Air Noise Environment
Environmental Monitoring and Assessment

Independent Verification: Approval Condition E8

M4 East Tunnel

Date of Issue: 28 September 2018

Prepared by:
Air Noise Environment

ABN: 13 081 834 513



Air

- Ambient Monitoring
- Auditing
- Computational Modelling
- Control Solutions
- Emission Inventories
- Expert Evidence
- Dust Assessment and Management
- Occupational Monitoring and Assessment
- Odour Monitoring and Assessment
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The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Air Noise Environment Pty Ltd for the purposes of this project is both complete and accurate.

Executive Summary

Air Noise Environment was commissioned by the CPB Samsung John Holland Joint Venture to conduct an independent compliance audit (this Audit) against Instrument of Approval (IoA) Conditions governing the M4 East project relating to ambient air quality assurance and quality control as defined in the IoA document SS16307 dated 11 February 2016. Condition E8 of the Approval states that the 'The Proponent must monitor (by sampling and obtaining results by analysis) the pollutants and parameters specified in Table 8 …Monitoring results must be … subject to an independent audit at six monthly intervals…..The auditor must be approved by the Secretary in consultation with the EPA and the AQCCC And the auditors report must be directly provided to the proponent and the AQCCC.'

Air Noise Environment Pty Ltd has been approved by the Secretary as an Independent Air Quality Specialist for the purposes of completing air quality assessment, auditing and compliance reporting for the M4 East Tunnel project.

The data audit assessing compliance with Condition E8 of the IoA was conducted by Gary Hall, Manager – Air Sampling, Air Noise Environment Pty Ltd. The audit assessed compliance with the ambient air quality monitoring requirements of IoA Condition E8. The data audit consisted of a desktop review of published reports and raw data provided by Ecotech.

The data audit methodology consisted of following representative raw data values from the analyser, through collection and storage by the data logger, the raw data validation/review process, calculations and then review of the final reported values. Raw data and the validated data was provided by Ecotech. A sample of the raw data for the month of June for all stations was reviewed. The raw data was checked against the values used by Ecotech for the validation and for the averaged data ultimately reported for each site for each month. The audit showed the raw data and results calculated from this by the Independent Air Quality Specialist matched very closely with the validated and reported data by Ecotech.

The data results were also compared to the compliance limits for the project. The results show full compliance for carbon monoxide and NO_2 for the 6 month period. Exceedences for the 24 hour PM_{10} and $PM_{2.5}$ were noted on a few occasions over the 6 month period, and may be caused by local or regional events.

The monitoring reports were reviewed for conformance to the reporting requirements of the relevant Australian Standard sampling methods. The reports were found to comply with the relevant requirements, with the exception of defining the calibrated range and full scale of the instruments. This omission is not considered significant, however it is recommended that this is addressed for future reports.

Limitations of this Report

During the preparation of this audit report, Air Noise Environment has evaluated the monthly ambient air quality reports prepared by Ecotech for the M4E project.

Air Noise Environment has reviewed the initial 6 months of ambient monitoring reports prepared by Ecotech and checked a representative sample of of raw data against the validated data used for the calculations and reporting purposes for the June 2018 report. Whilst the audit has not completed a detailed examination of all of the raw data presented in each of the monthly air quality reports, the adopted approach is considered suitable to verify the dataset, as the same procedures and calculation methodologies are adopted for each month of data collected. Whilst the possibility of calculation errors arising for other months of data cannot be entirely discounted, in our opinion the audit of a sample of data provides a suitable approach for data verification for the first 6 months of ambient air quality data.

The conclusions outlined in this audit report are professional opinions based solely upon Air Noise Environment's review and audit of the monthly reports and the data provided by Ecotech.

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1 Introduction

1.1 Background

The Instrument of Approval (IoA) Conditions governing the M4 East project are defined in the IoA document SS16307 dated 11 February 2016. The IoA includes a number of performance requirements relating to Air Quality, both in-tunnel and ambient. The project Construction Contractor, CPB Samsung John Holland Joint Venture, is contractually responsible for meeting some of these requirements through the design and construction of the tunnel on behalf of the Project Proponent – NSW Roads and Maritime Services (RMS).

The approval conditions also require that the air quality monitoring methodologies and air quality outcomes as defined in the IoA document are subject to verification by an Approved Independent person or organisation. Air Noise Environment Pty Ltd was nominated by RMS to undertake the role of independent specialist in accordance with the IoA for the WestConnex M4 East project. This nomination was subsequently approved by NSW Planning and Environment on 4 December 2017 and 24 May 2018.

