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BROADSPECTRUM PTY LTD

EastLink Ventilation Stack Emission Monitoring Report October - December 2016

Submitted to:

Broadspectrum Pty Ltd
EastLink Operations Centre,
2 Hillcrest Avenue,
Ringwood, 3134

Accredited for compliance with ISO/IEC 17025.

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



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REPORT



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: OCTOBER - DECEMBER 2016

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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 29th June, 2008 with the opening of the EastLink motorway. Results for the sampling period 1st October, 2016 to 31st December, 2016 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	745135	745070
November	745841	748981
December	758291	758291

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.

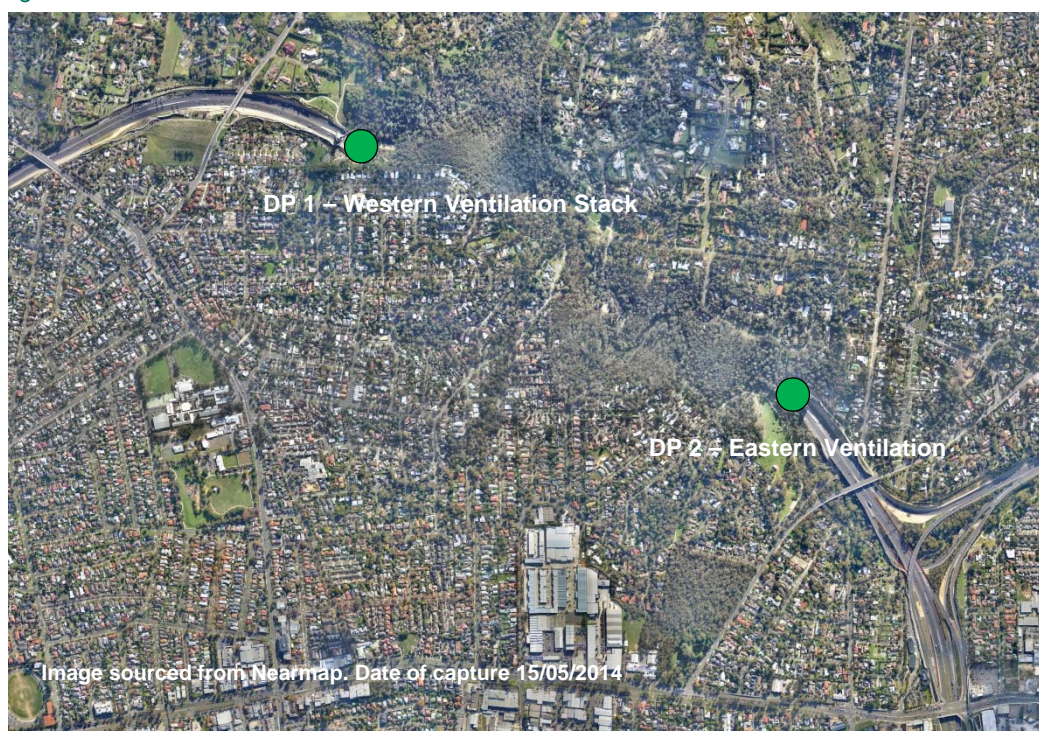
The locations of the discharges to air are described in Table 1 and presented in Figure 1.

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 temperature controlled cabinets 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 (PM₁₀)
- Total oxides of nitrogen (NO_x)
- Nitric oxide (NO)
- Nitrogen dioxide (NO₂)
- 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 (PM₁₀ WINS head fitted with a PM_{2.5} sharp cut cyclone (SCC)) at 1 m³/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 PM₁₀

PM₁₀ 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 PM₁₀ size selective inlet (PM₁₀ WINS head) at 1 m³/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 PM₁₀ 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 – PM₁₀ 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, NO₂ 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: 01/10/2016 – 31/10/2016

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, 2016 are shown in Table 3. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

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	742	744	99.7%
	Western	740	744	99.5%
PM ₁₀	Eastern	723	744	97.2%
	Western	739	744	99.3%
NO, NO ₂	Eastern	712	744	95.7%
	Western	711	744	95.6%
CO	Eastern	712	744	95.7%
	Western	712	744	95.7%

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	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.32	0.27	0.25	0.23	0.20	0.15	0.052
Western	0.51	0.29	0.26	0.18	0.14	0.10	0.045



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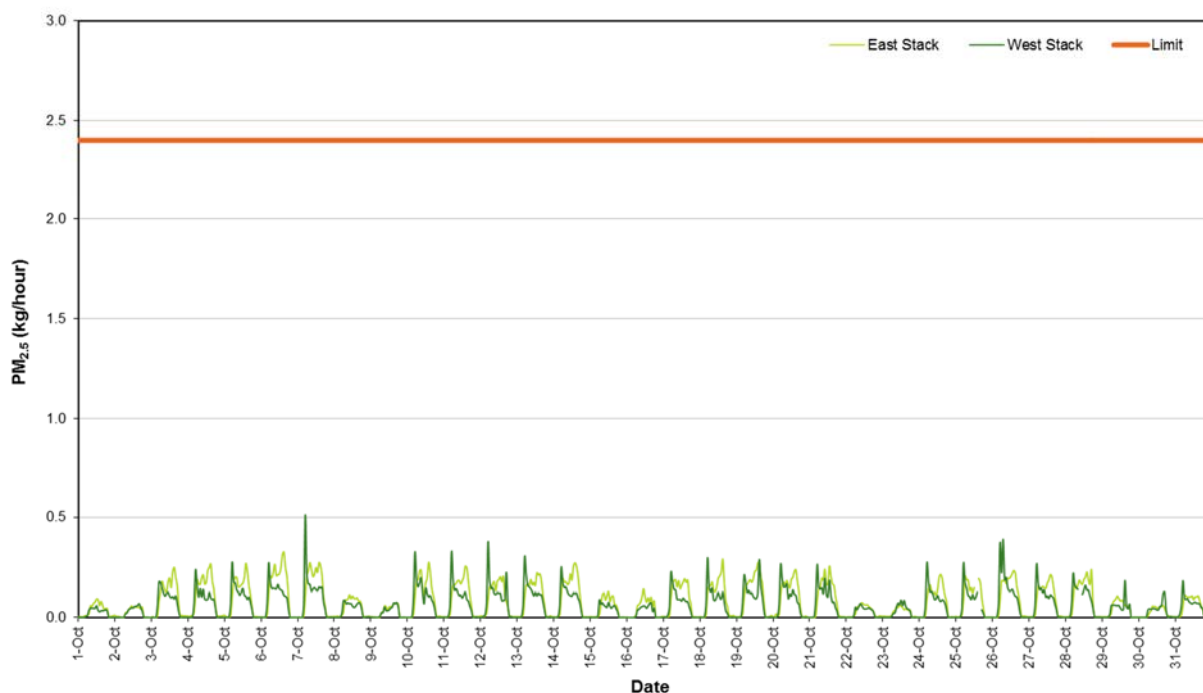


Figure 2: PM_{2.5} Mass Rate (1 Hour Average)

6.2.2 PM₁₀

PM₁₀ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 5. A plot of PM₁₀ (1 hour average) mass rate of emission for the reporting period is presented in Figure 3.

Table 5: PM₁₀ Mass Rate Percentiles (1 Hour Average)

Station	PM ₁₀ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.50	0.47	0.45	0.41	0.36	0.27	0.10
Western	1.1	0.75	0.57	0.31	0.26	0.19	0.089



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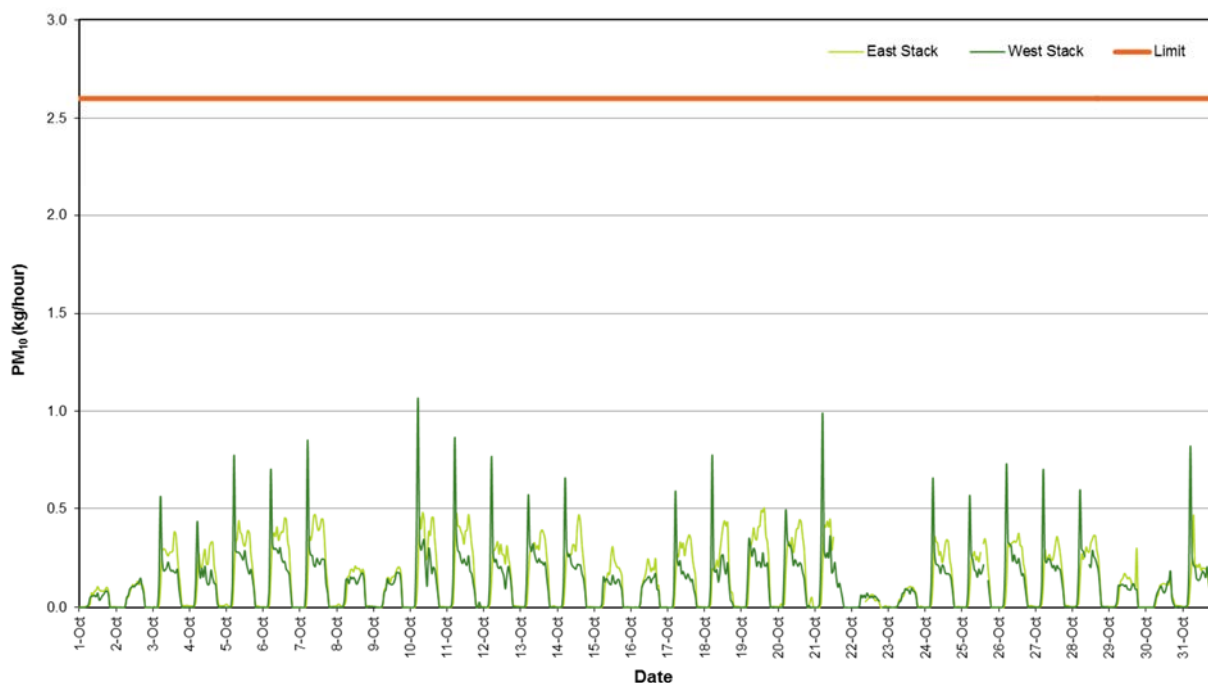


