

Fulton Hogan Egis Operations & Maintenance

WestConnex M4 East Project

In-Tunnel Eastbound and Westbound

Validated Air Quality Monitoring Report

1st September 2019 – 30th September 2019

Report No.: DAT15505 Revision 01

Report issue date: 07/08/2020

Maintenance contract: TU4000

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WestConnex M4 East In-Tunnel Report

Report No: DAT15505 Rev1

Fulton Hogan Egis

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Revision History			
Revision	Report ID	Date	Analyst
0	DAT15505	02/03/2020	Sofía Álvarez Castrejón
1	DAT15505	07/08/2020	Anthony Knoepfle

Refer to Appendix 3 for details of any amendments

Report by: Anthony Knoepfle



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Executive Summary

The Westconnex - M4 East Project connects Sydney's west and south-west with the Sydney Airport and the Port Botany precinct. It comprises two new three-lane tunnels of approximately 5.5km that feature various ventilation plant, equipment and air quality monitors to ensure pollutants do not exceed the targets and limits set by the Minister's Conditions of Approval.

M4 East air quality is monitored by large numbers of sensors and measures various pollutants across three main areas:

- *Ambient air* - air quality in the areas around the M4 tunnels
- *Ventilation* - air quality around the ventilation stacks
- *In Tunnel* - air quality inside the tunnels and portals (entrances to the tunnel)

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

This report details validated summary results of the 26 in-tunnel air quality sensors between the 1st – 30th September 2019.

Report Summary

The combined eastbound data capture for NO₂, CO and Visibility for the Westconnex - M4 East In-tunnel was below 95% during the reporting month.

The combined westbound data capture for NO₂ and CO for the Westconnex - M4 East In-tunnel was above 95% during the reporting month.

The combined westbound data capture for Visibility for the Westconnex - M4 East In-tunnel was below 95% during the reporting month.

There were no exceedances of the air quality limits at the WestConnex - M4 East In-Tunnel Air Quality Network for the reporting month.

1.0 Introduction

Ecotech Pty Ltd was commissioned by Fulton Hogan Egis O&M Pty Ltd to undertake the continuous emission monitoring maintenance and data reporting for the WestConnex M4 East in-tunnel sensors, located as detailed in section 2.0. Ecotech commenced data collection in July 2019.

This report presents the validated data for the 1st – 30th September 2019.

The data presented in this report:

- Describes in-tunnel air quality measurements;
- Compares monitoring results;
- Reports any readings above the WestConnex M4 East limits;
- Has been quality assured

2.0 Monitoring and Data Collection

2.1. Siting Details

The In-tunnel monitoring network consists of twenty six air quality sensors attached to the walls of both eastbound and westbound directions. The asset IDs of the sensors are shown in Table 1 and Table 2 and the locations are shown in Figure 1, Figure 2 and Figure 3.

Table 1: East Bound In-Tunnel Air Quality Sensors

Asset ID	Location Information
AQS 11001	Main tunnel portal
AQS11002	Main tunnel
AQS11003	Main tunnel
AQS11004	Main tunnel
AQS11005	Main tunnel
AQS11201	Concord on ramp
AQS11202	Concord on ramp
AQS11301	Parramatta off ramp
AQS11302	Parramatta off ramp
AQS11303	Parramatta portal AQS
AQS11401	Wattle street off ramp
AQS11402	Wattle street off ramp
AQS11403	Wattle street portal AQS

Table 2: West Bound In-Tunnel Air Quality Sensors

Asset ID	Location Information
AQS11501	Main tunnel portal
AQS11502	Main tunnel
AQS11503	Main tunnel
AQS11504	Main tunnel
AQS11505	Main tunnel
AQS11506	Main tunnel
AQS11507	Main tunnel
AQS11701	Concord West off
AQS11702	Concord West off

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Asset ID	Location Information
AQS11801	Wattle street on ramp
AQS11802	Wattle street on ramp
AQS11901	Parramatta on ramp
AQS11902	Parramatta on ramp

