbound tunnel (Melba) - Donvale
2	Eastern ventilation stack	Eastern end of outbound tunnel (Mullum Mullum) – Ringwood

Monitoring equipment is housed in a temperature controlled cabinet located at the base of each of the ventilation stacks. Particulate matter and gaseous sample inlets are installed inside the plenum chamber of each of the ventilation stacks.



**Figure 1: Ventilation Stack Locations**

### 3.0 VENTILATION STACK MONITORING PARAMETERS

The following parameters are monitored continuously, with averages logged at 5 minute intervals:

- Particulate matter with an equivalent aerodynamic diameter less than 2.5 microns (PM<sub>2.5</sub>)
- Particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM<sub>10</sub>)
- Total oxides of nitrogen (NO<sub>x</sub>)
- Nitric oxide (NO)
- Nitrogen dioxide (NO<sub>2</sub>)
- Carbon monoxide (CO)
- Stack velocity
- Stack temperature
- Ambient pressure.

## 4.0 METHODS

### 4.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> concentrations in the tunnel ventilation stacks are determined using 1400 Series Tapered Element Oscillating Microbalance (TEOM) analysers. Sample inlets are located inside the plenum chamber of each ventilation stack.

Exhaust gas is drawn through a PM<sub>2.5</sub> size selective inlet (PM<sub>10</sub> WINS head fitted with a PM<sub>2.5</sub> sharp cut cyclone (SCC)) at 1 m<sup>3</sup>/h. The flow is then isokinetically split into two streams; 1 l/min stream which passes through the filter on the mass transducer and a 15.7 l/min bypass stream.

The sample stream is heated to 50°C to maintain a low and therefore relatively constant humidity.

Measurements are made in real-time (2 s intervals) with the 5 minute averages logged. 1 hour averages are then calculated from the logged data.

The PM<sub>2.5</sub> monitoring method is based on the requirements of Australian Standard AS 3580.9.13, *“Methods for Sampling and Analysis of Ambient Air: Determination of Suspended Particulate Matter – PM<sub>2.5</sub> Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance Monitor”*.

### 4.2 PM<sub>10</sub>

PM<sub>10</sub> concentrations in the tunnel ventilation stacks are determined using 1400 Series Tapered Element Oscillating Microbalance (TEOM) analysers. Sample inlets are located inside the plenum chamber of each ventilation stack.

Exhaust gas is drawn through a PM<sub>10</sub> size selective inlet (PM<sub>10</sub> WINS head) at 1 m<sup>3</sup>/h. The flow is then isokinetically split into two streams; 1 l/min stream which passes through the filter on the mass transducer and a 15.7 l/min bypass stream.

The sample stream is heated to 50°C to maintain a low and therefore relatively constant humidity.

Measurements are made in real-time (2 s intervals) with the 5 minute averages logged. 1 hour averages are then calculated from the logged data.

The PM<sub>10</sub> monitoring method is based on the requirements of Australian Standard AS 3580.9.8, *“Methods for Sampling and Analysis of Ambient Air: Determination of Suspended Particulate Matter – PM<sub>10</sub> Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance Analyser”*.

### 4.3 Carbon Monoxide

Carbon monoxide concentrations in the tunnel ventilation stacks are determined by infra-red gas filter correlation analysers.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The carbon monoxide monitoring method is based on the requirements of Australian Standard AS 3580.7.1, *“Determination of Carbon Monoxide – Direct Reading Instrumental Method”*.

### 4.4 Oxides of Nitrogen

Oxides of nitrogen concentrations in the tunnel ventilation stacks are determined by chemiluminescence gas analysers.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The oxides of nitrogen (NO, NO<sub>2</sub> and NO<sub>x</sub>) monitoring method is based on the requirements of Australian Standard AS 3580.5.1, “*Determination of Oxides of Nitrogen – Chemiluminescence Method*”.

## 4.5 Stack Velocity

Stack gas velocity was determined using an optical flow sensor that complies with USEPA Code of Federal Regulations (CFR 40) Part 75, “*Continuous Emission Monitoring*” requirements.

## 5.0 MEASUREMENT UNCERTAINTY

**Table 2: Measurement Uncertainty**

Parameter	Method	Estimated Uncertainty
PM <sub>10</sub>	TEOM	± 5%
PM <sub>2.5</sub>	TEOM	± 5%
NO, NO <sub>2</sub> , NO <sub>x</sub>	Chemiluminescence	± 10%
CO	Infra-red gas filter correlation	± 10%
Stack velocity	Optical flow sensor	± 0.1 m/s or 5% of reading, whichever is greater
Ambient temperature	Thermocouple (TEOM)	± 2°C
Ambient pressure	TEOM pressure transducer	± 1.5%

## 6.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/04/2021 – 30/04/2021

### 6.1 Data Capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

The data capture statistics for the reporting period 1<sup>st</sup> April to 30<sup>th</sup> April 2021 are shown in Table 3. Averages were only collected for those periods where the 5 minute data constituted 75% data capture. Reduced data capture for NO<sub>x</sub> eastern ventilation system was due to analyser span drift out of tolerance.

Section 6.3 provides further information on the reasons for invalid data periods.

**Table 3: Data Capture Statistics - 1 Hour Averages**

Parameter	Station	Collected Periods	Available Periods	Data Capture
PM <sub>2.5</sub>	Eastern	719	720	99.9%
	Western	717	720	99.6%
PM <sub>10</sub>	Eastern	714	720	99.2%
	Western	716	720	99.4%
NO, NO <sub>2</sub>	Eastern	543	720	75.4%
	Western	641	720	89.0%
CO	Eastern	688	720	95.6%
	Western	687	720	95.4%

## 6.2 Results

### 6.2.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 4. A plot of PM<sub>2.5</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 2.

**Table 4: PM<sub>2.5</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>2.5</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.14	0.11	0.096	0.079	0.073	0.048	0.021
Western	0.20	0.14	0.12	0.091	0.073	0.052	0.031