Figure 3: PM10 Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	17	15	14	13	10	7.7	5.2
Western	18	16	14	11	10	7.2	5.6



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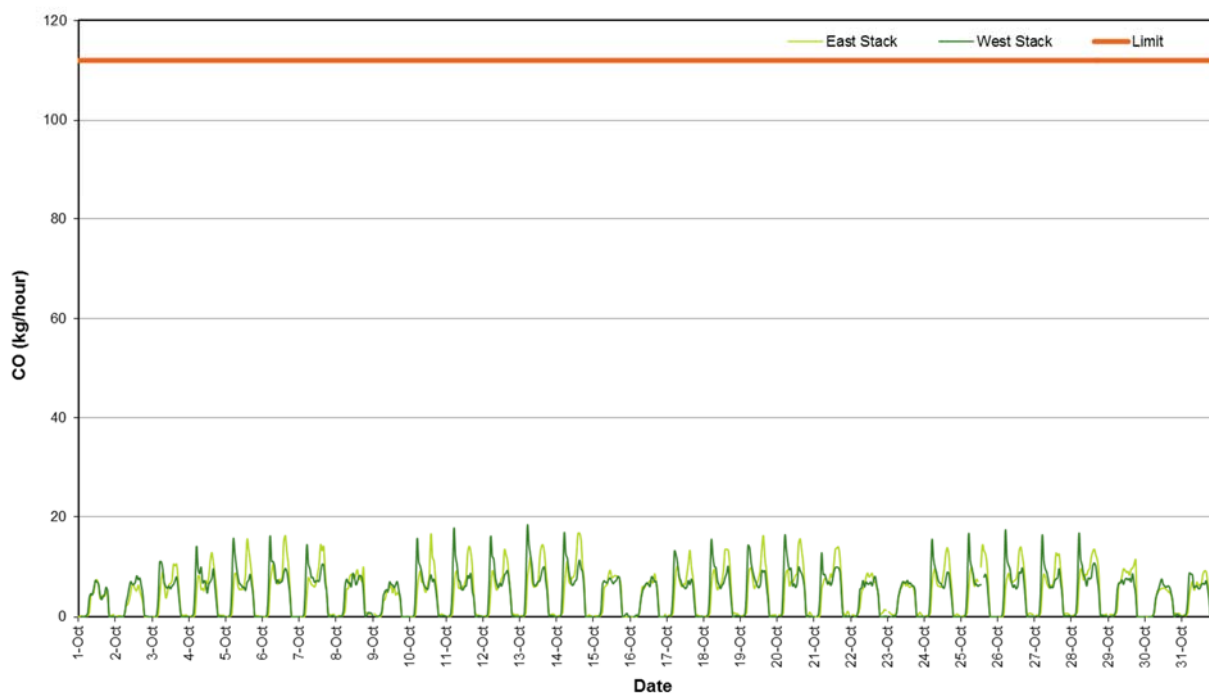


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	5.0	4.3	4.2	3.6	3.2	2.8	1.0
Western	6.3	5.7	5.2	3.6	3.0	2.4	1.2



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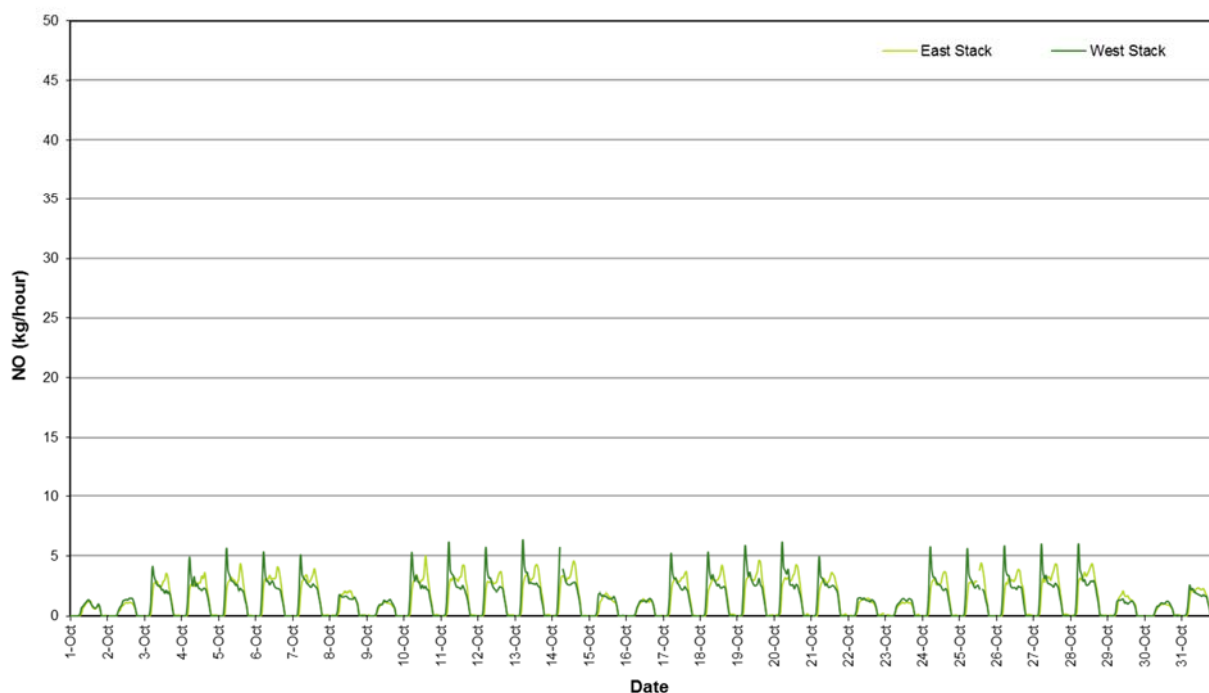


Figure 5: Nitric Oxide Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	1.0	0.93	0.89	0.76	0.62	0.52	0.24
Western	1.2	1.1	1.1	0.68	0.57	0.48	0.28



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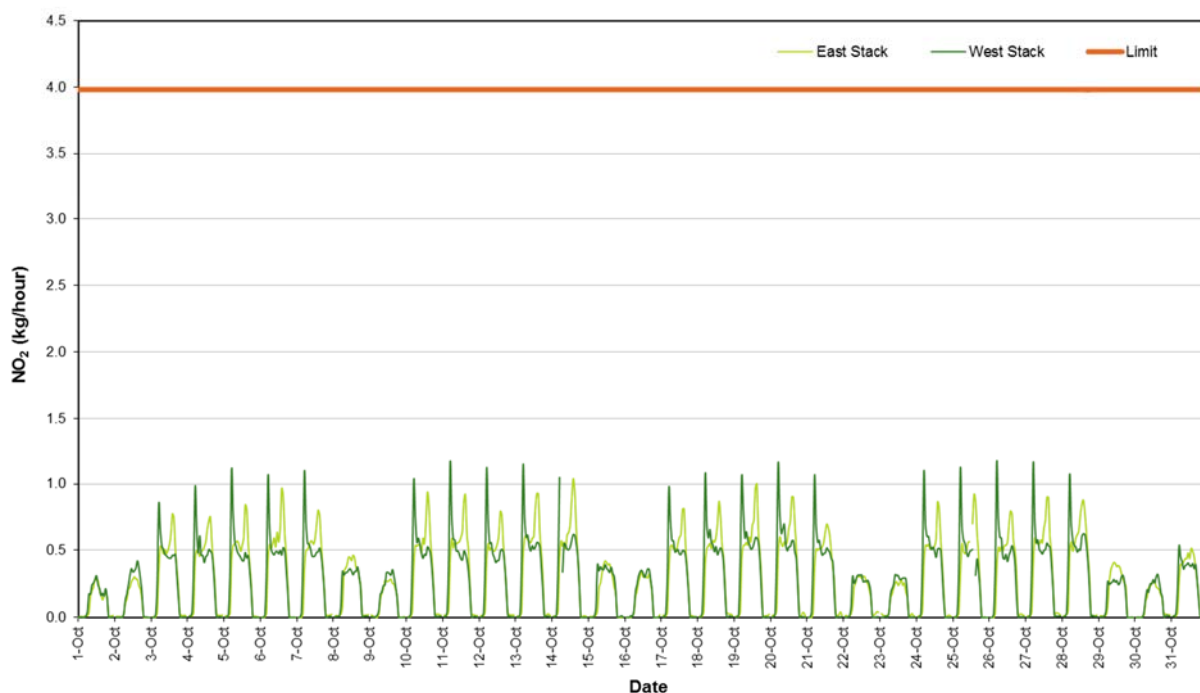


