REPORT

EastLink Ventilation Stack Emission Monitoring Report October - December 2019

Submitted to:

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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 29th June 2008 with the opening of the EastLink motorway. Results for the sampling period 1st October 2019 to 31st December 2019 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
October	TBA	TBA
November	TBA	TBA
December	TBA	TBA

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 ($PM_{2.5}$)
- Particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM_{10})
- Total oxides of nitrogen (NO_x)
- Nitric oxide (NO)
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO)
- Stack velocity
- Stack temperature
- Ambient pressure.

4.0 METHODS

4.1 $PM_{2.5}$

$PM_{2.5}$ 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 $PM_{2.5}$ size selective inlet (PM_{10} WINS head fitted with a $PM_{2.5}$ sharp cut cyclone (SCC)) at 1 m^3/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 $PM_{2.5}$ 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 – $PM_{2.5}$ Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance Monitor"*.

4.2 PM_{10}

PM_{10} 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_{10} size selective inlet (PM_{10} WINS head) at 1 m^3/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_{10} 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_{10} 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_2 and NO_x) 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_{10}	TEOM	± 5%
$PM_{2.5}$	TEOM	± 5%
NO, NO_2, NO_X	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: 01/10/2019 – 31/10/2019

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 1st October to 31st October 2019 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_x 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
$PM_{2.5}$	Eastern	720	744	96.8%
	Western	735	744	98.8%
PM_{10}	Eastern	741	744	97.6%
	Western	743	744	99.9%
NO, NO_2	Eastern	703	744	95.4%
	Western	710	744	95.4%
CO	Eastern	711	744	95.6%
	Western	706	744	94.9%

6.2 Results

6.2.1 $PM_{2.5}$

$PM_{2.5}$ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 4.
A plot of $PM_{2.5}$ (1 hour average) mass rate of emission for the reporting period is presented in Figure 2.

Table 4: $PM_{2.5}$ Mass Rate Percentiles (1 Hour Average)

Station	$PM_{2.5}$ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	0.24	0.15	0.14	0.11	0.078	0.062	0.028
Western	0.19	0.14	0.13	0.10	0.078	0.050	0.027

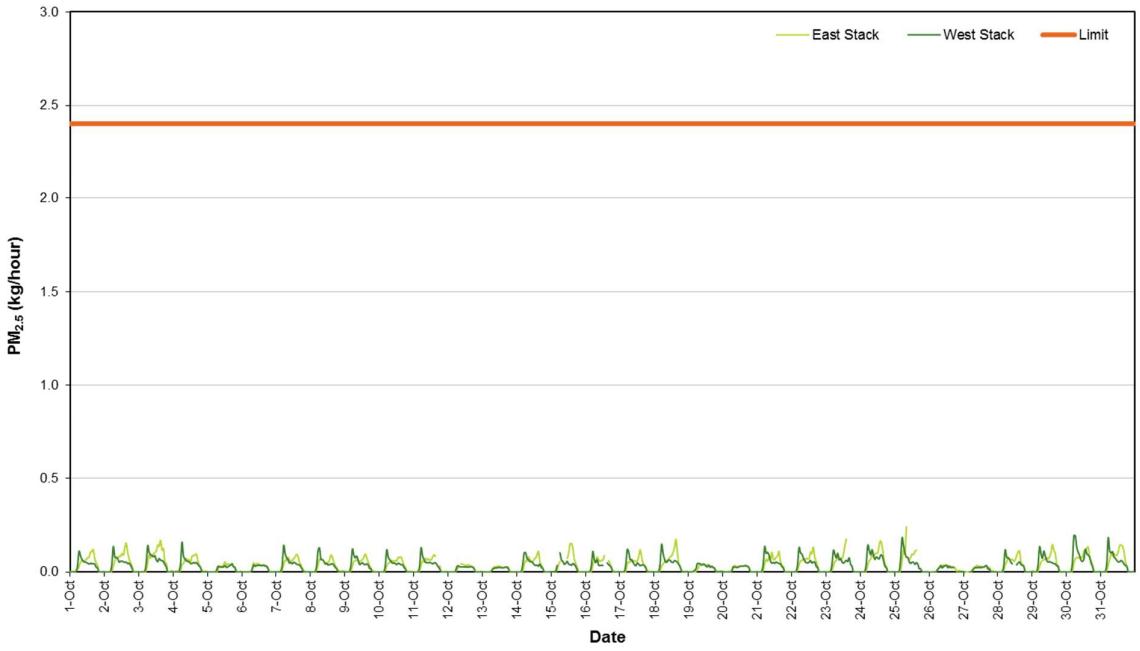

Figure 2: $PM_{2.5}$ Mass Rate (1 Hour Average)

6.2.2 PM_{10}

PM_{10} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 5.
A plot of PM_{10} (1 hour average) mass rate of emission for the reporting period is presented in Figure 3.

Table 5: PM_{10} Mass Rate Percentiles (1 Hour Average)

Station	PM_{10} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	1.3	0.31	0.25	0.19	0.14	0.097	0.056
Western	0.43	0.32	0.28	0.20	0.15	0.091	0.061

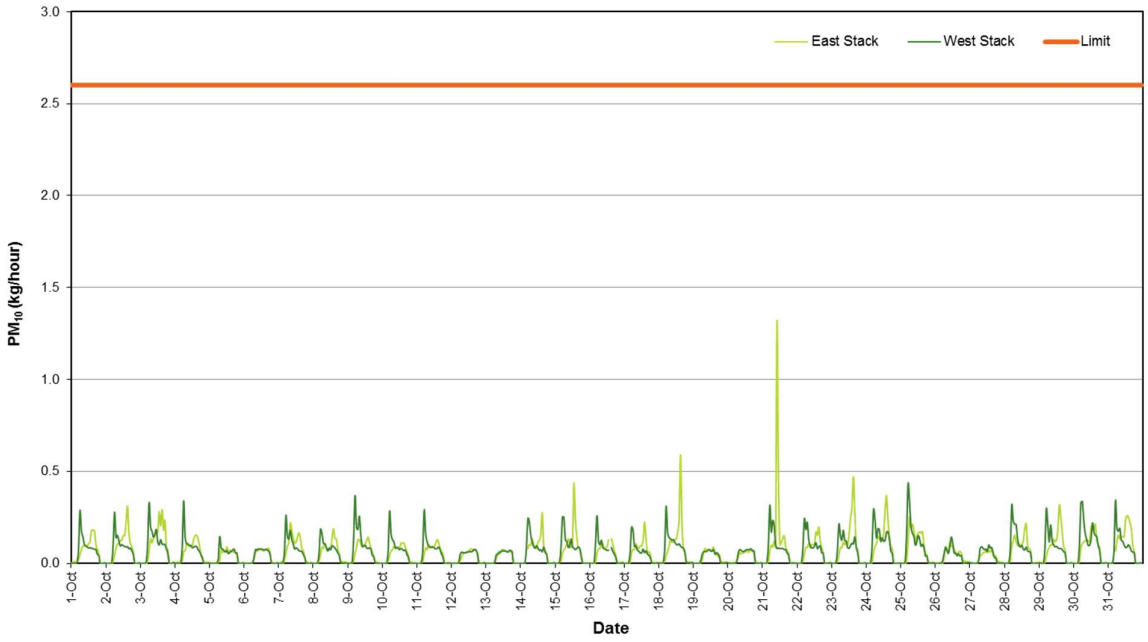

Figure 3: PM_{10} Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	13	7.3	7.0	5.6	4.2	2.9	2.2
Western	8.3	6.7	6.3	5.4	4.1	2.9	2.1