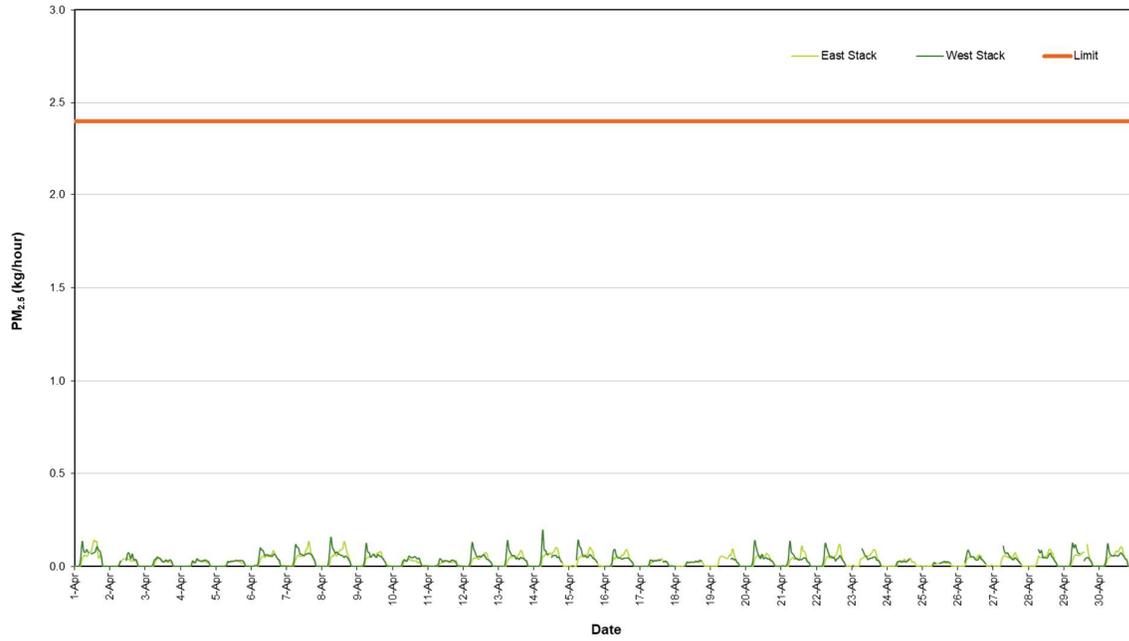


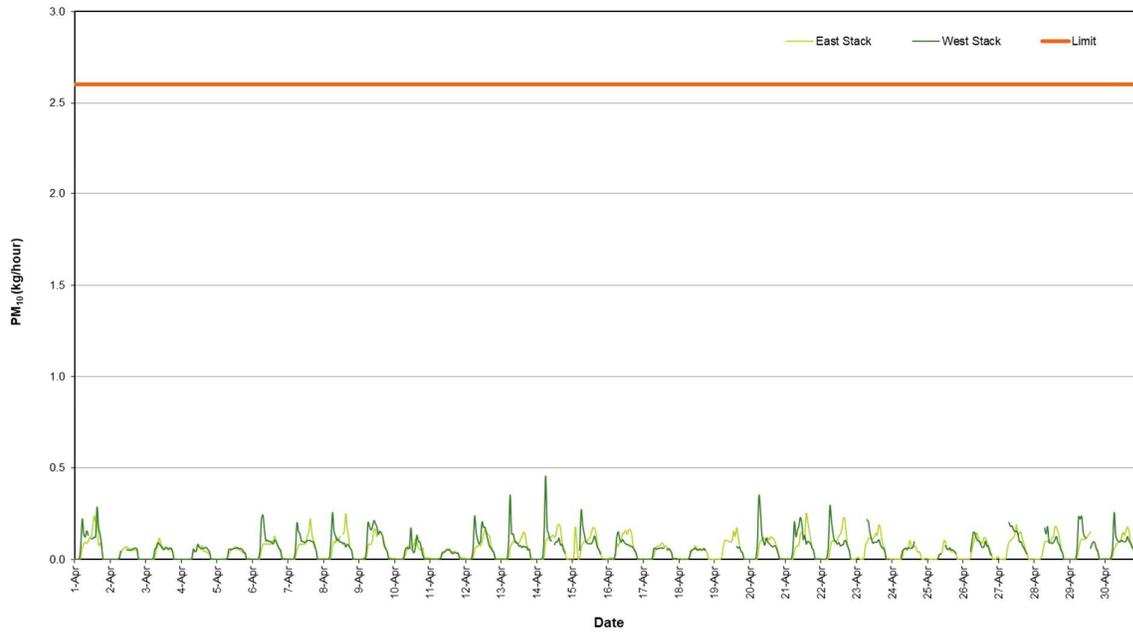
Figure 2: PM<sub>2.5</sub> Mass Rate (1 Hour Average)

### 6.2.2 PM<sub>10</sub>

PM<sub>10</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 5. A plot of PM<sub>10</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 3.

Table 5: PM<sub>10</sub> Mass Rate Percentiles (1 Hour Average)

Station	PM <sub>10</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.25	0.21	0.18	0.15	0.13	0.092	0.044
Western	0.46	0.27	0.23	0.18	0.14	0.096	0.056



**Figure 3: PM<sub>10</sub> Mass Rate (1 Hour Average)**

### 6.2.3 Carbon Monoxide

Carbon monoxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 6. A plot of carbon monoxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 4.

**Table 6: Carbon Monoxide Mass Rate Percentiles (1 Hour Average)**

Station	Carbon Monoxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	8.2	6.4	5.7	4.6	3.7	2.8	2.1
Western	8.7	7.5	6.7	5.4	4.5	3.4	2.7

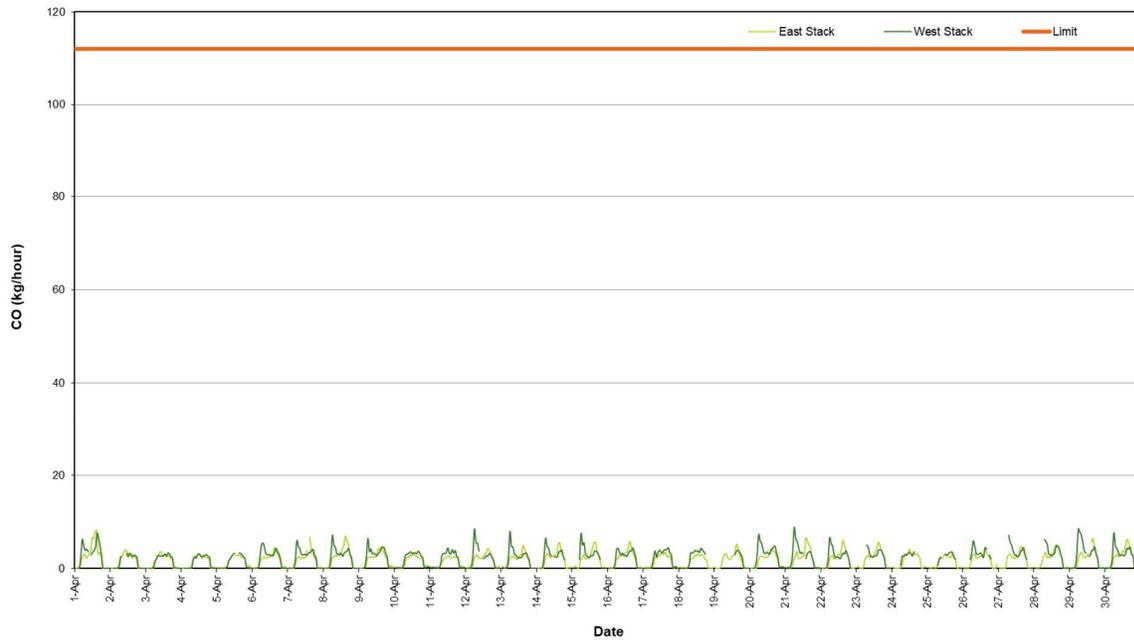


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)

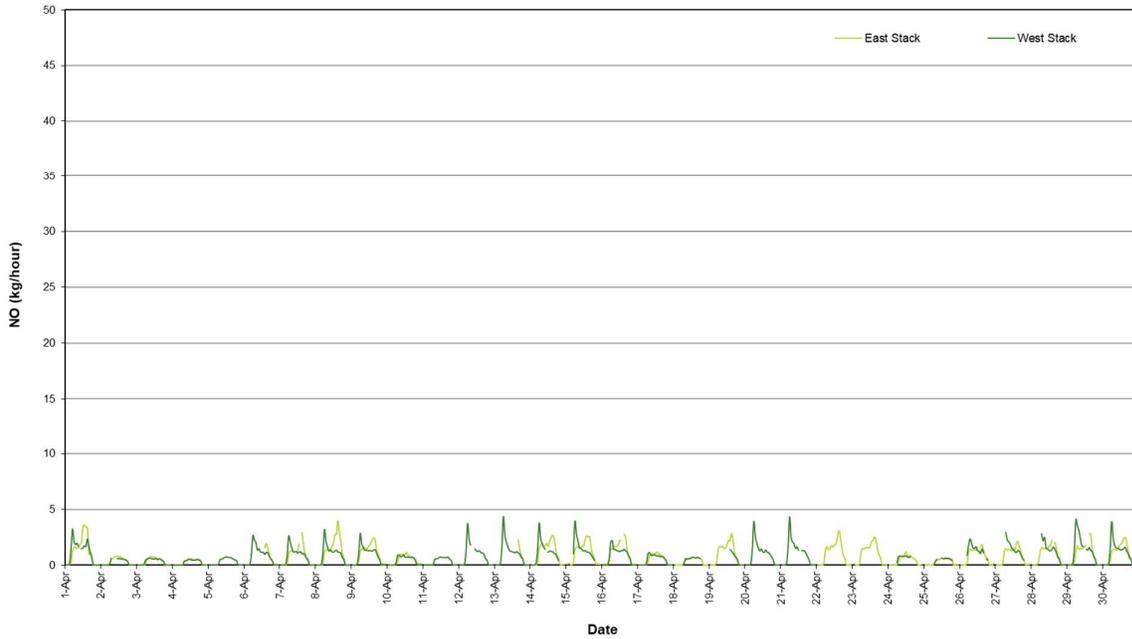
## 6.2.4 Oxides of Nitrogen

### 6.2.4.1 Nitric Oxide

Nitric oxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 7. A plot of nitric oxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 5.

Table 7: Nitric Oxide Mass Rate Percentiles (1 Hour Average)

Station	Nitric Oxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	4.0	3.1	2.8	2.4	1.9	1.4	0.56
Western	4.3	3.8	3.1	2.3	1.7	1.3	0.64



**Figure 5: Nitric Oxide Mass Rate (1 Hour Average)**

**6.2.4.2 Nitrogen Dioxide**

Nitrogen dioxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 8. A plot of nitrogen dioxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 6.

**Table 8: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average)**

Station	Nitrogen Dioxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.99	0.72	0.62	0.50	0.39	0.24	0.12
Western	0.29	0.24	0.21	0.15	0.11	0.087	0.063

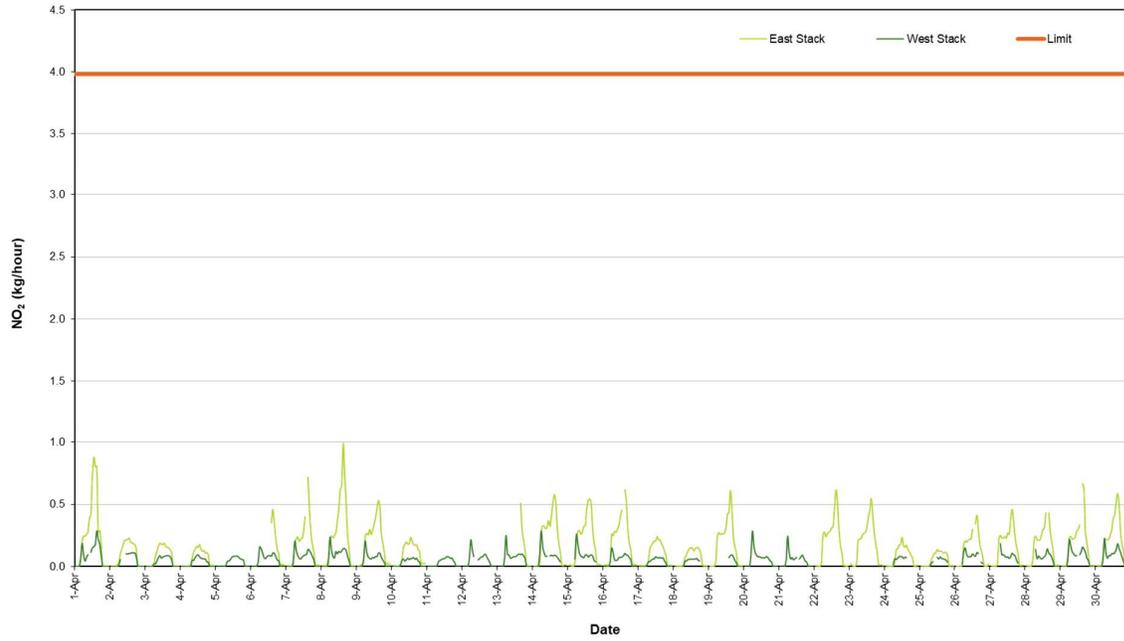


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)

### 6.2.5 Stack Velocity

The stack velocity (1 hour average) plot for the reporting period is presented in Figure 7.