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)

6.2.5 Stack Velocity

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

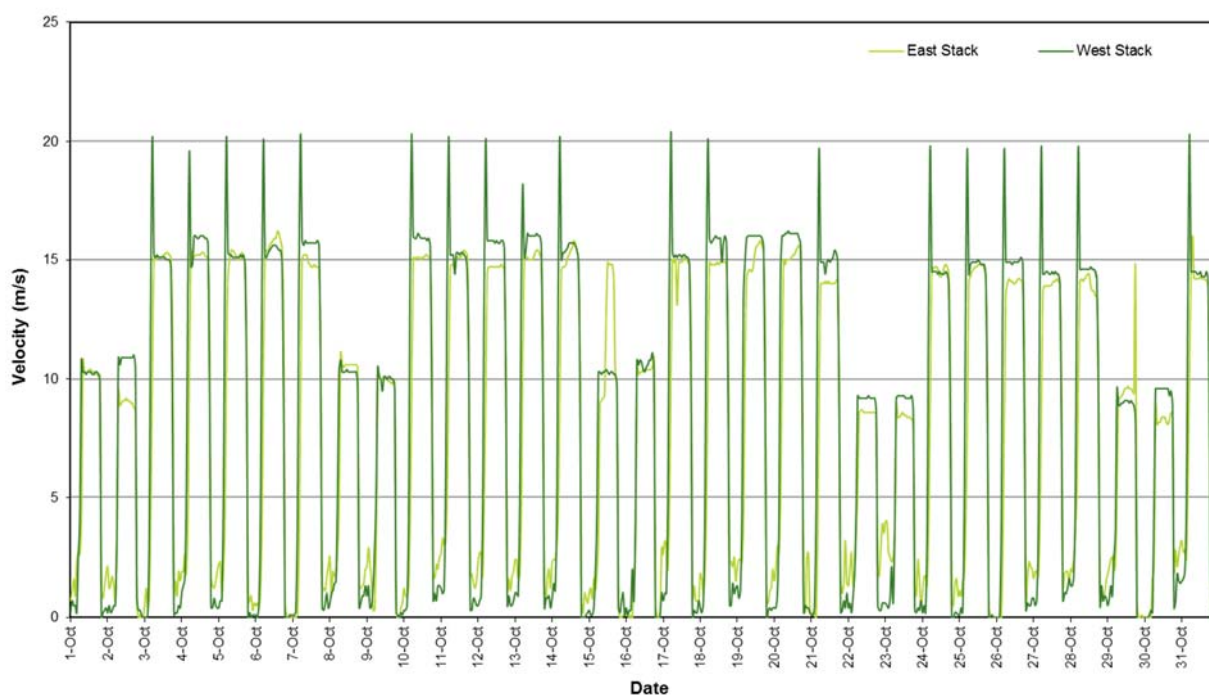


Figure 7: Stack Velocity (1 Hour Average)



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 respectively. 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 2016

Start	End	Parameter	Reason
1/10/2016 01:30	1/10/2016 01:30	Velocity	Invalid data ¹
1/10/2016 04:15	1/10/2016 04:15	Velocity	Invalid data ¹
1/10/2016 05:10	1/10/2016 05:10	Velocity	Invalid data ¹
1/10/2016 05:20	1/10/2016 05:20	Velocity	Invalid data ¹
1/10/2016 06:05	1/10/2016 06:10	Velocity	Invalid data ¹
1/10/2016 06:45	1/10/2016 06:45	Velocity	Invalid data ¹
2/10/2016 01:10	2/10/2016 01:10	Velocity	Invalid data ¹
3/10/2016 01:10	3/10/2016 01:10	Velocity	Invalid data ¹
3/10/2016 04:40	3/10/2016 04:45	PM ₁₀	Invalid data ¹
6/10/2016 12:35	6/10/2016 12:35	All parameters	Data logger error
8/10/2016 05:45	8/10/2016 05:45	Velocity	Invalid data ¹
15/10/2016 05:45	15/10/2016 05:45	Velocity	Invalid data ¹
21/10/2016 12:05	21/10/2016 12:05	PM ₁₀	Invalid data ¹
21/10/2016 13:15	21/10/2016 13:15	PM ₁₀	Invalid data ¹
21/10/2016 13:30	21/10/2016 13:35	PM ₁₀	Invalid data ¹
21/10/2016 13:45	22/10/2016 09:00	PM ₁₀	Invalid data ¹
21/10/2016 22:05	21/10/2016 22:15	PM _{2.5}	Invalid data ¹
25/10/2016 12:40	25/10/2016 13:05	NO, NO ₂ , NO _x	Maintenance / calibration
25/10/2016 12:40	25/10/2016 13:00	CO	Maintenance / calibration
25/10/2016 13:25	25/10/2016 14:15	PM _{2.5}	Maintenance / calibration
25/10/2016 13:35	25/10/2016 14:05	PM ₁₀	Maintenance / calibration
29/10/2016 05:45	29/10/2016 05:45	Velocity	Invalid data ¹

Notes: ¹ – In the opinion of the reviewer



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Table 10: Data Exceptions - Western Ventilation Stack: October 2016

Start	End	Parameter	Reason
14/10/2016 06:35	14/10/2016 07:10	NO, NO ₂ , NO _x	Maintenance/ calibration
22/10/2016 19:00	22/10/2016 19:20	PM ₁₀	Invalid data ¹
25/10/2016 14:40	25/10/2016 15:10	NO, NO ₂ , NO _x	Maintenance/ calibration
25/10/2016 14:40	25/10/2016 15:10	CO	Maintenance/ calibration
25/10/2016 15:20	25/10/2016 16:30	PM _{2.5}	Maintenance/ calibration
25/10/2016 15:35	25/10/2016 16:25	PM ₁₀	Maintenance/ calibration
28/10/2016 09:40	28/10/2016 10:25	PM _{2.5}	Maintenance/ calibration
28/10/2016 09:40	28/10/2016 10:35	PM ₁₀	Maintenance/ calibration

Notes: ¹ – In the opinion of the reviewer

A number of periods occurred where PM_{2.5} concentrations were greater than the corresponding PM₁₀ concentrations. 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 01/10/2016 21:20 – 23:50
- East Ventilation stack 02/10/2016 00:00 – 04:00
- East Ventilation stack 19/10/2016 22:05 – 23:55
- East Ventilation stack 22/10/2016 18:15 – 19:40
- East Ventilation stack 28/10/2016 17:25 – 17:40
- West Ventilation stack 07/10/2016 05:45 – 06:00
- West Ventilation stack 19/10/2016 22:45 – 23:25
- West Ventilation stack 29/10/2016 15:15 – 15:40
- West Ventilation stack 30/10/2016 06:45 – 07:05
- West Ventilation stack 30/10/2016 16:45 – 16:55



7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/11/2016 – 30/11/2016

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, 2016 are shown in Table 11. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

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	720	720	100%
	Western	718	720	99.7%
PM ₁₀	Eastern	720	720	100%
	Western	719	720	99.9%
NO, NO ₂	Eastern	684	720	95.0%
	Western	690	720	95.8%
CO	Eastern	690	720	95.8%
	Western	690	720	95.8%

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} 2.5 Mass Rate Percentiles (1 Hour Average)

Station	PM _{2.5} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.34	0.27	0.26	0.22	0.20	0.16	0.050
Western	0.33	0.31	0.28	0.19	0.15	0.11	0.048