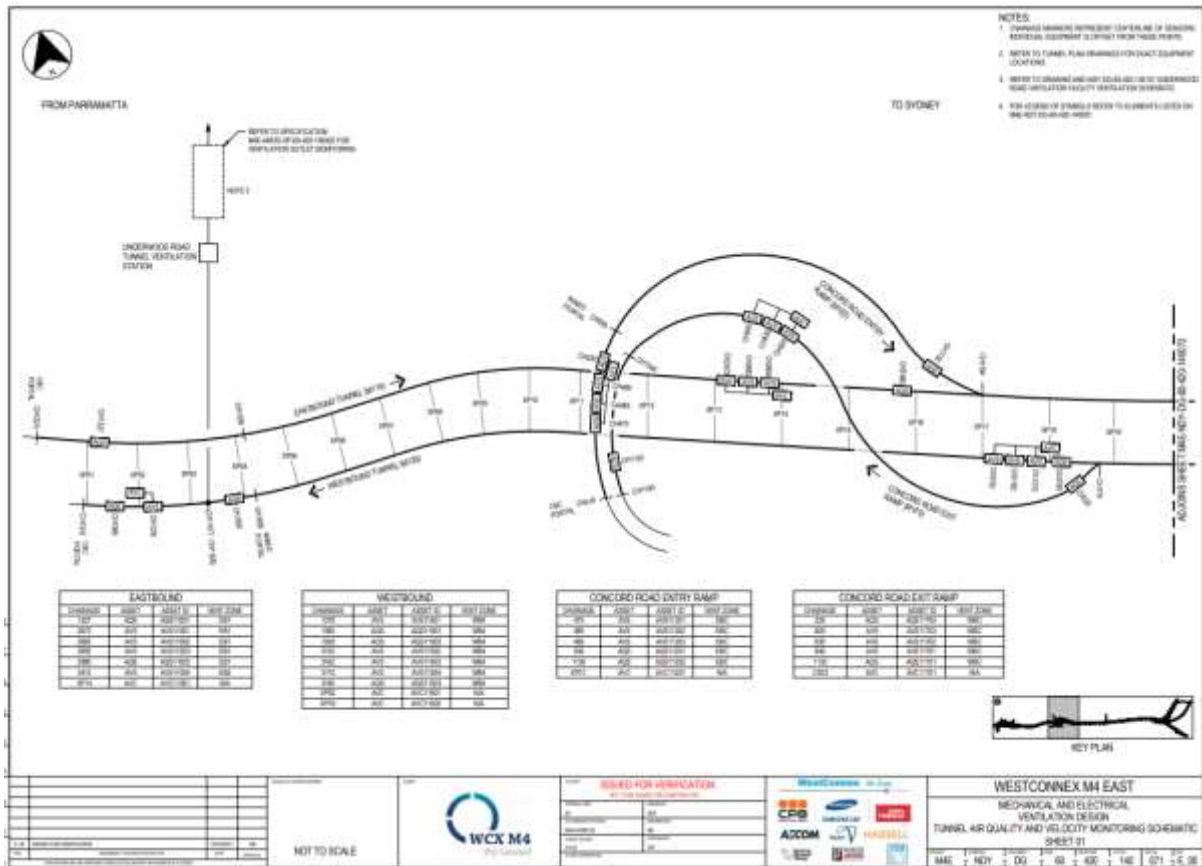


Figure 1: WestConnex M4 East In-Tunnel AQS Network Diagram 1

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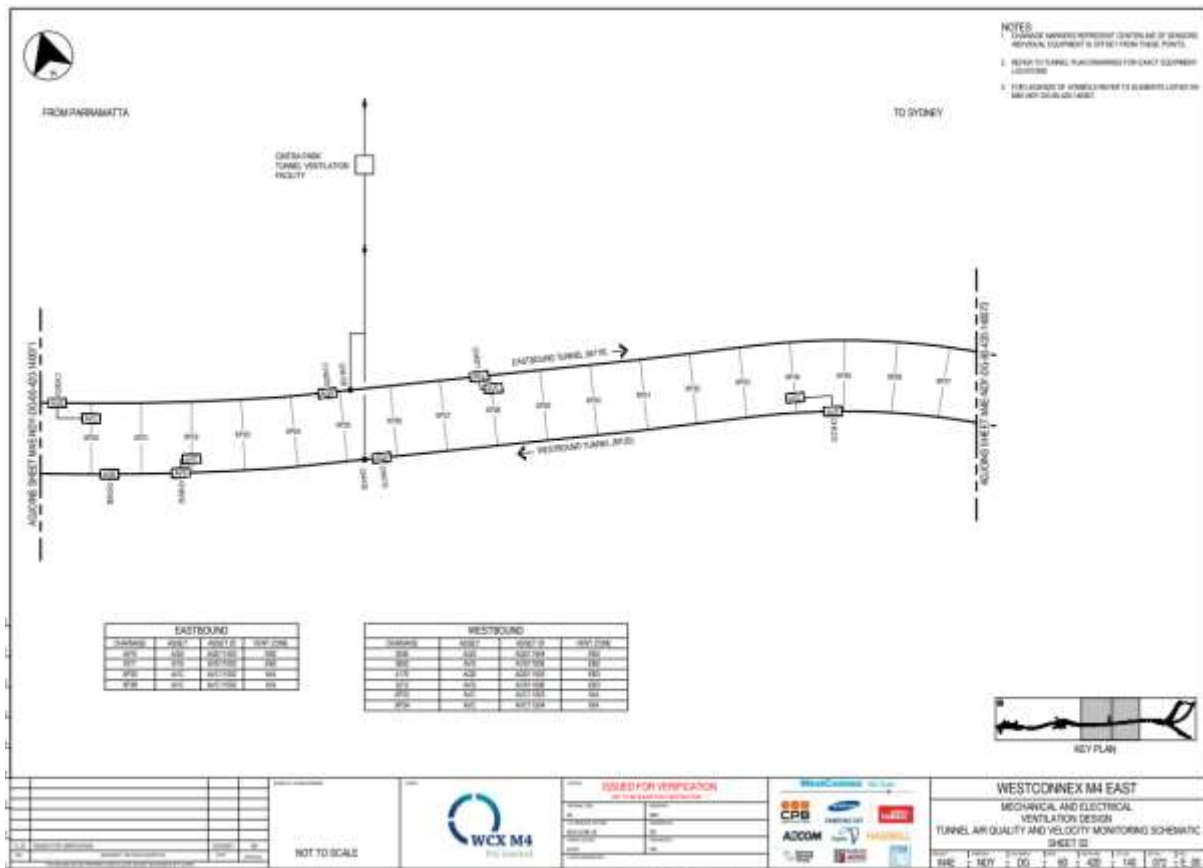


Figure 2: WestConnex M4 East In-Tunnel AQS Network Diagram 2

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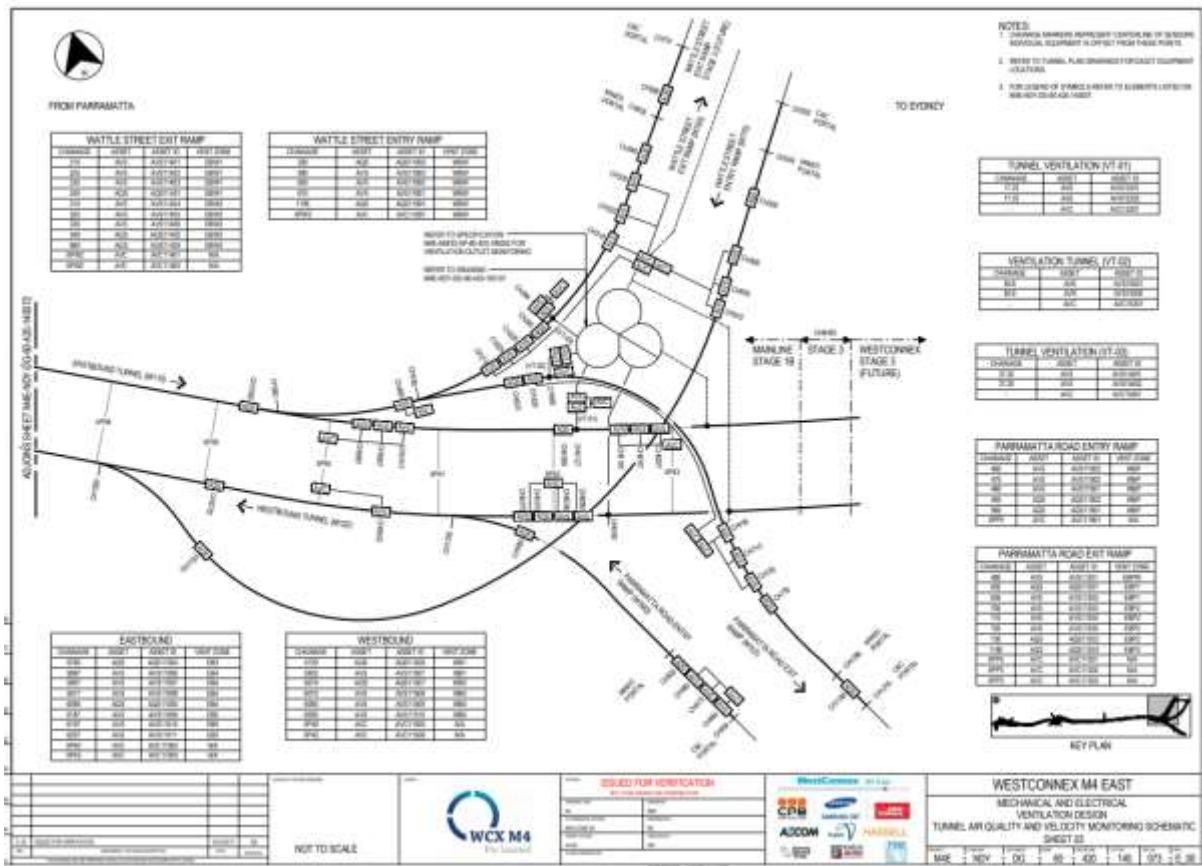


Figure 3: WestConnex M4 East In-Tunnel AQS Network Diagram 3

2.2. Monitored Parameters

Table 3 below details the parameters monitored and the instruments used at the monitoring network. Appendix 1 defines any abbreviated parameter names used throughout the report.

Table 3: Parameters measured at the West Connex M4 East In-tunnel Air Quality Network

Parameter Measured	Instrument Type
Visibility/Opacity	VICONOX-5
CO	VICONOX-5
NO ₂	VICONOX-5

2.3. Data Collection Methods

Table 4 below shows the methods used for data collection. Any deviations from the stated methods are detailed in section 2.3.1.

Table 4: Methods

Parameter Measured	Data Collection Methods Used	Description of Method
Visibility/Opacity	VICONOX Manual	Open path visibility measurement using light transmission opacity technique
CO	VICONOX Manual	Open path infrared spectroscopy technique for CO measurement
NO ₂	VICONOX Manual	Open path Direct optical measurement of nitrogen dioxide (NO ₂) using differential absorption

2.3.1. Compliance with Standards

Unless stated below, parameters are monitored at the WestConnex M4 East In-tunnel sensors according to the methods detailed in Table 4 above.

- The data from the individual sensors is transmitted to the control room when there is a change of reading. This data is then compiled into one minute readings and transferred to Ecotech by a third party. When data is not available due to a fault or communications problem, the data transfer system automatically extrapolates missing data points. It is not possible to distinguish these records from the measurement and therefore these data points have been included in the dataset unless for long periods.