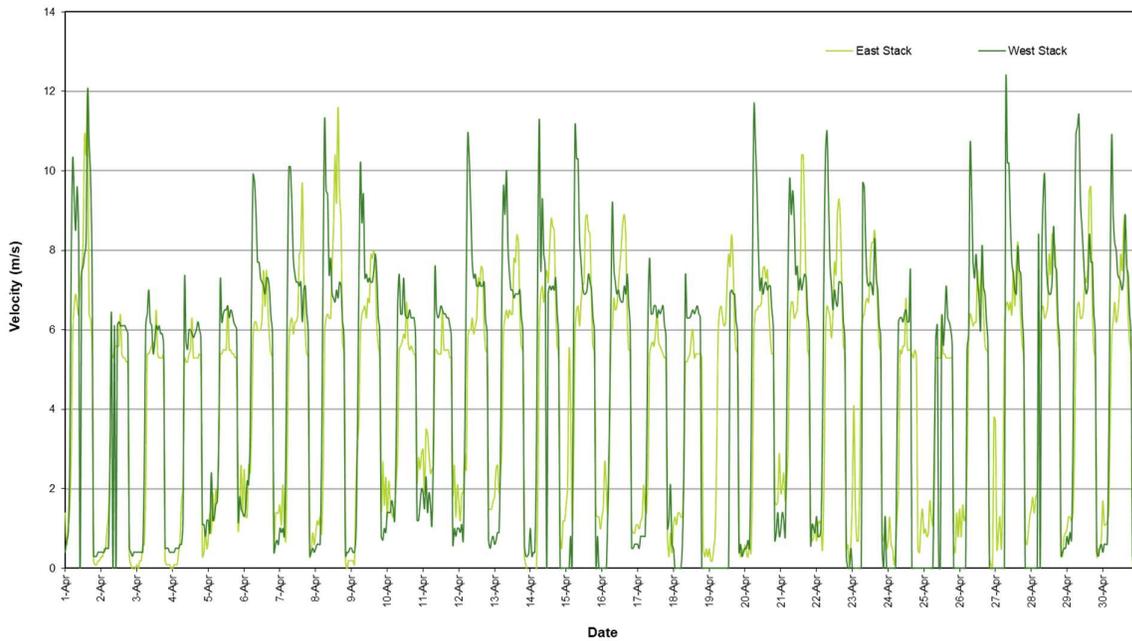


Figure 7: Stack Velocity (1 Hour Average)

### 6.3 Data Validation and Exceptions

Data contained in the report has been validated against performance and calibration requirements for each instrument. Data during maintenance and calibration periods has been removed from the validated data sets. Tables 9 and 10 list the data exceptions for the eastern and western ventilation stacks, where valid data is less than 75% of the one hour average. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

**Table 9: Data Exceptions - Eastern Ventilation Stack: April 2021**

Start	End	Parameter	Reason
5/04/2021 01:00	6/04/2021 13:30	NO, NO <sub>2</sub> , NO <sub>x</sub>	Span drift out of tolerance
7/04/2021 13:55	7/04/2021 14:30	CO, NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
11/04/2021 01:00	13/04/2021 15:15	NO, NO <sub>2</sub> , NO <sub>x</sub>	Span drift out of tolerance
16/04/2021 14:40	16/04/2021 15:00	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
20/04/2021 01:00	21/04/2021 14:50	NO, NO <sub>2</sub> , NO <sub>x</sub>	Span drift out of tolerance
26/04/2021 13:00	26/04/2021 13:25	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
29/04/2021 14:35	29/04/2021 15:10	CO, NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
29/04/2021 15:05	29/04/2021 15:45	PM <sub>2.5</sub>	Maintenance / calibration
29/04/2021 15:25	29/04/2021 16:25	PM <sub>10</sub>	Maintenance / calibration

**Table 10: Data Exceptions - Western Ventilation Stack: April 2021**

Start	End	Parameter	Reason
12/04/2021 09:40	12/04/2021 10:30	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
14/04/2021 20:35	15/04/2021 02:25	Stack velocity	Low signal
15/04/2021 22:05	15/04/2021 23:25	Stack velocity	Low signal
17/04/2021 15:20	17/04/2021 15:35	PM <sub>2.5</sub>	Maintenance / calibration
17/04/2021 15:20	17/04/2021 15:55	PM <sub>10</sub>	Maintenance / calibration
17/04/2021 15:55	17/04/2021 16:00	NO, NO <sub>2</sub> , NO <sub>x</sub>	Span drift out of tolerance
18/04/2021 01:40	18/04/2021 6:10	Stack velocity	Low signal
18/04/2021 19:35	19/04/2021 13:40	Stack velocity	Low signal
21/04/2021 13:20	21/04/2021 13:50	NO, NO <sub>2</sub> , NO <sub>x</sub>	Span drift out of tolerance

Start	End	Parameter	Reason
21/04/2021 13:20	21/04/2021 13:50	CO	Maintenance / calibration
22/04/2021 20:45	22/04/2021 22:50	Stack velocity	Low signal
22/04/2021 23:55	23/04/2021 06:35	Stack velocity	Low signal
23/04/2021 23:40	24/04/2021 06:05	Stack velocity	Low signal
24/04/2021 16:30	25/04/2021 06:45	Stack velocity	Low signal
25/04/2021 10:25	25/04/2021 11:25	Stack velocity	Low signal
25/04/2021 20:00	26/04/2021 04:35	Stack velocity	Low signal
26/04/2021 16:50	26/04/2021 17:40	CO, NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
26/04/2021 20:30	27/04/2021 03:30	Stack velocity	Low signal
27/04/2021 04:40	27/04/2021 06:30	Stack velocity	Low signal
27/04/2021 20:05	28/04/2021 4:35	Stack velocity	Low signal
29/04/2021 11:55	29/04/2021 12:35	CO, NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
29/04/2021 11:55	29/04/2021 13:55	PM <sub>2.5</sub>	Maintenance / calibration
29/04/2021 12:30	29/04/2021 13:35	PM <sub>10</sub>	Maintenance / calibration

There were instances where PM<sub>2.5</sub> concentration was greater than the corresponding PM<sub>10</sub> concentration. If no valid reason was found to exclude the data, the data was left unchanged in the data set. Examples of such occurrences are listed below:

- West Ventilation stack 16/04/2021 17:00 – 17/04/2021 01:30
- West Ventilation stack 25/04/2021 11:35 – 25/04/2021 12:40

## 7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/05/2021 – 31/05/2021

### 7.1 Data Capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

The data capture statistics for the reporting period 1<sup>st</sup> May to 31<sup>st</sup> May 2021 are shown in Table 11. Averages were only collected for those periods where the 5 minute data constituted 75% data capture. Reduced data capture for CO eastern ventilation system was due to analyser span out of tolerance.

Section 7.3 provides further information on the reasons for invalid data periods.