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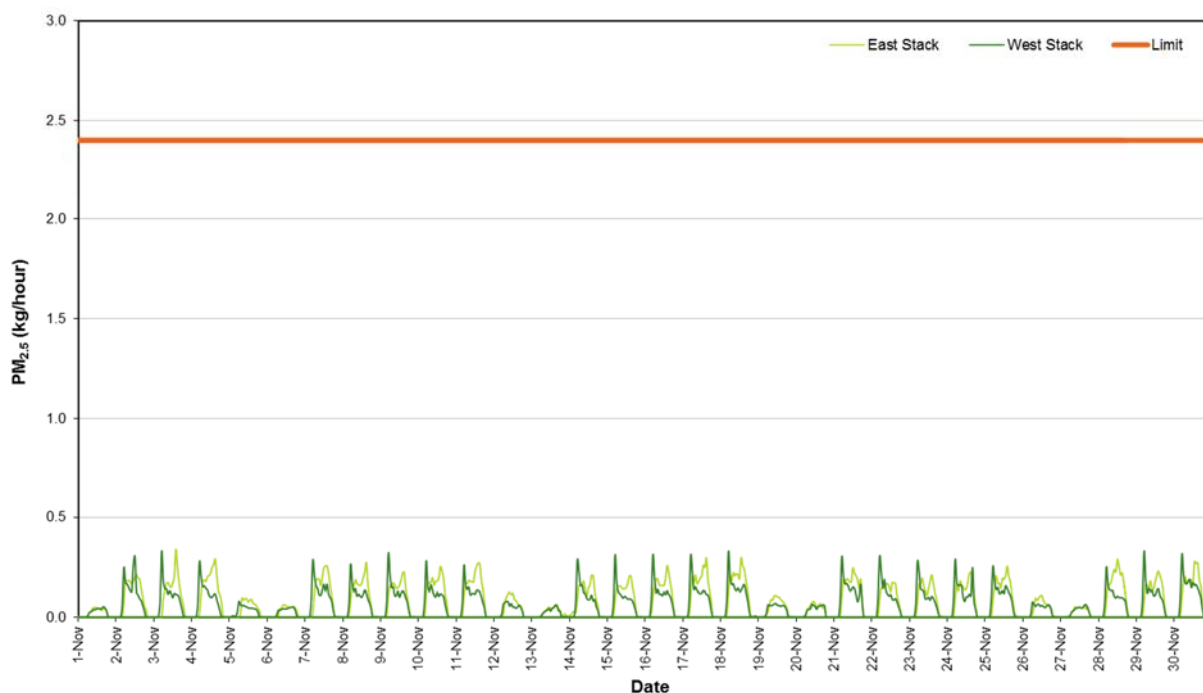


Figure 8: PM_{2.5} Mass Rate (1 Hour Average)

7.2.2 PM₁₀

PM₁₀ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 13. A plot of PM₁₀ (1 hour average) mass rate of emission for the reporting period is presented in Figure 9.

Table 13: PM₁₀ Mass Rate Percentiles (1 Hour Average)

Station	PM ₁₀ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.70	0.48	0.43	0.39	0.34	0.26	0.094
Western	1.2	0.69	0.57	0.30	0.26	0.21	0.11



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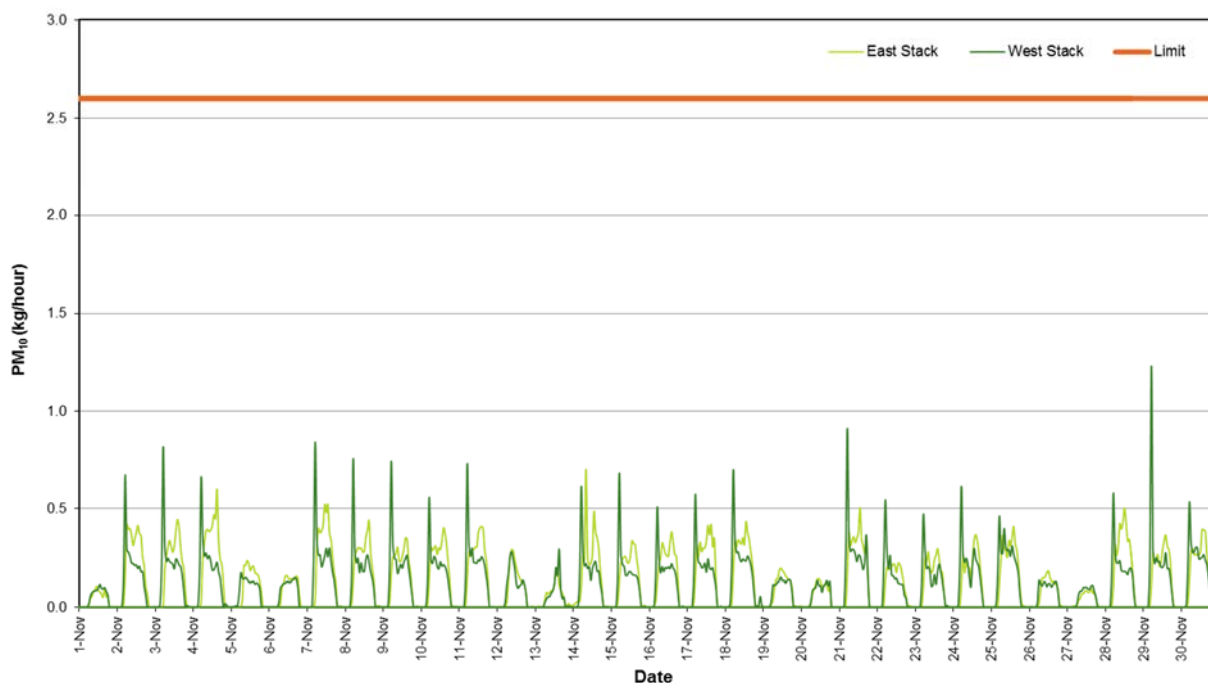


Figure 9: PM₁₀ Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	17	16	15	14	11	8.8	6.1
Western	21	17	16	12	10	7.9	5.8



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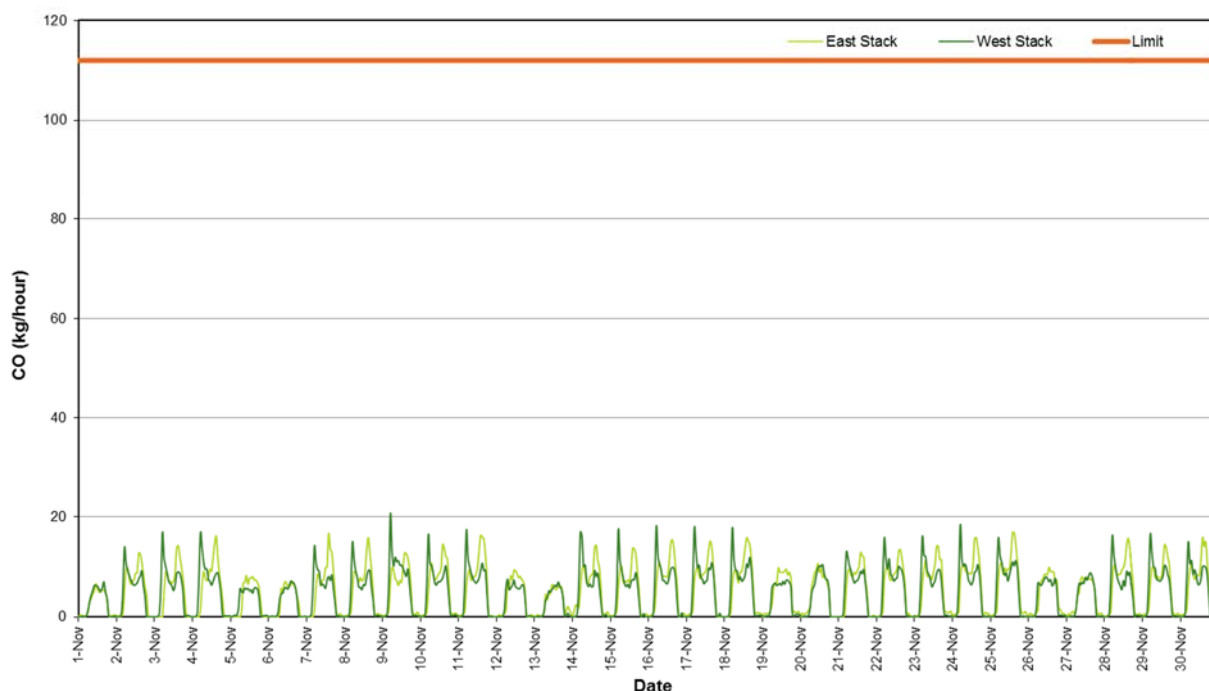


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	4.7	4.3	4.1	3.7	3.4	2.8	1.07
Western	6.5	5.6	5.1	3.4	3.0	2.4	1.2



