

# MSP 3: Air Quality Management Sub-Plan

A Transurban Group plan

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# NCX Air Quality Management Sub- Plan

# Revision history

Date	Version*	Author	Nature of change (including review history)
24/01/2020	00	Martin Howe	Initial Release
24/02/2020	01	Martin Howe	Changes following comments from Transurban and TfNSW

\* An automatic version of this document will be stored upon modifying. Before printing please insert the current version number into the table above and into the footer.

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## Glossary



Term	Definition
<b>AM-1</b>	Ambient Monitoring – guide for the siting of sampling units
<b>AM-2</b>	Ambient Monitoring – Guide for the measurement of horizontal wind for air quality applications
<b>AM-4</b>	Ambient Monitoring – meteorological guidance for regulatory modelling applications
<b>AM-12</b>	Ambient Monitoring – Carbon monoxide
<b>AQCCC</b>	Air Quality Community Consultative Committee
<b>CO</b>	Carbon monoxide
<b>DoH</b>	NSW Department of Health
<b>DPIE</b>	NSW Department of Planning, Infrastructure and Environment
<b>EPA</b>	NSW Environment Protection Authority
<b>MCoA</b>	Minister's Condition of Approval
<b>NO</b>	Nitrogen monoxide
<b>NO<sub>2</sub></b>	Nitrogen dioxide
<b>NO<sub>x</sub></b>	Oxides of nitrogen
<b>OEMP</b>	Operational Environmental Management Plan
<b>PAH</b>	Poly aromatic hydrocarbons
<b>PM<sub>10</sub></b>	Particulate matter with that can pass through a 10 micron filter
<b>PM<sub>2.5</sub></b>	Particulate matter with that can pass through a 2.5 micron filter
<b>ppb</b>	Parts per billion
<b>ppbh</b>	Parts per billion per hour
<b>ppm</b>	Parts per million
<b>ppmh</b>	Parts per million per hour
<b>REMM</b>	Revised Environmental Management Measure
<b>Tonne</b>	Metric tonne
<b>TfNSW</b>	Transport for New South Wales (formerly RMS - Roads and Maritime Services)
<b>VOC</b>	Volatile organic compounds
<b>µg/m<sup>3</sup></b>	Micrograms per cubic metre

# 1. Introduction

The NorthConnex Project includes:

- a) Two new dual-lane carriageways (one northbound, and one southbound) generally located beneath Pennant Hills Road and the Northern Railway in Sydney linking the M1 Freeway and the Hills M2 Motorway;
- b) An interchange at the northern end of the Motorway that provides vehicular access between the Motorway, Pennant Hills Road and the Pacific Highway;
- c) An interchange at the southern end of the Motorway that provides vehicular access between the Motorway, the Hills M2 Motorway and Pennant Hills Road;
- d) A Motorway Control Centre including operation and maintenance facilities; and
- e) Ventilation systems and other facilities for the operation of the motorway. The ventilation system includes for the provision of monitoring devices to continuously measure air speed and quality at key locations in the tunnel and ventilation outlets.

## 1.1 Purpose and Application

This document comprises the *NorthConnex Air Quality Management Sub-plan*. It applies to all operation and maintenance activities relating to the asset that require:

The control and management of:

- Dust
- Portal emissions
- Ventilation stack air quality emissions
- In tunnel air quality
- Ground level and ambient air quality emissions
- Monitoring and reporting of air quality metrics and parameters;
- Independent data and monitoring verification; and
- The issue of notices relating to incidents, emergencies and/or exceedances.

The sub-plan forms part of the Operational Environmental Management Plan (OEMP). It should be read and implemented in combination with the OEMP.

## 1.2 Sub-plan objectives

The objectives of this management sub-plan are:

- Ensure appropriate controls and procedures are implemented in operating and maintaining the asset to avoid or minimise air quality impacts and potential adverse impacts to sensitive receivers;
- Manage all operations and maintenance activities to ensure they do not harm or impact on air quality sensitive receivers;
- Maintain all assets to a standard that ensure compliance with the air quality limits (goals) specified in the Minister's Conditions of Approval (MCoA);
- Continually monitor air quality parameters in accordance with the MCoA;
- Publish and report verified and validated air quality monitoring data; and
- Operate with the target of having no air quality exceedances or complaints.

## 2. Legal and regulatory requirements

### 2.1 Approval and contractual conditions

The requirement to operate under an air quality management sub-plan is in response to the Minister's Conditions of Approval (MCoA) and Revised Environmental Management Measures (REMM) relating to the NorthConnex Tunnel (Asset).

**Table 2.1** summarises the relevant conditions relating to air quality management.

**Table 2.1: Approval Conditions**

MCoA	Obligation	Comment
<b>Environmental Performance</b>		
<b>Air Quality</b>		
B3	<p>The ventilation outlet exit plane must have a minimum exit velocity of:</p> <p>(a) 13 metres per second; or</p> <p>(b) a velocity, or variable velocity, to be determined in the Tunnel Ventilation Incident Response and Traffic Management Systems Integration Protocol required under condition B7, but only if an equivalent or better environmental outcome than presented in the Proponent's most up to date air assessment can be demonstrated to the satisfaction of the Secretary, in consultation with the EPA.</p>	<p>Tunnel Ventilation, Traffic Incident Response and Traffic Management Systems Integration Protocol has been prepared in consultation with the Transport Management Centre as required and is attached as Appendix A</p>
B4	<p>The tunnel ventilation system shall be designed, constructed and operated to release emissions from the ventilation outlets and to avoid emissions from the portals or the tunnel support facilities at Wilson Road and Trelawney Street, except for emergency smoke management purposes in the event of a fire in the tunnel and periodic testing of the system.</p>	<p>The tunnel ventilation system has been designed and will be operated to release emissions from ventilation outlets only and to avoid emissions from portals and/or the tunnel support facilities at Wilson Road and Trelawney Street, except for emergency smoke management purposes in the event of a fire in the tunnel and periodic testing of the system, as Outlined in Section 3.2</p>
B7	<p>Prior to operation, the Proponent shall prepare and implement a Tunnel Ventilation, Traffic Incident Response and Traffic Management Systems Integration Protocol in consultation with the Transport Management Centre, for the approval of the Secretary. The Protocol must be reviewed by a suitably qualified and experienced independent ventilation specialist to confirm that, before the tunnel is open to traffic, the ventilation/traffic management systems would operate together to ensure conditions E2, E3, E4, E8 and E11 are met. The Protocol should include a commissioning procedure to be completed before the tunnel is opened to traffic.</p> <p>Note: * Tunnel ventilation design and operation, incident response triggers</p>	<p>Tunnel Ventilation, Traffic Incident Response and Traffic Management Systems Integration Protocol has been prepared in consultation with the Transport Management Centre as required and is attached as Appendix A</p>

	and procedures, and traffic management, should be fully integrated in accordance with the primary objective of ensuring the safety of motorists in the tunnel.	
B8	<p>Prior to finalising the detailed design of the SSI and the establishment of the ambient air quality monitoring stations required under condition E7, the Proponent shall establish an Air Quality Community Consultative Committee (AQCCC) to provide input prior to and during the operation of the SSI. The AQCCC shall:</p> <p>(a) be comprised of:</p> <p>i) two representatives from the Proponent and tunnel operator,</p> <p>ii) one representative from each of the relevant Councils, and</p> <p>iii) three representatives from the local community, whose appointment has been approved by an expression of interest process conducted by the Proponent in consultation with the Secretary;</p> <p>(b) be chaired by an independent party put forward by the Proponent and approved by the Secretary;</p> <p>(c) meet at least four times a year, or as otherwise agreed by the chair and the Secretary;</p> <p>(d) review and provide advice on the location of the community based monitoring stations, operation environmental management plans and other operation stage documents, compliance tracking reporting, audit reports, or complaints; and</p> <p>(e) provide advice on the dissemination of monitoring results and other information on air quality issues.</p> <p>The AQCCC shall be operated for a period of two years from the commencement of operation, or as otherwise approved by the Secretary, in consultation with the chair.</p>	<p>The NorthConnex AQCCC committee was established mid-2017 and will continue to operate up to 2 years from the commencement of operations of NorthConnex in 2020. The purpose of the committee is to provide input into the location of the air quality monitoring locations and advice on related air quality matters. The committee comprises of four local community representatives; representatives from the local councils; TfNSW, and the tunnel operator NorthConnex Company Pty Ltd. The meeting is chaired by an independent in consultation with the Department of Planning, Infrastructure and Environment.</p>
<b>Air Quality</b>		
<b>In-Tunnel Air Quality</b>		
E1	<p>The Proponent must monitor (by sampling and obtaining results by analysis) the pollutants, within the tunnel, specified in Table 4. The Proponent must use the sampling method, units of measurement and sample at the frequency specified opposite in the other columns.</p> <p>The number and siting of the monitoring stations inside the tunnel must be determined to permit an accurate calculation, per the requirements of condition E2, E3 and E5, and be independently verified in accordance with a methodology approved by the Secretary in consultation with the EPA. As a minimum there should be monitoring</p>	<p>Monitoring of pollutants within the tunnel will be undertaken as identified in Section 3.1.1</p> <p>Special Method 1 specific to E1 has been defined as AS3580.18:2017, as approved by the EPA. Further details presented in Section 3.3.1</p>



	<p>stations at the entry portals, the base of the ventilation outlets, ramp junctions and at the intermediate exhaust outlets (Wilson Street and Trelawney Street emergency smoke extraction facilities).</p> <p>Sampling points and visibility monitoring points established under this condition shall be audited prior to its commencement of monitoring for compliance with the requirements set out in Table 4. Verification and compliance auditing is to be undertaken by an independent person(s) or organisation(s) approved by the Secretary, and paid for by the Proponent. Monitoring shall take place in accordance with this condition throughout operation of the SSI.</p> <p><b>Table 4 – In-Tunnel monitoring methodology</b></p> <table border="1"> <thead> <tr> <th>Pollutant/parameter</th> <th>Units of measure</th> <th>Frequency</th> <th>Method<sup>1</sup></th> </tr> </thead> <tbody> <tr> <td>CO</td> <td>ppm</td> <td>Continuous</td> <td>Special Method 1<sup>1</sup></td> </tr> <tr> <td>NO<sub>2</sub></td> <td>ppm</td> <td>Continuous</td> <td>Special Method 1<sup>1</sup></td> </tr> <tr> <td>Visibility</td> <td>m<sup>-1</sup></td> <td>Continuous</td> <td>Special Method 1<sup>1</sup></td> </tr> </tbody> </table> <p>Note: 1. Special Method 1 means a method approved by the Secretary in consultation with the EPA.</p>	Pollutant/parameter	Units of measure	Frequency	Method <sup>1</sup>	CO	ppm	Continuous	Special Method 1 <sup>1</sup>	NO <sub>2</sub>	ppm	Continuous	Special Method 1 <sup>1</sup>	Visibility	m <sup>-1</sup>	Continuous	Special Method 1 <sup>1</sup>	<p>Todoroski Air Sciences were approved by the Secretary to complete verification and compliance auditing.</p>
Pollutant/parameter	Units of measure	Frequency	Method <sup>1</sup>															
CO	ppm	Continuous	Special Method 1 <sup>1</sup>															
NO <sub>2</sub>	ppm	Continuous	Special Method 1 <sup>1</sup>															
Visibility	m <sup>-1</sup>	Continuous	Special Method 1 <sup>1</sup>															
E2	<p>The tunnel ventilation system must be designed and operated so that the average concentration of CO and NO<sub>2</sub>, calculated along the length of the tunnel, does not exceed the concentration limit specified for that pollutant in Table 5.</p> <p><b>Table 5 – In-Tunnel Single Point Exposure Limits</b></p> <table border="1"> <thead> <tr> <th>Pollutant</th> <th>Concentration Limit</th> <th>Units of Measurement</th> <th>Averaging Period</th> </tr> </thead> <tbody> <tr> <td>CO</td> <td>87</td> <td>ppm</td> <td>Rolling 15- minute</td> </tr> <tr> <td>CO</td> <td>50</td> <td>ppm</td> <td>Rolling 30 - minute</td> </tr> <tr> <td>NO<sub>2</sub></td> <td>0.5</td> <td>ppm</td> <td>Rolling 15- minute</td> </tr> </tbody> </table>	Pollutant	Concentration Limit	Units of Measurement	Averaging Period	CO	87	ppm	Rolling 15- minute	CO	50	ppm	Rolling 30 - minute	NO <sub>2</sub>	0.5	ppm	Rolling 15- minute	<p>The tunnel ventilation system will be operated to meet the required criteria, as identified in Sections 3.1.2 and 3.2.</p>
Pollutant	Concentration Limit	Units of Measurement	Averaging Period															
CO	87	ppm	Rolling 15- minute															
CO	50	ppm	Rolling 30 - minute															
NO <sub>2</sub>	0.5	ppm	Rolling 15- minute															
E3	<p>The tunnel ventilation system must be designed and operated so that the concentration of CO as measured at any single point in the tunnel must not exceed the concentration limit specified for that pollutant in Table 6 under all conditions (including congested conditions).</p> <p><b>Table 6 In-Tunnel Single Point Exposure Limits</b></p> <table border="1"> <thead> <tr> <th>Pollutant</th> <th>Concentration Limits</th> <th>Units of Measurement</th> <th>Averaging Period</th> </tr> </thead> <tbody> <tr> <td>CO</td> <td>200</td> <td>ppm</td> <td>Rolling 3 - minute</td> </tr> </tbody> </table>	Pollutant	Concentration Limits	Units of Measurement	Averaging Period	CO	200	ppm	Rolling 3 - minute	<p>The tunnel ventilation system will be operated to meet the required criteria, as identified in Sections 3.1.2 and 3.2.</p>								
Pollutant	Concentration Limits	Units of Measurement	Averaging Period															
CO	200	ppm	Rolling 3 - minute															
E4	<p>The tunnel ventilation system must be designed and operated so that the visibility in the tunnel does not exceed the level specified in Table 7.</p> <p><b>Table 7 – In-Tunnel Visibility Limits Along Length of Tunnel</b></p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Average extinction coefficient Limit</th> <th>Units of Measurement</th> <th>Averaging Period</th> </tr> </thead> <tbody> <tr> <td>Visibility</td> <td>0.005</td> <td>m<sup>-1</sup></td> <td>Rolling 15-minute</td> </tr> </tbody> </table>	Parameter	Average extinction coefficient Limit	Units of Measurement	Averaging Period	Visibility	0.005	m <sup>-1</sup>	Rolling 15-minute	<p>The tunnel ventilation system will be operated to meet the required criteria, as identified in Sections 3.1.1 and 3.2.</p>								
Parameter	Average extinction coefficient Limit	Units of Measurement	Averaging Period															
Visibility	0.005	m <sup>-1</sup>	Rolling 15-minute															
E5	<p>In addition to the general reporting requirements specified in condition E17, the Proponent shall, within 24 hours, notify the Secretary, EPA and Ministry of Health of any recordings above the limits specified in</p>	<p>Notification in relation to exceedance of the limits specified</p>																