2.3.2. Data Acquisition

Data acquisition is performed using the WestConnex M4 East Tunnel Control System. The recorded data is pushed to Ecotech and imported into Airodis™ on a daily basis (using Airodis™ version 5.1) and stored at Ecotech's Environmental Reporting Services (ERS) department in Melbourne, Australia. Data samples are stored in 1 minute intervals.

2.4. Data Validation and Reporting

2.4.1. Validation

The Ecotech ERS department performs daily data checks on continuously monitored parameters to ensure maximum data capture rates are maintained. Any equipment failures are communicated to the responsible field engineers for urgent rectification. Ecotech ERS maintains two distinct databases containing non-validated and validated data respectively.

The validated database is created by duplicating the non-validated database and then flagging data affected by instrument faults, calibrations and other maintenance activities. The data validation software requires the analyst to supply a valid reason (e.g. backed by maintenance notes, calibration sheets etc.) in the database for flagging any data as invalid.

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

Validation is performed by the analyst, and the validation is reviewed. Graphs and tables are generated based on the validated 1min data.

3.0 Air Quality Limits

The air quality limits and criteria for pollutants monitored at the Westconnex - M4 East Project ambient monitoring sites are based on SSI 6307 Planning Approval. The in-tunnel air quality limits and criteria are shown in Table 5 below.

Table 5: WestConnex - M4 East Project – In-Tunnel Air Quality Limits

Parameter	No. Monitoring Points	Time Period	Goal Level	Units
CO	Single Point	Rolling 3-minute	200	ppm
	Average along length of tunnel	Rolling 15-minute	87	ppm
	Average along length of tunnel	Rolling 30-minute	50	ppm
NO ₂	Average along length of tunnel	Rolling 15-minute	0.5	ppm
Visibility	Single Point	Rolling 15-minute	0.005	m ⁻¹

4.0 Results

4.1. Data Capture

Data capture is based on 1min data as applicable, and refers to the amount of available data collected during the report period.

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

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

Where:

- Reported air quality data = Number of instrument readings which have been validated through a quality assured process and excludes all data errors, zero data collection due to calibration, failures and planned and unplanned maintenance.
- Total data = Total number of instrument readings since the start of the term assuming no maintenance, errors, loss of data or calibration.

Table 4 below displays data capture statistics for September 2019.

Details of all invalid or missing data affecting data capture are included in the Valid Data Exception Table in section 5.0.

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Table 6: Monthly Data Capture for West Connex M4 East In-Tunnel Sensors

Direction	Asset ID	Data Capture (%)		
		CO	NO ₂	Visibility
Eastbound	AQS 11001	6.7	14.9	6.7
Eastbound	AQS11002	99.2	13.6	100.0
Eastbound	AQS11003	100.0	99.8	100.0
Eastbound	AQS11004	100.0	99.8	100.0
Eastbound	AQS11005	100.0	99.8	100.0
Eastbound	AQS11201	100.0	99.8	100.0
Eastbound	AQS11202	100.0	99.8	100.0
Eastbound	AQS11301	100.0	99.8	100.0
Eastbound	AQS11302	0.8	99.8	100.0
Eastbound	AQS11303	100.0	0.0	0.0
Eastbound	AQS11401	100.0	99.8	100.0
Eastbound	AQS11402	0.9	99.8	100.0
Eastbound	AQS11403	100.0	99.8	100.0
Westbound	AQS11501	99.7	89.9	0.0
Westbound	AQS11502	99.8	99.8	99.8
Westbound	AQS11503	99.8	99.8	99.8
Westbound	AQS11504	99.8	99.8	99.8
Westbound	AQS11505	99.8	99.8	99.8
Westbound	AQS11506	99.8	99.8	99.8
Westbound	AQS11507	99.8	99.8	92.4
Westbound	AQS11701	97.5	97.4	94.7
Westbound	AQS11702	97.5	97.5	97.5
Westbound	AQS11801	99.8	99.8	99.8
Westbound	AQS11802	99.8	99.8	99.8
Westbound	AQS11901	99.8	99.8	99.8
Westbound	AQS11902	99.7	99.7	99.8
Eastbound	Combined	77.5	78.9	85.1
Westbound	Combined	99.4	98.6	91.0
East & Westbound	Combined	88.5	88.8	88.0

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4.2. Air Quality Monthly Summary

Table 7 below includes a summary of any exceedances recorded at the Westconnex - M4 East In-tunnel sensors during the reported period.

Table 7: WestConnex M4 East In-Tunnel Exceedance Summary

Parameter	Time Period	Value of Exceedance	Date of Exceedance
CO	Rolling 3-minute	-	-
	Rolling 15-minute	-	-
	Rolling 30-minute	-	-
NO ₂	Rolling 15-minute	-	-
Visibility	Rolling 15-minute	-	-

3.2. Graphic Representations

Validated 1 min data for visibility, CO and NO₂ were used to construct the following monthly graphic representations. The data plotted is based on the compliance limits requirements for the project as stated in section 3.0. The single point compliance is plotted as the individual sensors 3min averages. The average along length of tunnel compliance is plotted as the average reading for the combined eastbound and combined westbound directions.