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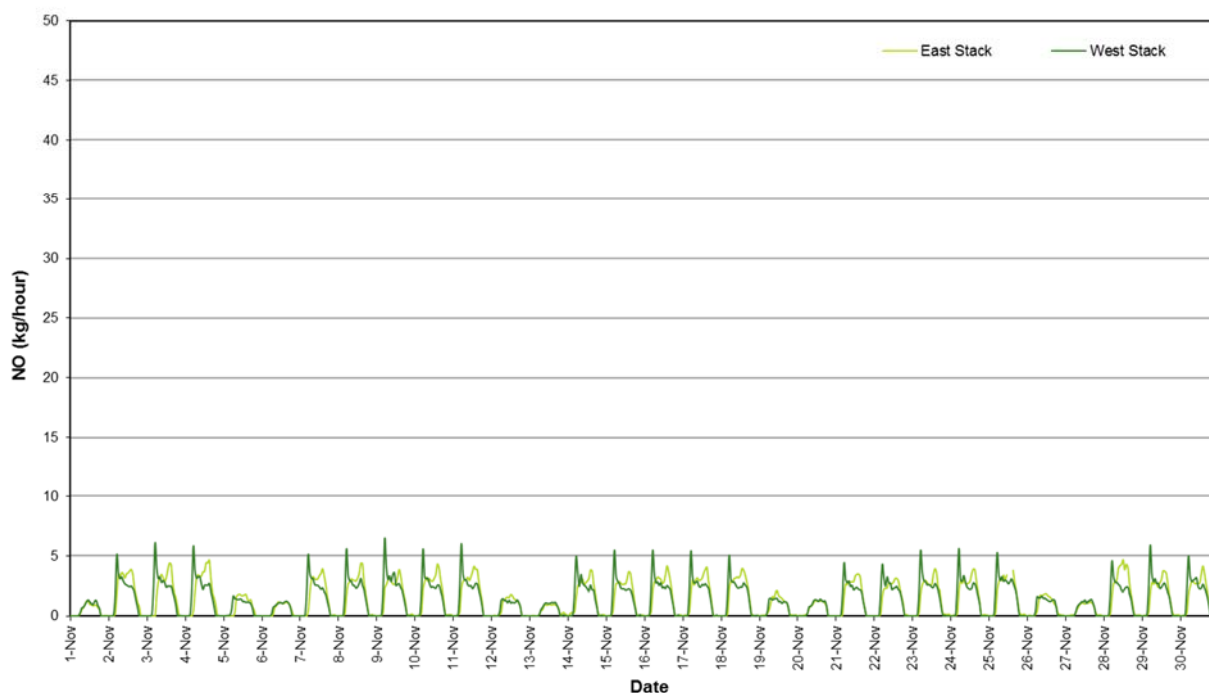


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	1.1	0.97	0.90	0.77	0.63	0.48	0.23
Western	1.3	1.1	1.0	0.67	0.59	0.49	0.27



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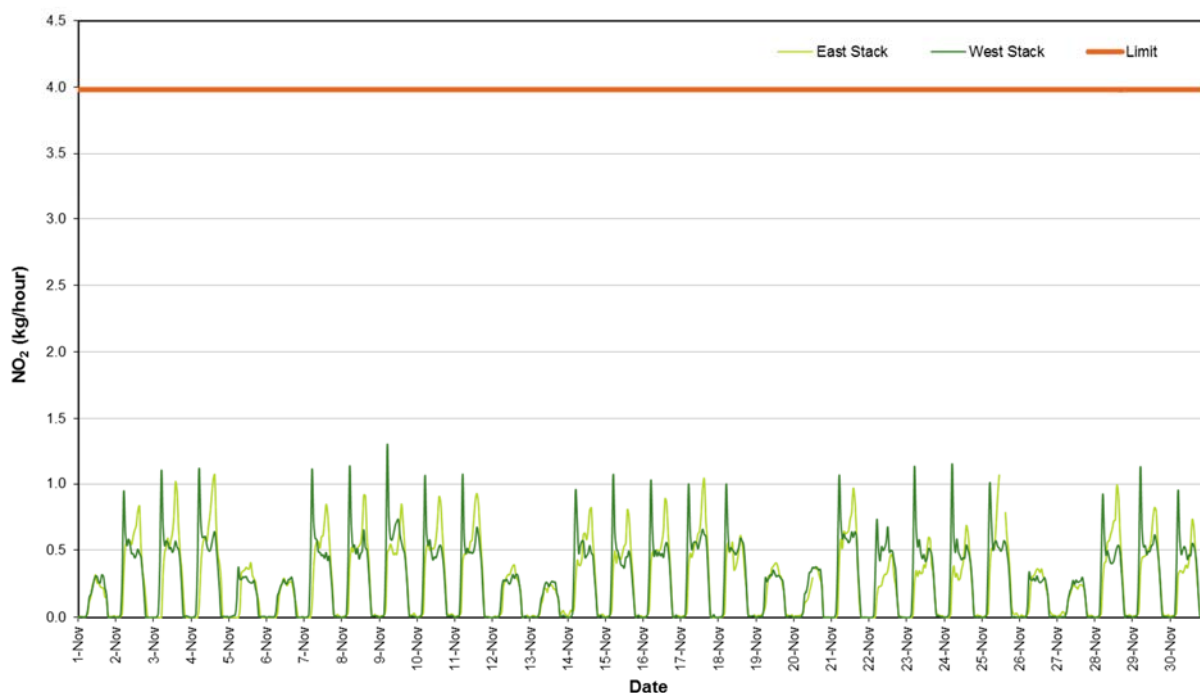


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)

7.2.5 Stack Velocity

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

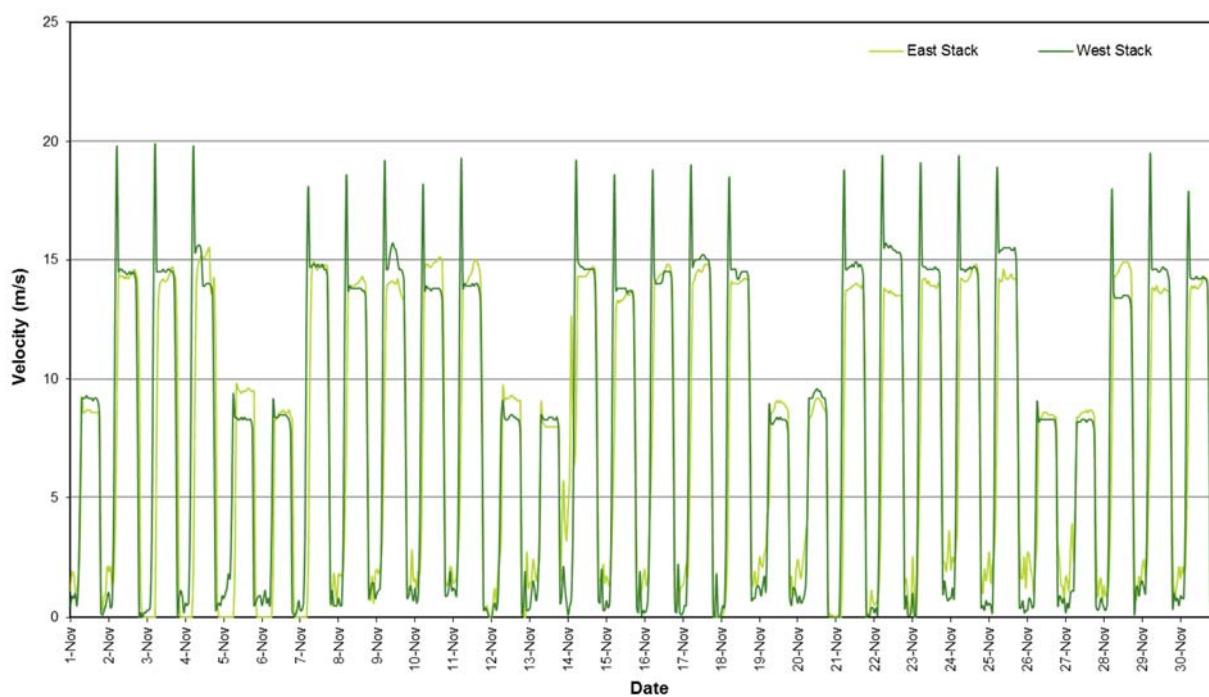


Figure 13: Stack Velocity (1 Hour Average)



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 respectively. 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 2016

Start	End	Parameter	Reason
3/11/2016 05:45	3/11/2016 06:10	Velocity	Invalid data ¹
10/11/2016 05:45	10/11/2016 06:05	CO	Maintenance/ calibration
12/11/2016 01:20	12/11/2016 01:30	PM _{2.5}	Invalid data ¹
12/11/2016 01:20	12/11/2016 01:30	PM ₁₀	Invalid data ¹
12/11/2016 21:20	12/11/2016 21:35	Velocity	Invalid data ¹
16/11/2016 17:45	16/11/2016 17:50	PM _{2.5}	Invalid data ¹
18/11/2016 21:20	18/11/2016 23:00	NO, NO ₂ , NO _x	Invalid data ¹
20/11/2016 13:10	20/11/2016 13:45	NO, NO ₂ , NO _x	Invalid data ¹
22/11/2016 19:35	22/11/2016 19:40	PM _{2.5}	Invalid data ¹
25/11/2016 12:00	25/11/2016 14:40	NO, NO ₂ , NO _x	Invalid data ¹
28/11/2016 20:15	28/11/2016 20:20	PM _{2.5}	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.