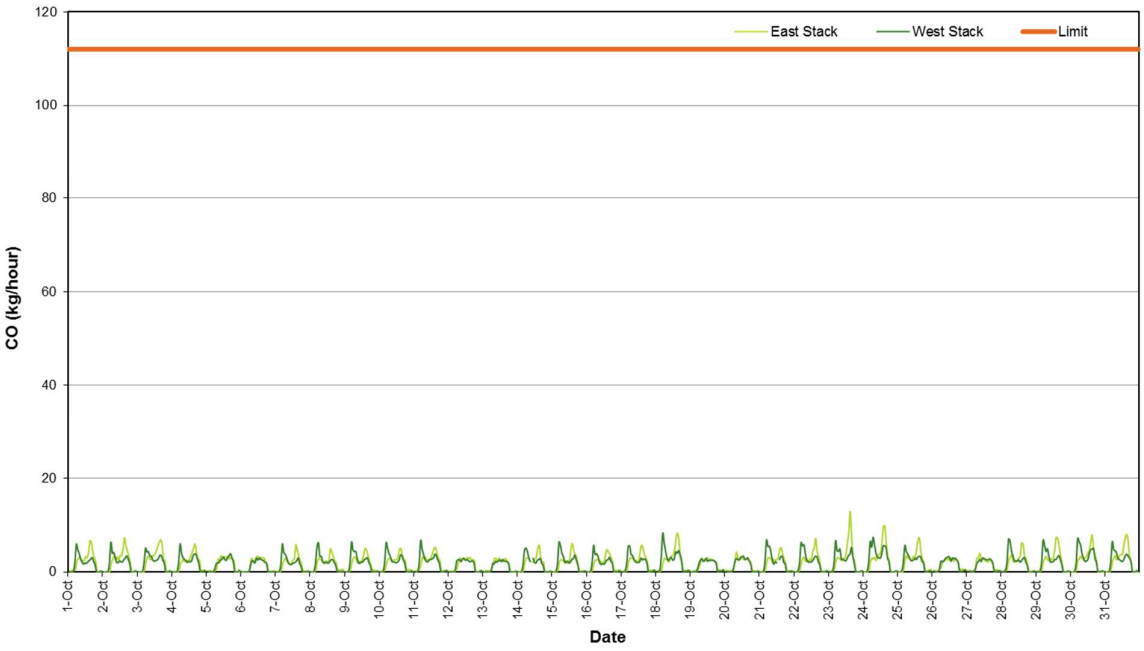

Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	4.3	3.2	2.7	2.3	1.9	1.4	0.56
Western	4.3	3.3	3.1	2.2	1.6	1.1	0.53

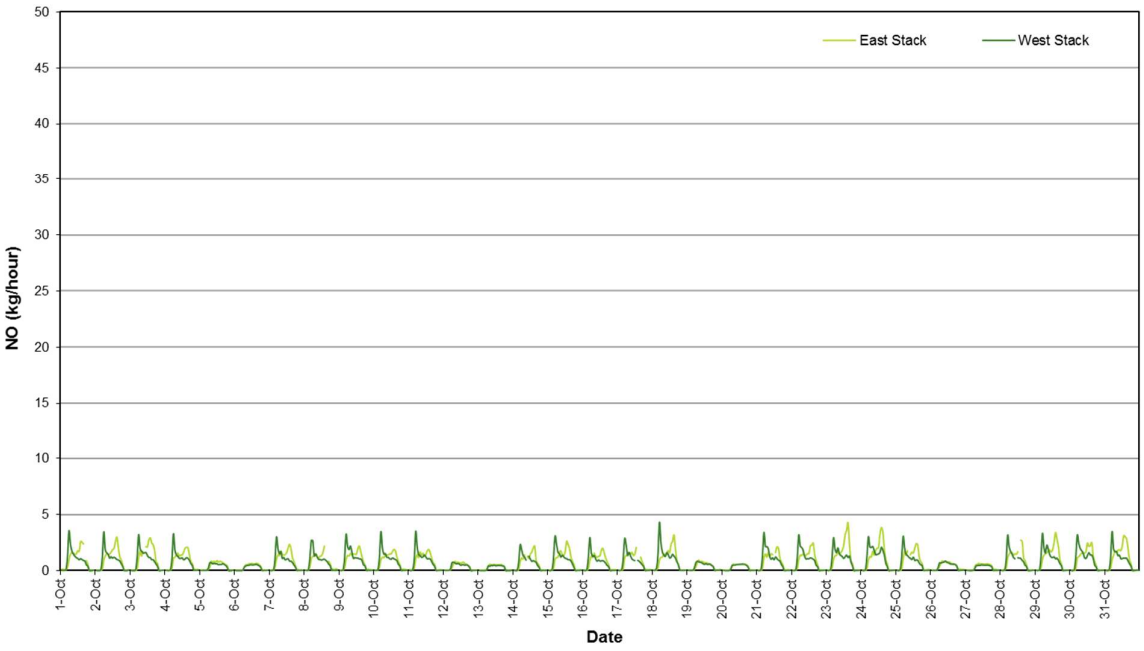

Figure 5: Nitric Oxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	1.1	0.77	0.67	0.53	0.39	0.26	0.13
Western	0.67	0.60	0.53	0.36	0.29	0.20	0.11

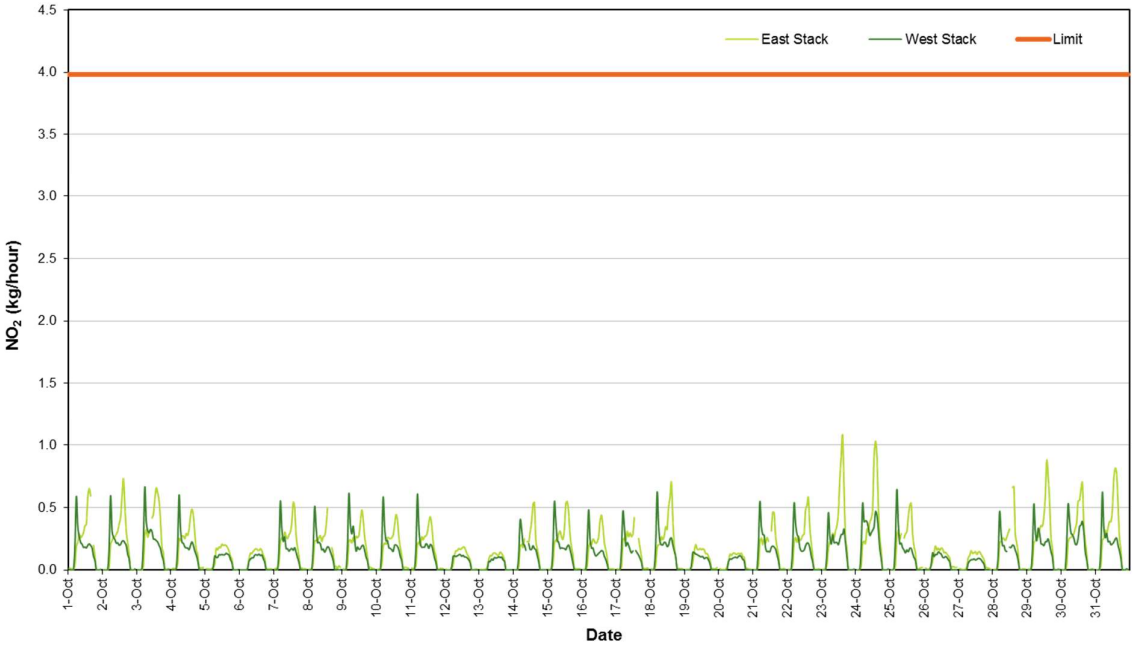

Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)