**Table 11: Data Capture Statistics - 1 Hour Averages**

Parameter	Station	Collected Periods	Available Periods	Data Capture
PM <sub>2.5</sub>	Eastern	743	744	99.9%
	Western	741	744	99.6%
PM <sub>10</sub>	Eastern	740	744	99.5%
	Western	737	744	99.1%
NO, NO <sub>2</sub>	Eastern	710	744	95.4%
	Western	664	744	89.2%
CO	Eastern	711	744	95.6%
	Western	704	744	94.6%

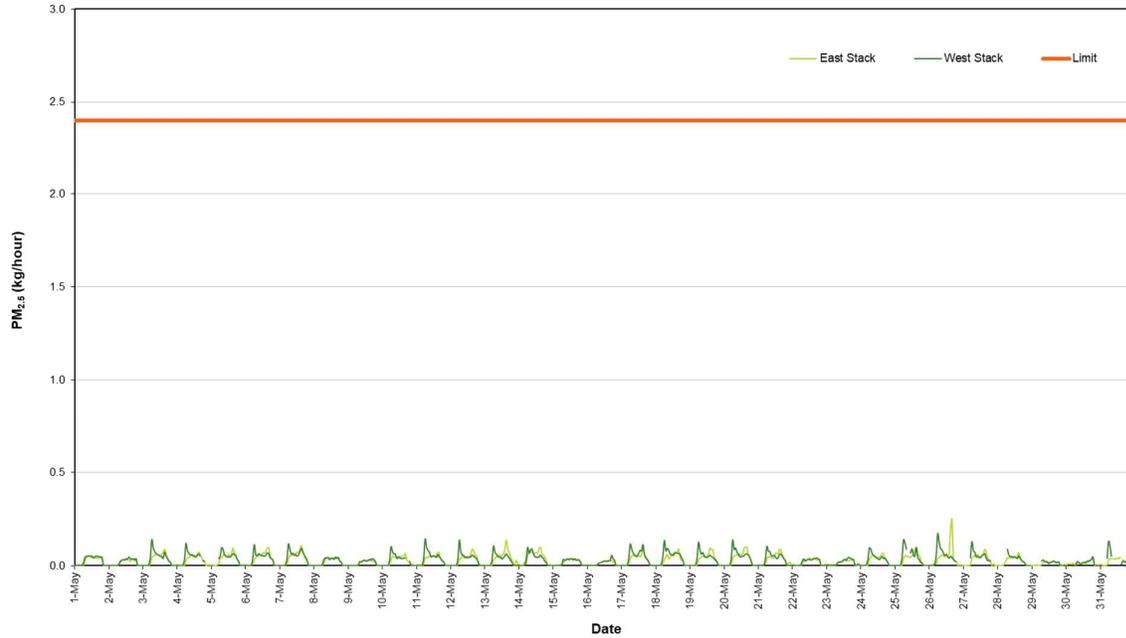
## 7.2 Results

### 7.2.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 12. A plot of PM<sub>2.5</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 8.

**Table 12: PM<sub>2.5</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>2.5</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.25	0.097	0.089	0.072	0.068	0.046	0.022
Western	0.17	0.13	0.12	0.088	0.068	0.050	0.029



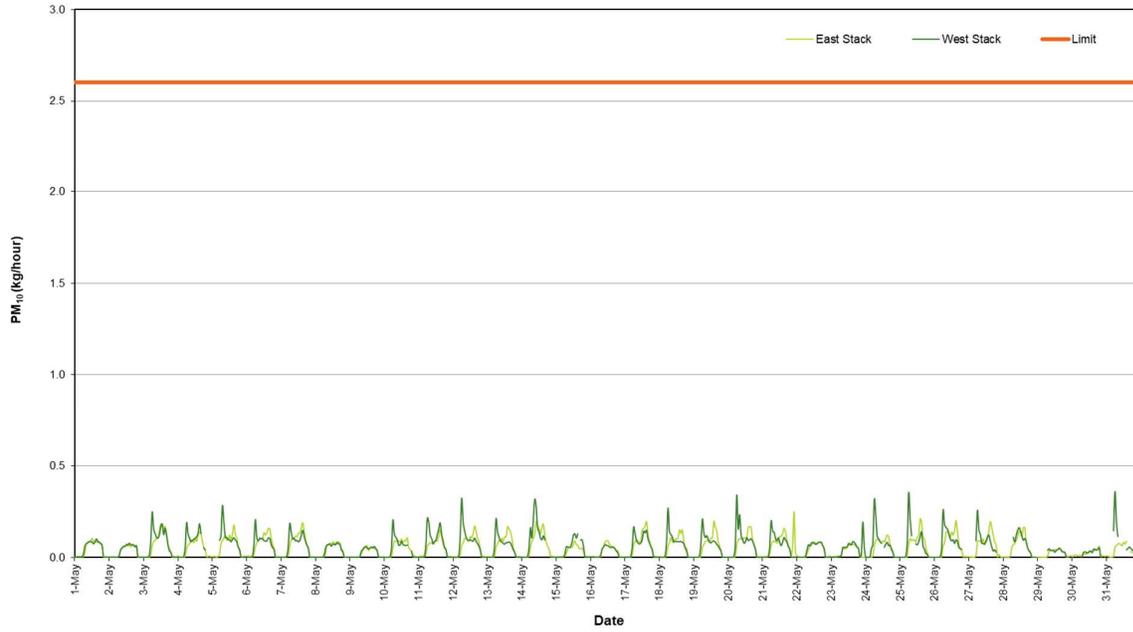
**Figure 8: PM<sub>2.5</sub> Mass Rate (1 Hour Average)**

**7.2.2 PM<sub>10</sub>**

PM<sub>10</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 13. A plot of PM<sub>10</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 9.

**Table 13: PM<sub>10</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>10</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.25	0.19	0.17	0.15	0.12	0.086	0.042
Western	0.36	0.28	0.22	0.17	0.13	0.090	0.054



**Figure 9: PM<sub>10</sub> Mass Rate (1 Hour Average)**

### 7.2.3 Carbon Monoxide

Carbon monoxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 14. A plot of carbon monoxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 10.

**Table 14: Carbon Monoxide Mass Rate Percentiles (1 Hour Average)**

Station	Carbon Monoxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	6.7	5.8	5.5	4.7	3.8	3.0	2.1
Western	9.1	7.6	7.1	6.0	4.5	3.5	2.5

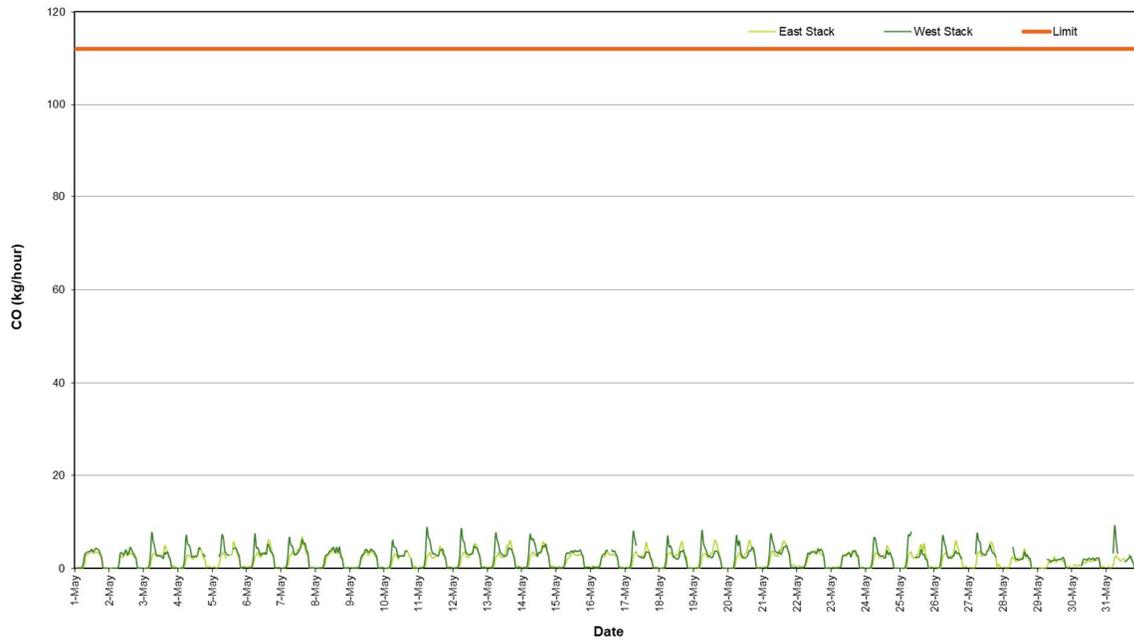


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

## 7.2.4 Oxides of Nitrogen

### 7.2.4.1 Nitric Oxide

Nitric oxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 15. A plot of nitric oxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 11.