	<p>conditions E2, E3 and E4. The notification shall detail the nature of the event, the concentration or visibility levels that occurred, the duration of the event, and the measures employed to minimise the concentration levels and/or improve the visibility levels.</p> <p>Upon receipt of this notification, the Secretary shall consider the circumstances of the event, including:</p> <p>(a) the nature of the event, including any details relating to the cause;</p> <p>(b) the duration of the event;</p> <p>(c) the extent and severity of the event;</p> <p>(d) the frequency of the event, including whether an event with the same or similar circumstances has occurred previously.</p> <p>Based on consideration of the circumstances of the event, the Secretary may request the Proponent to prepare a Tunnel Air Quality Management Systems Effectiveness Report.</p>	<p>in E2, E3 and E4 is addressed in Section 5.</p>
E6	<p>Within 20 working days of any request by the Secretary under condition E5, the Proponent shall prepare and submit a Tunnel Air Quality Management Systems Effectiveness Report on the overall system performance and cause and major contributor of any exceedances, detailing the following:</p> <p>(a) the overall performance and concentration levels in the tunnel for the preceding six month period (or since commencement of operation, where the SSI has operated for under six months), including average and maximum levels and time periods;</p> <p>(b) details of any instances throughout the operation of the SSI where pollutant concentration levels in the tunnel have exceeded the limits specified in E2, E3 and E4; and</p> <p>(c) consideration of improvements to the tunnel air quality management system, including but not limited to installation of the additional ventilation management facilities allowed for under condition B5, and discussion of whether those improvements are feasible and reasonable.</p> <p>The Tunnel Air Quality Management Systems Effectiveness Report is to be prepared by the Proponent and reviewed by a suitably qualified and experienced independent specialist(s). The Secretary shall approve the independent person/organisation.</p> <p>The Proponent shall comply with any requirements arising from the Secretary's review of this report.</p>	<p>Notification in relation to exceedance of the limits specified in E2, E3 and E4 is addressed in Section 5.</p> <p>The Tunnel Ventilation System Air Quality Report has been developed, and is available as Appendix B.</p>
<b>Ambient Air Quality</b>		
E7	<p>The Proponent shall 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:</p>	<p>Monitoring of the pollutants will be undertaken as identified in Section 4.3.</p>

	<p>(a) two ground level receptors near the northern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;</p> <p>(b) two ground level receptors near the southern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;</p> <p>(c) one location along Pennant Hills Road, at a location suitable for detecting any impact on air quality along Pennant Hills Road; and</p> <p>(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.</p> <p>All monitoring stations shall 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.</p> <p>The Proponent shall commence monitoring for at least twelve continuous months prior to operation. The locations are to be agreed to by the AQCCC. The Proponent shall meet all operating costs associated with the stations.</p> <p>The Proponent, following consultation with the AQCCC, shall 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 shall require the approval of the Secretary in consultation with the EPA.</p> <p>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 shall be assured through a NATA accredited process prior to the data being considered as a basis for compliance/auditing purposes.</p> <p>Monitoring results shall be made publicly available and shall be subject to an independent audit at six-monthly intervals (or at a longer interval, if approved by the Secretary). The auditor shall be approved by the Secretary in consultation with the EPA and the AQCCC, and the auditor's report shall be directly provided to the Proponent and the AQCCC.</p>	<p>Monitoring locations were agreed by the AQCCC, and are presented in Section 4.3</p> <p>Ecotech has been approved by the Secretary in consultation with the EPA and the AQCCC on 17/4/2018 to operate the monitoring stations.</p>
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Table 8 – Ambient Air Quality Monitoring Methodologies

Pollutant	Units of Measurement	Averaging Period	Frequency	Method <sup>1</sup>
NO	pphm	1-hour	Continuous	AM -12
NO <sub>2</sub>	pphm	1-hour	Continuous	AM- 12
NO <sub>x</sub>	pphm	1-hour	Continuous	AM- 12
PM10	µg/m <sup>3</sup>	24-hour	Continuous	AS3580.9.8 2008 <sup>2</sup>
PM2.5 <sup>5</sup>	µg/m <sup>3</sup>	24-hour	Continuous	AS3580.9.13-2013 <sup>3</sup>
CO	ppm	1-hour, 8-hour	Continuous	AM-2 & AM-6
Parameter <sup>4</sup>	Units of Measurement	Averaging Period	Frequency	Method <sup>1</sup>
Wind Speed @ 10m	m/s	1 – hour	Continuous	AM – 2 & AM - 4
Wind Direction @ 10m	°	1 – hour	Continuous	AM – 2 & AM - 4
Sigma Theta @ 10m	°	1 – hour	Continuous	AM – 2 & AM - 4
Temperature @ 2m	K	1 – hour	Continuous	AM - 4
Temperature @ 10m	K	1 - hour	Continuous	AM - 4
Other	Units of Measurement	Averaging Period	Frequency	Method <sup>1</sup>
Siting	NA	NA	NA	AM-1 & AM-4

Notes:

1. Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2007).
2. AS3580.9.8-2008, Methods for the Sampling and Analysis of Ambient Air – Determination of Suspended Particulate Matter – PM10 Continuous Direct Mass Method using Tapered Element Oscillating Microbalance Analyser (Standards Australia 2008).
3. AS3580.9.13-2013, Methods for the Sampling and Analysis of Ambient Air – Determination of Suspended Particulate Matter – PM2.5 Continuous Direct Mass Method using a Tapered Element Oscillating Microbalance Analyser (Standards Australia 2013).
4. TBD - location for meteorological monitoring station(s) to be representative of weather conditions likely to occur in the vicinity of the northern and southern ventilation outlets.
5. Appropriately modified to include size selective inlet for PM2.5 or as otherwise approved by the Secretary.

E8

Should ambient monitoring of air pollutants exceed the following goals, the provisions of Condition E9 shall apply:

- (a) CO – 8 hour rolling average of 9.0 ppm (NEPM);
- (b) NO<sub>2</sub> – One hour average of 0.12 ppm (245 µg/m<sup>3</sup>) (NEPM);
- (c) PM10 – 24 hour average of 50 µg/m<sup>3</sup> (NEPM); and
- (d) PM2.5 – 24 hour average of 25 µg/m<sup>3</sup> (proposed NEPM).

Only monitoring station(s) that meet the requirements of Australian Standard AS2922 – 1987 shall be used for the purposes of assessing compliance with the ambient goals specified in this condition, unless otherwise agreed by the Secretary. A Protocol for the evaluation of a potential measurement that exceeds the criteria shall be developed by the Proponent and approved by the Secretary in consultation with the EPA, Ministry of Health and the AQCCC.

The tunnel ventilation system shall be operated to meet the specified air quality criteria, as identified in Section 3.1.2.

An Ambient Above-Goal Reading Protocol has been approved and is provided in Appendix C.

E9	<p>Should the results of monitoring required under condition E7 show that any of the goals specified in Condition E8 have been exceeded for any given event (excluding extraordinary events such as bushfires, dust storms, etc. (as to be defined in the Protocol required under condition E10)), the Proponent shall immediately notify the Secretary, EPA and Ministry of Health. The notification shall be followed up with a detailed report within 20 working days, which shall be prepared by the Proponent, reviewed by a suitably qualified and experienced independent specialist(s), and submitted to the Secretary, on the cause and major contributor of the exceedance and the options available to prevent recurrence. The Secretary shall approve the independent person/organisation prior to the commencement of operation, or at some other time prior to preparation of the report.</p> <p>Where the operation of the tunnel is identified to be a significant contributor to the recorded exceedance, this report shall include consideration of improvements to the tunnel air quality management system so as to achieve compliance with the ambient air quality goals, including but not limited to installation of the additional ventilation management facilities allowed for under condition B5, and discussion of whether those improvements are feasible and reasonable.</p> <p>The Proponent shall comply with any requirements arising from the Secretary's review of the Report.</p>	An Ambient Above-Goal Reading Protocol has been approved and is provided in Appendix C.
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**Ventilation Outlets**

E10	<p>The Proponent shall install monitoring equipment to monitor pollutants inside the ventilation outlets. Pollutant monitoring inside the ventilation outlets (by sampling and obtaining results by analysis) shall be for the pollutants and parameters specified in Column 1 of Table 9.</p> <p>The Proponent must use the sampling method, units of measures and sample at the frequency specified in the other columns. Monitoring equipment installed under this condition is to be independently audited prior to its commencement of monitoring for compliance with the requirements set out in Table 9.</p> <p>Auditing is to be undertaken by an independent person(s) or organisation(s) approved by the Secretary and paid by the Proponent. Monitoring shall take place in accordance with this condition throughout operation of the SSI.</p>	<p>Installation of monitoring equipment and monitoring of pollutants within the ventilation outlets will be undertaken as identified in Section 3.1.2</p> <p>Monitoring will be undertaken using sampling methods, units of measure and frequency nominated in Table 9 as outlined in Section 3.1.2</p> <p>Special Method 1 specific to E10 has been defined as USEPA Performance Standard 11, as approved by the EPA. Further details presented in Section 3.1.2</p> <p>Todoroski Air Sciences were approved by the Secretary to complete independent auditing works.</p>
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**Table 9 – Ventilation Outlet Emission Monitoring Methodologies**

Pollutant	Units of Measure	Frequency	Method <sup>1</sup>
Solid particles	mg/m <sup>3</sup>	Continuous	Special Method 1 <sup>4</sup>
Solid particles	mg/m <sup>3</sup>	Quarterly	TM-15
PM10	mg/m <sup>3</sup>	Quarterly	OM-5
PM2.5	mg/m <sup>3</sup>	Quarterly	OM-5
NO2 or NO or both, as NO2 equivalent	mg/m <sup>3</sup>	Continuous	CEM-2
NO2	mg/m <sup>3</sup>	Continuous	CEM-2
CO	mg/m <sup>3</sup>	Continuous	CEM-4
VOC2	mg/m <sup>3</sup>	Continuous	CEM-8
Speciated VOC	mg/m <sup>3</sup>	Annual	TM-34
PAH	µg/m <sup>3</sup>	Annual	OM-6
Parameter	Units of Measure	Frequency	Method <sup>1</sup>
Velocity	m/s	Continuous	CEM-6
Volumetric flow rate	M <sup>3</sup> /s	Continuous	CEM-6
Moisture	%	Continuous	TM-22
Temperature	°C	Continuous	TM-2
Other	Units of Measure	Frequency	Method <sup>1</sup>
Selection of sampling location	N/A	N/A	TM-1

Notes:

1. Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2007) or an alternative method approved by the Secretary in consultation with the EPA.
2. Must include, but not limited to: Benzene, Toluene, Xylenes, 1,3-Butadiene, Formaldehyde and Acetaldehyde.
3. Must include, but not limited to; 16 USEPA priority PAHs, namely Naphthalene, Phenanthrene, Benz(a)anthracene, Acenaphthylene, Anthracene, Chrysene, Indeno(1,2,3-cd)pyrene, Acenaphthene, Fluoranthene, Benzo(b)fluoranthene, Dibenz(a,h)anthracene, Fluorene, Pyrene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene.
4. Special Method 1 means a method approved by the Secretary in consultation with the EPA.