6.2.5 Stack Velocity

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

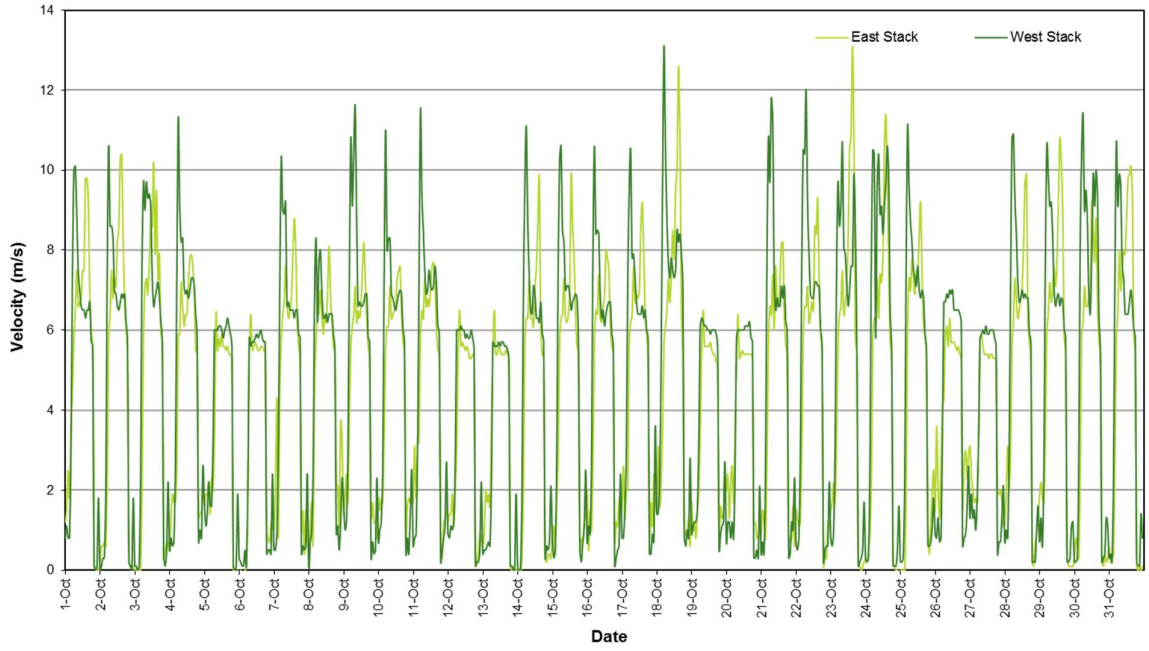

Figure 7: Stack Velocity (1 Hour Average)

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: October 2019

Start	End	Parameter	Reason
1/10/2019 17:00	1/10/2019 17:30	NO, NO_2, NO_x	Maintenance / calibration
3/10/2019 10:25	3/10/2019 10:55	NO, NO_2, NO_x	Maintenance / calibration
8/10/2019 15:40	8/10/2019 16:20	NO, NO_2, NO_x	Maintenance / calibration
14/10/2019 09:25	14/10/2019 10:05	CO, NO, NO_2, NO_x	Maintenance / calibration
15/10/2019 01:50	15/10/2019 03:10	$PM_{2.5}$	Invalid data[1]
15/10/2019 07:20	15/10/2019 10:55	$PM_{2.5}$	Invalid data[1]
16/10/2019 14:25	16/10/2019 15:15	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
17/10/2019 14:10	17/10/2019 15:50	NO, NO_2, NO_x	Maintenance / calibration
20/10/2019 12:20	20/10/2019 13:45	$PM_{2.5}$	Invalid data[1]
21/10/2019 12:40	21/10/2019 13:05	NO, NO_2, NO_x	Maintenance / calibration
23/10/2019 18:20	23/10/2019 19:30	$PM_{2.5}$	Invalid data[1]
25/10/2019 09:05	25/10/2019 09:35	CO, NO, NO_2, NO_x	Maintenance / calibration
25/10/2019 09:05	25/10/2019 10:05	$PM_{2.5}$	Maintenance / calibration
25/10/2019 16:40	25/10/2019 19:45	$PM_{2.5}$	Invalid data[1]
28/10/2019 12:55	28/10/2019 13:15	NO, NO_2, NO_x	Maintenance / calibration

Notes: [1] – In the opinion of the reviewer

Table 10: Data Exceptions - Western Ventilation Stack: October 2019

Start	End	Parameter	Reason
6/10/2019 07:15	6/10/2019 07:25	$PM_{2.5}$ / PM_{10}	Invalid data[1]
14/10/2019 10:30	14/10/2019 11:05	CO, NO, NO_2, NO_x	Maintenance / calibration
15/10/2019 05:20	15/10/2019 5:55	$PM_{2.5}$	Invalid data[1]
16/10/2019 13:20	16/10/2019 14:25	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
17/10/2019 13:00	17/10/2019 13:45	NO, NO_2, NO_x	Maintenance / calibration
21/10/2019 13:25	21/10/2019 14:00	CO	Maintenance / calibration
26/10/2019 18:05	26/10/2019 20:05	$PM_{2.5}$	Invalid data[1]
27/10/2019 02:10	27/10/2019 03:35	$PM_{2.5}$	Invalid data[1]
27/10/2019 14:10	27/10/2019 14:20	$PM_{2.5}$	Invalid data[1]
27/10/2019 15:30	27/10/2019 15:35	$PM_{2.5}$	Invalid data[1]
28/10/2019 11:05	28/10/2019 11:35	NO, NO_2, NO_x	Maintenance / calibration
28/10/2019 11:40	28/10/2019 12:50	$PM_{2.5}$	Invalid data[1]

Notes: [1] – In the opinion of the reviewer

There were several instances where $PM_{2.5}$ concentration was greater than the corresponding PM_{10} 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:

- East Ventilation stack 25/10/2019 08:10 – 25/10/2019 08:40
- West Ventilation stack 19/10/2019 03:30 – 19/10/2019 05:40

7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/11/2019 – 30/11/2019

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 1st November to 30th November 2019 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
$PM_{2.5}$	Eastern	703	720	97.6%
	Western	651	720	90.4%
PM_{10}	Eastern	703	720	97.6%
	Western	695	720	96.5%
NO, NO_2	Eastern	571	720	79.3%
	Western	689	720	95.7%
CO	Eastern	688	720	95.6%
	Western	686	720	95.3%

7.2 Results

7.2.1 $PM_{2.5}$

$PM_{2.5}$ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 12.
A plot of $PM_{2.5}$ (1 hour average) mass rate of emission for the reporting period is presented in Figure 8.

Table 12: $PM_{2.5}$ Mass Rate Percentiles (1 Hour Average)

Station	$PM_{2.5}$ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	0.22	0.16	0.14	0.11	0.082	0.060	0.024
Western	0.19	0.16	0.14	0.11	0.082	0.047	0.026

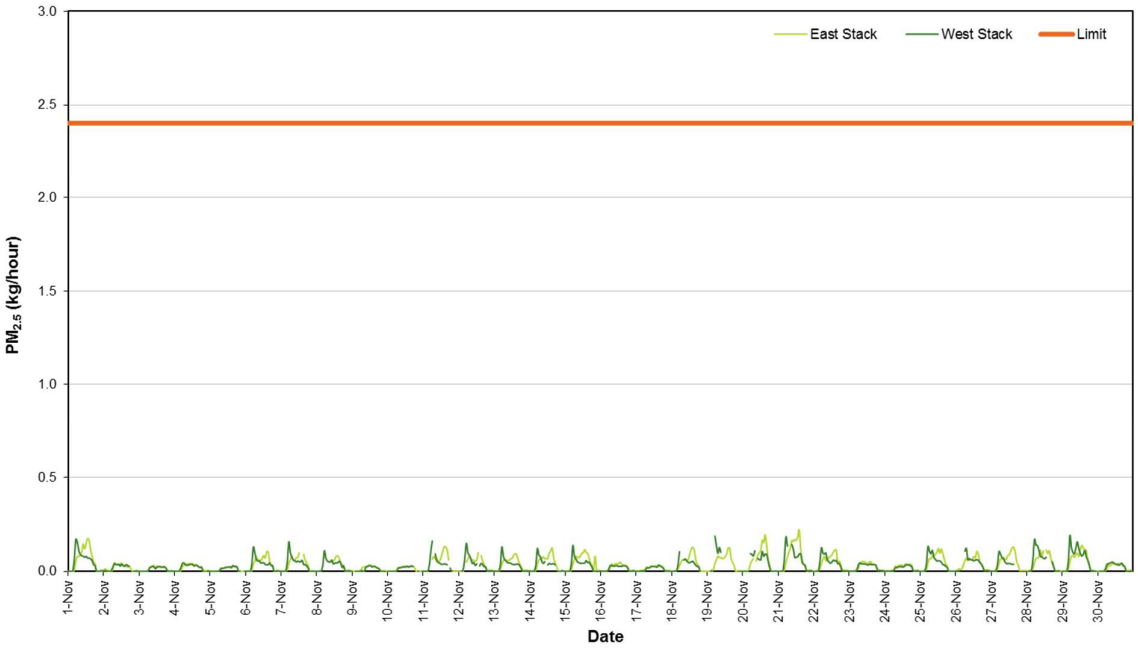

Figure 8: $PM_{2.5}$ Mass Rate (1 Hour Average)

7.2.2 PM_{10}

PM_{10} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 13. A plot of PM_{10} (1 hour average) mass rate of emission for the reporting period is presented in Figure 9.