Table 15: Nitric Oxide Mass Rate Percentiles (1 Hour Average)

Station	Nitric Oxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	2.9	2.5	2.3	2.0	1.7	1.4	0.59
Western	4.8	3.8	3.6	2.5	1.7	1.3	0.69

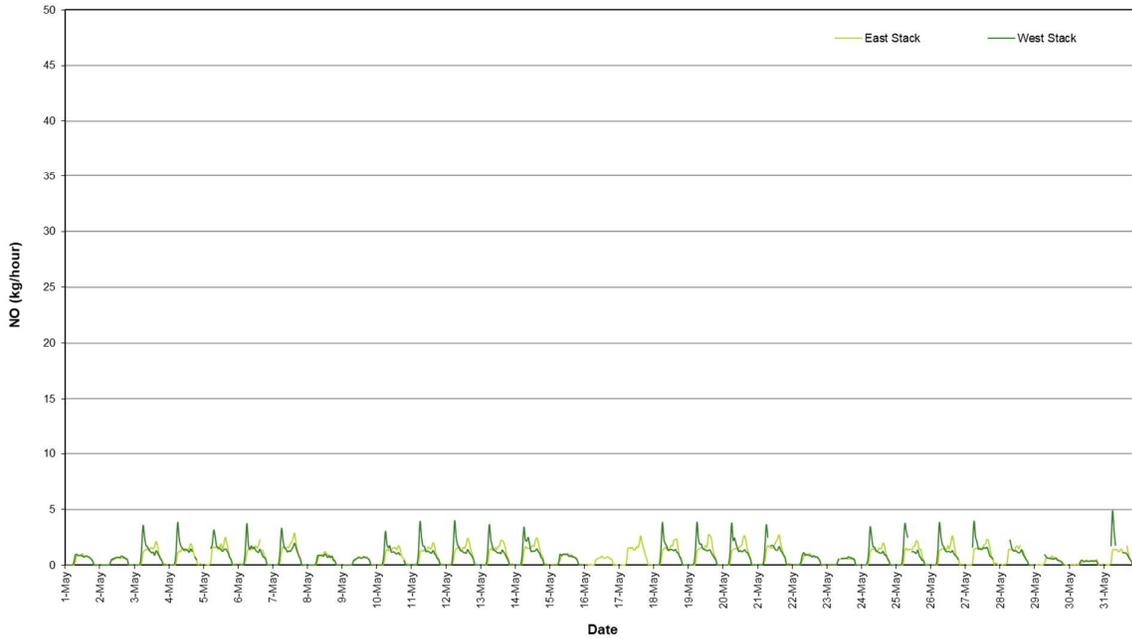


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

### 7.2.4.2 Nitrogen Dioxide

Nitrogen dioxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 16. A plot of nitrogen dioxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 12.

Table 16: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average)

Station	Nitrogen Dioxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.58	0.50	0.47	0.40	0.31	0.24	0.12
Western	0.37	0.26	0.21	0.13	0.11	0.084	0.062

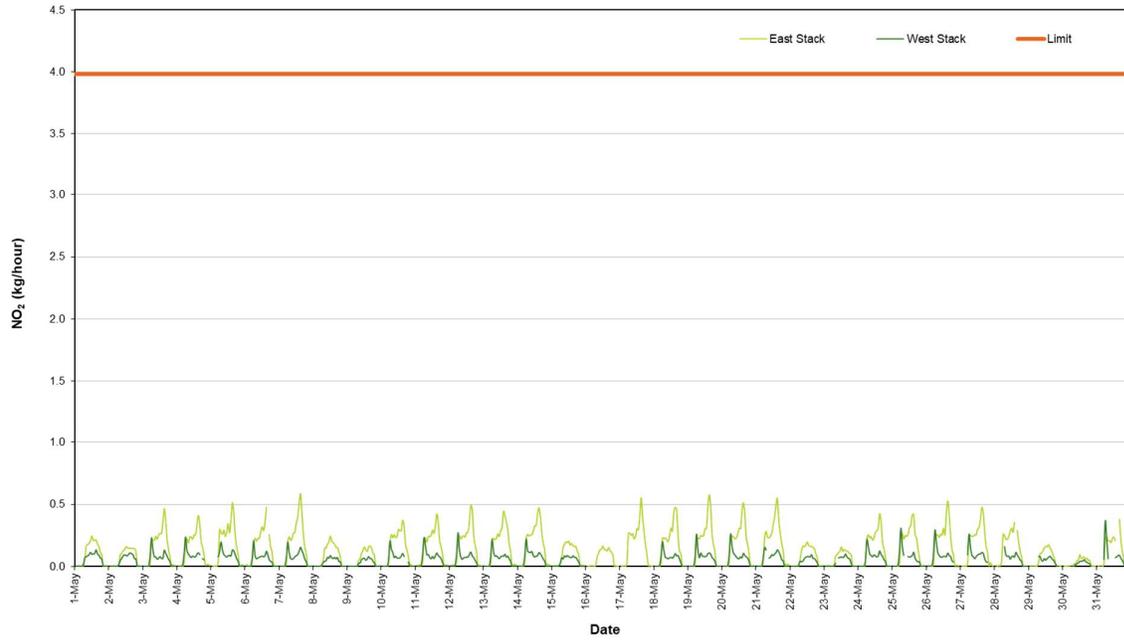
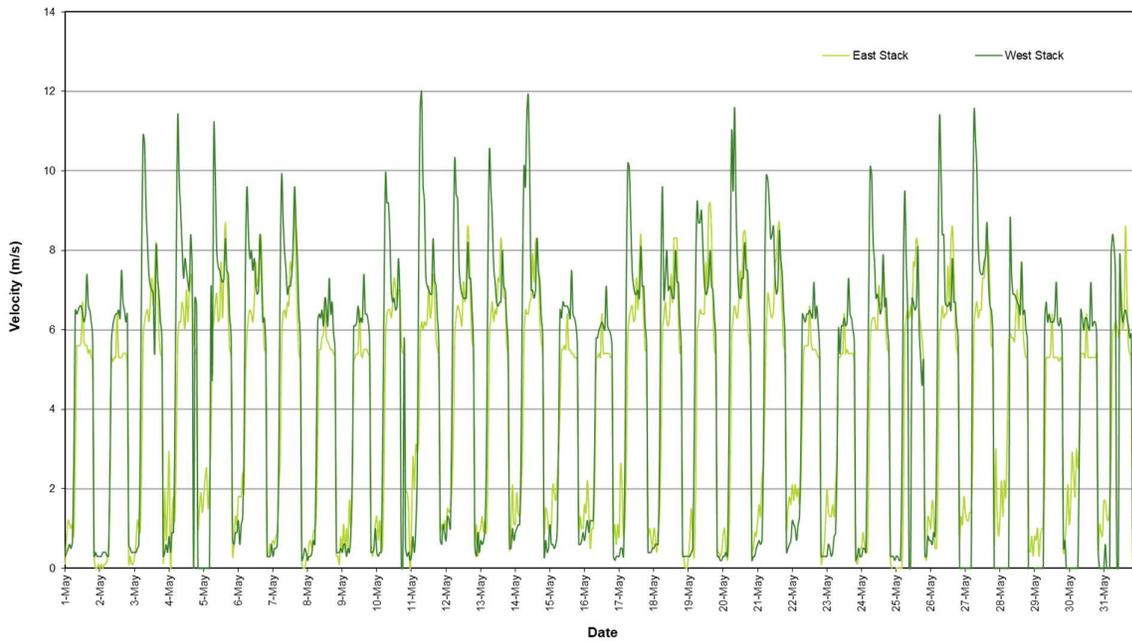


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)

### 7.2.5 Stack Velocity

The stack velocity (1 hour average) plot for the reporting period is presented in Figure 13.



**Figure 13: Stack Velocity (1 Hour Average)**

### 7.3 Data Validation and Exceptions

Data contained in the report has been validated against performance and calibration requirements for each instrument. Data during maintenance and calibration periods has been removed from the validated data sets. Tables 17 and 18 list the data exceptions for the eastern and western ventilation stacks, where valid data is less than 75% of the one hour average. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

**Table 17: Data Exceptions - Eastern Ventilation Stack: May 2021**

Start	End	Parameter	Reason
6/05/2021 16:15	6/05/2021 16:55	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
31/05/2021 14:40	31/05/2021 15:20	CO, NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
31/05/2021 15:05	31/05/2021 15:45	PM <sub>2.5</sub>	Maintenance / calibration
31/05/2021 15:20	31/05/2021 17:00	PM <sub>10</sub>	Maintenance / calibration

Note: <sup>1</sup> – In the opinion of the reviewer.

**Table 18: Data Exceptions - Western Ventilation Stack: May 2021**

Start	End	Parameter	Reason
4/05/2021 20:05	5/05/2021 04:35	Stack velocity	Low signal
10/05/2021 17:40	10/05/2021 18:45	Stack velocity	Low signal
14/05/2021 17:40	14/05/2021 19:40	PM <sub>10</sub>	Invalid <sup>1</sup>
16/05/2021 01:00	17/05/2021 23:55	NO, NO <sub>2</sub> , NO <sub>x</sub>	Span drift out of tolerance
16/05/2021 13:15	16/05/2021 14:25	CO	Maintenance / calibration
17/05/2021 08:45	17/05/2021 10:05	CO	Maintenance / calibration
21/05/2021 07:45	21/05/2021 08:55	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
23/05/2021 09:00	23/05/2021 09:40	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
25/05/2021 09:15	25/05/2021 11:00	Stack velocity	Low signal
26/05/2021 20:20	26/05/2021 23:55	Stack velocity	Low signal
27/05/2021 01:00	27/05/2021 04:50	Stack velocity	Low signal
27/05/2021 20:20	27/05/2021 21:35	Stack velocity	Low signal

Start	End	Parameter	Reason
27/05/2021 22:20	27/05/2021 23:55	Stack velocity	Low signal
28/05/2021 1:00	28/05/2021 05:25	Stack velocity	Low signal
29/05/2021 1:00	29/05/2021 06:25	Stack velocity	Low signal
29/05/2021 21:55	30/05/2021 06:25	Stack velocity	Low signal
30/05/2021 21:00	31/05/2021 4:25	Stack velocity	Low signal
31/05/2021 10:00	31/05/2021 11:05	Stack velocity	Low signal
31/05/2021 11:50	31/05/2021 12:35	CO, NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
31/05/2021 12:15	31/05/2021 14:55	PM <sub>2.5</sub>	Maintenance / calibration
31/05/2021 12:30	31/05/2021 13:55	PM <sub>10</sub>	Maintenance / calibration

**Notes:** 1 – In the opinion of the reviewer

There were instances where PM<sub>2.5</sub> concentration was greater than the corresponding PM<sub>10</sub> concentration. If no valid reason was found to exclude the data, the data was left unchanged in the data set. Examples of such occurrences are listed below:

- East Ventilation stack 14/05/2021 04:05 – 14/05/2021 05:10
- East Ventilation stack 26/05/2021 03:50 – 26/05/2021 05:10
- West Ventilation stack 16/05/2021 17:00 – 17/05/2021 01:30
- West Ventilation stack 25/05/2021 11:35 – 25/05/2021 12:40

## 8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/06/2021 – 30/06/2021

### 8.1 Data Capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

The data capture statistics for the reporting period 1<sup>st</sup> June to 30<sup>th</sup> June 2021 are shown in Table 19. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

Section 8.3 provides further information on the reasons for invalid data periods.