As the Approved Independent Specialist, Air Noise Environment will complete review and auditing of compliance with the following air quality related Approval conditions:

- Condition E1 — verification and compliance auditing for in-tunnel air quality monitoring;
- Condition E5 – verification that compliance with in-tunnel limits will not preclude compliance with the outcomes in the EIS and will not result in impacts greater than predicted in the EIS, assess how the ventilation system has been optimised with respect to air quality and energy use;
- Condition E8 — independent audit of ambient air quality monitoring results;
- Condition E13 — audit of ventilation outlet monitoring equipment prior to commencement of monitoring;
- Condition E15 – verification that compliance with the ventilation outlet limits will not preclude compliance with the outcomes in the EIS and will not result in impacts greater than predicted in the EIS, assess how ventilation outlet discharge velocities have been optimised in consideration of energy requirements and air quality impacts;
- Condition E25 — review and, if appropriate, approve the quality assurance and quality control measures for ambient monitoring.

1.2 Scope of Work and Audit Criteria

This report presents the Independent Verification of conformance with the requirements of Approval Condition E8 (see below) relating to the independent audit of ambient air quality data for the initial six months of operation of the ambient monitoring stations.

> ***'Condition E8 – Ambient Air Quality Monitoring***
>
> *The Proponent must monitor (by sampling and obtaining results by analysis) the pollutants and parameters specified in Column 1 of Table 8 at the following locations as a minimum:*
>
> *(a) two ground level receptors near the eastern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;*
>
> *(b) two ground level receptors near the western ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;*
>
> *(c) one location along Parramatta Road, at a location suitable for detecting any impact on air quality along Parramatta Road; and*
>
> *(d) one location, away from any of the locations at (a), (b) and (c), suitable for providing background ambient air quality reference data for the project area.*
>
> *In selecting the monitoring locations, consideration is to be given to the desirability of like-to-like comparison of monitoring results to available pre-construction data, and the requirement in condition E46 for the independent team of experts to review the accuracy of predicted environmental outcomes discussed in the documents listed in conditions A2(b) and A2(c) . All monitoring stations must be established subject to the land owner's and occupier's agreement. The Proponent must use the sampling method, units of measure, and sampling frequency specified in Table 8.*
>
> *The Proponent must commence monitoring for at least twelve continuous months prior to operation. The locations are to be agreed to by the AQCCC. The Proponent must meet all operating costs associated with the stations.*
>
> *The Proponent, following consultation with the AQCCC, must review the need for the continuation of the ambient monitoring stations after a period of two years from commencement*
>
> *of operation. Any recommendation to close the stations will require the approval of the Secretary in consultation with the EPA.*
>
> *The establishment and operation of the stations is to be undertaken in accordance with recognised Australian standards and undertaken by an organisation accredited by NATA for this purpose and approved by the Secretary in consultation with the EPA and the AQCCC. The quality of the monitoring results must be assured through a NATA accredited process prior to the data being considered as a basis for compliance/auditing purposes.*
>
> *Monitoring results must be made publicly available and must be subject to an independent audit at six-monthly intervals (or at a longer interval, if approved by the Secretary). The*

auditor must be approved by the Secretary in consultation with the EPA and the AQCCC, and the auditor's report must be directly provided to the Proponent and the AQCCC.'

The scope for this audit is restricted to verification of the requirements of the final paragraph of Condition E8 in relation to the independent audit of monitoring results.

1.3 Audit Objectives

The objective of the audit is to assess compliance with Condition E8 of the IoA in relation to the independent audit of ambient air quality monitoring station results for the months of January to June 2018.

1.4 Audit Team

The data audit was performed and prepared by Gary Hall, BSc,(Hons),Env Sci (Manager - Air Monitoring, Air Noise Environment Pty Ltd). Gary Hall has over 20 years experience in Air Monitoring.

2 Methodology

2.1 Approach Adopted

The audit consisted of a desktop review of published ambient air monitoring reports and analysis of the raw data and validated data provided by Ecotech.

Ambient monitoring data has been published on the M4 East website since 21 December 2017. AT the time of preparing this report, 6 reports had been published on the M4 East website. These are:

- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st January 2018 - 31st January 2018 issued 21 March 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st February 2018 - 28th February 2018 issued 21 March 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st March 2018 - 31st March 2018 issued 13 April 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st April 2018 - 30th April 2018 issued 15 May 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st May 2018 - 31st May 2018 issued 15 June 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st June 2018 – 30 th June 2018 issued 19 July 2018.

2.2 Initial Review of Monthly Reports

Based on an initial review of the six monthly reports from January to June 2018, it was concluded that there were no obvious errors or areas of concern. The data capture rates for each ambient air monitoring station have been included in Table 12 of each of the monthly reports. The data capture rates for each compound or measurement parameter is listed for each station.

Overall the sites achieved greater than 95% data capture rates for most periods. The lowest data capture rate for any station was recorded as 79.3% for the Haberfield site for nitrogen dioxide for the month of May 2018. However, for the same month, all other parameters at all 6 ambient monitoring stations recorded data capture rates over 90%.