E11

The concentration of a pollutant discharged from the ventilation outlets referred to must not exceed the respective limits specified for that pollutant in Table 10.

**Table 10 — Ventilation Outlet Mass Pollutant Concentrations**

Pollutant	100 percentile limit	Units of measurement	Averaging period	Reference conditions
Solid particles	1.1	mg/m <sup>3</sup>	1 hour, or the minimum sampling period specified in the relevant test method, whichever is the greater	Dry, 273K, 101.3kPa
NO <sub>2</sub> or NO or both, as NO <sub>2</sub> equivalent	20	mg/m <sup>3</sup>	1 hour block	Dry, 273K, 101.3kPa
NO <sub>2</sub>	2.0	mg/m <sup>3</sup>	1 hour block	Dry, 273K, 101.3kPa
CO	40	mg/m <sup>3</sup>	1 hour rolling	Dry, 273K, 101.3kPa
VOC (as propane)	4.0 4.0	mg/m <sup>3</sup>	1 hour rolling	Dry, 273K, 101.3kPa

The tunnel ventilation system will be operated to meet the required ventilation outlet criteria, as further identified in Section 3.1.2

E12

An independent person or organisation, approved by the Secretary shall:

Validation of recorded monitoring data and certification of compliance with ventilation outlet limits will be undertaken 6-monthly

	<p>(a) verify that compliance with ventilation outlet limits detailed in Table 10 will not result in air quality impacts greater than predicted in the documents listed in condition A2;</p> <p>(b) undertake an appropriate assessment to indicate how ventilation outlet discharge velocities have been optimised in consideration of energy requirements and air quality impacts at all sensitive receivers; and,</p> <p>(c) validate recorded monitoring data and certify compliance with the ventilation outlet limits.</p> <p>The information required in paragraphs (a)-(c) will be made available to the Secretary on request.</p> <p>The ventilation outlet limits detailed in Table 10 shall be reviewed on a five-yearly basis and may be lowered (i.e. made more stringent), subject to a sustainability assessment and there being improvements in vehicle fleet emissions, if the Proponent is directed to do so by the Secretary following consultation with the EPA.</p>	during 6-monthly audits discussed in Section 6.
E13	<p>Should the results of monitoring show that any of the ventilation outlet limits specified in Condition E11 have been exceeded, the Proponent shall immediately notify the Secretary, EPA and Ministry of Health. The notification shall followed up with a detailed report within 20 working days, which shall be prepared by the Proponent, reviewed by a suitably qualified and experienced independent specialist(s), and submitted to the Secretary, on the cause and major contributor of the exceedance and the options available to prevent recurrence. The Secretary shall approve the independent person/organisation prior to the commencement of operation, or at some other time prior to preparation of the report.</p> <p>Where the operation of the tunnel is identified to be a significant contributor to the recorded exceedance, this report shall include consideration of improvements to the tunnel air quality management system so as to achieve compliance with the ambient air quality goals, including but not limited to installation of the additional ventilation management facilities allowed for under condition B5, and discussion of whether those improvements are feasible and reasonable.</p> <p>The Proponent shall comply with any requirements arising from the Secretary's review of the Report.</p>	Notification in the event of an exceedance of the nominated criteria would for ventilation outlets would be undertaken in accordance with Section 5.2.
<b>Emergency Discharge</b>		
E14	<p>Conditions E2, E3, E4, E8 and E11 do not apply in an emergency to prevent damage to life or limb.</p> <p>The Proponent shall, as soon as reasonably practicable, notify the Secretary and the EPA of any such discharge.</p>	Noted, see Section 3.1.4
<b>Local and Sub-Regional Air Quality</b>		

E15	The Proponent shall assist the relevant Council(s) in developing an air quality assessment process for inclusion in a Development Control Plan or other appropriate planning instrument, in considering planning and building approvals for new development in the area adjacent to the northern and southern ventilation outlets which would be within a potential three-dimensional zone of affectation (buffer volume). This process shall include procedures for identifying the width and height of buildings that are likely to be either affected by the plume from the ventilation outlet or affect the dispersion of the plume from the ventilation outlet through building wake effects. The Proponent shall meet all reasonable costs for the development of this process and any necessary amendments to the planning instrument(s) required to implement the process.	TfNSW have consulted with the relevant Councils. The report has now been finalised.
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**General Air Quality Reporting and Public Access to Monitoring Results**

E16	Prior to operation, the Proponent shall investigate, in consultation with the EPA the measures for smoky vehicle enforcement in areas surrounding the SSI, taking into consideration cost effectiveness. Any measures implemented as a result of investigation recommendations shall be in accordance with current RMS (now TfNSW) smoky vehicle enforcement programs. The effectiveness of the smoky vehicle enforcement measures shall be documented in the Independent Environmental Audit required under condition E31.	TfNSW have investigated measures in consultation with the EPA. These measures have been finalised and documented in a Report dated November 2019 entitled "Options for Smoky Vehicle Enforcement in Areas Surrounding the SSI".
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E17	The Proponent must develop and implement a reporting system for in-tunnel, ambient and ventilation outlet limits to the satisfaction of the Secretary in consultation with the EPA. The reporting system must be approved, fully implemented and operational prior to operation. Minimum analytical reporting requirements for air pollution monitoring stations shall be as specified in the Approved Methods of Modelling and Assessment of Air Pollutants in NSW (EPA 2007, or as updated).	A reporting system for in-tunnel, ambient and ventilation outlet limits has been developed in consultation with the EPA. Refer to Section 5.
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E18	Results of hourly updated real-time ambient monitoring of PM10, PM2.5, visibility, NO2, and CO at the approved monitoring stations, in-tunnel CO/NO2 and ventilation outlet measurements, and relevant meteorological data, shall be provided on a website and made publicly available each month in hard copy format in an easy to interpret format. These data shall be preliminary until a quality assurance check has been undertaken by a person or organisation accredited by NATA for this purpose. The availability of these data shall be conveyed to the local community by way of newsletter (including translation into common community languages in the area) and newspaper advertisement at least one month prior to the commencement of operation.	Specified monitoring data shall be made available on the Asset website, as well as made publically available each month in hard copy. ( <a href="http://northconnex.com.au/environment-and-approvals/air-quality">http://northconnex.com.au/environment-and-approvals/air-quality</a> )
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**Air Quality Auditing and Quality Assurance**

E19	The provision, operation and maintenance (including all auditing and validation of data) of all air quality monitoring and reporting shall be funded by the Proponent.	Noted.
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E20	All continuous emissions monitoring systems installed and operated as a requirement of condition E10 shall undergo relative accuracy test	Refer to Section 6.
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	audits at an interval not exceeding 12 months, or as otherwise agreed to by the Secretary in consultation with the EPA.	
E21	The Proponent shall appoint an external auditor to conduct an audit of the air quality monitoring (in tunnel and external) at six-monthly intervals or at any longer interval if approved by the Secretary. Air quality audits shall commence six months from commencement of operation. The auditor shall ensure that the operating procedures and equipment to acquire air monitoring, meteorological data and emission monitoring data and monitoring reporting comply with NATA (or equivalent) requirements and sound laboratory practice. The Proponent must document the results of the audit and make available all audit data for inspection by the Secretary upon request. A copy of the audit report shall also be issued to the Proponent and AQCCC.	Todoroski Air Sciences were approved by the Secretary to complete 6-monthly audits, including NATA requirements, as described in Section 6.
E22	The Proponent shall undertake appropriate quality assurance (QA) and quality control (QC) measures for air quality and ventilation outlet emission monitoring data. This shall include, but not necessarily be limited to: accreditation/quality systems, staff qualifications and training, auditing, monitoring procedures, service and maintenance, equipment or system malfunction and records/reporting. The QA/QC measures shall be approved by an independent expert approved by the Secretary prior to monitoring of air quality and ventilation outlet emissions as appropriate.	Todoroski Air Sciences were approved by the Secretary to ensure appropriate QA and QC measures are in place for air quality and ventilation outlet emission monitoring.
<b>REMM</b>	<b>Obligation</b>	<b>Comment</b>
OpAQ1	<p>A management framework would be developed and implemented to ensure that significant congestion is effectively managed and that acceptable in-tunnel air quality is maintained. The framework would include:</p> <ul style="list-style-type: none"> <li>• In-tunnel monitoring of carbon monoxide, nitrogen dioxide and / or visibility (extinction coefficient).</li> <li>• Monitoring of traffic conditions and traffic speeds within the main alignment tunnels, and upstream and downstream of the project.</li> <li>• Measures to limit and manage traffic entering the project tunnels in the event of significant congestion conditions that may lead to unacceptable in-tunnel air quality. This may include measures such as lane closures, rapid responses to incidents / breakdowns, and broader traffic network management.</li> <li>• Operational requirements to ensure that operation of the project's ventilation system reflects traffic volumes and in-tunnel air quality requirements.</li> <li>• Provision for the review of the management framework after a period of operation, once sufficient actual in-tunnel air quality and traffic data have been gathered.</li> <li>• Contingency measures in the event of elevated, unexpected in-tunnel air quality (including measures to manage emergency situations).</li> <li>• Provision for publication of relevant in-tunnel air quality performance data.</li> </ul>	Tunnel Ventilation, Traffic Incident Response and Traffic Management Systems Integration Protocol has been prepared in consultation with the Transport Management Centre as required and is attached as Appendix A.

	Review of the performance of smoky vehicle regulation / enforcement and whether additional or amended measures may be required.	
OpAQ2	Air quality in the vicinity of the project would be monitored for a specified time period following project opening. If pollutant concentrations contributed by the project are above predicted levels, additional feasible and reasonable mitigation measures would be considered to meet applicable predicted limits.	Refer Section 6.
OpAQ3	Funding would be provided to research into in-tunnel air quality conditions for motorists. The terms of referenced for the study would be approved by the Advisory Committee on Tunnel Air Quality.	TfNSW funded and project managed the development of In Tunnel Air Quality (Nitrogen Dioxide) Policy on behalf of the Advisory Committee in April 2015 and February 2016. The terms of reference were approved by the Advisory Committee.

## 2.2 Legal provisions

In NSW there is one primary piece of legislation (as supported by various guidance) provisioned at preventing and limiting air pollution.

**Table 2.2: Statutory obligations**

Legislation	Relevance
<i>NSW Protection of the Environment Operations Act 1997</i> <i>NSW Protection of the Environment Operations (Clean Air) Regulation 2010</i>	This Act and its supporting regulation define and control air pollution. There is a requirement on NorthConnex to prevent pollution and a duty to notify NSW Environment Protection Authority of any perceived or actual environmental harm. There is also a requirement NorthConnex to obtain an Environmental Protection Licence (EPL) for air emissions from the ventilation outlets.

## 2.3 Non-legal provisions

TfNSW and other Government Agencies have developed guidance and policy for air quality assessment, management and protection. Transurban will work under the following guidance and policy:

- National Environmental Protection Measure for Ambient Air Quality Guidelines (National Environmental Protection Council, 1998);
- Approved Methods and Guidance for Modelling and Assessment of Air Pollutants in NSW (NSW DEC, 2005);
- Air Quality Monitoring Criteria for Deposited Dust (DEC, 2005);
- Australian Standard 3580: 1.1 Methods for Sampling and Analysis of Ambient Air, Part 1.1 Guide to Siting Air Quality Monitoring Equipment (Australian Standards, 2007);
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2007); and
- Action for Air (NSW DECCW, 2009).

## 2.4 Permits, licences and operational limits

Air quality limits (goals) are set within the MCoA. They are based on the limits set within the above guidance documents. **Table 2.1** outlines the air quality criteria that NorthConnex must comply with when operating and maintaining the asset. These goals must not be exceeded except under a very limited set of circumstances.