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Eastbound CO 3-min Average

September 2019

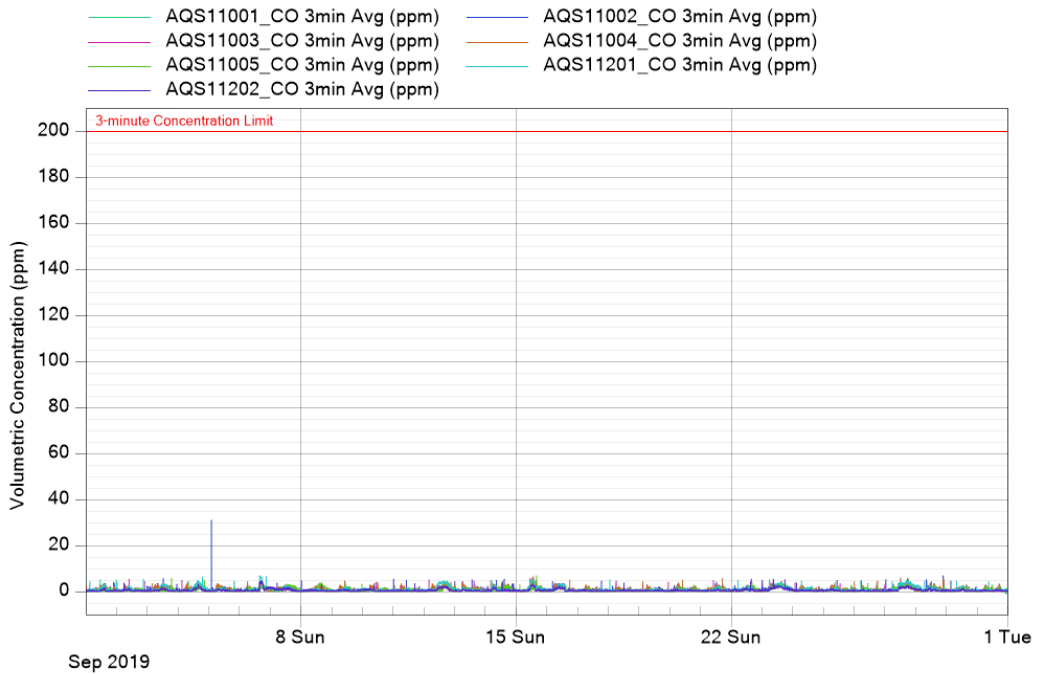


Figure 4: CO 3 minutes for September 2019 (Eastbound) AQS11001 to AQS11202

Eastbound CO 3-min Average

September 2019

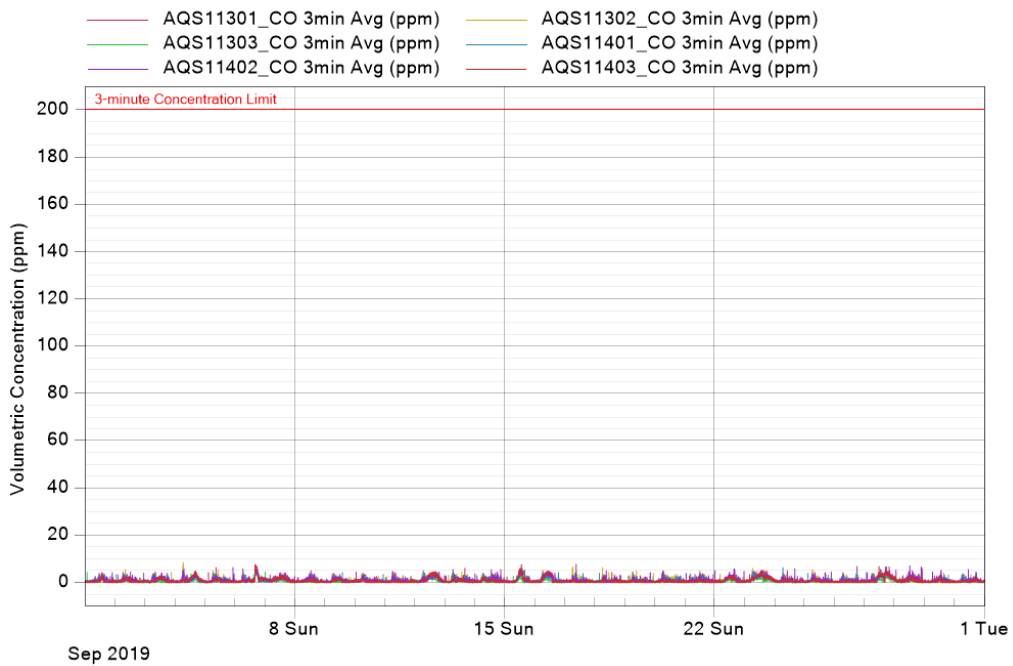


Figure 5: CO 3 minutes for September 2019 (Eastbound) AQS11301 to AQS11403

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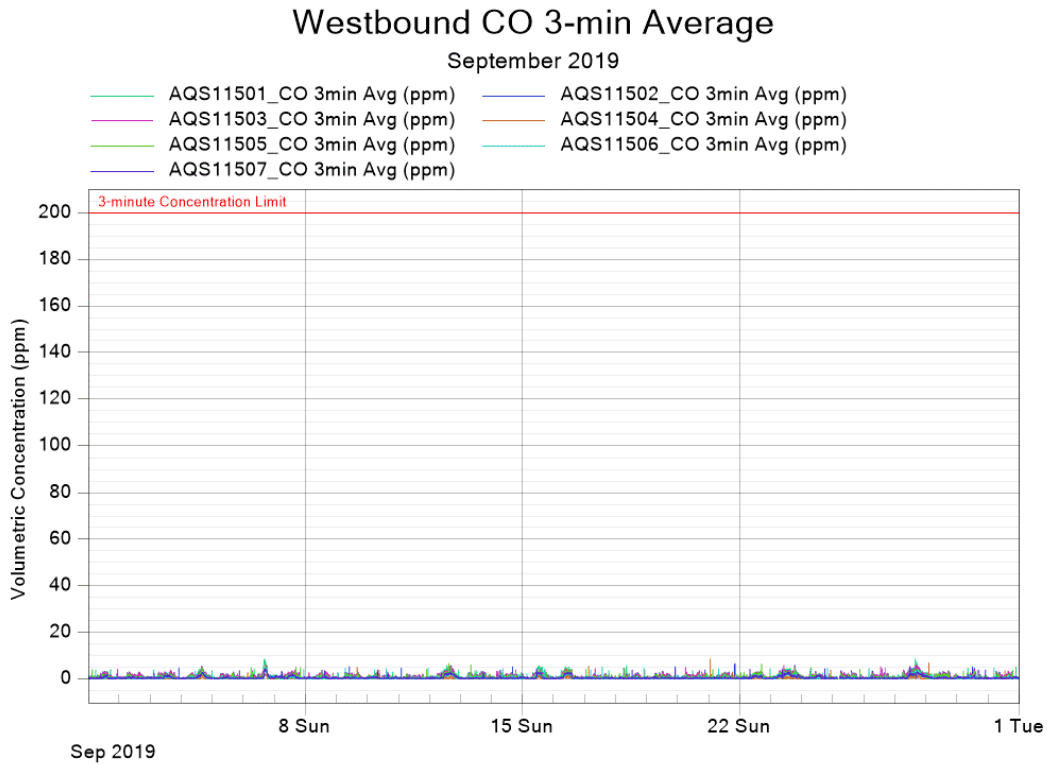