The lowest data capture rate for the June monthly report was recorded as 84% for the Haberfield site for carbon dioxide. However, for the same month, all other parameters at all 6 ambient monitoring stations recorded data capture rates over 95%.

The overall data capture rate for all parameters for stations for the January to June period was calculated as 97.0%.

2.3 Detailed Audit

To allow a more detailed audit of the data to be completed, the six reports were reviewed to determine whether there was any specific period where unusual results occurred that could warrant a more detailed investigation. As there was little difference in the % data capture, the reported values and the number of exceedances, the June 2018 report was selected for the desktop review. In the absence of any specific reason for selecting one of the six monthly reports, the June report was chosen as it was the most recently available report at the time of completing this audit. The report is numbered DAT13450 and was issued under NATA accreditation number 14184. Raw data and validated data was provided by Ecotech for the month of June to allow a detailed examination of the data and calculations that resulted in the reported air quality concentrations and meteorological parameters.

Ambient station monitoring data should be validated and verified in a consistent manner ensuring the integrity and representativeness of the environmental conditions present at the time of collection. Data reduction is the conversion of raw data into a more ordered, simplified, user- friendly form. Data audits are a means to assure data integrity. The data also needs to be summarised from 5 minute collected averages to hourly or daily (24 hourly) averages for reporting purposes.

As per the Australian Standards AS 3580, 5.1, 7.1, 9.8 and 9.12, the data validation process requires :

- A review of the data by trained personnel using data screening criteria
- Identification of possible incorrect values e.g. data collected during calibration or maintenance procedures.
- Regular review of the data
- An ongoing process of the data review
- Review of calibration information, the recorded data, and any status flags that could affect data.
- All data should be considered valid unless evidence or sound scientific principles can be given to support its invalidation
- Copies of the original raw data should be kept for audit purposes

This is the process completed by Ecotech for the on-going data review, analysis and presentation. A methodology consistent with these requirements was adopted for the data audit.

In completing the audit, a data audit trail was used to check for data recording/transfer errors. The data audit trail encompasses a check of data from the raw data through to the summarised validated date and ultimately presented in the report. Data is recorded by the analysers and instruments at the ambient monitoring stations at 5 minute intervals. The data is then validated and checked for errors and faults. Validated data is then converted to hourly and then 24 hourly averages which is presented in the final monthly report for each station. This audit has followed sections of raw data as downloaded from the ambient station instruments, through the validation process and then

compared the calculated values determined from the raw data with the results of those reported by Ecotech in the monthly report.

Data listed in the valid data exception tables in the June 2018 report has also been checked to confirm the validity of the exceptions and reasons the data was invalidated.

The standards also specify the data and parameters required for the reporting of measured results. The reporting requirements include:

- Reference to the relevant Standard
- The reporting organisation or company
- The concentration of the components measured in correct units (ppm or ug/m^3)
- The full scale value of the instruments.
- Sampling location—all relevant details, including a coordinate reference including height to within 100 m above ground level.
- The type of instrument.
- Any non-conformances with the standards
- The uncertainty associated with the measurement along with the confidence interval and coverage factor.
- Any other relevant data, e.g. meteorological conditions.

The June 2018 report prepared by Ecotech has been checked against these requirements.

3 Audit Findings

3.1 Comparison of Raw Data

Raw data was reviewed for both completeness and correctness. Generally, data is considered complete if there is 5% of valid data within an hour, 75% of valid hours within a day, 75% of valid days within a month, 75% of valid days within a quarter, and 4 complete quarters within a calendar year.

Raw data from each station for the month of June 2018 was checked against the validated and processed data Ecotech used for the reporting requirements. The raw data for each station was compared to the data presented in the validated Ecotech spreadsheet. Comparisons were made and calculation checks were completed to confirm that the raw data matched with the reported results for each station. 5 minute raw and validated data was provided for all parameters except for $PM_{2.5}$ and Sigma Theta. For $PM_{2.5}$, sampled using the beta attenuation method, the last 10 minutes of each hour are a calibration cycle. Therefore, only one hour average data are provided for $PM_{2.5}$ as sub 1-hour data is not valid. In the case of sigma theta, this is a calculated value determined from the wind directions for the measurements completed during the previous hour.

The audit findings and comparison results of the raw data are shown in Tables 3.1 to 3.6 below. The results of the ANE validation checks are discussed in Section 3.2.

Calibration data was also reviewed, and confirmed that the daily calibration checks were evident in the datasets. Monthly and six monthly calibration checks were also completed in accordance with the manufacturer's recommendations, although the timing for some of the calibration checks varied slightly due to staffing and maintenance issues. This is not considered to be a significant issue, and Ecotech have confirmed that subsequent six monthly checks are to be completed in accordance with the original schedule.