Table 13: PM_{10} Mass Rate Percentiles (1 Hour Average)

Station	PM_{10} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	1.0	0.31	0.28	0.19	0.15	0.10	0.048
Western	1.1	0.35	0.29	0.21	0.15	0.092	0.051

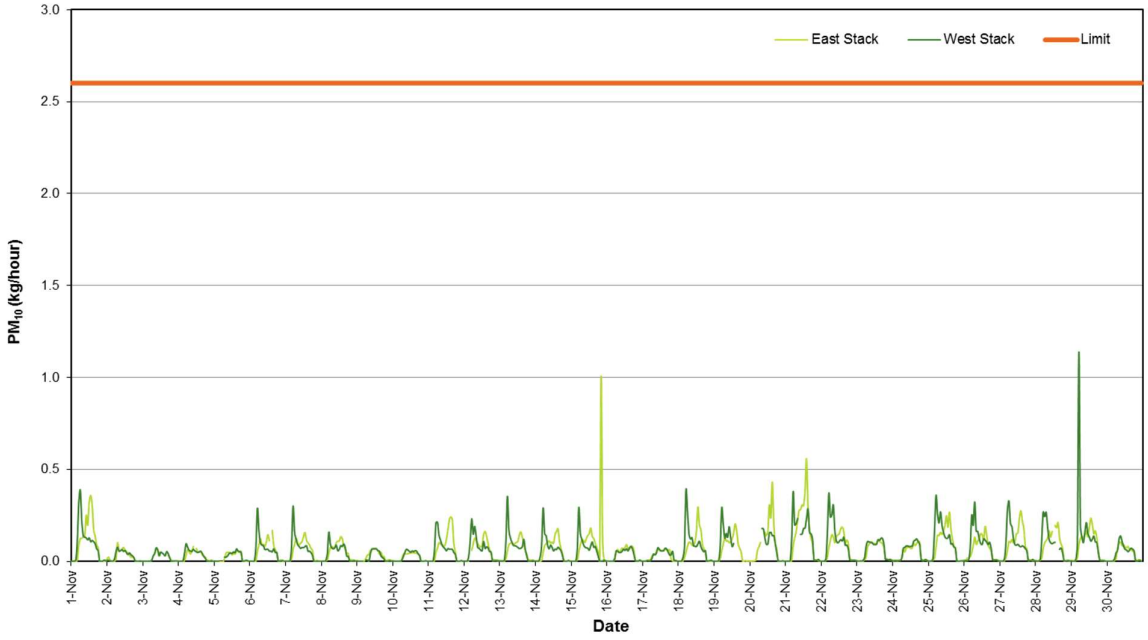

Figure 9: PM_{10} Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	11	7.5	7.1	5.7	4.2	3.1	2.3
Western	7.5	7.0	6.6	5.6	4.4	3.2	2.4

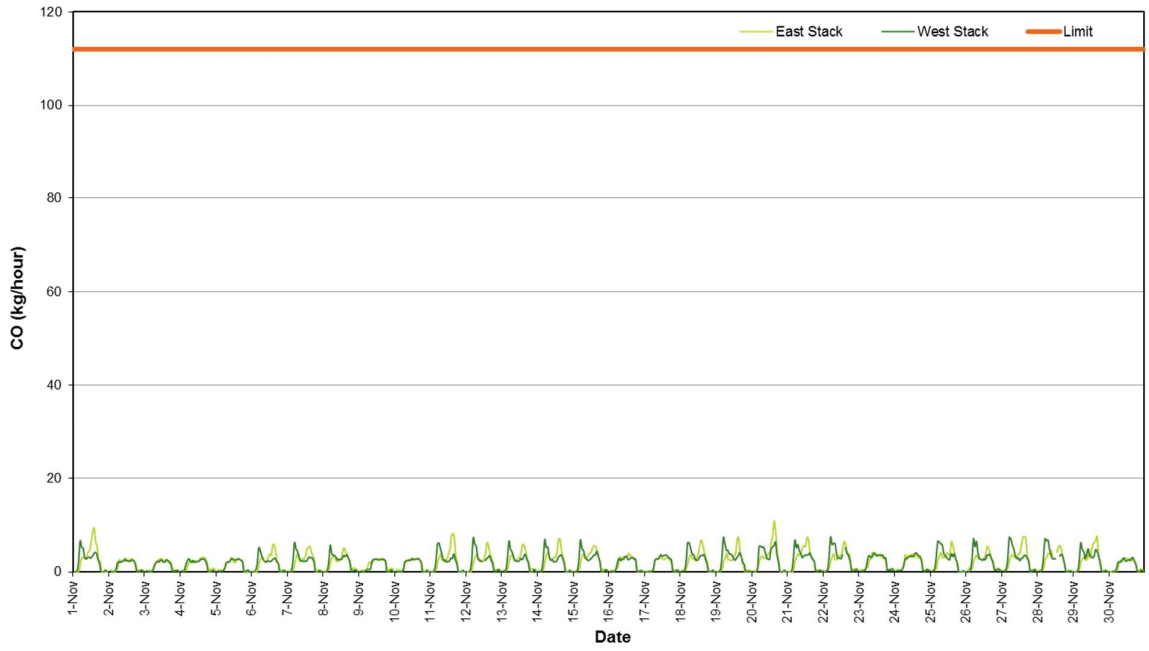

Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	3.9	3.0	2.8	2.4	2.0	1.3	0.56
Western	3.8	3.3	2.9	2.2	1.7	1.1	0.51

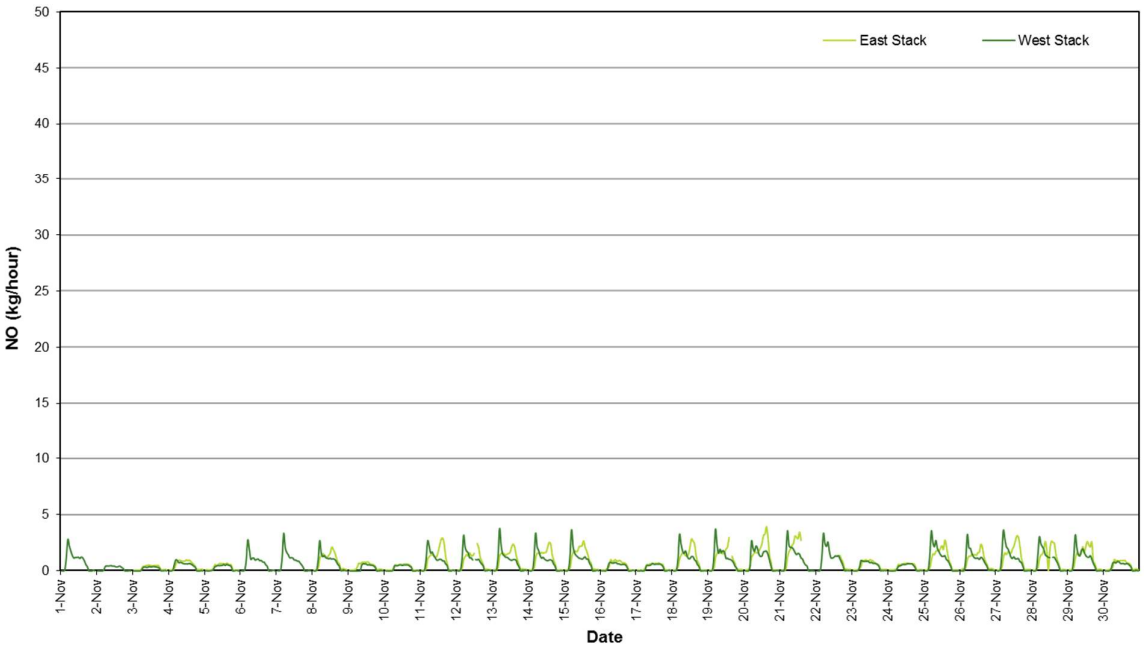

Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	1.0	0.78	0.70	0.54	0.40	0.25	0.12
Western	0.73	0.55	0.48	0.36	0.27	0.17	0.092