**Table 19: Data Capture Statistics - 1 Hour Averages**

Parameter	Station	Collected Periods	Available Periods	Data Capture
PM <sub>2.5</sub>	Eastern	643	720	89.3%
	Western	687	720	95.4%
PM <sub>10</sub>	Eastern	711	720	98.8%
	Western	720	720	100%
NO, NO <sub>2</sub>	Eastern	634	720	88.1%
	Western	686	720	95.3%
CO	Eastern	688	720	95.6%
	Western	688	720	95.6%

## 8.2 Results

### 8.2.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 20. A plot of PM<sub>2.5</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 14.

**Table 20: PM<sub>2.5</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>2.5</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.11	0.084	0.078	0.066	0.061	0.040	0.018
Western	0.17	0.13	0.12	0.086	0.061	0.044	0.030

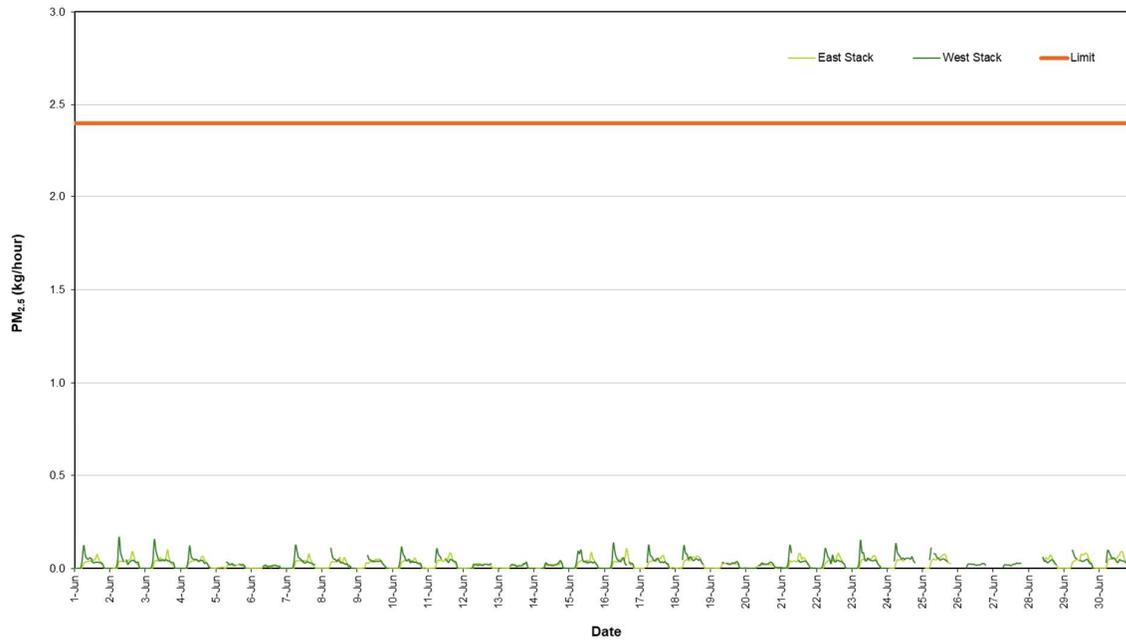


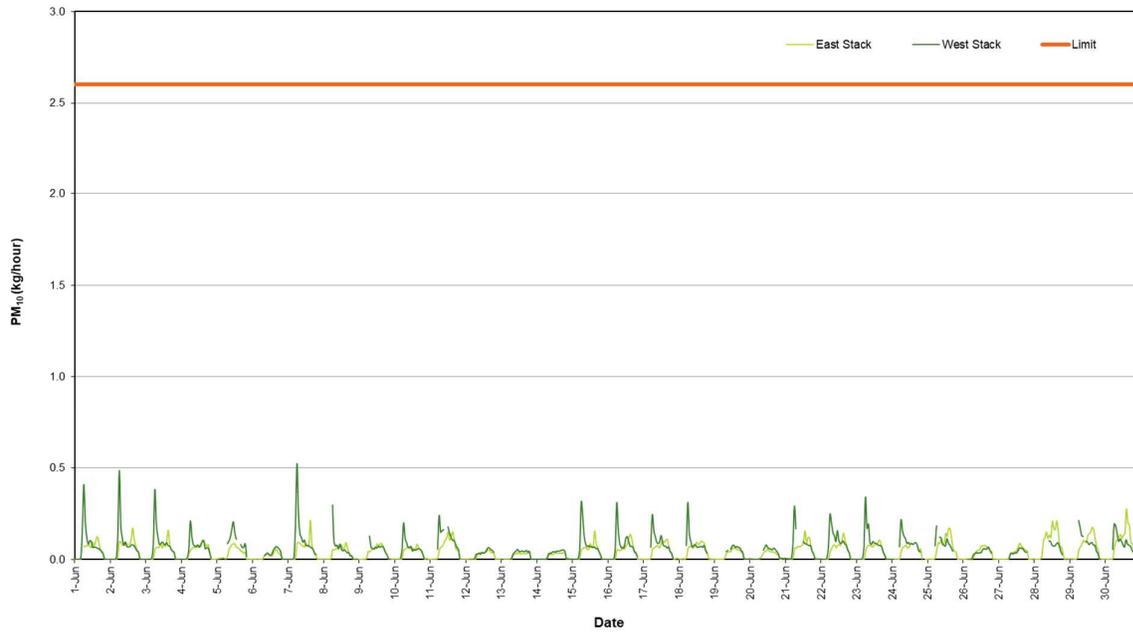
Figure 14: PM<sub>2.5</sub> Mass Rate (1 Hour Average)

### 8.2.2 PM<sub>10</sub>

PM<sub>10</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 21. A plot of PM<sub>10</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 15.

Table 21: PM<sub>10</sub> Mass Rate Percentiles (1 Hour Average)

Station	PM <sub>10</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.28	0.17	0.16	0.12	0.095	0.069	0.033
Western	0.52	0.31	0.24	0.18	0.13	0.084	0.058



**Figure 15: PM<sub>10</sub> Mass Rate (1 Hour Average)**

### 8.2.3 Carbon Monoxide

Carbon monoxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 22. A plot of carbon monoxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 16.

**Table 22: Carbon Monoxide Mass Rate Percentiles (1 Hour Average)**

Station	Carbon Monoxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	7.2	4.7	4.5	3.8	3.1	2.4	1.5
Western	8.2	7.3	6.8	5.3	4.0	2.9	2.3

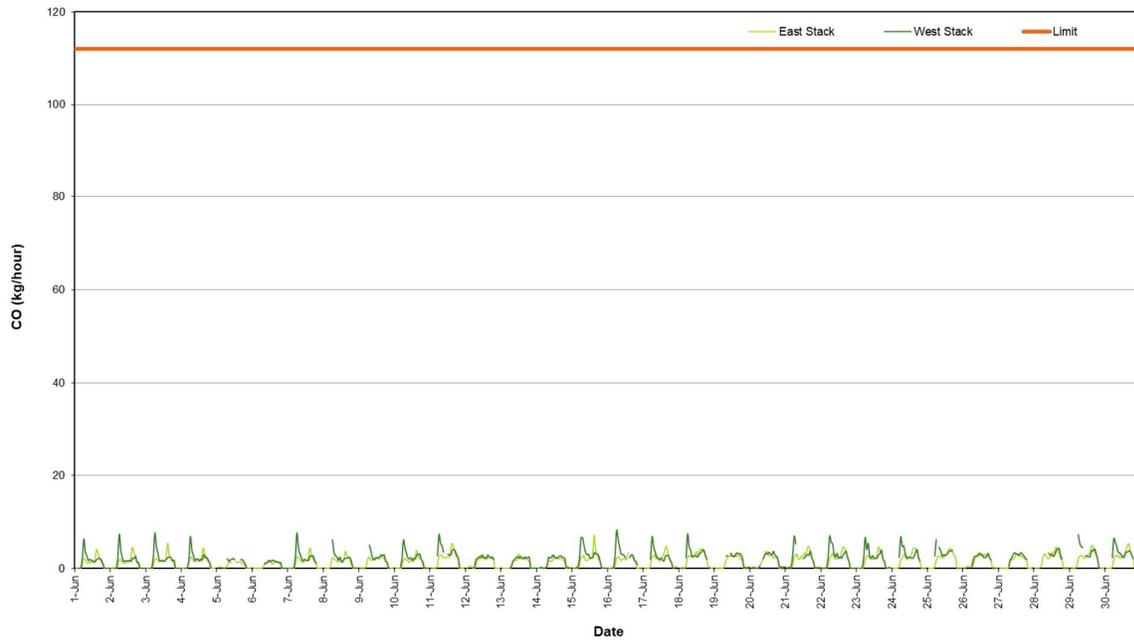


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

## 8.2.4 Oxides of Nitrogen

### 8.2.4.1 Nitric Oxide

Nitric oxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 23. A plot of nitric oxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 17.