Table 3.1: Verification of Raw Data Compared to Validated Data for Allen Street

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	$PM_{2.5}$	Not available – see footnote	No Validated 5 minute data available for $PM_{2.5}$ in the Ecotech spreadsheet. However, 1 hourly data was provided and this accurately averaged into 24 hour data.
01/06/2018 - 30/06/2018	PM_{10}	Yes. Raw data matched the validated very closely.	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. All the data for the month is present except the period 06/06/18 13:25 to 06/06/18 14:20 when Ecotech reported non scheduled maintenance was carried out and for the period 20/6/18 08:40 – 20/6/18 15:45 where Ecotech reported Scheduled 6 monthly maintenance performed followed by instrument stabilisation.
01/06/2018 - 30/06/2018	CO	Yes. Raw data matched the validated very closely.	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 – to 01:20) and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these appear to have been correctly invalidated. Non scheduled maintenance was performed on 06/06/18 14:24 until 06/06/18 14:20. This is a relatively short time with insignificant data loss.
01/06/2018 – 30/06/2018	NO	Yes. Raw data matched the validated very closely.	The NO, NO_2 and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 – to 01:20) and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated. The sum of NO and NO_2 also matches the NO_x values for the raw and validated data.
01/06/2018 - 30/06/2018	NO_2	Yes. Raw data matched the validated very closely.	
01/06/2018 - 30/06/2018	NO_x	Yes. Raw data matched the validated very closely.	
01/06/2018 - 30/06/2018	WS	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/06/2018 - 30/06/2018	WD	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/06/2018 - 30/06/2018	Sigma	Yes. Raw data matched the validated very closely.	Calculations made by ANE of raw data matches very closely the validated data Ecotech used for the report.
01/06/2018 - 30/06/2018	@ 2 m	Yes. Raw data matched the validated very closely.	No errors observed between raw data and data used for validation and reporting.

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	@ 10 m	Yes. Raw data matched the validated very closely.	No errors observed between raw data and data used for validation and reporting.

Table 3.2: Verification of Raw Data Compared to Validated Data for Concord Oval

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	$PM_{2.5}$	Yes	The 1 hourly data was provided and this accurately averaged into 24 hour data.
01/06/2018 - 30/06/2018	PM_{10}	Yes	Overall, the raw data matches closely the validated data used in the Ecotech spreadsheet for reporting. 100% of the data for the month of June is present
01/06/2018 - 30/06/2018	CO	Yes	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 – to 01:20 and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these appear to have been correctly invalidated.
01/06/2018 - 30/06/2018	NO	Yes	The NO, NO_2 and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 – to 01:25) and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated. Th Sum of NO and NO_2 also matches the NO_x values for the raw and validated data.
01/06/2018 - 30/06/2018	NO_2	Yes	
01/06/2018 – 30/06/2018	NO_x	Yes	
01/06/2018 - 30/06/2018	WS	Yes	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 - 30/06/2018	WD	Yes	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 - 30/06/2018	Sigma	Yes	Calculations made by ANE of raw data matches very closely the validated data Ecotech used for the report. 100% of data reported.
01/06/2018 - 30/06/2018	@ 2 m	Yes	No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 - 30/06/2018	@ 10 m	Yes	No errors observed between raw data and data used for validation and reporting. 100% of data reported.

Table 3.3: Verification of Raw Data Compared to Validated Data - Haberfield Public School

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	$PM_{2.5}$	Yes	The 1 hourly data was provided and this accurately averaged into 24 hour data.
01/06/2018 - 30/06/2018	PM_{10}	Yes	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. All the data for the month is present except for a few intermittent errors affecting less than 0.5% of the data.
01/06/2018 - 30/06/2018	CO	Yes	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks followed by instrument stabilisation (01:00 – to 01:50) and the background checks daily from 23:45 to 23:50. The raw data shows a relatively high proportion of unrealistic data at various periods of the month. This data has been invalidated and the invalidation's appear reasonable. The CO instrument was also affected by a few faults – 10/6/18 01:00 – 10/6/18 11:40, 11/6/18 01:00 – 11/6/18 14:45, 26/6/18 01:00 – 26/6/18 10:15. Non scheduled maintenance was carried out on 4/6/18 10:00 to 4/6/18 12:20, 10/6/18 11:45 – 10/6/18 12:35, 11/6/18 14:50 – 11/6/18 16:45 with scheduled monthly maintenance performed on 28/6/18 10:20 – 28/6/18 16:00. Overall the station reported 84% data for CO for the month of June.
01/06/2018 - 30/06/2018	NO	Yes	The NO, NO_2 and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 – to 01:20 and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated. Non scheduled maintenance was carried out on 4/6/18 10:00 to 4/6/18 12:20, 10/6/18 11:45 – 10/6/18 12:35, 11/6/18 14:50 – 11/6/18 16:45 with scheduled monthly maintenance performed on 28/6/18 10:20 – 28/6/18 16:00. The sum of NO and NO_2 also matches the NO_x values for the raw and validated data.) Overall the data reported covers 99.4% of the month.
01/06/2018 - 30/06/2018	NO_2	Yes	
01/06/2018 - 30/06/2018	NO_x	Yes	
01/06/2018 - 30/06/2018	WS	Yes	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.4% of data reported.
01/06/2018 - 30/06/2018	WD	Yes	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.4% of data reported.
01/06/2018 - 30/06/2018	Sigma	Yes	Calculations made by ANE of raw data matches very closely the validated data Ecotech used for the report. 99.4% of data reported.
01/06/2018 - 30/06/2018	@ 2 m	Yes	No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.
01/06/2018 - 30/06/2018	@ 10 m	Yes	No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.