Figure 6: CO 3 minutes for September 2019 (Westbound) AQS11501 to AQS11507

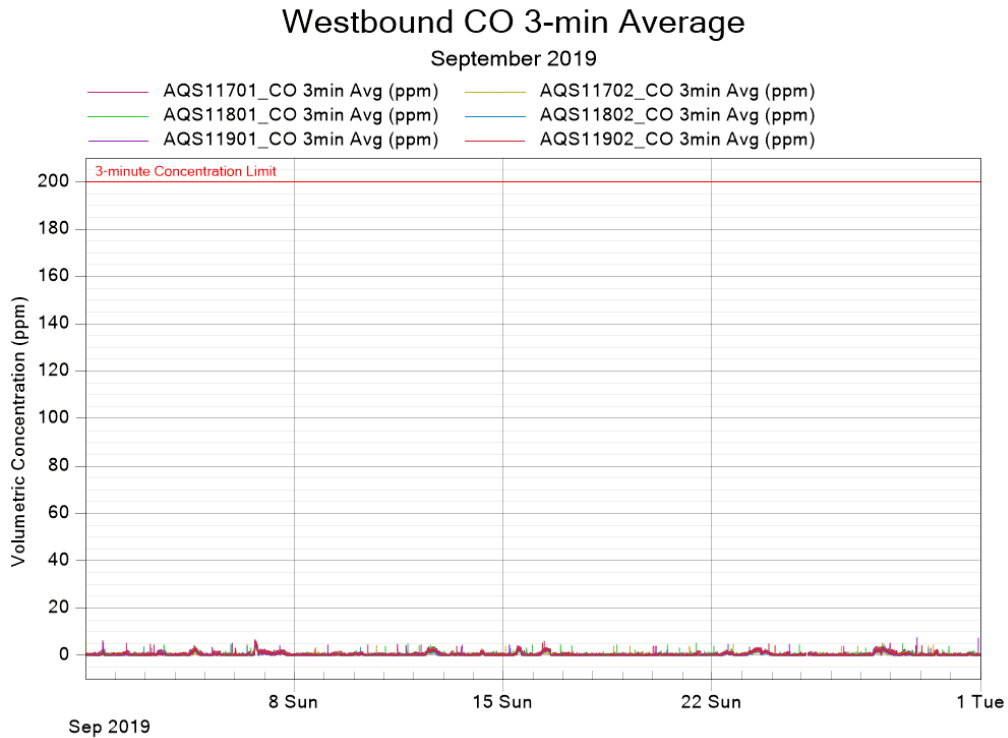


Figure 7: CO 3 minutes for September 2019 (Westbound) AQS11701 to AQS11902

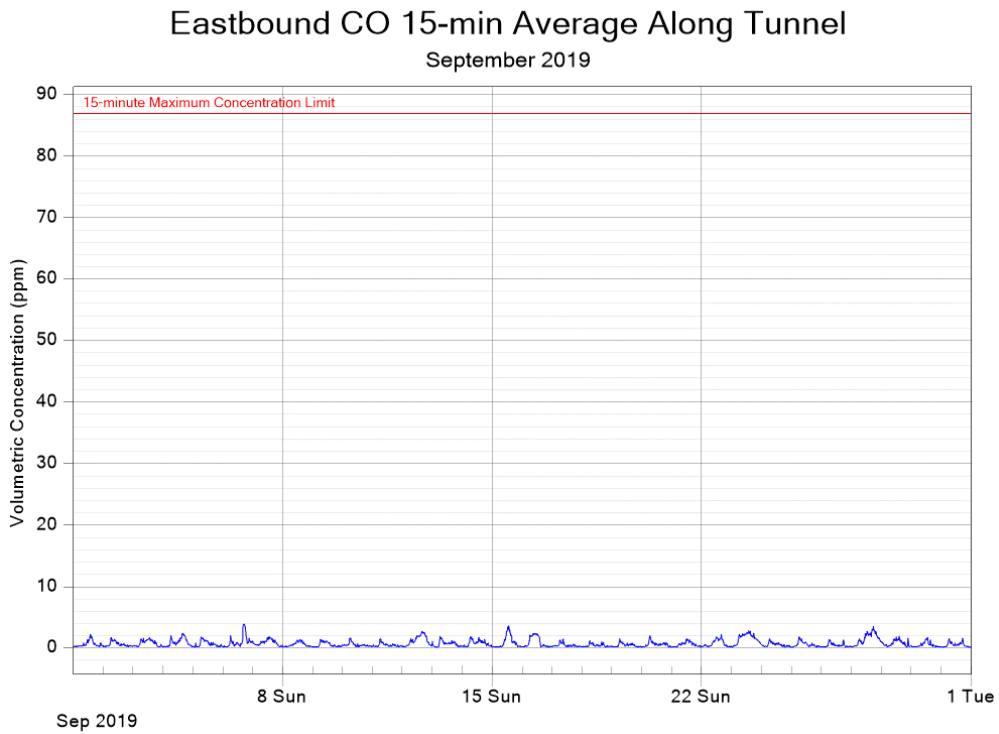


Figure 8: CO 15 minutes for September 2019 (Eastbound)

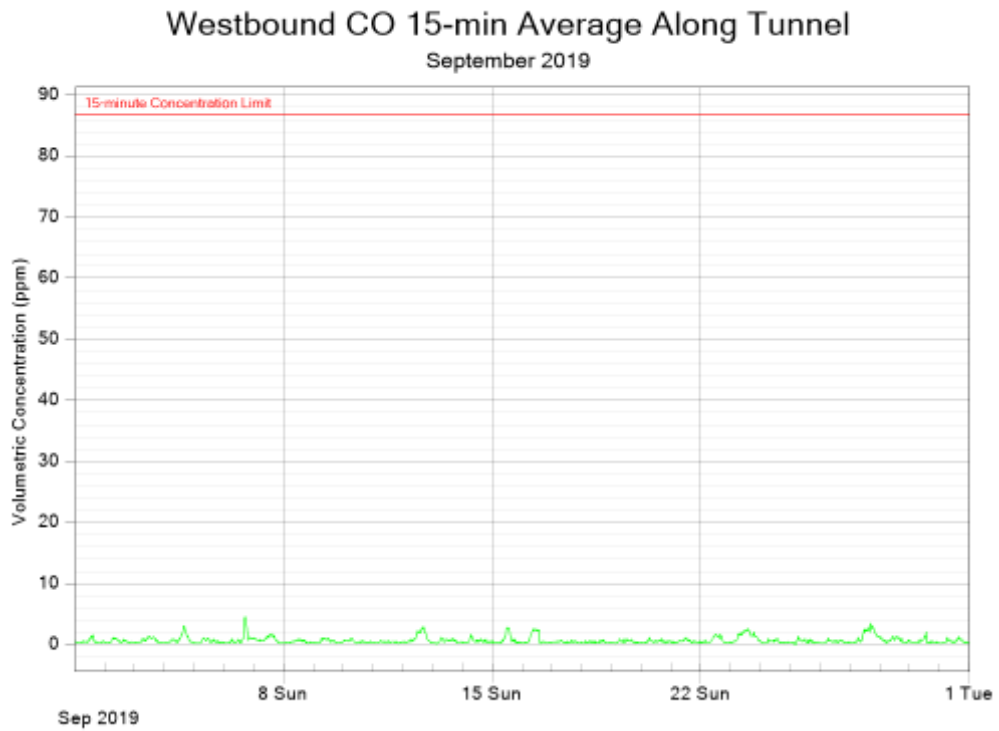


Figure 9: CO 15 minutes for September 2019 (Westbound)

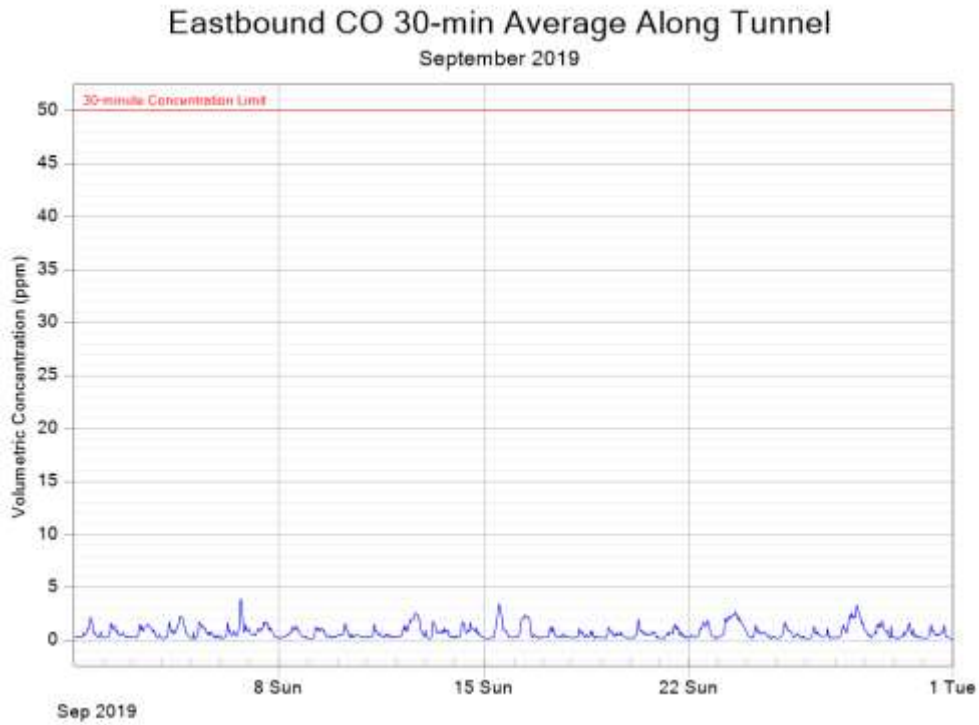


Figure 10: CO 30 minute for September 2019 (Eastbound)