In accordance with the Protection of the Environment Operations Act 1997 Section 35A of Schedule 1, an Environment Protection Licence (EPL) is required for the NorthConnex Tunnel ventilation outlets. Application for an EPL was submitted on 3 February 2020 and will be obtained prior to operation and complied with during operation of the Asset. The MCoA ventilation outlet conditions will be reflected in the EPL conditions.

### 3. Air quality infrastructure in the Asset

#### 3.1 Ventilation and Traffic Management Integration

The motorway Operations, Management and Control System (OMCS) contains three main elements for managing traffic, a monitoring system, a traffic control system and associated devices, and an incident management system.

The Traffic Monitoring subsystem provides information to operators concerning the road capacity, incident detection and safety systems. The OMCS operator information includes monitoring data, alarms and graphics to indicate traffic volumes and speeds and highlight any unusual changes. The Traffic Control subsystem is used to convey information to drivers concerning the road capacity, incident detections and safety systems. The operator can operate signage or devices either independently or as part of a traffic management plan.

The Incident Management System (IMS) is provided to manage any planned or unplanned incident which impacts on the normal flow of traffic.

The motorway connects the M2 in the South to the M1 in the North, and the current connection along Pennant Hills Road remains unchanged. Therefore, in the event of an incident that will cause the traffic speed in the tunnel to drop below 20 km/hr, traffic can be diverted onto Pennant Hills Road, subject to the other network management considerations of TfNSW Traffic Management Centre (TMC).

There is a comprehensive signage system comprising static and electronic signage on the approaches to and throughout the tunnel. The electronic signs allow the operators to implement various traffic plans to suit incidents that occur within the tunnel, from issuing cautions to an incident ahead through to a full tunnel closure using the dedicated barriers on the tunnel approaches.

The operators can view the entire tunnel and approaches using the CCTV camera system which has over 700 cameras.

The tunnel is restricted to vehicles that are under 5.15m high, with detectors on the approaches that trigger alarms for the operators and can close the tunnel. Dangerous goods vehicles are also excluded from NorthConnex (as with other Sydney tunnels) and there is signage on the approaches to warn drivers to detour.

Tunnel Signage includes an Integrated Speed and Lane Use sign above each lane, alternating with a single Tunnel Message Sign at approximately 180m spacing. The Tunnel Message sign can display messages to motorists and the ISLUS can display either the speed limit, a merge arrow or a red cross, amber light or a green arrow to indicate the traffic conditions. Large variable message signs are located on the tunnel approaches and surrounding roads to alert motorists to the conditions within the tunnel or surrounding road network.

A Ramp Control system, comprising specific traffic control signals, is available for both on ramps to the tunnel. This system can be used to regulate the entry of cars from the ramps into the mainline tunnel so as to maintain a more uniform traffic flow.

A Moveable Median Strip System, comprising of a movable median and associated warning signs and in pavement lights will be provided to facilitate full or partial tunnel closures. These are placed at the final diverge point before each tunnel entry point to provide guidance for motorists away from the tunnel.

Movable Physical Barriers (boom gates) are provided in front of every entry portal to close the tunnel and aid in preventing vehicles from entering the tunnel.

Standalone regulatory systems are installed in both carriageways to detect speeding vehicles and large smoky trucks. These systems are separated from the OMCS such that the necessary enforcement actions can be taken by the relevant authorities.

### 3.2 Ventilation Overview

The Tunnel Ventilation System design is based on a longitudinal ventilation concept whereby the in-tunnel air quality is maintained by achieving a longitudinal flow of air through the tunnel. The tunnel airflow is generally developed in the direction of traffic flow and assisted by a series of jet fans distributed throughout the tunnels.

Typically, fresh air will be drawn in from the entry portals and pushed towards the mainline exit portals by the vehicle generated piston effect. Where the vehicle generated airflow is insufficient, such as during slow moving traffic conditions, the mainline airflow will be assisted by jet fans attached to the roof of the tunnel. The tunnel air will be then extracted from the tunnel upstream of the tunnel exit portals by ventilation fans located in the portal ventilation stations. Air will be drawn back down the tunnel off-ramps to prevent portal emissions. Jet fans will be used to maintain the required airflow against the direction of traffic flow in the off-ramps. This air will combine with the mainline tunnel airflow and be extracted via the ventilation outlets.

The Tunnel Ventilation System will contain two (2) above ground portal ventilation outlets, one at end of each tunnel, North and South (VS04 and VS01 respectively). The northern portal ventilation station (VS04) will be located in the Northern Services Facility. The southern portal ventilation station (VS01) will be located in the Motorway Operations Compound. Two (2) above ground mid-point ventilation stations are also provided along the tunnel alignment with one at the Wilson Road Service Facility (VS02) and one at the Trelawney Street Services Facility (VS03).

The ventilation outlets (VS01 and VS04) will extract the air from the tunnel along with fresh air drawn in from the exit and entry portals to prevent portal emissions. The air will be exhausted via a ventilation take off (intake) located upstream from the mainline exit portals. The air will be transferred to the ventilation outlet via a ventilation shaft and then discharged from the ventilation outlet to the atmosphere. Partitioned ventilation outlets will ensure that the discharge velocity will be maintained above the minimum level nominated in the MCoA B3 (13m/s). This arrangement of managing discharge velocities will be used at both the ventilation outlets (VS01 and VS04), serving the southbound and northbound tunnels respectively.

The two (2) mid-point ventilation stations will be used to provide smoke extraction in the event of an emergency and to supply fresh air to the tunnels during congested operations. During emergency modes smoke will be extracted from the tunnel and transferred to the ventilation outlets (VS02 and VS03) via a vertical shaft. The smoke will then be discharged from the ventilation outlet to the atmosphere.

During low speed and congested operations additional fresh air may be introduced via these mid-point ventilation intakes to provide additional dilution to the in-tunnel air. This will be achieved by operating the ventilation fans in the reverse direction to supply fresh air to the tunnels. The Wilson Road Ventilation intake will be operated to supply fresh air to the northbound tunnel, while the Trelawney Street Ventilation intake will be operated to supply fresh air to the southbound tunnel.

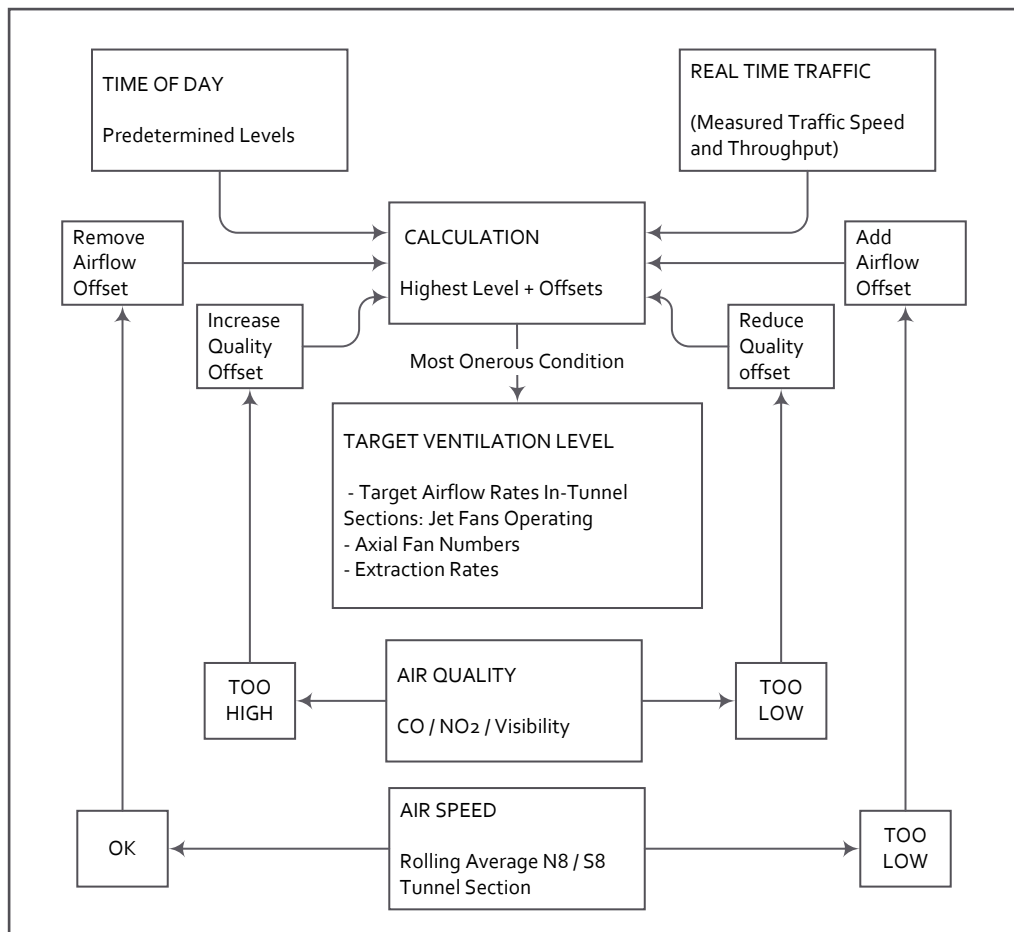
The ventilation control system (VCS) is set up primarily to ensure that the pollution levels are kept under the defined limits and portal emissions are prevented. The VCS will reference the normal operation look-up table, which will specify the required airflow for each section of the tunnel, the supply air requirements of the mid-point ventilation stations and the extraction requirements of the portal ventilation outlets for each ventilation level. The VCS will determine the number of jet fans required to operate to maintain tunnel air quality and prevent portal emissions under varying traffic conditions, which will be altered in response to the varying flow rates induced by traffic. There is a dead-band applied to the target airflows in each section of the tunnel to avoid unnecessary changes in jet fan operation.

The VCS will usually operate in a fully automatic manner for normal operation. A concept diagram is shown below in Figure 3.1 below. However, it may be overridden or manually commanded by the operator to activate any of the pre-programmed ventilation modes or operate individual equipment in manual mode if required.

Control system functionality will generally comprise the following elements.

- Traffic and/or pollutant level data and/or portal emission management will determine the overall ventilation rate and target flow rates;
- Airflow through tunnel sections will be maintained by automatic feedback control of jet fans to meet airflow requirements; and

- Higher pollutant levels, as measured by the air quality sensors, will cause the VCS to increase the ventilation level.



**Figure 3.1: Normal Ventilation Mode Flow Chart**

### 3.3 Monitoring Equipment

#### 3.3.1 In-tunnel monitoring

The MCoA requires the tunnel to be continuously monitored for Nitrogen Dioxide (NO<sub>2</sub>), Carbon Monoxide (CO) and Visibility as outlined in Table 2.1. This is achieved using the instruments outlined in Table 3.5.

**Table 3.5: In-tunnel Measured Parameters & Instruments**

Parameter Measured	Instrument and Measurement Technique	Description
Visibility	Tunnel Sensors VICONOX 3 - Light Transmission Obscuration Method	Measures the reduction in the light signal caused by the particulate passing through the open path beam.
CO	Tunnel Sensors VICONOX 3 - Nondispersive Infrared (NDIR) Spectroscopy	Measures the extinction of specified frequencies in the resultant radiation spectrum after exposure to an infrared radiation source.

Parameter Measured	Instrument and Measurement Technique	Description
NO <sub>2</sub>	Tunnel Sensors VICONOX 3 - Differential Optical Absorption Spectroscopy (DOAS) Method	Measures the extinction of specified frequencies in the resultant radiation spectrum after exposure to a radiation source.

The in-tunnel monitoring methods for CO, NO<sub>2</sub> and visibility are considered Special Methods, as there is no relevant Australian Standard and are subject to approval from the Secretary in consultation with the EPA. This Special Method has been defined as AS3580.18:2017, as approved by the EPA. It is of note that Test Method 18 of the Australia and New Zealand Methods for sampling and analysis of ambient air, (i.e. AS/NZS 3580.18: 2017, Measurement of road tunnel air quality) was not finalised at the time the NCX Project conditions were drafted. Table 3.5 above details the specific process and measurement technique of AS3580.18:2017.

The selected in-tunnel air quality sensors are purpose designed for road tunnel applications and environments. The sensors will be distributed throughout the tunnel at high level outside the vehicle clearance envelope. As the tunnel air is well mixed, the height of the sensors is not considered critical in ensuring the sensor measurement is an accurate representation of the average tunnel value. This installation practice is in accordance with equipment manufacturer's recommendations.

In accordance with MCoA Section E1, sensors are located at entry portals, the base of ventilation extraction points, ramp junctions and intermediate exhaust outlet connections. To ensure adequate coverage of all sections of the tunnel, a minimum of two (2) off sensors will be included in the majority of the discrete sections of the tunnel.