Table 18: Data Exceptions - Western Ventilation Stack: November 2016

Start	End	Parameter	Reason
12/11/2016 01:00	12/11/2016 02:00	PM _{2.5}	Invalid data ¹
12/11/2016 01:15	12/11/2016 01:30	PM ₁₀	Invalid data ¹
12/11/2016 19:50	12/11/2016 20:10	Velocity	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.

A number of periods occurred where PM_{2.5} concentrations were greater than the corresponding PM₁₀ concentrations. 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 03/11/2016 14:25 – 14:30
- West Ventilation stack 02/11/2016 11:10 – 11:45
- West Ventilation stack 02/11/2016 12:00 – 12:55
- West Ventilation stack 05/11/2016 01:55 – 02:20
- West Ventilation stack 24/11/2016 16:20 – 16:40



8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/12/2016 – 31/12/2016

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, 2016 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	740	744	99.5%
	Western	732	744	98.4%
PM ₁₀	Eastern	722	744	97.0%
	Western	742	744	99.7%
NO, NO ₂	Eastern	712	744	95.7%
	Western	682	744	91.7%
CO	Eastern	712	744	95.7%
	Western	712	744	95.7%

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	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.34	0.28	0.26	0.24	0.21	0.14	0.052
Western	0.69	0.39	0.33	0.22	0.17	0.11	0.053



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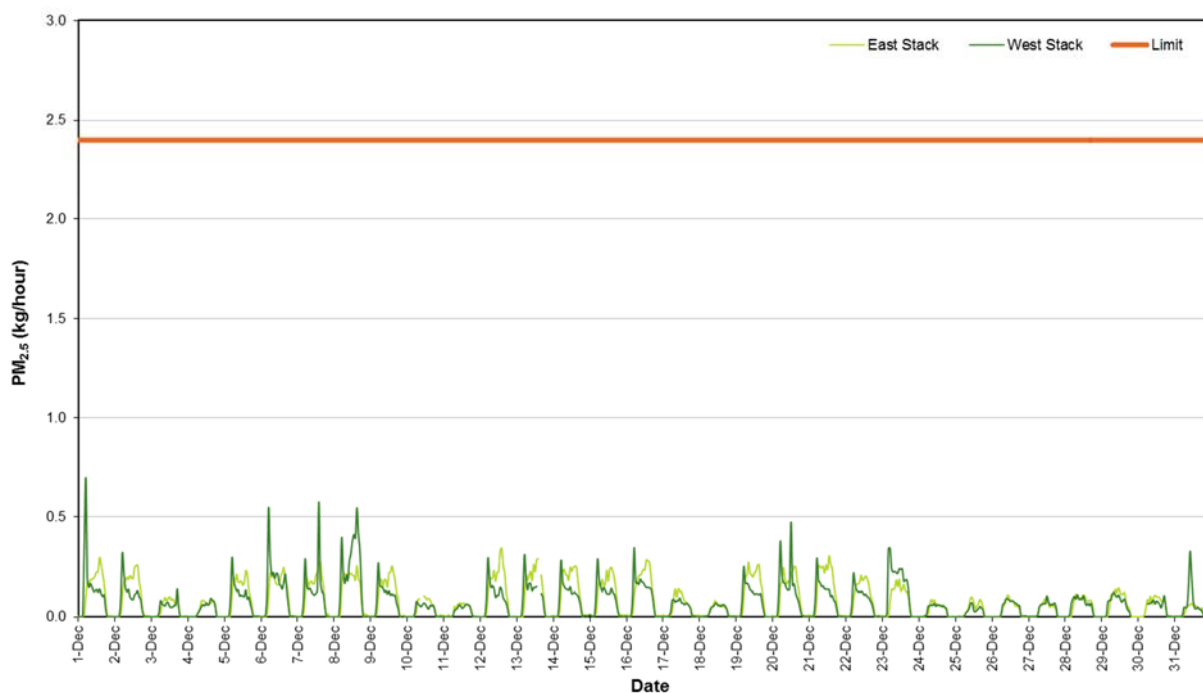


Figure 14: PM_{2.5} Mass Rate (1 Hour Average)

8.2.2 PM₁₀

PM₁₀ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 21. A plot of PM₁₀ (1 hour average) mass rate of emission for the reporting period is presented in Figure 15.

Table 21: PM₁₀ Mass Rate Percentiles (1 Hour Average)

Station	PM ₁₀ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.58	0.49	0.46	0.42	0.37	0.25	0.11
Western	1.1	0.76	0.49	0.30	0.25	0.19	0.099



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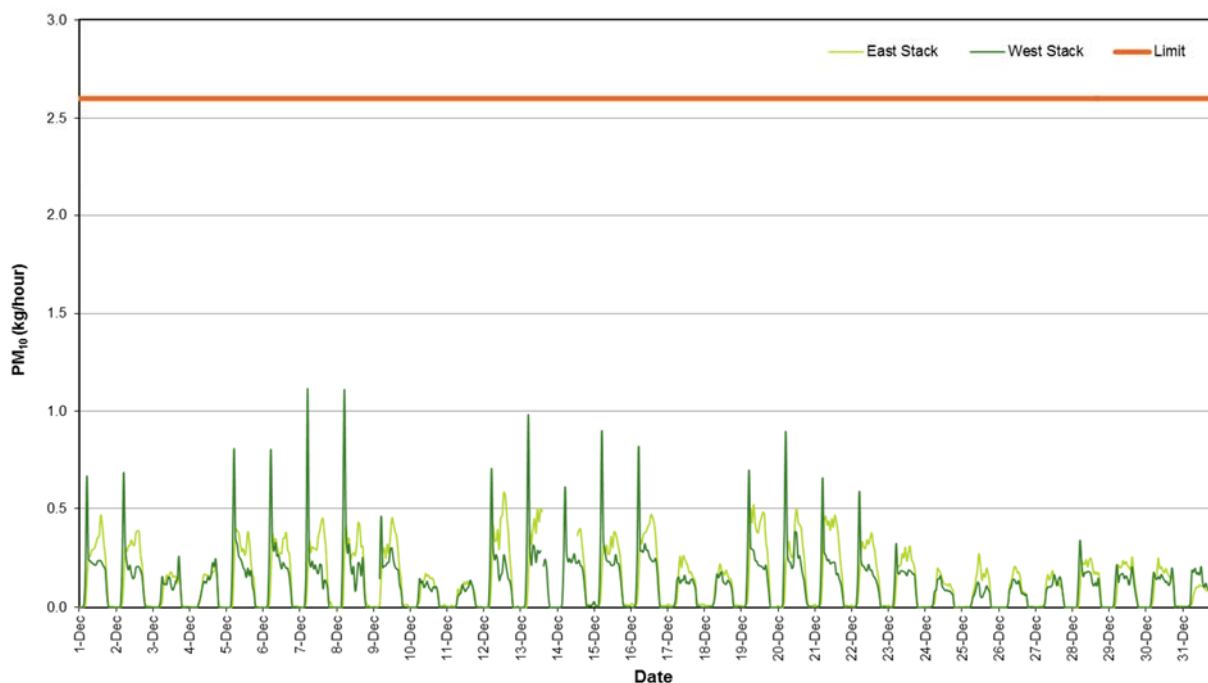


Figure 15: PM₁₀ Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	22	18	16	15	11	9.1	6.1
Western	20	16	14	11	10	8.1	6.0