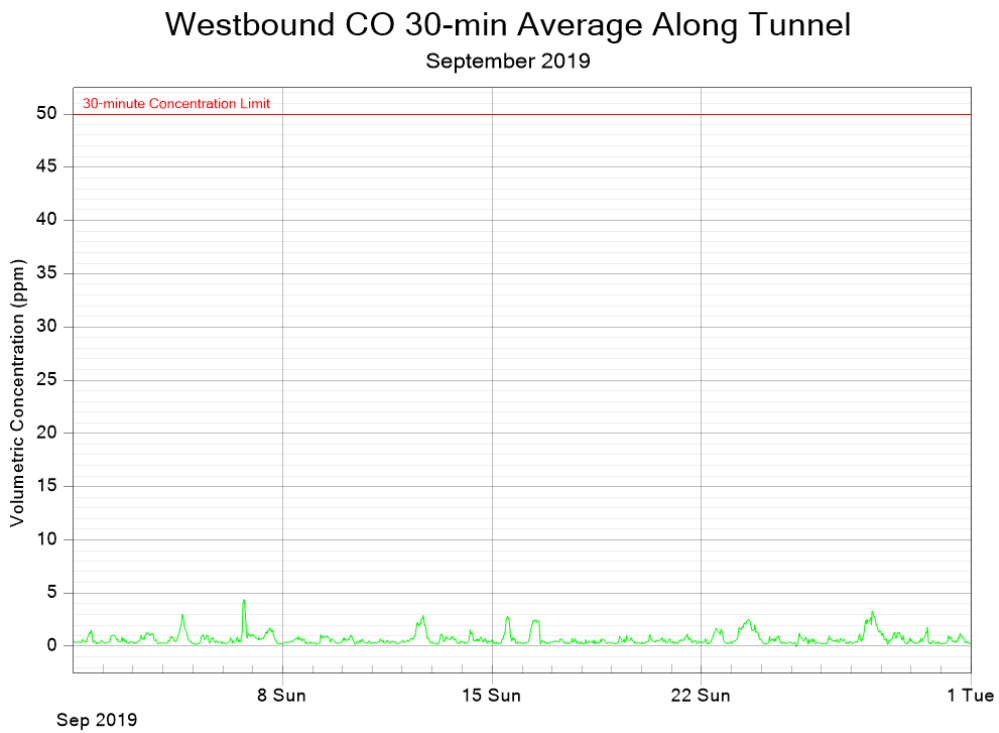


Figure 11: CO 30 minutes for September 2019 (Westbound)

Eastbound NO₂ 15-min Average Along Tunnel September 2019

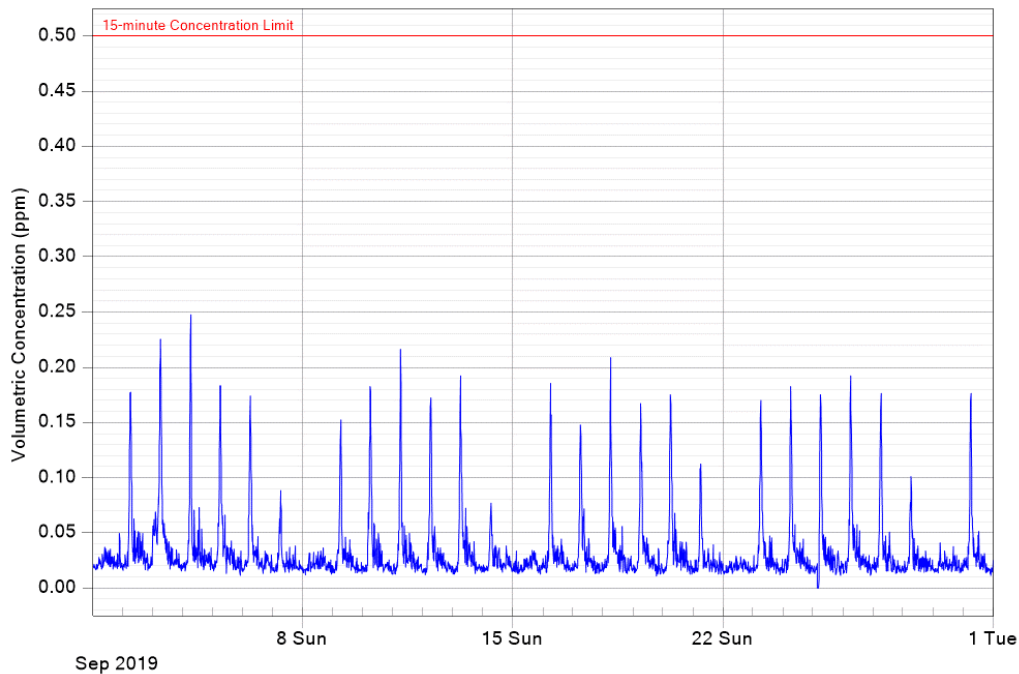


Figure 12: NO₂ 15 minutes for September 2019 (Eastbound)

Westbound NO₂ 15-min Average Along Tunnel September 2019

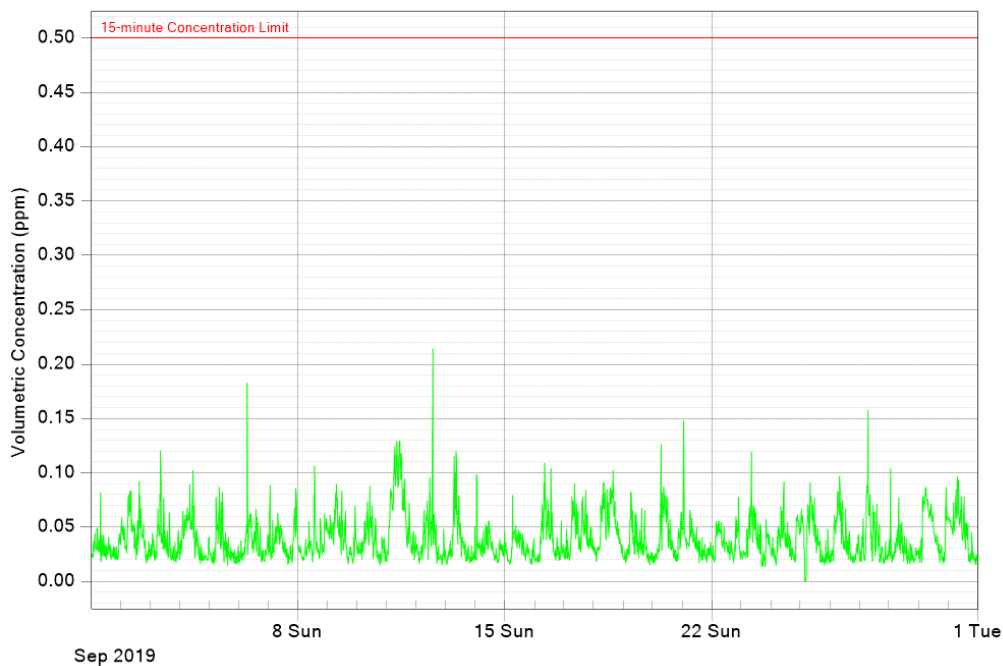


Figure 13: NO₂ 15 minutes for September 2019 (Westbound)