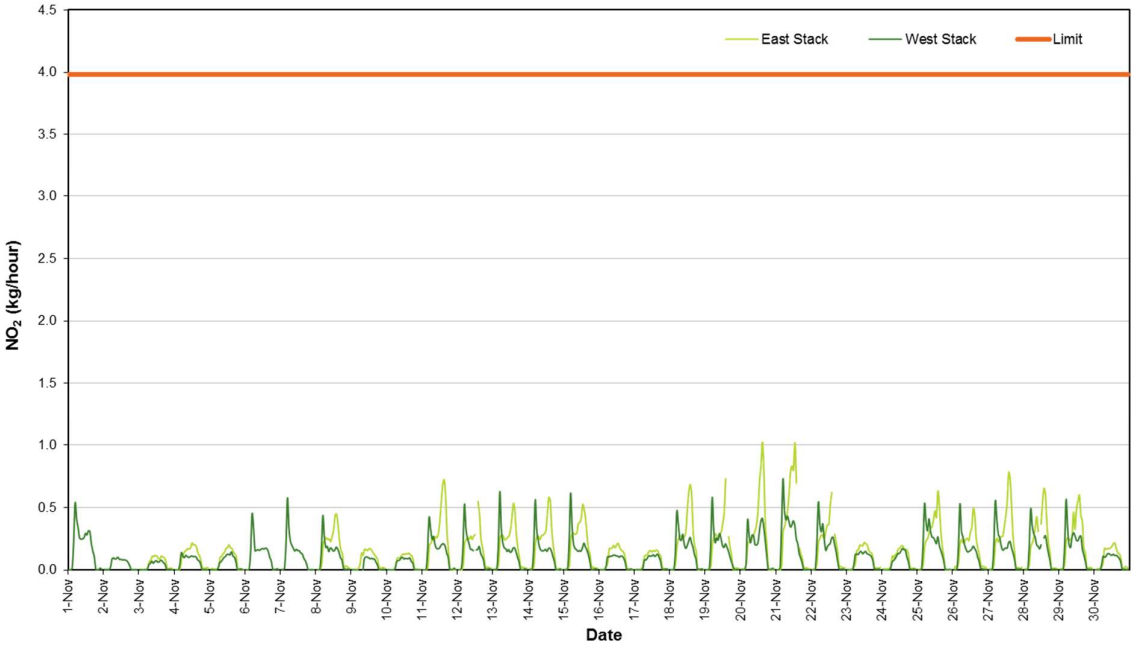

Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)

7.2.5 Stack Velocity

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

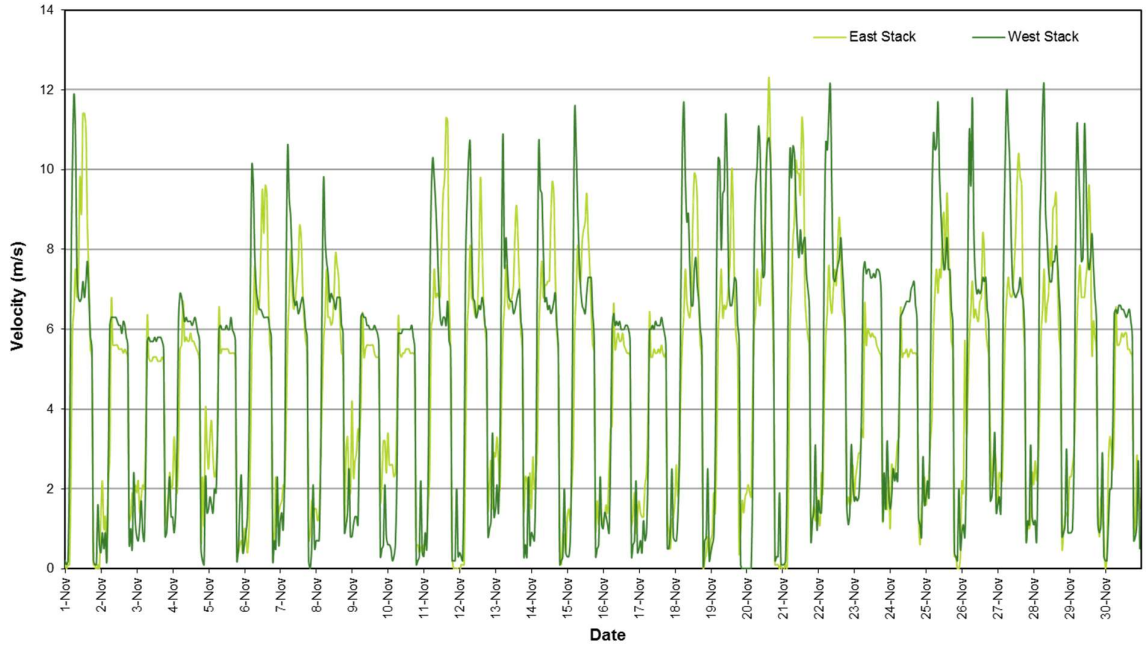

Figure 13: Stack Velocity (1 Hour Average)

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: November 2019

Start	End	Parameter	Reason
1/11/2019 00:00	3/11/2019 00:40	NO, NO_2, NO_x	Invalid data - span drift
3/11/2019 15:30	3/11/2019 16:35	PM_{10}	Invalid data[1]
5/11/2019 01:00	5/11/2019 03:00	PM_{10}	Invalid data[1]
6/11/2019 00:00	8/11/2019 00:40	NO, NO_2, NO_x	Invalid data - span drift
7/11/2019 13:10	7/11/2019 14:55	$PM_{2.5}$	Invalid data[1]
8/11/2019 02:35	8/11/2019 05:05	$PM_{2.5}$	Invalid data[1]
8/11/2019 08:25	8/11/2019 9:55	$PM_{2.5}$	Invalid data[1]
11/11/2019 04:25	11/11/2019 06:10	$PM_{2.5}$	Invalid data[1]
12/11/2019 13:25	12/11/2019 13:55	CO, NO, NO_2, NO_x	Maintenance / calibration
12/11/2019 13:55	12/11/2019 14:35	$PM_{2.5}$	Maintenance / calibration
19/11/2019 14:50	19/11/2019 15:20	NO, NO_2, NO_x	Maintenance / calibration
20/11/2019 08:15	20/11/2019 09:05	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
21/11/2019 15:35	22/11/2019 15:40	NO, NO_2, NO_x	Invalid data - span drift
28/11/2019 11:25	28/11/2019 11:45	NO, NO_2, NO_x	Maintenance / calibration
28/11/2019 11:25	28/11/2019 12:20	CO	Maintenance / calibration
28/11/2019 11:55	28/11/2019 13:10	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
30/11/2019 15:00	30/11/2019 15:20	$PM_{2.5}$	Invalid data[1]

Note: [1] – In the opinion of the reviewer.

Table 18: Data Exceptions - Western Ventilation Stack: November 2019

Start	End	Parameter	Reason
2/11/2019 17:50	2/11/2019 19:15	$PM_{2.5}$	Invalid data[1]
4/11/2019 20:05	4/11/2019 21:35	$PM_{2.5}$	Invalid data[1]
5/11/2019 04:10	5/11/2019 06:50	PM_{10}	Invalid data[1]
5/11/2019 21:00	5/11/2019 22:45	$PM_{2.5}$	Invalid data[1]
9/11/2019 21:00	9/11/2019 23:55	$PM_{2.5}$	Invalid data[1]
11/11/2019 19:50	12/11/2019 01:35	$PM_{2.5}$	Invalid data[1]
12/11/2019 12:25	12/11/2019 12:45	CO, NO, NO_2, NO_x	Maintenance / calibration
12/11/2019 12:25	12/11/2019 12:30	PM_{10}	Maintenance / calibration
12/11/2019 12:55	12/11/2019 13:30	$PM_{2.5}$	Maintenance / calibration
18/11/2019 06:35	18/11/2019 07:45	$PM_{2.5}$	Invalid data[1]
18/11/2019 20:15	19/11/2019 02:10	$PM_{2.5}$	Invalid data[1]
19/11/2019 13:25	19/11/2019 21:55	$PM_{2.5}$	Invalid data[1]
19/11/2019 14:20	20/11/2019 07:20	PM_{10}	Logger error
20/11/2019 09:10	20/11/2019 10:10	$PM_{2.5}$	Maintenance / calibration
21/11/2019 07:40	21/11/2019 08:45	$PM_{2.5}$	Invalid data[1]
22/11/2019 14:10	22/11/2019 14:50	CO	Maintenance / calibration
26/11/2019 03:05	26/11/2019 05:15	$PM_{2.5}$	Invalid data[1]
27/11/2019 16:05	27/11/2019 23:55	$PM_{2.5}$	Invalid data[1]
28/11/2019 13:15	28/11/2019 13:50	CO, NO, NO_2, NO_x	Maintenance / calibration
28/11/2019 14:00	28/11/2019 16:45	$PM_{2.5}$	Invalid data[1]
28/11/2019 14:35	28/11/2019 15:20	PM_{10}	Maintenance / calibration
28/11/2019 22:55	28/11/2019 23:15	$PM_{2.5}$	Invalid data[1]

Note: [1] – In the opinion of the reviewer.