The off-ramps will have one (1) off sensor in the vicinity of where the ramp meets the mainline tunnel. As the ramp entry and exit portals are in close proximity to each other, the air quality sensors installed in the on-ramp entry portal areas will be used as a basis for the incoming air quality for both portals.

The in-tunnel air quality sensors will be connected to the PMCS for monitoring, recording and input to the tunnel ventilation control system to ensure the in-tunnel concentration remains below the maximum permitted limits as outlined in the MCoA. The PMCS will record and store a history of measurements from the in-tunnel air quality sensors for reporting purposes. These results are then made available for use as required by the Project on the reporting website.

### 3.3.2 Ventilation stack/outlet monitoring

The MCoA requires each ventilation outlet to be continuously monitored in accordance with the requirements of E10 outlined in Table 2.1. This is achieved using the instruments outlined in Table 3.6.

**Table 3.6: Outlet Measured Parameters & Instruments**

Parameter Measured	Instrument and Measurement Technique	Description
Total Solid Particles (TSP)	Palas Fidas 200-E - Optical Light Scattering	Measures the amount of light that is scattered due to the reflection and refraction from the particulates in the air.
Nitrogen Oxide (NO)	Chemiluminescence	

Parameter Measured	Instrument and Measurement Technique	Description
Nitrogen Dioxide (NO <sub>2</sub> )	Chemiluminescence	Compares the light intensity emitted by two (2) separate samples of air to determine the concentration of NO <sub>2</sub> . This method introduces a bias towards the over prediction of NO <sub>2</sub> and provides a conservative measurement of the NO <sub>2</sub> concentration.
Carbon Monoxide (CO)	Ecotech Serinus 30 - Nondispersive Infrared (NDIR) Spectroscopy	Measures the extinction of specified frequencies in the resultant radiation spectrum after exposure to an infrared radiation source.
Volatile Organic Compounds (VOC)	Flame Ionisation Detection (FID)	Provides the total, non-speciated concentration of hydrocarbons through measuring the current that is produced when air is mixed with hydrogen and ignited.  FID is the only viable method that provides a total, non-speciated measurement.
Velocity	Tunnel Sensors Crossflow - Ultrasonic Sensor	Measures and compares the time in flight of the sound waves that are emitted from each transceiver unit.
Volumetric Flow Rate	Tunnel Sensors Crossflow - Ultrasonic Sensor	
Temperature	Vaisala HMT337	Measures the temperature of the air path.
Moisture	Vaisala HMT337	Measures the moisture content of the air path.

The outlet air monitoring probes and sensors will be installed within the outlets of the portal ventilation stations. Two probes will be installed in each partition of each ventilation outlet; one probe will be installed to measure the CO, NO, NO<sub>2</sub>, VOC, temperature and moisture while another probe will be installed to measure the TSP in each outlet. The outlet monitoring sensors will be connected directly to the PMCS to allow the tunnel operator to see the readings on the OMCS. These connections will include analogue signals for sensor readings, as well as digital signals for healthy and faults. A connection from the OMCS will be provided to the remote reporting website.

Manual sampling points will be provided at the portal ventilation stations (VS01 and VS04) to allow for quarterly and/or annual testing of:

- TSP;
- Particulate Matter 2.5 (PM<sub>2.5</sub>);
- Particulate Matter 10 (PM<sub>10</sub>);
- Speciated VOC; and
- Polycyclic Aromatic Hydrocarbon (PAH).

The sampling points will enable samples of the air being exhausted from the tunnel to be taken for testing and comparison to the outlet air monitoring system. The sampling points are located at the ventilation station exhaust shafts. Access to the sampling points is provided by way of permanent platforms and stairways.



The outlet sensors are connected to the PMCS to allow the tunnel Operator to have full visibility of the Tunnel Ventilation System performance. The PMCS records and stores a history of measurements from these sensors for reporting purposes. These results are then made available for use as required by the Project on the reporting website.

### 3.3.3 Ambient monitoring

The ambient air quality monitoring parameters are identified in MCoA E7 outlined in Table 2.1 using the instruments outlined in Table 3.8 below.

**Table 3.8: Parameters measured at the NorthConnex Project ambient monitoring stations**

Parameter Measured	Instrument and Measurement Technique	Elevation
CO	Ecotech Serinus 30 – NDIR gas filter correlation infrared photometry	2m
NO, NO <sub>2</sub> , NO <sub>x</sub>	Ecotech Serinus 40 – gas phase chemiluminescence	2m
PM <sub>2.5</sub>	Met One BAM 1020 – Beta ray attenuation	2m
PM <sub>10</sub>	Thermo – 1405 TEOM (Tapered Element Oscillating Microbalance)	2m
Differential Temperature	Met One 062MP	2m
Differential Temperature	Met One 062MP	10m
Wind Speed (horizontal)	Gill Windsonic Op3	10m
Wind Direction	Gill Windsonic Op3	10m
Sigma	Calculation	-

### 3.3.4 Ambient Air Quality Monitoring locations

The NorthConnex Project monitoring network consists of six ambient air quality and weather monitoring stations. These monitoring locations were approved for adequacy by the AQCCC. The stations location and siting details are described Table 3.9 below.

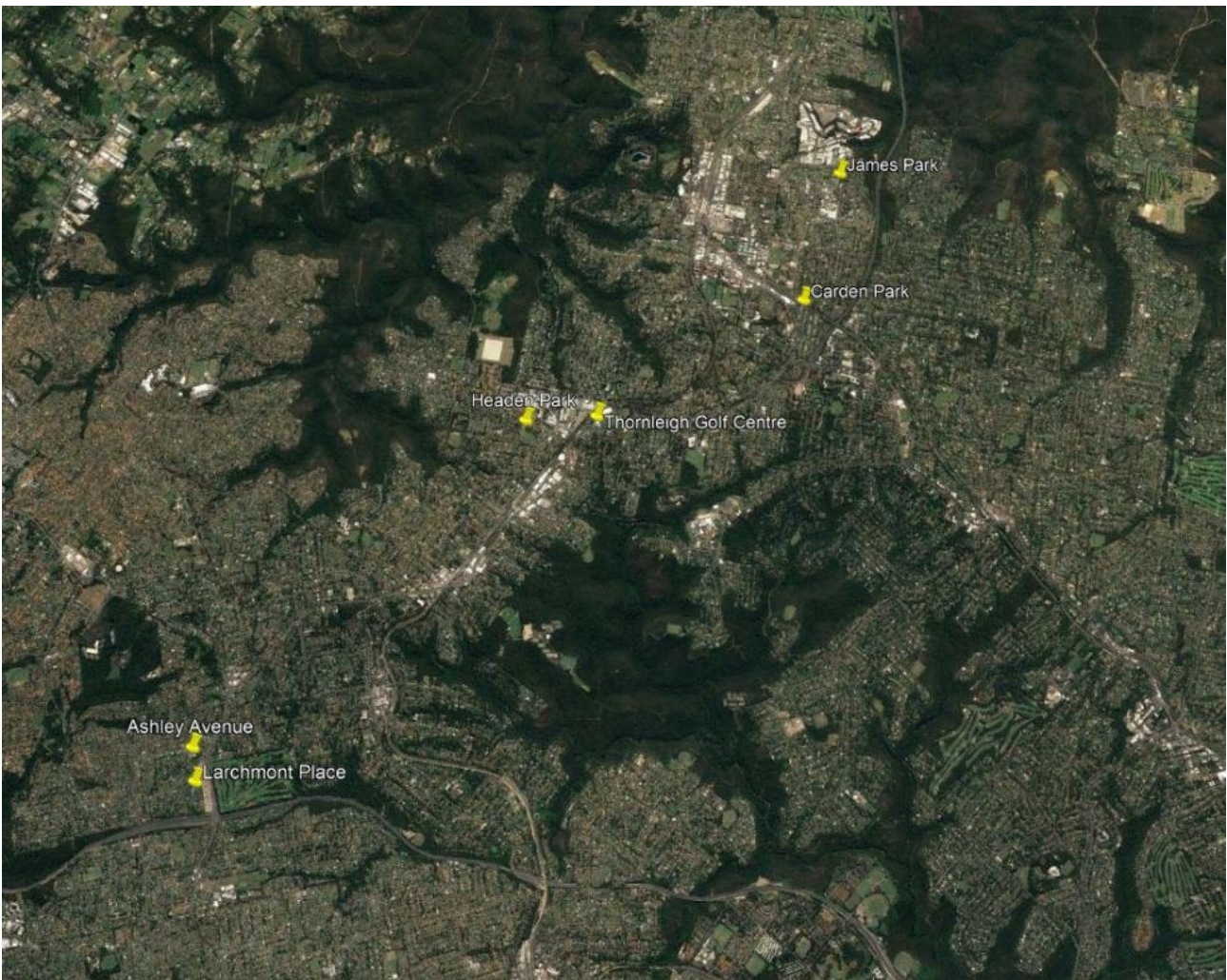
**Table 3.9: NorthConnex Project ambient monitoring sites locations**

Site Name	Geographical Coordinates	Height Above Sea Level (m)
Ashley Avenue	33°45'13.87"S, 151 °2'45.11"E	126
Carden Park	33°42'48.15"S, 151° 6'33.10"E	187
Headen Park	33°43'29.42"S, 151° 4' 44.38"E	175
Janes Park, Hornsby	33°42'2.28"S, 151°6'48.59"E	175
Larchmont Place	33°45'24.12"S, 151°2'46.97"E	110

Site Name	Geographical Coordinates	Height Above Sea Level (m)
Thornleigh Golf Centre	33°43'28.06"S, 151°5'11.99"E	182

Stations are audited against the guidelines and mandatory requirements in the standards below, as relevant:

- AS/NZS 3580.1.1:2016 “Methods for sampling and analysis of ambient air – guide to siting air monitoring equipment”.
- AS/NZS 3580.14:2014 “Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications”.



**Figure 2: NorthConnex Project Ambient Monitoring Station Locations**

Ecotech Pty Ltd were approved by the Secretary on 22 March 2018 to provide monitoring and data reporting for the NorthConnex ambient air quality and weather monitoring network, as detailed in Table 3.9. Ecotech commenced data collection in October 2018.

Data captured by this monitoring station network is reported on the NorthConnex website, and in general includes the below;

- Describes air quality measurements;
- Compares monitoring results;
- Conforms with NATA accreditation requirements, where applicable.

### 3.3.5 Emergency Discharge

The air quality parameters identified in MCoA E2, E3, E4, E8 and E11 and shown in Table 2.1 do not apply in an emergency situation, as outlined in MCoA E14.

An emergency is an out-of-the-ordinary event, or set of circumstances that causes or threatens to cause harm to the safety or well-being of the community, employees, or users of the Motorway or associated assets. It often requires a coordinated response from NSW Emergency Services and the Tunnel Operator.

An emergency discharge is an emission from the ventilation system that is caused by an incident or set of circumstances which does not ordinarily occur in the everyday use of the tunnel and is beyond:

- Merely heavy traffic or congestion, or
- The capacity of the tunnel operator to control or to have prevented by taking steps which a prudent, experience and competent operator would have taken.

In the event of an emergency situation that results in a discharge that exceeds the above nominated criteria, the Secretary and the EPA would be notified, as per notification standards outlined in Section 5.

## 4. Air quality monitoring and measurement

The requirement to maintain, replace or upgrade any road or noise mitigation infrastructure may need approval either under part 5 of the *Environmental Planning and Assessment Act 1979* or as a modification to the project approval under Part 5.1 of the same Act.

The relevant asset stakeholders must consult the HSE Advisor to discuss the proposal to maintain, retain or upgrade any of this equipment and confirm what approvals will be required prior to its implementation.

NorthConnex will adopt the following measures to manage air quality during the asset's operation and maintenance:

- Implement air quality management controls for all operation and maintenance activities;
- Ensure that all air quality mitigation infrastructure are on an active maintenance schedule;
- Manage operational road traffic emissions;
- Implement a good neighbor policy to manage air quality complaints;
- Ensure the continual monitoring of air quality emissions from the operational asset;
- Audit collected air quality data and report in a simple, clear and transparent manner;
- Ensure there is a process to independently audit the operational equipment that monitor air emissions and calibration of that monitoring equipment; and
- Ensure there is a clear and transparent process for managing and reporting exceedances and incidents.

### 4.1 Management provisions

Table 4.1 lists the air quality management provisions for the asset. These provisions satisfy the conditions of approval referenced in Table 2.1 relating to air quality.