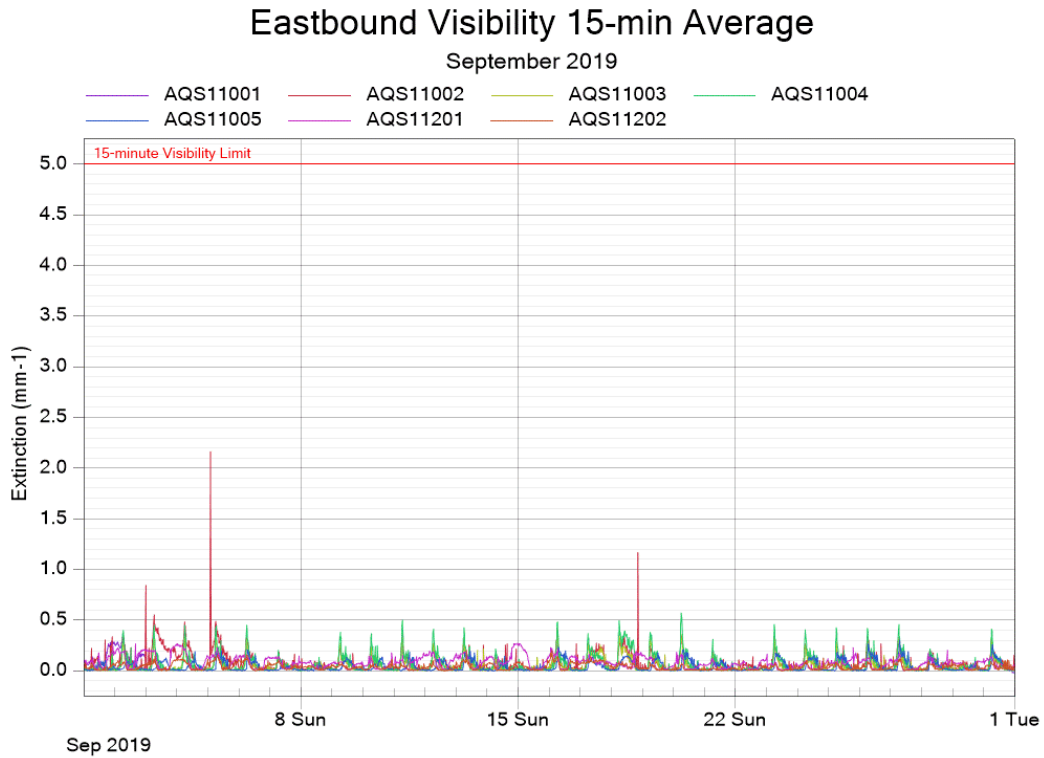


Figure 14: Visibility 15 minutes for September 2019 (Eastbound) AQS11001 to AQS11202

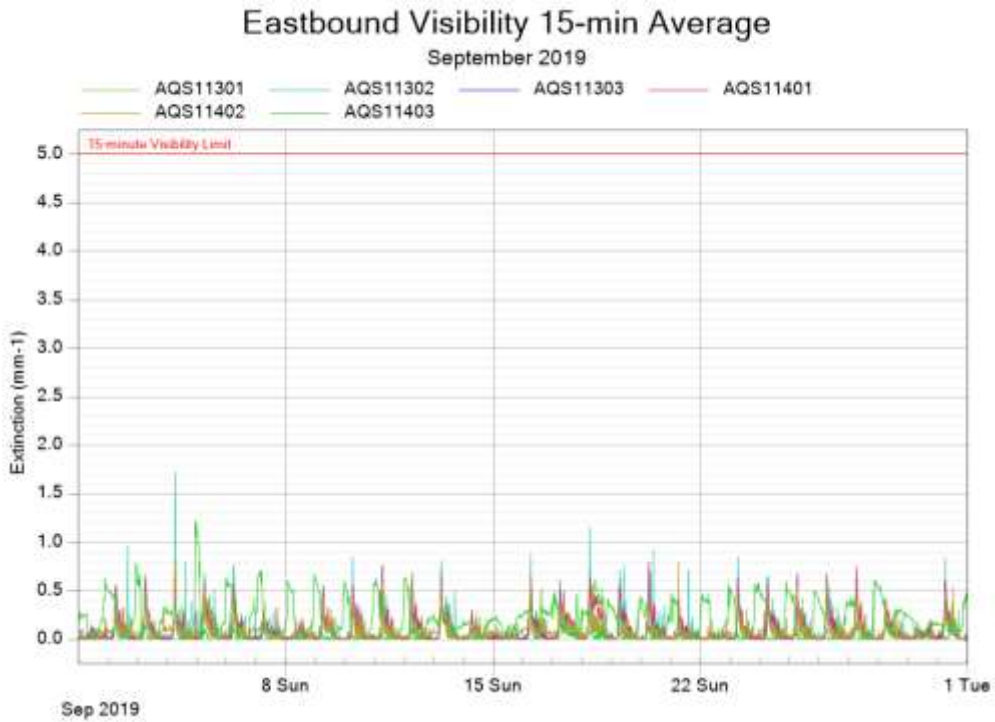


Figure 15: Visibility 15 minutes for September 2019 (Eastbound) AQS11301 to AQS11403

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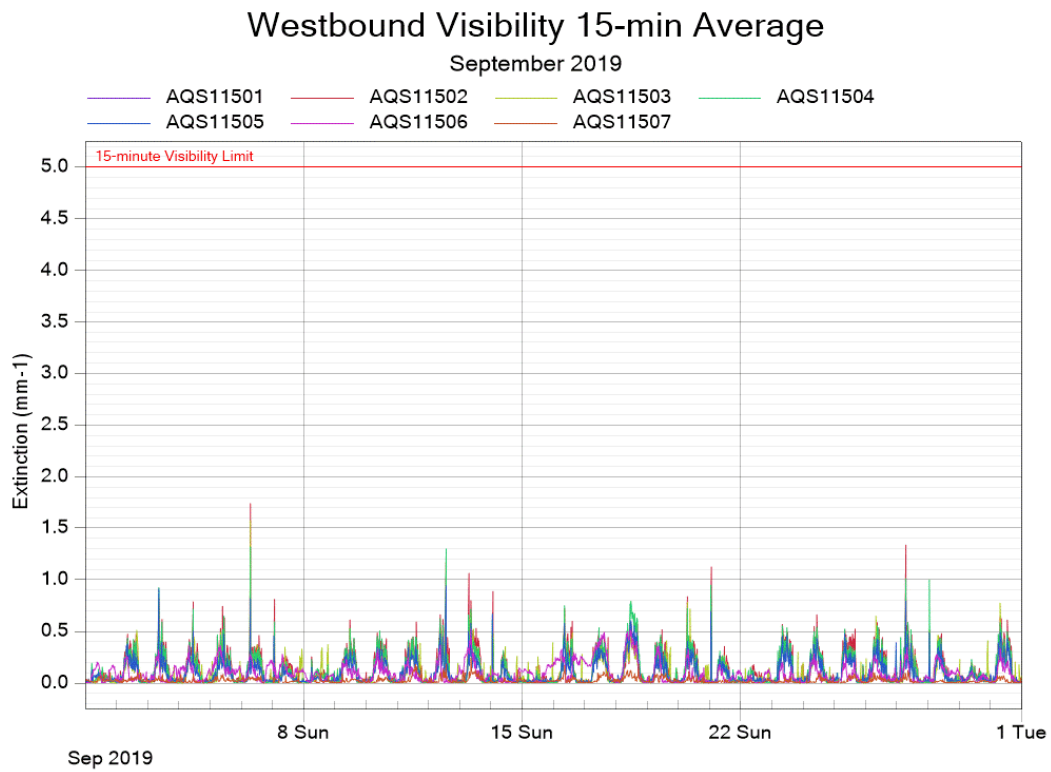


Figure 16: Visibility 15 minutes for September 2019 (Westbound) AQS11501 to AQS11507