Table 3.4: Verification of Raw Data Compared to Validated Data for Powells Creek

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	$PM_{2.5}$	Yes	The 1 hourly data was provided and this accurately averaged into 24 hour data.
01/06/2018 - 30/06/2018	PM_{10}	Yes	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. Non Scheduled maintenance performed on 29/6/18 15:15 – 29/6/18 15:35 when the filter paper was changed. Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20 All the data for the month is present except for a few intermittent errors affecting less than 0.2% of the data.
01/06/2018 - 30/06/2018	CO	Yes	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 – to 01:20 and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these appear to have been correctly invalidated. Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20.
01/06/2018 - 30/06/2018	NO	Yes	The NO, NO_2 and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 – to 01:20 and the Background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated. Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20 The sum of NO and NO_2 also matches the NO_x values for the raw and validated data.
01/06/2018 - 30/06/2018	NO_2	Yes	
01/06/2018 - 30/06/2018	NO_x	Yes	
01/06/2018 - 30/06/2018	WS	Yes	Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.
01/06/2018 - 30/06/2018	WD	Yes	Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.
01/06/2018 - 30/06/2018	Sigma	Yes	Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.
01/06/2018 - 30/06/2018	@ 2 m	Yes	Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.
01/06/2018 - 30/06/2018	@ 10 m	Yes	Scheduled monthly maintenance was performed on 1/06/18 14:00 until 1/06/18 15:20. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.8% of data reported.

Table 3.5: Data Verification of Raw Data Compared to Validated Data for Ramsay Street

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	$PM_{2.5}$	Yes	The 1 hourly data was provided and this accurately averaged into 24 hour data.
01/06/2018 - 30/06/2018	PM_{10}	Yes	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. All the data for the month is present except for a few intermittent errors affecting less than 0.4% of the data.
01/06/2018 - 30/06/2018	CO	Yes	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 – to 01:20 and the Background checks daily from 23:45 to 23:50. A few intermittent errors throughout the month were also noted and these appear to have been correctly invalidated. Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Non scheduled maintenance was performed on 4/6/18 13:25 – 4/6/18 13:55. Overall 96.3 % of the data was reported.
01/06/2018 - 30/06/2018	NO	Yes	The NO, NO_2 and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 – to 01:20 and the Background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated. Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00 The sum of NO and NO_2 also matches the NO_x values for the raw and validated data. Overall 96.3 % of the data for the month of June was reported.
01/06/2018 - 30/06/2018	NO_2	Yes	
01/06/2018 - 30/06/2018	NO_x	Yes	
01/06/2018 - 30/06/2018	WS	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 - 30/06/2018	WD	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 - 30/06/2018	Sigma	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 - 30/06/2018	@ 2 m	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/06/2018 -	@ 10 m	Yes	Scheduled monthly maintenance was performed on 29/06/18

Date	Parameter	Raw data matches validated data	Comments
30/06/2018			11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.

Table 3.6: Data Verification of Raw Data Compared to Validated Data for Saint Lukes Park

Date	Parameter	Raw data matches validated data	Comments
01/06/2018 - 30/06/2018	$PM_{2.5}$	Yes	The 1 hourly data was provided and this accurately averaged into 24 hour data.
01/06/2018 - 30/06/2018	PM_{10}	Yes	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. Scheduled partial 6 monthly maintenance was performed on 20/6/18 14:00 to 20/6/18 16:25 and 25/06/18 10:00 to 25/6/18 16:25.All the data for the month is present except for a few intermittent errors affecting less than 0.6% of the data.
01/06/2018 - 30/06/2018	CO	Yes	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 – to 01:20 and the background checks daily from 23:45 to 23:50. A few intermittent errors throughout the month were also noted and these appear to have been correctly invalidated. Scheduled partial 6 monthly maintenance was performed on 20/6/18 14:00 to 20/6/18 16:25 and 25/06/18 10:00 to 25/6/18 16:25.. Overall 95.9 % of the data was reported.
01/06/2018 - 30/06/2018	NO	Yes	The NO, NO_2 and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 – to 01:25 and the Background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated. Scheduled partial 6 monthly maintenance was performed on 20/6/18 14:00 to 20/6/18 16:25 and 25/06/18 10:00 to 25/6/18 16:25. The sum of NO and NO_2 also matches the NO_x values for the raw and validated data. Overall 95.6 % of the data for the month of June was reported.
01/06/2018 - 30/06/2018	NO_2	Yes	
01/06/2018 - 30/06/2018	NO_x	Yes	
01/06/2018 - 30/06/2018	WS	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.4% of data reported.
01/06/2018 - 30/06/2018	WD	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.4% of data reported.
01/06/2018 - 30/06/2018	Sigma	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated

Date	Parameter	Raw data matches validated data	Comments
			data very closely. No errors observed between raw data and data used for validation and reporting. 99.4% of data reported.
01/06/2018 - 30/06/2018	@ 2 m	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.5% of data reported.
01/06/2018 - 30/06/2018	@ 10 m	Yes	Scheduled monthly maintenance was performed on 29/06/18 11:30 until 29/06/18 14:00. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 99.5% of data reported.

3.2 Overall data comparison check

The raw data for June has been checked against the Ecotech validated data used for the reporting and discussed in Section 3.1 above. Calculations and checks were also performed by Air Noise Environment to verify the Ecotech calculations are correct when converting from 5 minute raw data averages to the reported hourly and 24 hourly averages. This is necessary as the data is downloaded from the instruments in 5 minute averages and converted into hourly averages and then 24 hourly averages for reporting. The exception to this is for the particulate data, where 1 hour data is provided (ie, for $PM_{2.5}$ and sigma theta).

Air Noise Environment used the validated data supplied by Ecotech as part of the reporting process and performed calculations to convert from 5 minute data to 1 hourly averages. The 1 hourly averages were then converted to 24 hourly averages and compared to the 24 hourly average results which Ecotech have reported in the monthly reports. A summary of the calculation results are included in Table 3.7 below.

Table 3.7: ANE Calculated Data Compared to Ecotech Report (% agreement)

Station	$PM_{2.5}$ ug/m^3	PM_{10} ug/m^3	CO ppm	NO ppm	NO_2 ppm	NO_x ppm	WS m/s	WD °	Sigma °	Temp @2m K	Temp @10m K
St Lukes	100.2	100.1	99.9	100.1	100.2	100.1	100.5	95.2	100.1	100.0	100.0
Ramsay Street	100.0	100.0	100.1	99.7	100.6	100.4	100.0	107.6	100.0	100.0	100.0
Powells Creek	102.5	100.1	100.4	99.8	100.5	100.3	100.4	101.0	100.0	100.0	100.0
Haberfield School	99.5	100.0	99.5	99.7	100.2	100.2	100.5	109.8	100.2	100.0	100.0
Concord Oval	100.0	100.0	100.5	99.0	100.6	100.9	100.0	109.3	100.0	100.0	103.5
Allen Street	102.7	100.0	99.8	100.5	100.2	99.8	100.4	104.7	98.8	100.0	103.5

The results from Table 3.7 show a high percentage agreement between the Ecotech calculated averages and the Air Noise Environment calculated averages from the raw data.

Based on the comparison of the raw data supplied by Ecotech and the validated spreadsheets used for the reporting of the data, it is the opinion of ANE that the validation process used by Ecotech for the reporting is accurate. It is also the opinion of ANE that the results presented in the June report (Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st June 2018 – 30th June 2018 issued 19th July 2018.) match within 3.5 % of the raw data except for wind direction. For wind direction, greater differences occur (up to 9.8 %) and this appears likely to be due to differences in the calculation methodology between Ecotech and ANE. Given that a 9.8 % variability in wind direction equates to less than 4°, this difference is not considered significant and is unlikely to materially affect any applications (such as air dispersion modelling) that the data is ultimately used for.

3.3 Compliance with Approval Limits

The Instrument of Approval (IoA) Conditions governing the M4 East project are defined in the IoA document SS16307 dated 11 February 2016. The Approval includes a number of performance requirements relating to Air Quality, both in-tunnel and ambient as well as limits.

Condition E9 lists the ambient air pollutants goals.

(a) CO – 8 hour rolling average of 9.0 ppm (NEPM);

(b) NO_2 – One hour average of 0.12 ppm (245 µg/m^3) (NEPM);

(c) PM_{10} – 24 hour average of 50 µg/m^3 (NEPM);

(d) $PM_{2.5}$ – 24 hour average of 25 µg/m^3 (proposed NEPM)

(e) PM_{10} – annual average of 25 µg/m^3 (Meeting of Environment Ministers – Agreed

Statement); and

(f) $PM_{2.5}$ – annual average of 8 µg/m^3 (Meeting of Environment Ministers – Agreed

Statement).

Ecotech has included a table in the monthly reports to highlight any exceedences that may occur above these goals. No specific reasons for the exceedences are given in the report. It is noted that on some occasions, the exceedences are occurring at more than 1 Station and the exceedence values are similar. This indicates that the cause is likely to relate to local or regional air pollution sources.