**Table 4.1 Environmental Management**

Activity/ Step	Management provisions	Responsibility
<b>Operations and maintenance air quality management measures</b>		
<b>Activity 1: Management of air quality</b>		
1.1	During normal operation of the Asset, the OMCS is used to automatically operate the tunnel and adjust the in-tunnel ventilation requirements. The tunnel ventilation system, in conjunction with the traffic management system, is designed to operate such that the in-tunnel and stack air quality conditions in the MCoA are complied with and portal emissions are avoided. The responses required by the Operator to prevent an air quality exceedance are detailed in the procedure NCX-OI-MP-3 IMP Air Quality.	NorthConnex Op. Operations Manager
<b>Activity 2: Air Quality monitoring</b>		
2.1	All air quality monitoring required to demonstrate compliance with MCoA's, is outlined in procedure NCX-OI-MP-3 IMP Air Quality. The procedure outlines monitoring requirements from the MCoA, monitoring equipment specifications and how the system interacts with the PCMS.	NorthConnex Op. Operations Manager

Activity/ Step	Management provisions	Responsibility
	<p>The location of monitoring points are shown in Appendix D to this document.</p> <p>Continuous monitoring data from the Air Quality Monitoring System is relayed back to the Traffic Control Room for action by the Operators. Activity 5 below outlines actions required for an air quality limit exceedance.</p>	
<b>Activity 3: Reporting Air Quality data</b>		
3.1	For In-Tunnel airflow, CO, NO <sub>2</sub> and Visibility monitoring, the data is logged and stored in the PCMS. The data is retrieved by the air quality contractor who reviews and validates the data on a monthly basis in a report. The report is then provided on the NorthConnex Website. The reporting process for In-Tunnel air quality is outlined in Section 5.1.	NorthConnex Op. Operations Manager  NorthConnex Op. Maintenance Manager
	For Ventilation Stack monitoring, the data is logged and stored in the PCMS. The data is retrieved by the air quality contractor who reviews and validates the data on a monthly basis in a report. The data is then provided on the NorthConnex Website. The reporting process for In-Tunnel air quality is outlined in Section 5.2.	
	For Ventilation Stack quarterly and annual monitoring, an air quality expert contractor would conduct the stack monitoring required by MCoA E10 Table 9. The data is to be provided on the NorthConnex Website as reports become available.	
	For Ambient monitoring the data is logged by the individual monitoring sites and transferred to NorthConnex website. The reporting process for In-Tunnel air quality is outlined in Section 5.3.	NorthConnex Op. Maintenance Manager
3.3	Historical results are then archived in the NorthConnex document management system.	NorthConnex Op. Maintenance Manager
<b>Activity 4: Auditing of Air Quality monitoring</b>		
4.1	<p>NorthConnex will implement quality assurance and quality control for air quality monitoring data through its air quality contractor by ensuring that:</p> <ul style="list-style-type: none"> <li>All equipment is accredited, calibrated and checked;</li> <li>Monitoring procedures are quality assurance checked;</li> <li>All equipment is routinely serviced and maintained to ensure compliance with NATA requirements;</li> <li>All monitoring procedures are checked and updated; and</li> </ul> <p>Equipment and system malfunctions are minimised through adopting a proactive maintenance schedule.</p>	NorthConnex Op. Maintenance Manager
4.2	As outlined in MCoA 21, an external auditor would audit the operating procedures, equipment to acquire in-tunnel air monitoring data and monitoring data reporting for compliance with NATA (or equivalent) requirements and sound laboratory practice at 6 monthly intervals. This report is provided to NorthConnex who forward the report to the AQCC. The audit findings are to be made available for inspection by the DPIE upon request.	NorthConnex Op. Maintenance Manager
<b>Activity 5: Management of an air quality limit exceedance</b>		
5.1	<p>In any instance where there is either a validated or non-validated exceedance of the air quality limits either In-Tunnel or at the Ventilation Outlets, then:</p> <ul style="list-style-type: none"> <li>The operations team will immediately notify the HSE Lead/Advisor describing the nature, location and circumstances of the in-tunnel or ventilation stack exceedance using the agreed template; and</li> </ul>	NorthConnex Op. Operations Manager  NorthConnex Op. Maintenance Manager

Activity/ Step	Management provisions	Responsibility
	<ul style="list-style-type: none"> <li>The HSE Lead/Advisor or their delegate will notify the TfNSW, DPIE, EPA and NSW Department of Health within 24-hours of becoming aware of the exceedance.</li> </ul> <p>A detailed report will be prepared by an independent air quality specialist (approved by the DPIE) within 20 working days describing:</p> <ul style="list-style-type: none"> <li>Validate recorded monitoring data and certify compliance with the in-tunnel, ventilation stack and ambient limits.</li> <li>The condition when the monitoring was undertaken.</li> <li>Confirm the reason for any departure between the monitoring results and the manufacturer/design and build specifications, allowing for natural fluctuations and expected 'real world' variations.</li> <li>The cause and the main contributing factors that led to the exceedance.</li> <li>The options available to prevent any reoccurrence.</li> </ul> <p>This report will be submitted to DPIE.</p>	NorthConnex Op. HSE Advisor
5.2	For recorded instances of the exceedances for the Ambient air quality goals, the Ambient Above-Goal Reading Protocol shall be followed as contained in Appendix C.	NorthConnex Op. Operations Manager NorthConnex Op. HSE Advisor
5.3	Following an air quality exceedance, the issue will be reviewed by all relevant stakeholders.	NorthConnex Op. Manager
<b>Activity 6: Management of emergencies and incidents</b>		
6.1	During a permitted discharge ensure the circumstances that led to the permitted discharge must be recorded and monitored.	NorthConnex Op. Operations Manager
6.2	<p>The air quality parameters identified in MCoA E2, E3, E4, E8 and E11 and shown in Table 2.1 do not apply in an emergency situation, as outlined in MCoA E14.</p> <p>An emergency is an out-of-the-ordinary event, or set of circumstances that causes or threatens to cause harm to the safety or well-being of the community, employees, or users of the Motorway or associated assets. It often requires a coordinated response from NSW Emergency Services and the Tunnel Operator.</p> <p>All emergency emissions shall be reported to the HSE Advisor, to allow reporting, as soon as reasonably practicable, notify DPIE and the EPA of any such discharge.</p>	NorthConnex Op. Operations Manager NorthConnex Op. HSE Advisor
6.6	<p>In the event of an emergency the Operators shall contact the Transport Management Centre who will provide assistance to the NorthConnex Operator, using its reasonable endeavours, with the aim of managing traffic in the surrounding road network. TMC's reasonable endeavors may include:</p> <ul style="list-style-type: none"> <li>Displaying messages on traffic devices such as VMS's on the surrounding road network; and</li> <li>Notifying the travelling public via radio and/or internet.</li> </ul>	NorthConnex Op. Operations Manager
<b>Activity 7: Maintenance and calibration of air quality monitoring equipment</b>		
7.1	Develop and implement a proactive inspection and maintenance schedule to ensure the all ventilation system equipment performs to within its manufacturer specifications.	NorthConnex Op. Maintenance Manager NorthConnex Op. HSE Advisor

Activity/ Step	Management provisions	Responsibility
7.2	Calibration of air quality monitoring equipment as required by applicable standards. This includes nightly calibrations of gaseous analysers and six monthly calibration during tunnel shuts.	NorthConnex Op. Maintenance Manager
7.3	Where possible switch off engines and equipment next to sensitive receivers when it is not being used and limit the amount of idling time when work is taking place.	
7.4	All Operators are to be trained in Air Quality Management procedures, including for operations and emergency situations.	NorthConnex Op. Operations Manager
7.5	Train all relevant Asset stakeholders on the requirements of the OEMP and this management sub-plan through inductions, toolbox talks and targeted training.	NorthConnex Op. HSE Advisor
7.6	Relevant air quality control mitigations are required for operational and maintenance activities carried out on the Asset. This should include: <ul style="list-style-type: none"> <li>• Standard operating procedures and work method statements.</li> <li>• Dust extraction.</li> <li>• Erosion and sediment controls.</li> <li>• Cover loaded haulage trucks.</li> <li>• Keep the surface moist (not wet) through use of water carts, sprinklers, sprays and dust screens.</li> <li>• Stabilise disturbed areas as soon as practicable to prevent or minimise windblown dust.</li> <li>• Road sweeping.</li> </ul>	NorthConnex Op. Operations Manager NorthConnex Op. Maintenance Manager NorthConnex Op. HSE Advisor

## 4.2 Quality Assurance and Quality Control

Air quality monitoring and sampling will be carried out by a suitably qualified and NATA accredited individual and/or company. Air sampling analysis will be carried out in a NATA accredited laboratory under appropriate quality assurance and quality control (QA/QC) protocol requirements. The QA/QC measures to be implemented during the operation of the Asset have been approved by Todoroski Air Sciences, an independent expert approved by the Secretary to monitor air quality and ventilation emissions. Details of the QA/QC measures will be included in reports made available on the NorthConnex website. Some of these measures include, but are not limited to;

- Quality systems
- Staff qualifications and training
- Auditing
- Calibration, service and maintenance of all monitoring equipment
- Equipment and/or systems malfunctions
- Record and reporting

## 4.3 Monitoring Data Availability

Information regarding the air quality monitoring required during the operation of the Asset will be made available on the NorthConnex Website. Information will include hourly updated real-time monitoring of;

- PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub> and CO at the approved monitoring stations
- In-tunnel Co, NO<sub>2</sub> and visibility
- Ventilation outlet measurements

- Relevant meteorological data

The above data will also be made available each month in an easy to interpret, hard copy format and is publically available on the on the NorthConnex Website. The data will be preliminary until appropriate quality assurance checks have been undertaken.

The local community will be notified (by way of newsletter and newspaper advertisement) of the availability of this information at least one month prior to commencement of operation of the Asset.

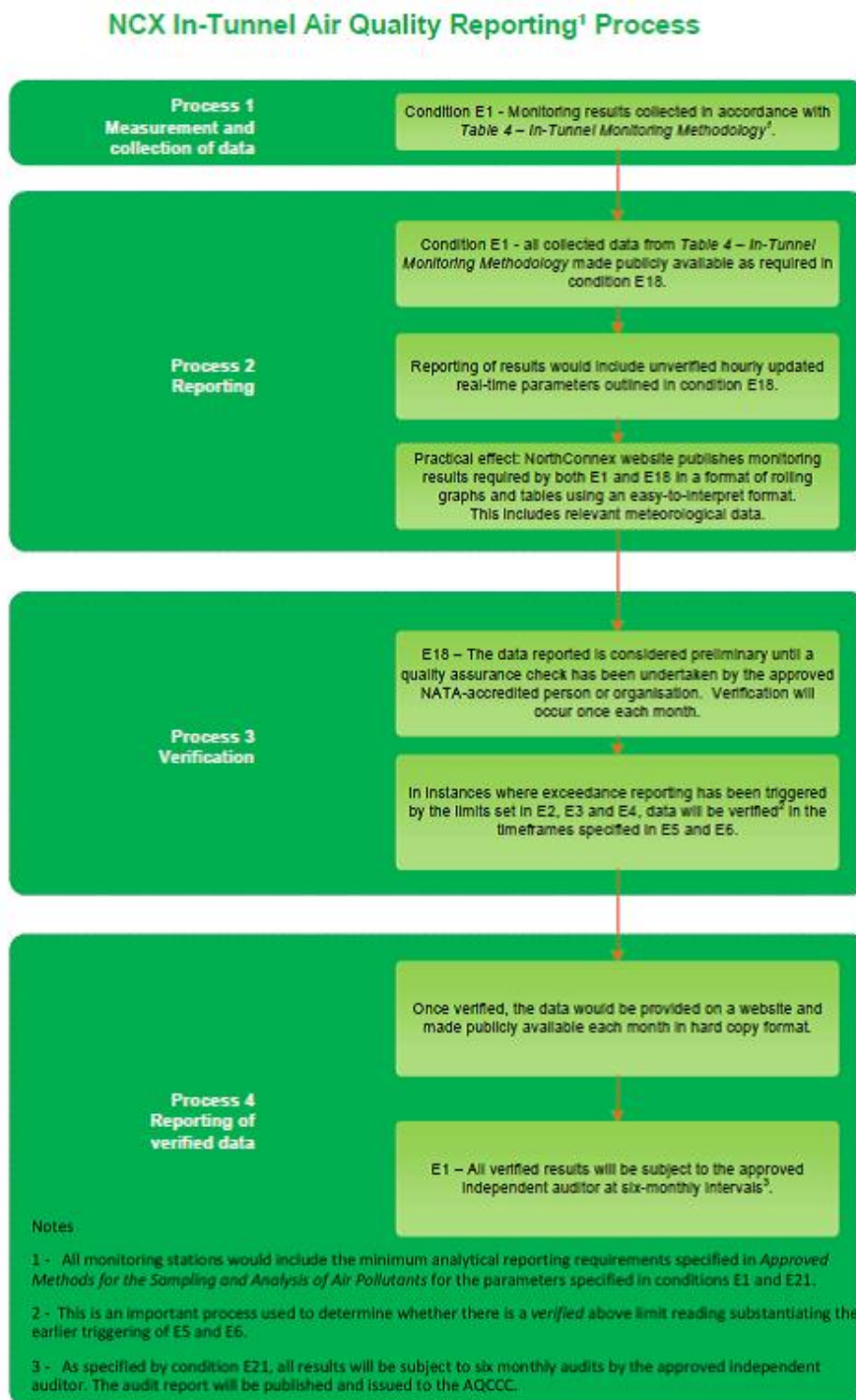


## 5. Notification and Reporting

A reporting system for in-tunnel, ventilation outlet and ambient air quality limits has been developed in consultation with the EPA, in accordance with MCoA E17. The air quality reporting system must be approved by the Secretary and fully implemented and operational prior to Asset operation.