There was an instances where $PM_{2.5}$ concentration was greater than the corresponding PM_{10} 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 21/11/2019 10:20 – 21/11/2019 10:30

8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/12/2019 – 31/12/2019

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 1st December to 31st December 2019 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
$PM_{2.5}$	Eastern	730	744	98.1%
	Western	719	744	96.6%
PM_{10}	Eastern	734	744	98.7%
	Western	736	744	98.9%
NO, NO_2	Eastern	605	744	81.3%
	Western	671	744	90.2%
CO	Eastern	703	744	94.5%
	Western	706	744	94.9%

8.2 Results

8.2.1 $PM_{2.5}$

$PM_{2.5}$ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 20.
A plot of $PM_{2.5}$ (1 hour average) mass rate of emission for the reporting period is presented in Figure 14.

Table 20: $PM_{2.5}$ Mass Rate Percentiles (1 Hour Average)

Station	$PM_{2.5}$ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	0.27	0.19	0.16	0.12	0.095	0.058	0.030
Western	0.23	0.18	0.16	0.12	0.095	0.062	0.031

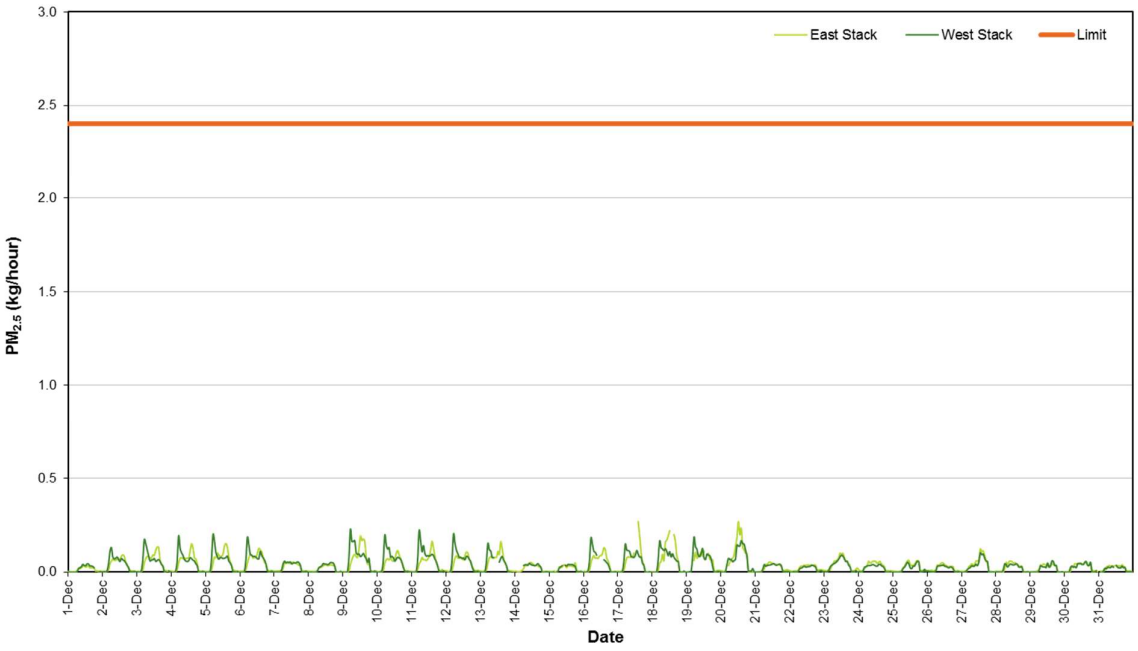

Figure 14: $PM_{2.5}$ Mass Rate (1 Hour Average)

8.2.2 PM_{10}

PM_{10} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 21.
A plot of PM_{10} (1 hour average) mass rate of emission for the reporting period is presented in Figure 15.

Table 21: PM_{10} Mass Rate Percentiles (1 Hour Average)

Station	PM_{10} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	0.43	0.33	0.26	0.19	0.15	0.10	0.060
Western	0.36	0.29	0.27	0.21	0.15	0.099	0.063

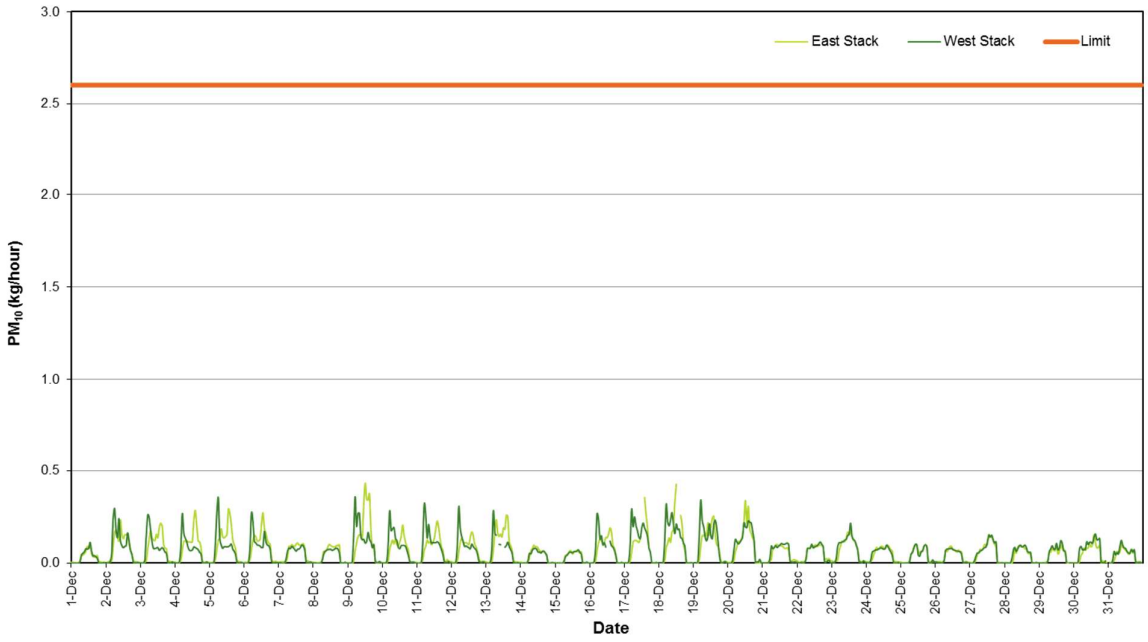

Figure 15: PM_{10} Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	8.2	7.4	6.4	5.0	3.7	2.9	2.0
Western	7.8	6.6	6.0	5.1	4.3	3.1	2.2