The Ecotech monthly reports clearly identify exceedances of the IoA criteria, and these are reproduced in Tables 3.8 to 3.14 below.

Table 3.8: Allen Street Exceedences for January to June 2018.

Parameter	Averaging Time	January	February	March	April	May	June
NO_2 (ppm)	1 Hour	-	-		-	-	-
CO (ppm)	1 Hour	-	-		-	-	-
PM_{10} (µg/m^3)	24 hour	-	-	64.9 (19/03/18)	-	-	-
	Annual [a]	-	-	-	-	-	-
$PM_{2.5}$ (µg/m^3)	24 Hour	-	-		26 (13/04/18)	32 (27/5/18) 36 (29/5/18)	-
	Annual [a]	-	-	-	-	-	-
[a] Insufficient data to report annual average, any exceedences will be reported in January 2019.							

Table 3.9: Concord Oval Exceedences for January to June 2018.

Parameter	Averaging Time	January	February	March	April	May	June
NO_2 (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM_{10} (µg/m^3)	24 hour	-	56.1 (15/02/18)	51.2 (20/03/18)	-	-	-
	Annual [a]	-	-	-	-	-	-
$PM_{2.5}$ (µg/m^3)	24 Hour	-	-	-	-	31 (27/5/18) 39 (29/5/18)	-
	Annual [a]	-	-		-	-	-
[a] Insufficient data to report annual average, any exceedences will be reported in January 2019.							

Table 3.10: Haberfield Public School Exceedences for January to June 2018.

Parameter	Averaging Time	January	February	March	April	May	June
NO_2 (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM_{10} (µg/m^3)	24 hour	-	53.2 (15/02/18)	60.7 (19/3/18)	-	-	-
	Annual [a]	-	-	-	-	-	-
$PM_{2.5}$ (µg/m^3)	24 Hour	-	-	-	-	-	-
	Annual [a]	-	-	-	-	-	-
[a] Insufficient data to report annual average, any exceedences will be reported in January 2019.							

Table 3.11: Powells Creek Exceedences for January to June 2018.

Parameter	Averaging Time	January	February	March	April	May	June
NO_2 (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM_{10} (µg/m^3)	24 hour	-	54.1 (15/2/18)	65.5 (19/3/18)	-	52.9 (8/5/18) 53.0 (9/5/18) 60.7 (29/5/18)	-
	Annual [a]	-	-	-	-	-	-
$PM_{2.5}$ (µg/m^3)	24 Hour	-	-	-	-	26 (09/5/18) 34 (27/5/18) 27 (28/5/18) 41 (29/5/18)	-
	Annual [a]	-	-	-	-	-	-
[a] Insufficient data to report annual average, any exceedences will be reported in January 2019.							

Table 3.12: Ramsay Street Exceedences for January to June 2018.

Parameter	Averaging Time	January	February	March	April	May	June
NO_2 (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM_{10} (µg/m^3)	24 hour	-	52.3 (15/02/18)	65.0) 19/3/18)	-	51.3 (29/5/18)	-
	Annual [a]	-	-	-	-	-	-
$PM_{2.5}$ (µg/m^3)	24 Hour	-	-	-	-	27 (06/5/18) 30 (08/5/18) 36 (27/5/18) 27 (28/5/18) 41 (29/05/18)	-
	Annual [a]	-	-	-	-	-	-
[a] Insufficient data to report annual average, any exceedences will be reported in January 2019.							

Table 3.13: Saint Lukes Park Exceedences for January to June 2018.

Parameter	Averaging Time	January	February	March	April	May	June
NO_2 (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM_{10} (µg/m^3)	24 hour	-	53.3 (15/2/18)	61.5 (19/3/18)	-	-	-
	Annual [a]	-	-	-	-	-	-
$PM_{2.5}$ (µg/m^3)	24 Hour	-	-	-	-	33 (27/05/18) 40 (29/05/18)	-
	Annual [a]	-	-	-	-	-	-
[a] Insufficient data to report annual average, any exceedences will be reported in January 2019.							

3.4 Reporting Requirements

For each parameter sampled, the relevant Australian Standard defines specific reporting requirements for the way data is reported and presented. The Ecotech reports have been reviewed and comparison to the reporting requirements is presented in Table 3.14 below.

Table 3.14: Compliance With Required Reporting Details as Listed in the Relevant Australian Standards.