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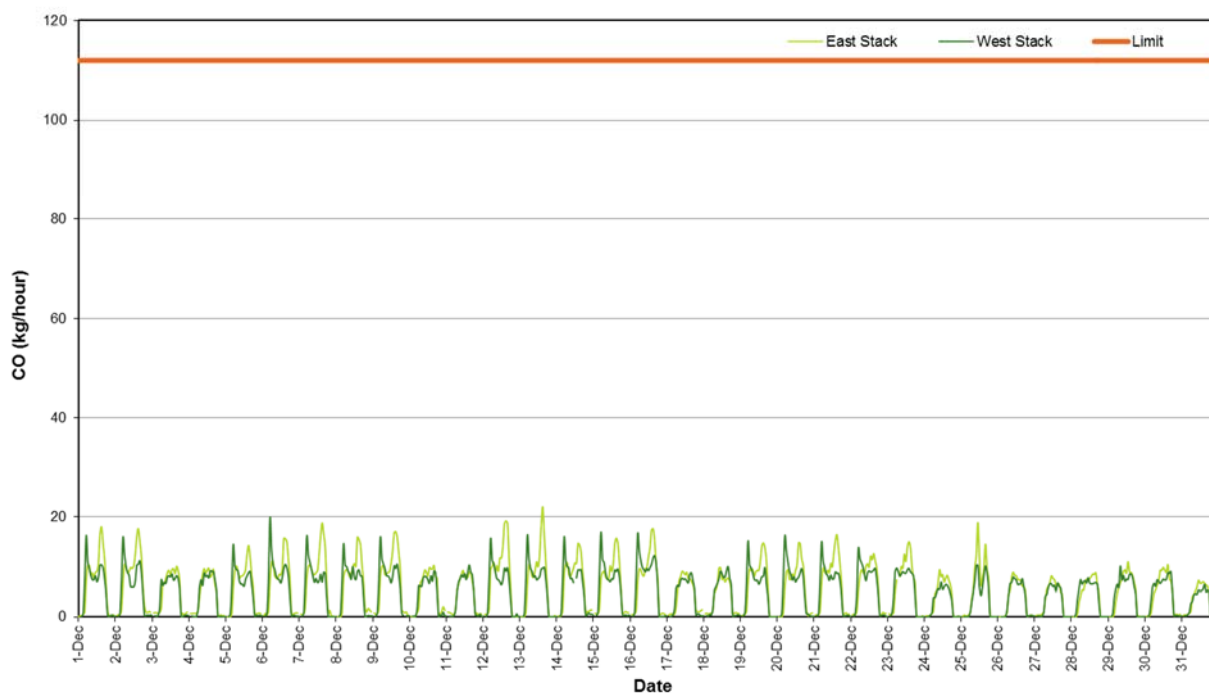


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	5.5	4.5	4.3	3.9	3.5	2.5	0.99
Western	6.6	5.3	4.4	3.2	2.8	2.3	1.0



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: OCTOBER - DECEMBER 2016

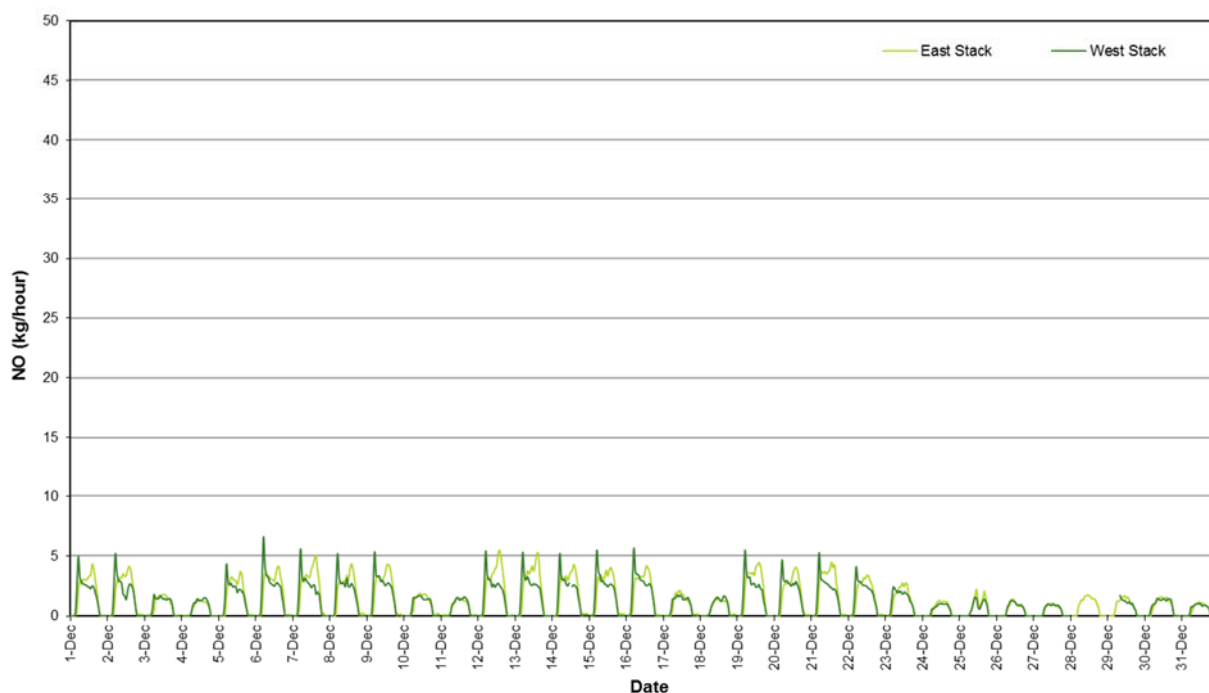


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

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 th	98 th	95 th	90 th	75 th	50 th
Eastern	1.5	1.2	0.99	0.84	0.68	0.45	0.22
Western	1.2	1.0	0.89	0.63	0.57	0.47	0.24



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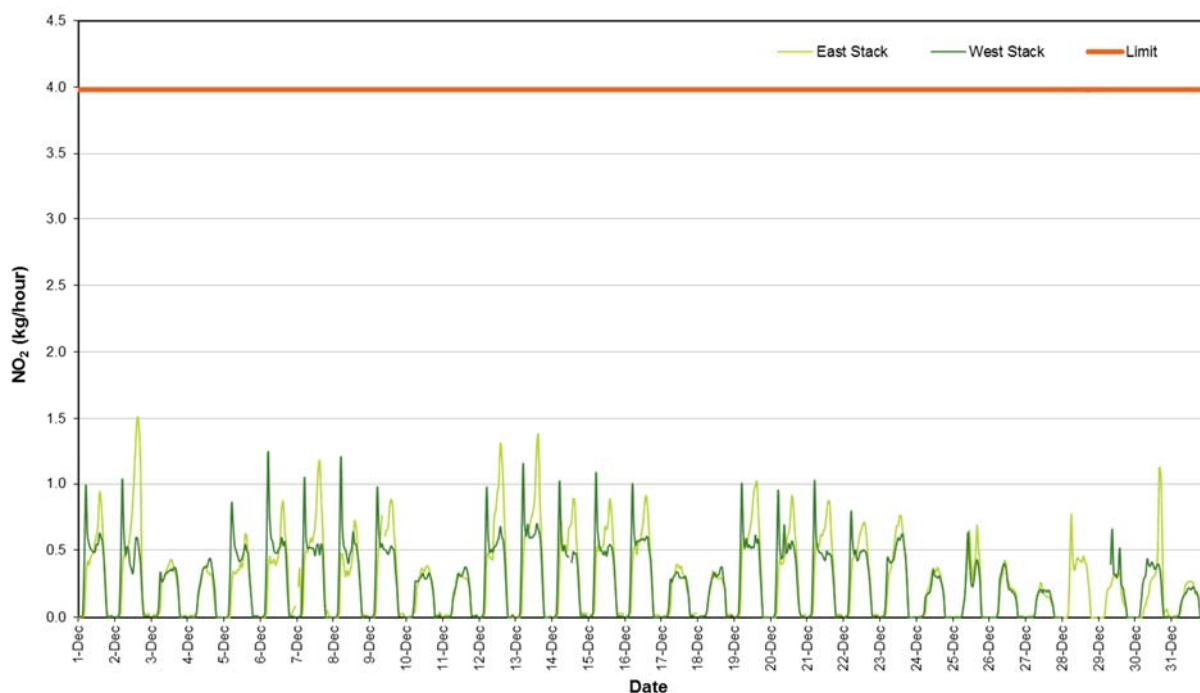


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)