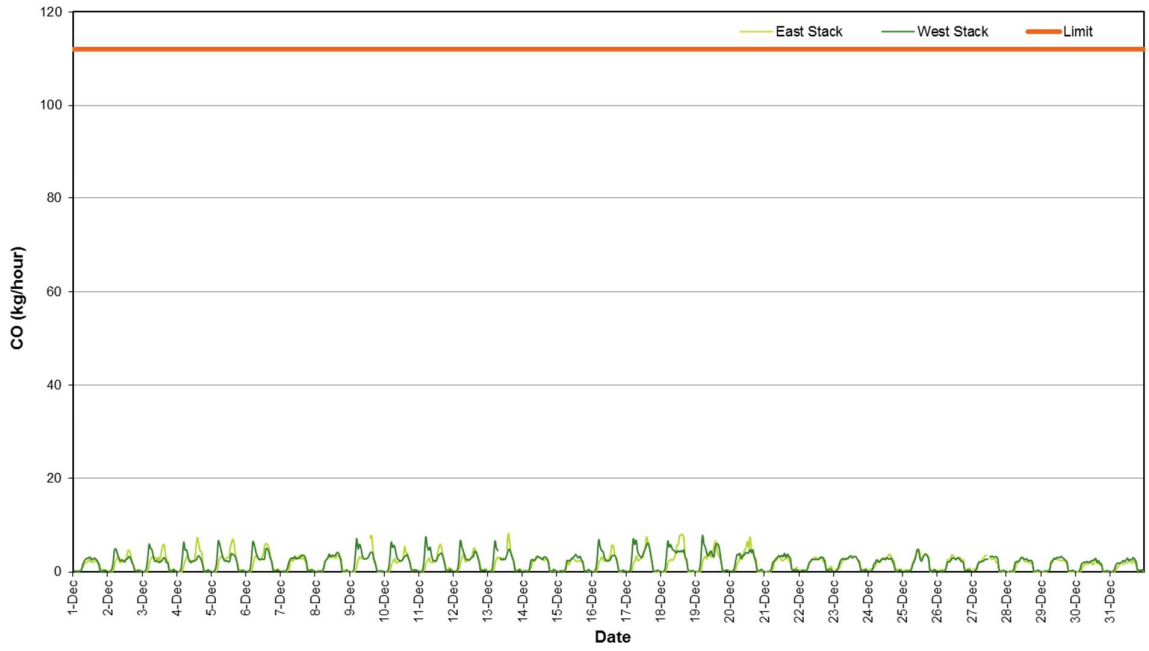

Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	4.3	3.5	2.9	2.3	1.7	1.0	0.51
Western	4.0	3.3	2.5	1.9	1.5	0.87	0.46

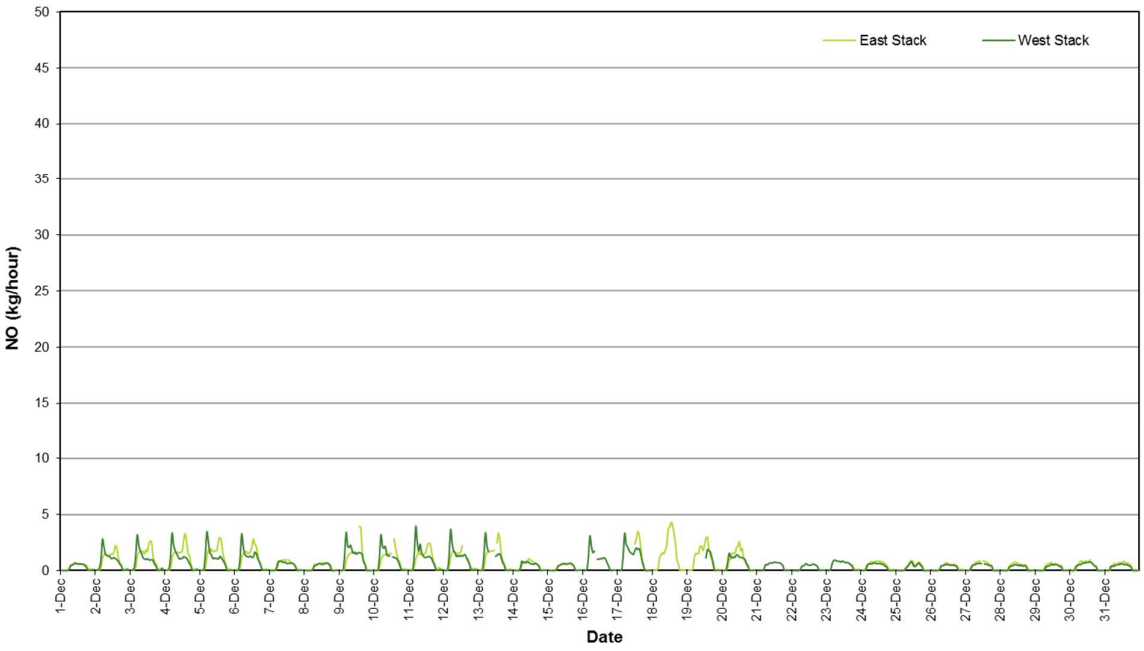

Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	1.2	0.91	0.74	0.53	0.33	0.24	0.11
Western	0.70	0.55	0.44	0.36	0.25	0.17	0.092

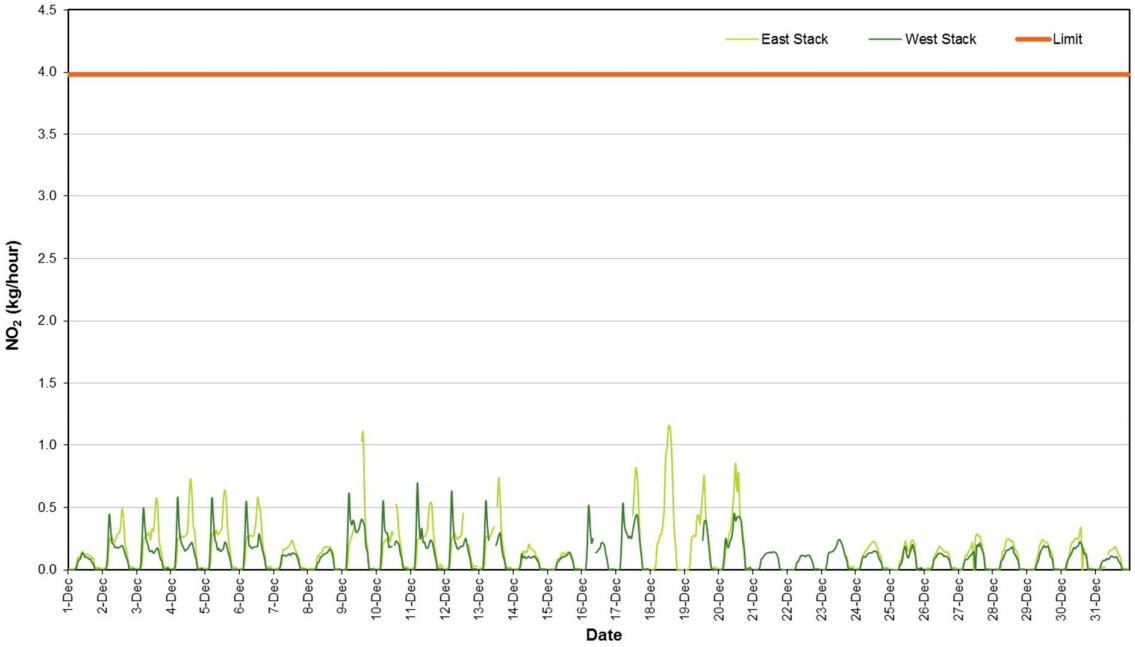

Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)

8.2.5 Stack Velocity

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

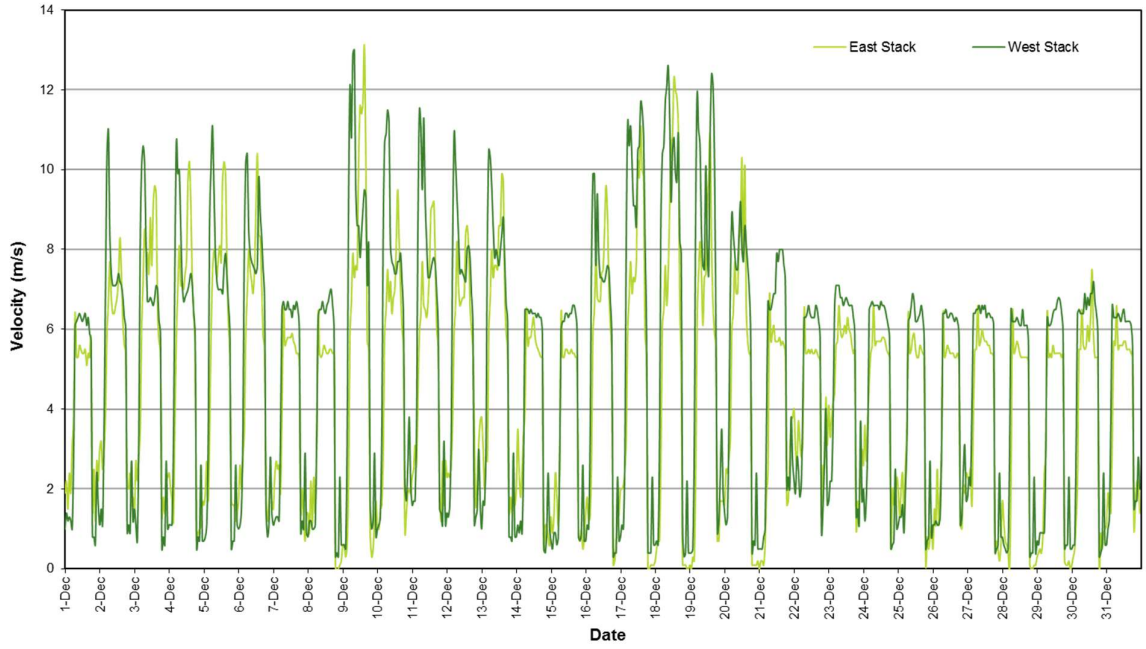

Figure 19: Stack Velocity (1 Hour Average)