Reporting Requirements	Report Compliance
Reference to the relevant Standard	The relevant standard for each parameter is noted in Table 3 of the report
The reporting organisation or company address and certification details.	Details of Ecotech are included in the report. The NATA certification number is also included.
The concentration of the components measured in correct units (ppm or ug/m^3)	The concentrations of the components are corrected labelled in the report. NO_2 and CO are reported as ppm. PM_{10} and $PM_{2.5}$ are correct reported as ug/m^3
The dates, time and period of sampling	The sampling dates and times and period identified in the report in the various results tables tables and graphs. (Figures 2 – 11 and Tables 20 – 25). Time is expressed as Eastern standard time. Consideration to the averaging period is also included when referencing the air quality goals in Table 4.
The full scale value of the instruments.	***These are not presented in the report.***
Sampling location—all relevant details, including a coordinate reference including height to within 100 m above ground level and classification of area .	Site sampling name, geographical location and height above sea level is included in the report in Table 1.
The type of instrument.	The instrument types and brands are detailed in Table 2
Any non-conformances with the standards.	No non conformance are listed. Valid data exception details are provided for each station in Tables 20 to 25.
The uncertainty associated with the measurement along with the confidence interval and coverage factor.	The measurement uncertainties are detailed for each parameter in Table 5.

Based on the analysis presented in Table 3.14, the Ecotech reports comply with the reporting requirements with the exception of the presentation of the full scale value of the instruments. Whilst this is not significant in terms of the data audit, for completeness it is recommended that future Ecotech reports include the instrument ranges and full scale values. It is also recommended that the calibrated range of the instruments is identified, as only data that is within the range of the instrument that has been calibrated in accordance with ISO 17025 can be considered as fully conforming with the requirements of Condition E8. Where data falls outside of the ISO 17025 certified calibrated range of the instruments, the report should note that the data is provided for information only.

4 Conclusions

The monthly ambient air quality reports for the period January to June 2018 have been reviewed, and the June 2018 report selected for detailed review.

A sample of the raw data for the month of June 2018 was checked against the values used by Ecotech for the validation and for the averaged data ultimately reported for each site for each month. The audit showed the raw data matched very closely with the validated and reported data as used by Ecotech. The procedures adopted for the data validation and reporting by Ecotech for the June 2018 report are the same as for the previous five months. In our opinion, the sample of data reviewed is representative of the data processing procedures for the preceding months, hence provides a suitable verification approach for the 6 month dataset.

The data results were also compared to the compliance limits for the project. The results show full compliance for carbon monoxide (CO) and nitrogen dioxide (NO_2) for the 6 month period. exceedences for the 24 hour PM_{10} and $PM_{2.5}$ were noted on a few occasions over the 6 month period.

The reporting of the ambient air quality monitoring data complied with the relevant requirements, with the exception of the presentation of the full scale value of the instruments. Whilst this is not significant in terms of the data audit, for completeness it is recommended that future reports should include the instrument ranges and full scale values, and whether or not the ISO 17025 calibration for each instrument covers all or only a part of the full range of each instrument.

5 References

AS/NZS 3580.9.12:2013 Methods for Sampling and Analysis of Ambient Air - Determination of Suspended Matter – $PM_{2.5}$ Beta Attenuation Monitors.

AS/NZS 3580.5.1-2011 Methods for sampling and analysis of ambient air Method 5.1: Determination of oxides of nitrogen—Direct-reading instrumental method.

AS/NZS 3580.7.1-2011 Methods for sampling and analysis of ambient air Method 7.1: Determination of carbon monoxide—Direct-reading instrumental method.

AS/NZS 3580.9.8 – 2008 Methods for sampling and analysis of ambient air Method 9.8: Determination of suspended particulate matter—PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser.

AS 2923-1987 Ambient Air – Guide for the Measurement of Horizontal Wind for Air Quality Applications.

Ecotech Ambient Air Quality and Weather Monitoring Validated Reports , M4 East Project 1st January 2018 - 30th June 2018 (monthly reports).

Appendix A - Air Quality Glossary

APPENDIX B: GLOSSARY OF AIR QUALITY TERMINOLOGY	
Conversion of ppm to mg/m^3	Where R is the ideal gas constant; T, the temperature in kelvin (273.16 + T°C); and P, the pressure in mm Hg, the conversion is as follows: $\mu g\ m^{-3} = (P/RT) \times \text{Molecular weight} \times (\text{concentration in ppm})$ $= \frac{P \times \text{Molecular weight} \times (\text{concentration in ppm})}{62.4 \times (273.2 + T°C)}$
g/s	Grams per second
mg/m^3	Milligrams (10^{-3}) per cubic metre.
$\mu g/m^3$	Micrograms (10^{-6}) per cubic metre.
ppb	Parts per billion.
ppm	Parts per million.
PM_{10}, $PM_{2.5}$, PM_1	Fine particulate matter with an equivalent aerodynamic diameter of less than 10, 2.5 or 1 micrometres respectively. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
50th percentile	The value exceeded for 50 % of the time.
NO_x	Oxides of nitrogen – a suite of gaseous contaminants that are emitted from road vehicles and other sources. Some of the compounds can react in the atmosphere and, in the presence of other contaminants, convert to different compounds (eg, NO to NO_2).
VOC	Volatile Organic Compounds. These compounds can be both toxic and odorous.