Table 23: Nitric Oxide Mass Rate Percentiles (1 Hour Average)

Station	Nitric Oxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	2.7	2.4	1.9	1.7	1.5	1.2	0.47
Western	4.6	4.1	3.8	2.6	1.8	1.3	0.75

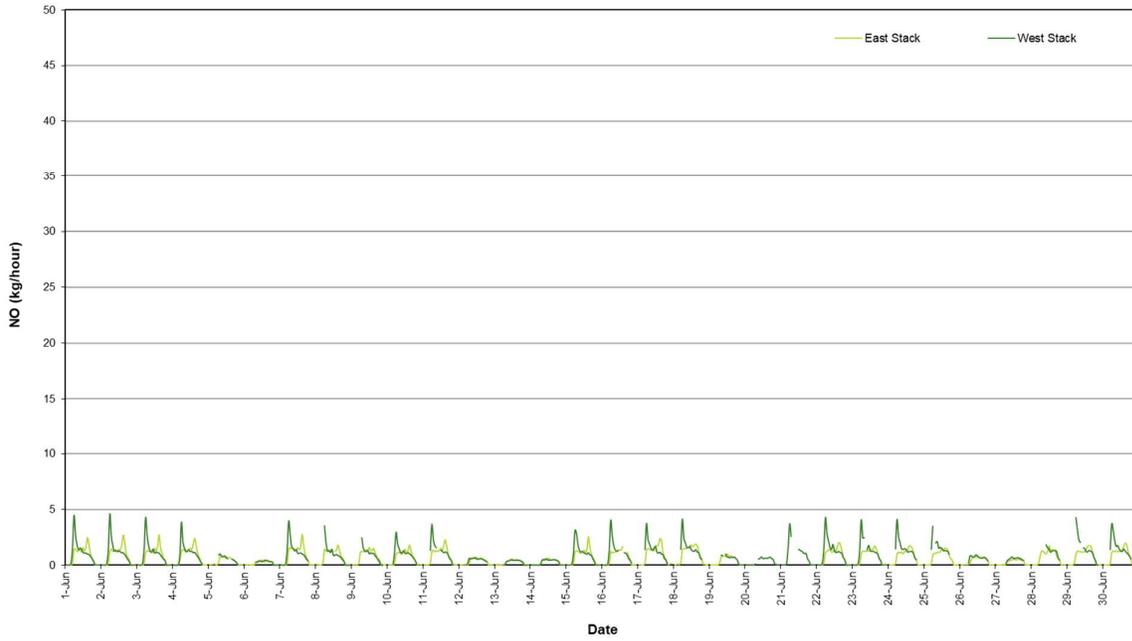


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

### 8.2.4.2 Nitrogen Dioxide

Nitrogen dioxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 24. A plot of nitrogen dioxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 18.

Table 24: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average)

Station	Nitrogen Dioxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.60	0.49	0.41	0.35	0.28	0.22	0.098
Western	0.34	0.29	0.26	0.16	0.11	0.084	0.063

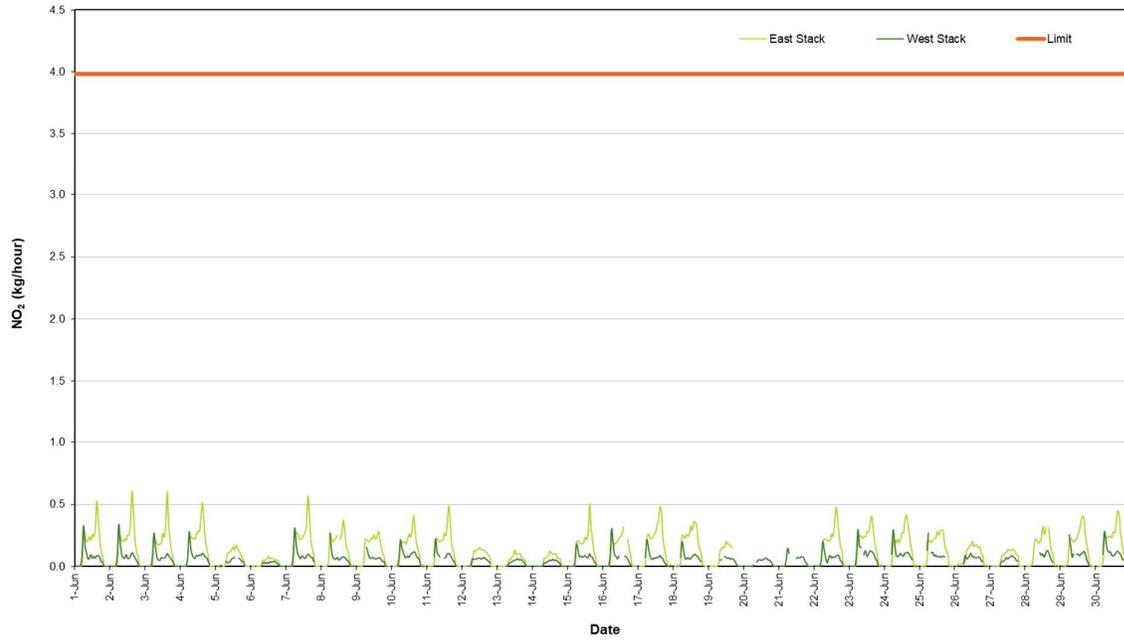


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)

### 8.2.5 Stack Velocity

The stack velocity (1 hour average) plot for the reporting period is presented in Figure 19.

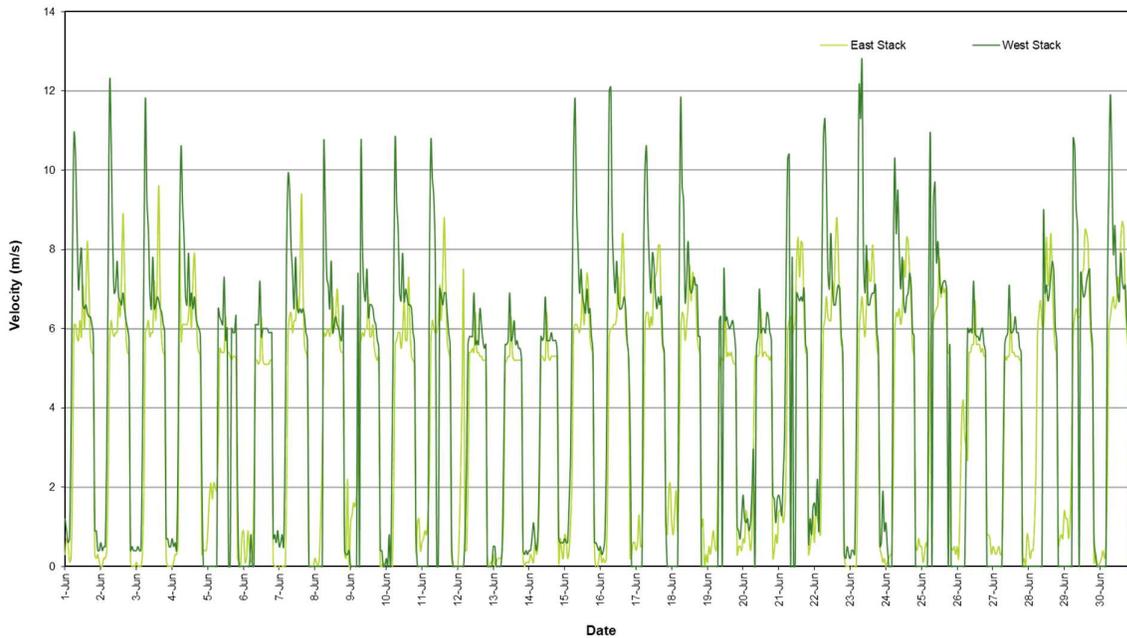


Figure 19: Stack Velocity (1 Hour Average)

### 8.3 Data Validation and Exceptions

Data contained in the report has been validated against performance and calibration requirements for each instrument. Data during maintenance and calibration periods has been removed from the validated data sets. Tables 25 and 26 list the data exceptions for the eastern and western ventilation stacks, where valid data is less than 75% of the one hour average. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