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: December 2019

Start	End	Parameter	Reason
9/12/2019 10:15	9/12/2019 14:00	CO, NO, NO_2, NO_x	Maintenance / calibration
10/12/2019 12:45	10/12/2019 14:05	NO, NO_2, NO_x	Maintenance / calibration
12/12/2019 14:40	12/12/2019 16:40	NO, NO_2, NO_x	Maintenance / calibration
13/12/2019 12:00	13/12/2019 12:25	CO, NO, NO_2, NO_x	Maintenance / calibration
16/12/2019 01:00	17/12/2019 11:30	NO, NO_2, NO_x	Invalid data – span drift
17/12/2019 11:50	17/12/2019 13:55	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
18/12/2019 13:20	18/12/2019 14:25	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
19/12/2019 01:55	19/12/2019 04:15	$PM_{2.5}$	Invalid data[1]
19/12/2019 12:50	19/12/2019 14:40	$PM_{2.5}$	Maintenance / calibration
21/12/2019 01:00	23/12/2019 17:10	NO, NO_2, NO_x	Invalid data – span drift
23/12/2019 14:15	23/12/2019 16:40	CO	Maintenance / calibration
27/12/2019 11:25	27/12/2019 11:45	CO, NO, NO_2, NO_x	Maintenance / calibration
30/12/2019 15:10	30/12/2019 15:35	NO, NO_2, NO_x	Maintenance / calibration
31/12/2019 08:05	31/12/2019 08:40	CO, NO, NO_2, NO_x	Maintenance / calibration

Note: [1] – In the opinion of the reviewer.

Table 26: Data Exceptions - Western Ventilation Stack: December 2019

Start	End	Parameter	Reason
10/12/2019 11:50	10/12/2019 12:15	NO, NO_2, NO_x	Maintenance / calibration
13/12/2019 8:10	13/12/2019 11:20	NO, NO_2, NO_x	Maintenance / calibration
13/12/2019 9:45	13/12/2019 12:55	$PM_{2.5}$	Maintenance / calibration
13/12/2019 10:50	13/12/2019 12:25	PM_{10}	Maintenance / calibration
13/12/2019 22:40	14/12/2019 3:30	$PM_{2.5}$	Invalid data[1]

Start	End	Parameter	Reason
16/12/2019 09:40	16/12/2019 10:05	NO, NO_2, NO_x	Maintenance / calibration
16/12/2019 10:25	16/12/2019 14:05	$PM_{2.5}$	Maintenance / calibration
16/12/2019 12:05	16/12/2019 14:05	PM_{10}	Maintenance / calibration
18/12/2019 01:00	19/12/2019 12:50	NO, NO_2, NO_x	Invalid data – span drift
27/12/2019 12:20	27/12/2019 12:45	CO, NO, NO_2, NO_x	Maintenance / calibration

Note: [1] – In the opinion of the reviewer.

There was an instances where $PM_{2.5}$ concentration was greater than the corresponding PM_{10} 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 15/12/2019 18:45 – 15/12/2019 20:10

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 (01/10/2019 - 31/12/2019)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	$PM_{2.5}$	0.23	2.4
		PM_{10}	1.1	2.6
		NO_2	0.73	3.98
		CO	8.3	112
2	Eastern ventilation stack	$PM_{2.5}$	0.27	2.4
		PM_{10}	1.3	2.6
		NO_2	1.2	3.98
		CO	13	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:

- $PM_{2.5}$ (DP1, DP2): 2.0 kg/h
- PM_{10} (DP1, DP2): 2.0 kg/h

There were no exceedances of the PM_{10} or $PM_{2.5}$ TEOM mass rate compliance levels for DP1 during the reporting period.

There were no exceedances of the PM_{10} or $PM_{2.5}$ TEOM mass rate compliance levels for DP2 during the reporting period.

EPA Victoria's historical air quality data[1] reported significant levels of $PM_{2.5}$ and PM_{10} throughout their metropolitan and regional AAQMS network during the latter half of December. Elevated $PM_{2.5}$ and PM_{10} levels may possibly be attributed to regional smoke haze events from bushfires.

[1] www.epa.vic.gov.au/ our-work/monitoring-the-environment/epa-airwatch/historic-air-quality-data-table

9.2 Data Capture Year to Date

Data capture statistics for 2019 year to date (01/01/2019 – 31/12/2019) are presented in Table 28.

Table 28: Data Capture Year to Date (%)

Station	NO_2	CO	$PM_{2.5}$	PM_{10}	Velocity
Eastern	87.1%	96.0%	98.5%	98.3%	100%
Western	93.7%	96.4%	98.0%	98.8%	99.9%

1.1 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 1st July to 30th June each year to coincide with the Annual Performance Statement (APS) reporting period. Ventilation stack emission rates year to date (1/07/2019 to 31/12/2019) are shown in Table 29.

Table 29: Ventilation Stack Emissions 1/07/2019 – 31/12/2019 (tonnes/year)

Station	NO_2	CO	$PM_{2.5}$	PM_{10}
Eastern	0.62	8.4	0.14	0.25
Western	0.47	8.3	0.13	0.26
Total	1.1	17	0.27	0.51
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.

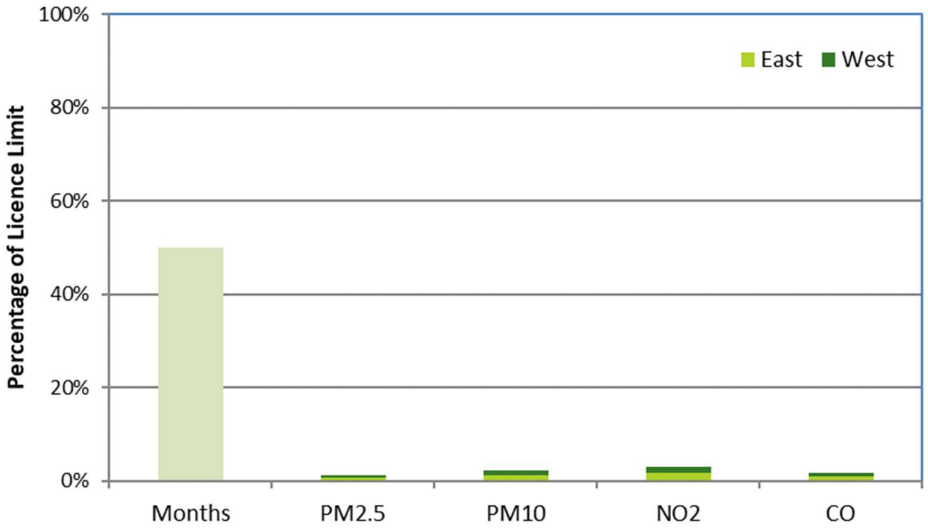

Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2019 – 31/12/2019)

The corresponding bubble limits for uncorrected $PM_{2.5}$ and PM_{10} TEOM data are:

- $PM_{2.5}$ (DP1 and DP2): 17.5 tonnes/year
- PM_{10} (DP1 and DP2): 17.5 tonnes/year

Signature Page

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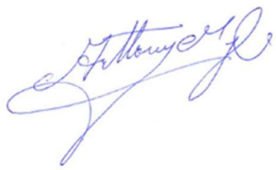

Anthony Myszka
Environmental Technician

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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