### 5.1 In-Tunnel Reporting

The In-Tunnel Air Quality Reporting Process is presented below in Figure 5.1.



**Figure 5.1: NCX In-Tunnel Air Quality Reporting Process**

## 5.2 Ventilation Outlet Reporting

The Ventilation Outlet Reporting Process is presented below in Figure 5.2.



**Figure 5.2: NCX Ventilation Outlet Reporting Process**

### 5.3 Ambient Reporting

The Ambient Air Quality Reporting Process is presented below in Figure 5.3.

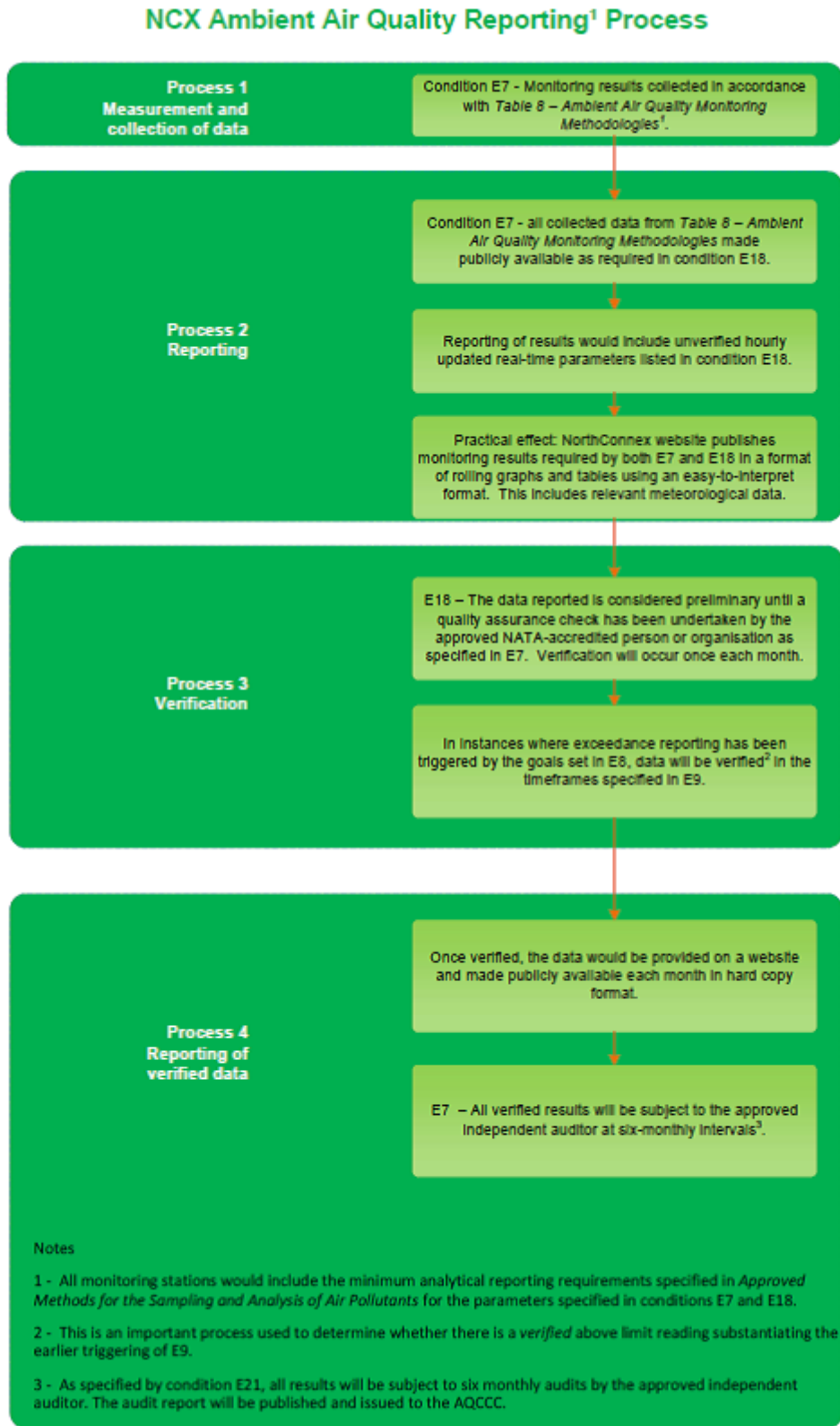


Figure 5.3: NCX Ambient Air Quality Reporting Process

## 6. Communications and complaints

When a complaint is received it will be forwarded to the NorthConnex Operation and Maintenance Managers for review in consultation with the HSE Advisor to determine the actions required to address the complaint. This may include a review of air quality mitigation measures or monitoring. Information regarding communications and complaints is contained in Section 3.3 of the OEMP.

## 7. Training and awareness

All asset stakeholders will be trained and made aware of air quality management requirements prior to (planning for), during (undertaking) and after (reporting) any operation and maintenance activity.

The training will form part of induction requirements, toolbox talks, meetings and subcontractor requirements, as discussed in Section 5.5 the OEMP.

## 8. Auditing and Review

### 8.1 Six Monthly Audits

Todoroski Air Sciences has been approved by the Secretary, in consultation with the EPA and AQCCC, to conduct audits on the air quality monitoring (in-tunnel and external) at six monthly intervals. These audits will commence six months after the commencement of operation, other than those audits of the ambient air quality monitoring.

These audits will review the operating procedures and equipment to acquire air monitoring, meteorological data and emission monitoring data and confirm monitoring reports comply with NATA requirements and sound laboratory practice. These reports will be issued directly to the Asset Operator and the AQCCC and all data will be made available to the Secretary upon request.

### 8.2 Ventilation Outlet Review and Accuracy Audit

In accordance with MCoA E12, the ventilation outlet limits details in MCoA E11 must be reviewed on a five yearly basis and may be lowered (i.e. made more stringent), subject to a sustainability assessment and there being improvements in the vehicle fleet emission, if the Proponent is directed to do so by the Secretary following consultation with the EPA.

All continuous emissions monitoring systems installed and operated as a requirement of MCoA E10, will undergo relative accuracy test audits at an interval not exceeding 12 months, or as otherwise agreed by the Secretary in consultation with the EPA.

### 8.3 Ambient Air Quality Monitor Review

After a period of two years from commencement of operation, the Operator in consultation of the AQCCC must review the need for the continuation of the ambient monitoring stations. Any recommendations to close the stations will require the approval of the Secretary, in consultation with the EPA.

### 8.4 Monitoring, Auditing and Review of the Sub-Plan

This sub management plan will be assessed and reviewed in accordance with the OEMP and will be based upon:

- Internal and external audits of procedures to verify compliance to maintenance procedures for ventilation system components.
- Auditing of any ventilation system maintenance and air quality monitoring programs.
- The outcome of routine inspections and audits.
- The completion of annual reports.

Otherwise, the plan will be audited and reviewed annually in line with the OEMP annual review, unless there is a notable change or recorded incident. Proactive inspections of the Asset's operations and maintenance will be completed to review environmental performance as will periodic inspections in the event that there is a concern about implementation or performance.

Reviews will comprise:

- Reviewing contractor documentation;
- Observing procedure and protocol onsite; and
- Re-auditing performance once the corrective actions have been implemented.

Where there is inconsistency between the plan's intention and audit findings, management procedures and protocols will be reviewed and amended as necessary to ensure continuous improvement.

# Appendix A: Tunnel Ventilation, Traffic Incident Response and Traffic Management Systems Integration Protocol

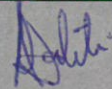
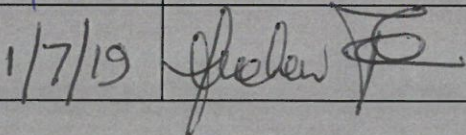
To be issued for DPIE review separately

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# Appendix B: Tunnel Ventilation System Air Quality Report

# All NCX Zones - Tunnel Ventilation System Air Quality Report Template

## NorthConnex Project Mechanical & Electrical

	Name	Position	Date	Signed/Authorised
Approved	Ashkun Jalili	Design Manager - M&E	28/6/19	
Authorised	Andrew Johnson	Construction Director - M&E	1/7/19	

Document Number:  
NCX-LLB-13-0008-ME-RP-0001

Revision: 00



# All NCX Zones - Tunnel Ventilation System

## Air Quality Report Template

### Document Control

A person using Project documents or data accepts the risk of:

- a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.
- b) Using the documents or data for any purpose not agreed to in writing by the LLBJV.

Title	Report Title	Doc No: NCX-LLB-13-0008-ME-RP-0001
General Description:	Monthly Air Quality Report template to be used for monthly reporting after completion.	
Document Path:	TeamBinder	
Document Template:	M&E Report : Version 10, 17 May, 2017	

### Revision

Revision	Date	Description	Prepared
Revision 00	27/06/2019	Issued for Project Co Review	Robert Draper

# All NCX Zones - Tunnel Ventilation System Air Quality Report Template

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# All NCX Zones - Tunnel Ventilation System Air Quality Report Template



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# All NCX Zones - Tunnel Ventilation System Air Quality Report Template

## Standard Terms and Definitions

Term	Definition
ASJV	Aurecon and SMEC Design Joint Venture in association with Golder Associates
BYCA	Bouygues Construction Australia Pty
Client	NorthConnex Project Company and NorthConnex State Works Contractor (together the Project Company Group) under the NorthConnex D&C Deed
D&C	Design and Construction
DCD	Developed Concept Design
Deed	As appropriate to the defined scope of the NorthConnex D&C Deed
FDD	Final Design Documentation
IC	Independent Certifier - APP Corporation Pty Limited engaged in accordance with either the NCX or M2I Independent Certifier Deeds.
IFC	Issued For Construction
LLBJV	Lend Lease Bouygues Joint Venture (Contractor)
LLEMS	Lend Lease Engineering Management System
M&E	Mechanical and Electrical
NCX	NorthConnex
NSW	New South Wales
O&M	Operation and Maintenance
PMP	Project Management Plan
PMS	Project Management System
Project	NorthConnex Project
Project Company	NorthConnex Company Pty Ltd, which acts on behalf of the Client's under the NCX D&C Deed
Project Company Group	NorthConnex Company Pty Ltd (Project Company) and NorthConnex State Works Contractor Pty Ltd
QP	Quality Plan
SDD	Substantial Detailed Design
Sub IC	Sub Independent Certifier - APP Corporation Pty Limited engaged in accordance with either the NCX or M2I Sub Deed of Appointment of Independent Certifier.
SWTC	As appropriate to the defined scope of the Scope of Works & Technical Criteria defined as Exhibit A under the NorthConnex D&C Deed
TMC	The New South Wales Transport Management Centre at Eveleigh
WoL	Whole of Life

# All NCX Zones - Tunnel Ventilation System Air Quality Report Template

## Abbreviations

Abbreviation	Definition
CO	Carbon Monoxide
HGV	Heavy Goods Vehicle
LDV	Light-Duty Vehicle
NO <sub>2</sub>	Nitrogen Dioxide
NO <sub>x</sub>	Oxides of Nitrogen
PM	Particulate Matter
PMCS	Plant Management and Control System
PCU	Passenger Car Unit
VCS	Ventilation Control System
VS01	Southern Ventilation Station
VS02	Wilson Road Ventilation Station
VS03	Trelawney Street Ventilation Station
VS04	Northern Ventilation Station
VSD	Variable Speed Drive

# All NCX Zones - Tunnel Ventilation System Air Quality Report Template

## 1 Executive Summary

### 1.1 Summary of Monthly Results

XX

Insert commentary about the results obtained, explanation of any abnormal results or events and any significant issues with the monitoring equipment.