**Table 25: Data Exceptions - Eastern Ventilation Stack: June 2021**

Start	End	Parameter	Reason
8/06/2021 12:20	8/06/2021 12:45	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
16/06/2021 14:50	16/06/2021 16:45	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
16/06/2021 15:35	16/06/2021 16:40	CO	Maintenance / calibration
19/06/2021 16:50	21/06/2021 13:10	NO, NO <sub>2</sub> , NO <sub>x</sub>	Invalid sample flow
23/06/2021 13:35	24/06/2021 01:30	PM <sub>2.5</sub>	Maintenance / calibration
24/06/2021 13:35	24/06/2021 16:50	PM <sub>10</sub>	Maintenance / calibration
25/06/2021 20:30	28/06/2021 10:30	PM <sub>2.5</sub>	Invalid sample flow

**Table 26: Data Exceptions - Western Ventilation Stack: June 2021**

Start	End	Parameter	Reason
2/06/2021 10:30	2/06/2021 11:15	PM <sub>10</sub> , PM <sub>2.5</sub>	Maintenance / calibration
4/06/2021 21:05	5/06/2021 06:25	Stack velocity	Low signal
5/06/2021 04:55	5/06/2021 06:50	PM <sub>2.5</sub>	Invalid <sup>1</sup>
5/06/2021 14:15	5/06/2021 15:25	Stack velocity	Low signal
5/06/2021 21:20	6/06/2021 04:50	Stack velocity	Low signal
6/06/2021 06:20	6/06/2021 07:20	Stack velocity	Low signal
7/06/2021 20:40	8/06/2021 05:20	Stack velocity	Low signal
8/06/2021 20:50	8/06/2021 20:55	Stack velocity	Low signal
9/06/2021 01:00	9/06/2021 04:35	Stack velocity	Low signal
9/06/2021 22:35	10/06/2021 00:10	Stack velocity	Low signal
10/06/2021 20:50	11/06/2021 04:30	Stack velocity	Low signal
11/06/2021 10:30	11/06/2021 11:35	Stack velocity	Low signal

Start	End	Parameter	Reason
11/06/2021 21:25	12/06/2021 04:55	Stack velocity	Low signal
12/06/2021 02:30	12/06/2021 05:05	PM <sub>2.5</sub>	Invalid <sup>1</sup>
12/06/2021 19:55	13/06/2021 06:00	Stack velocity	Low signal
12/06/2021 20:30	12/06/2021 23:40	PM <sub>2.5</sub>	Invalid <sup>1</sup>
13/06/2021 05:00	13/06/2021 07:40	PM <sub>2.5</sub>	Invalid <sup>1</sup>
14/06/2021 02:05	14/06/2021 04:30	PM <sub>2.5</sub>	Invalid <sup>1</sup>
16/06/2021 12:40	16/06/2021 14:25	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
16/06/2021 13:15	16/06/2021 14:25	CO	Maintenance / calibration
16/06/2021 21:35	17/06/2021 04:30	Stack velocity	Low signal
17/06/2021 21:10	18/06/2021 04:30	Stack velocity	Low signal
18/06/2021 20:20	19/06/2021 06:30	Stack velocity	Low signal
19/06/2021 03:55	19/06/2021 06:35	PM <sub>2.5</sub>	Invalid <sup>1</sup>
21/06/2021 10:05	21/06/2021 11:45	Stack velocity	Low signal
23/06/2021 09:00	23/06/2021 09:40	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
24/06/2021 02:00	24/06/2021 04:15	Stack velocity	Low signal
24/06/2021 20:05	25/06/2021 04:30	Stack velocity	Low signal
25/06/2021 20:15	26/06/2021 05:40	Stack velocity	Low signal

**Note:** <sup>1</sup> – In the opinion of the reviewer.

There were instances where PM<sub>2.5</sub> concentration was greater than the corresponding PM<sub>10</sub> concentration. If no valid reason was found to exclude the data, the data was left unchanged in the data set. An example of such an occurrence is listed below:

- West Ventilation stack 15/06/2021 08:30 – 15/06/2021 08:45

## 9.0 DISCUSSION

### 9.1 Comparison with Licence Limits

EastLink emissions to air from the road tunnel ventilation stacks DP1 and DP2 are subject to the licence requirements contained in Environment Protection Authority (Victoria) Environmental Licence No. 2043 (The Licence).

The maximum measured 1 hour average mass rate for each parameter is compared with the applicable licence limit in Table 27.

**Table 27: Maximum (1 Hour Average) Mass Rate (01/04/2021 - 30/06/2021)**

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM <sub>2.5</sub>	0.20	2.4
		PM <sub>10</sub>	0.52	2.6
		NO <sub>2</sub>	0.37	3.98
		CO	9.1	112
2	Eastern ventilation stack	PM <sub>2.5</sub>	0.25	2.4
		PM <sub>10</sub>	0.28	2.6
		NO <sub>2</sub>	0.99	3.98
		CO	8.2	112

There were no exceedances of the licence limits for DP1 and DP2 during the reporting period.

The procedure for reporting of particulate matter results from the TEOMs and assessment of licence compliance is outlined in the EastLink Particulate Matter Protocol (PMP) dated 17/6/2013 (Golder Reference 107613157-020-R-Rev0). The PMP requires validated uncorrected TEOM one hour clock average data to be reported and compared to the following TEOM mass rate compliance limits for both DP1 and DP2:

- PM<sub>2.5</sub> (DP1, DP2): 2.0 kg/h
- PM<sub>10</sub> (DP1, DP2): 2.0 kg/h

There were no exceedances of the PM<sub>10</sub> or PM<sub>2.5</sub> TEOM mass rate compliance levels for DP1 during the reporting period.

There were no exceedances of the PM<sub>10</sub> or PM<sub>2.5</sub> TEOM mass rate compliance levels for DP2 during the reporting period.

## 9.2 Data Capture Year to Date

Data capture statistics for 2021 year to date (01/01/2021 – 30/06/2021) are presented in Table 28.

**Table 28: Data Capture Year to Date (%)**

Station	NO <sub>2</sub>	CO	PM <sub>2.5</sub>	PM <sub>10</sub>	Velocity
Eastern	90.0%	97.1%	98.1%	99.3%	100%
Western	94.4%	94.4%	95.6%	99.5%	92.8%

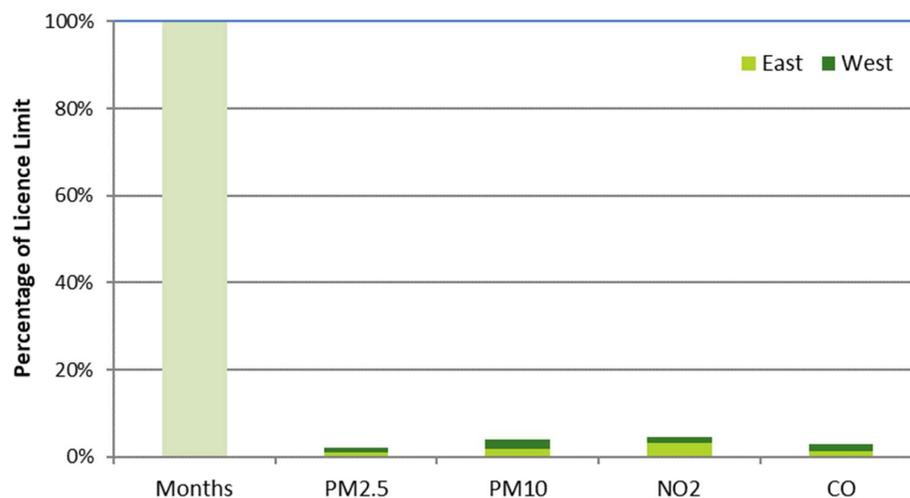
## 9.3 Bubble Licence

The Licence contains a Bubble Limit which specifies the annual discharge limits of each parameter for each ventilation stack. Annual emission rates are calculated from 1<sup>st</sup> July to 30<sup>th</sup> June each year to coincide with the Annual Performance Statement (APS) reporting period. Ventilation stack emission rates year to date (1/07/2020 to 30/06/2021) are shown in Table 29.

**Table 29: Ventilation Stack Emissions 1/07/2020 – 30/06/2021 (tonnes/year)**

Station	NO <sub>2</sub>	CO	PM <sub>2.5</sub>	PM <sub>10</sub>
Eastern	1.1	13	0.22	0.43
Western	0.45	15	0.23	0.47
<b>Total</b>	1.6	28	0.45	0.91
Licence limit	35	980	21	23

Figure 20 presents the ventilation stack emissions of each parameter as a percentage of the Licence limit compared with the percentage of APS reporting period elapsed.



**Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2020 – 30/06/2021)**

**The corresponding bubble limits for uncorrected PM<sub>2.5</sub> and PM<sub>10</sub> TEOM data are:**

- PM<sub>2.5</sub> (DP1 and DP2): 17.5 tonnes/year
- PM<sub>10</sub> (DP1 and DP2): 17.5 tonnes/year

## Signature Page

### Golder Associates Pty Ltd



Anthony Myszka  
*Environmental Technician*



Mark Tulau  
*Senior Air Quality Specialist*

AM/MDT/am

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**APPENDIX A**

**Important Information Relating to  
this Report**

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Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

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