8.2.5 Stack Velocity

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

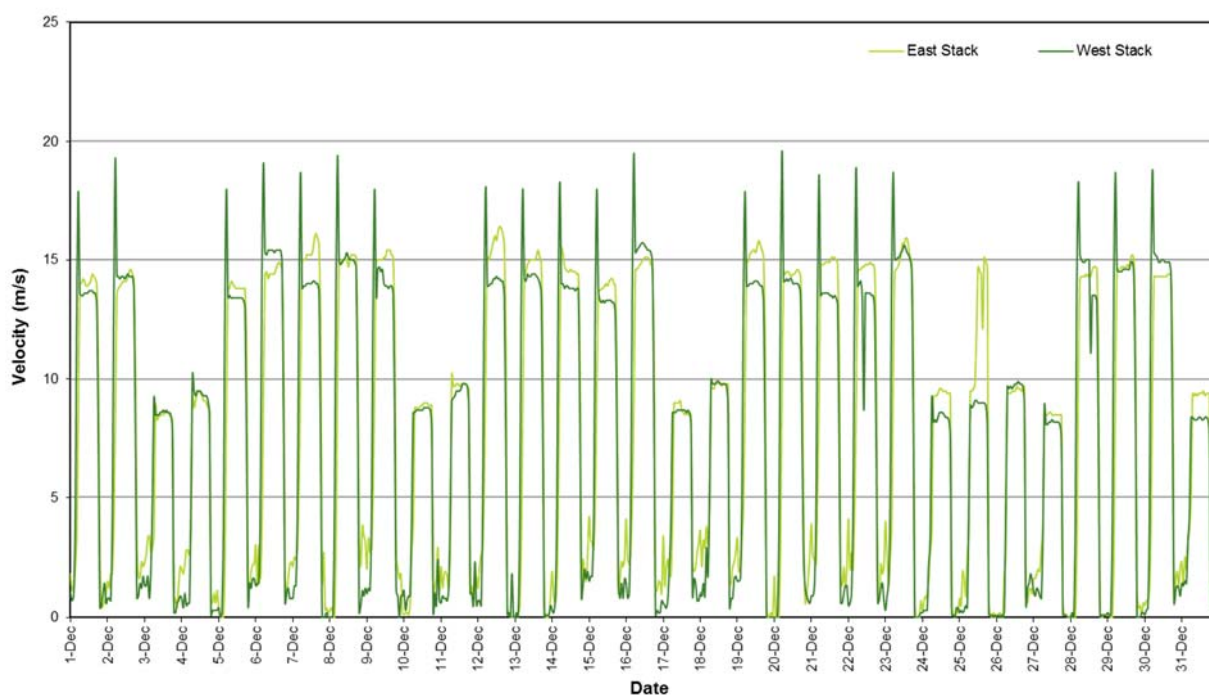


Figure 19: Stack Velocity (1 Hour Average)



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: OCTOBER - DECEMBER 2016

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 respectively. 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 2016

Start	End	Parameter	Reason
9/12/2016 08:45	9/12/2016 10:05	NO, NO ₂ , NO _x	Invalid data ¹
9/12/2016 20:15	9/12/2016 20:50	PM _{2.5}	Invalid data ¹
10/12/2016 09:15	10/12/2016 10:50	PM _{2.5}	Invalid data ¹
13/12/2016 14:45	13/12/2016 15:30	PM _{2.5}	Maintenance / calibration
13/12/2016 14:50	14/12/2016 12:15	PM ₁₀	Invalid data ¹
14/12/2016 11:50	14/12/2016 12:00	NO, NO ₂ , NO _x	Maintenance / calibration
14/12/2016 11:50	14/12/2016 11:55	CO	Maintenance / calibration
14/12/2016 12:15	14/12/2016 12:15	PM _{2.5}	Maintenance / calibration
23/12/2016 07:10	23/12/2016 07:40	CO	Maintenance / calibration

Note: ¹ – In the opinion of the reviewer.

Table 26: Data Exceptions - Western Ventilation Stack: December 2016

Start	End	Parameter	Reason
9/12/2016 03:35	9/12/2016 03:50	PM ₁₀	Invalid data ¹
9/12/2016 21:25	9/12/2016 21:40	Velocity	Invalid data ¹
9/12/2016 22:25	9/12/2016 22:25	Velocity	Invalid data ¹
13/12/2016 14:00	13/12/2016 16:05	PM _{2.5}	Maintenance / calibration
13/12/2016 14:10	13/12/2016 14:55	PM ₁₀	Maintenance / calibration
13/12/2016 23:20	13/12/2016 23:30	PM ₁₀	Invalid data ¹
14/12/2016 12:40	14/12/2016 12:55	NO, NO ₂ , NO _x	Maintenance / calibration
14/12/2016 12:40	14/12/2016 12:55	CO	Maintenance / calibration
28/12/2016 01:00	29/12/2016 08:05	NO, NO ₂ , NO _x	Invalid data – span drift
29/12/2016 19:50	29/12/2016 23:55	PM _{2.5}	Invalid data ¹
30/12/2016 01:00	30/12/2016 05:40	PM _{2.5}	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: OCTOBER - DECEMBER 2016

A number of periods occurred where PM_{2.5} concentrations were greater than the corresponding PM₁₀ concentrations. 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 29/12/2016 20:05 – 20:25
- East Ventilation stack 29/12/2016 22:10 – 22:20
- West Ventilation stack 01/12/2016 04:15 – 05:35
- West Ventilation stack 06/12/2016 16:25 – 16:35
- West Ventilation stack 07/12/2016 14:20 – 16:05
- West Ventilation stack 08/12/2016 10:15 – 18:40
- West Ventilation stack 20/12/2016 12:25 – 12:50



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 (01/10/2016 - 31/12/2016)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM _{2.5}	0.69	2.4
		PM ₁₀	1.2	2.6
		NO ₂	1.3	3.98
		CO	21	112
2	Eastern ventilation stack	PM _{2.5}	0.34	2.4
		PM ₁₀	0.70	2.6
		NO ₂	1.5	3.98
		CO	22	112

There were no exceedences 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
- PM₁₀ (DP1, DP2): 2.0 kg/h

There was no exceedences of the PM₁₀ or PM_{2.5} TEOM mass rate compliance levels for DP1 during the reporting period.

There was no exceedences of the PM₁₀ or PM_{2.5} TEOM mass rate compliance levels for DP2 during the reporting period.

9.2 Data Capture Year to Date

Data capture statistics for 2016 year to date (01/01/2016 – 31/12/2016) are presented in Table 28.

Table 28: Data Capture Year to Date (%)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀	Velocity
Eastern	96.9	96.6	99.2	98.5	100
Western	96.0	97.0	99.4	99.5	100



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 1st July to 30th June each year to coincide with the Annual Performance Statement (APS) reporting period. Ventilation stack emission rates year to date (1/07/2016 to 31/12/2016) are shown in Table 29.

Table 29: Ventilation Stack Emissions 1/07/2016 – 31/12/2016 (tonnes/year)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀
Eastern	1.2	21	0.33	0.58
Western	1.2	20	0.28	0.53
Total	2.4	41	0.61	1.1
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.

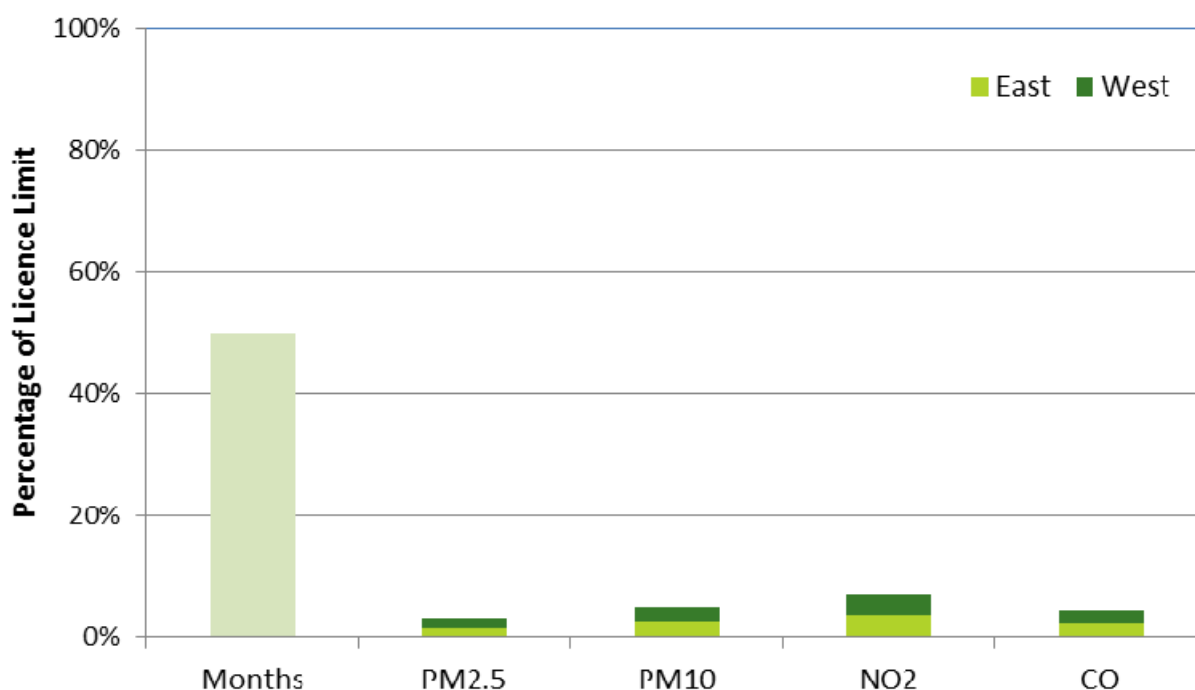


Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2016 – 31/12/2016)

The corresponding bubble limits for uncorrected PM_{2.5} and PM₁₀ TEOM data are:

- PM_{2.5} (DP1 and DP2): 17.5 tonnes/year
- PM₁₀ (DP1 and DP2): 17.5 tonnes/year



Report Signature Page

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APPENDIX A

Important Information Relating to this Report



IMPORTANT INFORMATION RELATING TO THIS REPORT

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