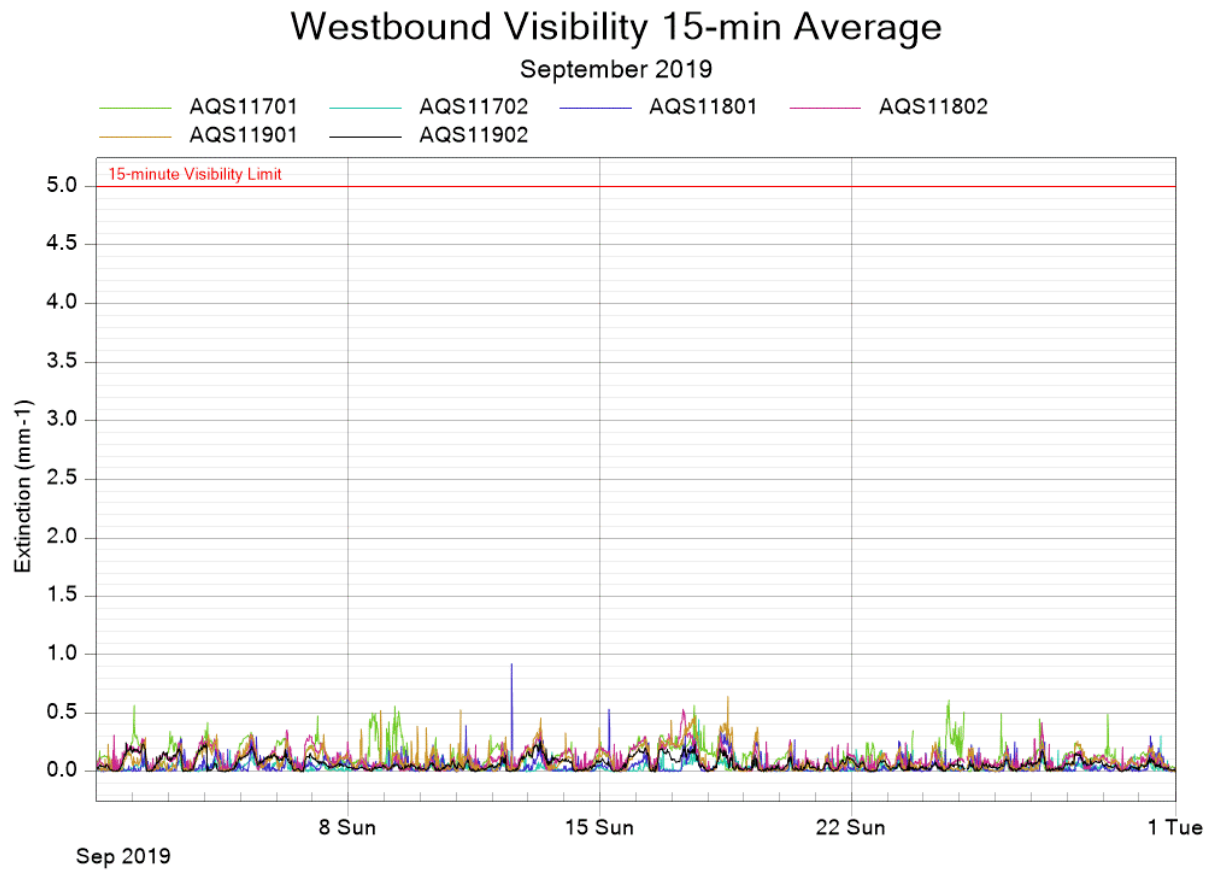


Figure 17: Visibility 15 minutes for September 2019 (Westbound) AQS11701 to AQS11902

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5.0 Valid Data Exception Tables

Tables 8 to 9 below detail all changes made to the raw data set during the validation process. An explanation of reasons given in the table can be found in Appendix 2.

Table 8: WestConnex M4 East In-Tunnel East bound Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
1/09/19 00:01	1/10/19 00:00	Data flatlined	AQS11303_NO ₂ , AQS11303_Vis	AK	23/07/20
3/09/19 00:25	1/10/19 00:00	Intermittent unrealistic data	AQS11001_CO, AQS11001_NO ₂ , AQS11001_Vis	AK	23/07/20
5/09/19 02:10	1/10/19 00:00	Unrealistic data	AQS11002_NO ₂	AK	23/07/20
24/09/19 23:10	25/09/19 05:08	Data flatlined	AQS11002_CO	AK	23/07/20
25/09/19 03:30	25/09/19 05:11	Unrealistic data	All NO ₂	AK	23/07/20

Table 9: WestConnex M4 East In-Tunnel West bound Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
1/09/19 00:00	1/10/19 00:00	Unrealistic data	AQS11501_Vis	AK	06/08/20
3/09/19 03:47	6/09/19 08:24	Intermittent unrealistic data	AQS11501_NO ₂	AK	05/08/20
4/09/19 01:40	4/09/19 02:22	Data affected by in-tunnel maintenance	AQS11902_CO, AQS11902_NO ₂	AK	05/08/20
4/09/19 02:28	4/09/19 03:07	Data intermittently affected by in-tunnel maintenance	AQS11501_CO	AK	05/08/20
4/09/20 16:36	28/09/20 03:23	Intermittent unrealistic data	AQS11507_Vis	AK	07/08/20
20/09/19 20:26	25/09/19 10:58	Intermittent unrealistic data	AQS11701_Vis	AK	06/08/20

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Start Date	End Date	Reason	Change Details	User Name	Change Date
23/09/19 16:49	25/09/19 05:13	Intermittent data flatlined	All channels	AK	05/08/20
25/09/19 03:29	25/09/19 05:11	Unrealistic data	AQS11503_NO ₂	AK	05/08/20

6.0 Report Summary

- The combined eastbound data capture for NO₂, CO and Visibility for the Westconnex - M4 East In-tunnel was below 95% during the reporting month. This was mainly because a number of sensors had flatlined data for the entire month.
- The combined westbound data capture for NO₂ and CO for the Westconnex - M4 East In-tunnel was above 95% during the reporting month.
- The combined westbound data capture for Visibility for the Westconnex - M4 East In-tunnel was below 95% during the reporting month. This was mainly because one sensor had flatlined data for the month.
- There were no exceedances of the air quality limits at the WestConnex - M4 East In-Tunnel Air Quality Network for the reporting month.

Appendix 1 - Definitions & Abbreviations

ERS	Environmental Reporting Services
AQMS	Air Quality Monitoring Station
AQM	Air Quality Monitor
AQS	Air Quality Sensor
LDL	Lower Detectable Limit
$\mu\text{g}/\text{m}^3$	Micrograms per cubic metre at standard temperature and pressure (0°C and 101.3 kPa)
AT	Ambient Temperature
CO	Carbon monoxide
mg/m^3	Milligrams per cubic metre at standard temperature and pressure (0°C and 101.3 kPa)
m-1	Per meter (unit of visibility)
mm	Millimeters
mm-1	Per millimeter (unit of visibility)
NO	Nitric oxide
NO ₂	Nitrogen dioxide
NO _x	Oxides of nitrogen
ppb	Parts per billion
ppm	Parts per million

Appendix 2 - Explanation of Exception Table

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

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

Commissioning refers to the initial setup and calibration of the instrument when it is first installed. For some instruments there may be a stabilisation period before normal operation commences.

Data transmission error refers to a period of time when the instrument could not transmit data. This may be due to interference, or a problem with the phone line or modem.

Equipment malfunction/instrument fault refers to a period of time when the instrument was not in the normal operating mode and did not measure a representative value of the existing conditions.

Gap in data/data not available refers to a period of time when either data has been lost or could not be collected.

Instrument Alarm refers to an alarm produced by the instrument. A range of alarms can be produced depending on how operation of the instrument is being affected.

Instrument out of service refers to a lack of data due to an instrument being shut down for repair, maintenance, or factory calibration.

Linear offset or multiplier refers to when an offset or multiplier has been applied between two points where the values of the offset or multiplier are different and the correction is interpolated between the two points.

Maintenance refers to a period of time when the logger/instrument was switched off due to maintenance.

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

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

Warm up after power interruption refers to the startup period of an instrument after power has been restored.

Appendix 3 - Amendments

This amended report supersedes previously issued versions of the report. Refer to the revision history table on page 2 for details of previous revisions. The following modifications have been made in this revision:

- The original report was based on summary data. The report has been updated to include the data from the individual sensors now available.

-----END OF REPORT-----