XX

## 2 Introduction

### 2.1 Project Background

The NorthConnex Project includes:

- a) Two new dual-lane carriageways (one northbound, and one southbound) generally located beneath Pennant Hills Road and the Northern Railway in Sydney linking the M1 Freeway and the Hills M2 Motorway;
- b) An interchange at the northern end of the Motorway that provides vehicular access between the Motorway, Pennant Hills Road and the Pacific Highway;
- c) An interchange at the southern end of the Motorway that provides vehicular access between the Motorway, the Hills M2 Motorway and Pennant Hills Road;
- d) A Motorway Control Centre including operation and maintenance facilities; and
- e) Ventilation systems and other facilities for the operation of the motorway. The ventilation system includes for the provision of monitoring devices to continuously measure air speed and quality at key locations in the tunnel and ventilation outlets.

### 2.2 Purpose

This report provides the monthly air quality data recorded on the NorthConnex project within the tunnels and the ventilation outlets. This report addresses the criteria required by the Ministers Conditions of Approval E17 and E18. Whilst the data is to be provided in real time on a website, the report is to be prepared on a monthly basis and made publically available.

A similar report is prepared for the Ambient Air Quality Monitoring stations that are located externally to the tunnel and do not form part of the permanent air quality monitoring systems.

## 3 Scope

### 3.1 Scope

The equipment included in this report includes the following:

- a) In-tunnel air velocity sensors (34 off);
- b) In-tunnel air quality sensors (26 off-combined Visibility/Nitrogen Dioxide/Carbon Monoxide);
- c) CEMS Combined Monitor (2 off-Nitrogen Monoxide and Dioxide, Carbon Monoxide, Volatile Organic Compounds, Temperature and Humidity); and

# All NCX Zones - Tunnel Ventilation System

## Air Quality Report Template

d) CEMS Particulate Monitor (4 off-Total suspended particles).

The data from these devices is continuously monitored by the Operation and Management Control System (OMCS) and the data captured within the system. This data is made available in real time on the NorthConnex website ([www.northconnex.com.au](http://www.northconnex.com.au)) and is collated on a monthly basis to form part of this report. This report is then checked for quality prior to public release.

As required by Ministers Condition of Approval E21, the air quality monitoring system will be audited on a 6 monthly basis. In addition, as required by Ministers Condition of Approval E22, an independent expert will be engaged by the NorthConnex Project Company to ensure the quality systems and quality checks being undertaken are appropriate.

## 4 Air Quality Limits

The following limits are extracted from the Ministers Conditions of Approval

**Table 4-1 : In-tunnel Air Quality Limits**

Pollutant / Parameter	Type of Measurement	Concentration Limit
CO (ppm)	Rolling Average – 15 min	87
CO (ppm)	Rolling Average – 30 min	50
CO (ppm)	Rolling Maximum – 3 min	200
NO <sub>2</sub> (ppm)	Rolling Average – 15 min	0.50
Visibility (m <sup>-1</sup> )	Rolling Maximum – 15 min	0.0050

**Table 4-2 : Ventilation Outlet Air Quality Limits**

Pollutant / Parameter	Type of Measurement	Concentration Limit
CO (mg/m <sup>3</sup> )	Average – 1 hour rolling	40
NO <sub>2</sub> (mg/m <sup>3</sup> )	Average – 1 hour block	2.0
NO (mg/m <sup>3</sup> )	Average – 1 hour block	20
Solid Particles (mg/m <sup>3</sup> )	Average – 1 hour	1.1
VOC (as propane) (mg/m <sup>3</sup> )	Average – 1 hour rolling	4

## 5 Monitoring Equipment

### 5.1 In-tunnel Monitors

The Ministers Conditions of Approval requires the tunnel to be continuously monitored using Special Method 1 for NO<sub>2</sub>, CO and Visibility. This is achieved using the following instruments.

**Table 5-1 : In-tunnel Measured Parameters & Instruments**

Parameter Measured	Instrument and Measurement Technique
Visibility	Tunnel Sensors VICONOX 3 - Light Transmission Obscuration Method

# All NCX Zones - Tunnel Ventilation System

## Air Quality Report Template

Parameter Measured	Instrument and Measurement Technique
Carbon Monoxide (CO)	Tunnel Sensors VICONOX 3 - Nondispersive Infrared (NDIR) Spectroscopy
Nitrogen Dioxide (NO <sub>2</sub> )	Tunnel Sensors VICONOX 3 - Differential Optical Absorption Spectroscopy (DOAS) Method

### 5.2 Outlet Monitors

The Ministers Conditions of Approval requires each ventilation outlet to be continuously monitored in accordance with the requirements of Table 5-2.

**Table 5-2 : Monitoring Requirements**

Pollutant / Parameter	Units of Measure	Method <sup>1</sup>
Solid Particles	mg/m <sup>3</sup>	Special Method 1 <sup>3</sup>
NO	mg/m <sup>3</sup>	CEM-2
NO <sub>2</sub>	mg/m <sup>3</sup>	CEM-2
CO	mg/m <sup>3</sup>	CEM-4
VOC <sup>2</sup>	mg/m <sup>3</sup>	CEM-8
Moisture	%	TM-22
Temperature	°C	TM-2

1. Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2007) or an alternative method approved by the Secretary in consultation with the EPA.

2. Must include, but not be limited to: Benzene, Toluene, Xylenes, 1,3-Butadiene, Formaldehyde and Acetaldehyde.

3. Special Method 1 means a method approved by the Secretary in consultation with the EPA.

The pollutant and parameters will be continuously measured using the instruments identified in Table 5-3 below.

**Table 5-3 : Outlet Measured Parameters & Instruments**

Parameter Measured	Instrument and Measurement Technique
Total Solid Particles (TSP)	Palas Fidas 200-E - Optical Light Scattering
Nitrogen Oxide (NO)	Ecotech Serinus 40 - Chemiluminescence
Nitrogen Dioxide (NO <sub>2</sub> )	Ecotech Serinus 40 - Chemiluminescence
Carbon Monoxide (CO)	Ecotech Serinus 30 - Nondispersive Infrared (NDIR) Spectroscopy
Volatile Organic Compounds (VOC)	Ecotech VOC1000 Methane / Non-Methane Hydrocarbon (MNME) Analyser - Flame Ionisation Detection (FID)
Velocity	Tunnel Sensors Crossflow - Ultrasonic Sensor
Volumetric Flow Rate	Tunnel Sensors Crossflow - Ultrasonic Sensor
Temperature	Vaisala HMT337
Moisture	Vaisala HMT337



## 6 Data Validation and Reporting

### 6.1 Validation

The OMCS monitors the status of the air quality measurement devices and provides alarms to the operators should equipment failures be detected. Control room staff monitor the motorway on a 24/7 basis and will report equipment failures to the maintenance team for rectification. The faulty device will be isolated in the OMCS. Two air quality monitors are typically included in each tunnel ventilation section and each reading is used to calculate an overall average. In the event of an air quality monitor fault, the OMCS will substitute a default value for the faulty device. Once the device has been rectified, the operators will return the device to service on the OMCS.

In the event that the device is in a healthy state but there are anomalies with the readings, or devices have been taken out of service for routine maintenance and calibration checks, these details will be shown in the exceptions tables in section 8 of this report.

### 6.2 Reporting

The data is reported in real time at the NorthConnex website (URL. <http://northconnex.com.au/>)

Summary monthly data is recorded and reported within the OMCS and is included in the Appendices to this report.

- a) Air Speed Northbound
- b) Air Speed Southbound
- c) Air Quality Northbound
- d) Air Quality Southbound
- e) Air Quality Northern Outlet
- f) Air Quality Southern Outlet

Averages are based on all readings within the averaging period.

In addition to this, the OMCS can generate ad hoc reports for specific events or periods, and these will be included in the report as required, to provide additional detail for an abnormal event or incident.

## 7 Calibration and Maintenance

### 7.1 Maintenance

The equipment in use is specifically designed to suit a tunnel application, and therefore does not require high levels of maintenance. The maintenance requirements are detailed in the respective operation and maintenance manuals and occur as described in the table below.

**Table 7-1 : Indicative Maintenance Requirements**

Device	Frequency
Tunnel Air Speed Sensor	3 monthly and annually
Tunnel Air Quality Sensor	3 monthly, 6 monthly and annually

# All NCX Zones - Tunnel Ventilation System

## Air Quality Report Template

Device	Frequency
Outlet Air Quality Sensors - CEMS Combined Monitor	Monthly, 3 monthly, 6 monthly and annually
Outlet Air Quality Sensors - CEMS Particulate Monitor	Monthly, 3 monthly and annually

The maintenance records for the devices are maintained in the Maximo Asset Management System used by the project.

### 7.2 Calibration

The in-tunnel air speed sensors are to be calibrated at annual intervals as described in the Operation and Maintenance manuals prepared for the project.

The in-tunnel air quality sensors are to be calibrated at annual intervals as described in the Operation and Maintenance manuals prepared for the project.

The CEMS combined monitors undergo a daily calibration check and are to be manually calibrated at monthly intervals as described in the Operation and Maintenance manuals prepared for the project. The automatic daily calibration check will be performed using calibration gases and zero air for dilution.

The CEMS particulate monitors are to be manually calibrated at 3 monthly intervals as described in the Operation and Maintenance manuals prepared for the project. The CEMS particulate monitors will also undergo gravimetric correlation testing at yearly intervals as described in the Operation and Maintenance manuals prepared for the project.

A list of all the devices and the latest calibration details are included in Appendix A.

## 8 Exceptions & Exceedances

This section outlines any issues noted with the monitoring equipment during the reporting period.

**Table 8-1 : Exceptions**

Date	Device	Details
xx/xx/xxxx	xxxxx	xxxxxxx

Any instances of exceedances of the in tunnel or outlet air quality levels beyond the Ministers Conditions of Approval goals as set out in Table 4-1 and Table 4-2 are noted below:

**Table 8-2 : In tunnel Exceedances**

Pollutant / Parameter	Type of Measurement	Concentration Limit	Value of exceedance	Date and time of exceedance	Location of exceedance
CO (ppm)	Rolling Average – 15 min	87	-	-	-
CO (ppm)	Rolling Average – 30 min	50	-	-	-

# All NCX Zones - Tunnel Ventilation System Air Quality Report Template

Pollutant / Parameter	Type of Measurement	Concentration Limit	Value of exceedance	Date and time of exceedance	Location of exceedance
CO (ppm)	Rolling Maximum – 3 min	200	-	-	-
NO <sub>2</sub> (ppm)	Rolling Average – 15 min	0.50	-	-	-
Visibility (m <sup>-1</sup> )	Rolling Maximum – 15 min	0.0050	-	-	-

**Table 8-3 : Ventilation Outlet Exceedances**

Pollutant / Parameter	Type of Measurement	Concentration Limit	Value of exceedance	Date and time of exceedance	Location of exceedance
CO (mg/m <sup>3</sup> )	Average – 1 hour rolling	40	-	-	-
NO <sub>2</sub> (mg/m <sup>3</sup> )	Average – 1 hour block	2.0	-	-	-
NO (mg/m <sup>3</sup> )	Average – 1 hour block	20	-	-	-
Solid Particles (mg/m <sup>3</sup> )	Average – 1 hour	1.1	-	-	-
VOC (as propane) (mg/m <sup>3</sup> )	Average – 1 hour rolling	4	-	-	-

## 9 Documentation

The following documentation is included with this report.

**Table 9-1 : Documentation**

Appendix	Description
Appendix A	Calibration Details
Appendix B	Monthly Report- Air Speed Northbound
Appendix C	Monthly Report- Air Speed Southbound
Appendix D	Monthly Report- Air Quality Northbound
Appendix E	Monthly Report- Air Quality Southbound
Appendix F	Monthly Report- Air Quality Northern Outlet
Appendix G	Monthly Report- Air Quality Southern Outlet

# Appendix A

## Calibration Details

# All NCX Zones - Tunnel Ventilation System

## Air Quality Report Template

Equipment ID	Description	Calibration Frequency	Last Calibration
ASS101	Air Speed Sensor	Annually	
ASS102	Air Speed Sensor	Annually	
ASS103	Air Speed Sensor	Annually	
ASS104	Air Speed Sensor	Annually	
ASS106	Air Speed Sensor	Annually	
ASS107	Air Speed Sensor	Annually	
ASS109	Air Speed Sensor	Annually	
ASS110	Air Speed Sensor	Annually	
ASS111	Air Speed Sensor	Annually	
ASS112	Air Speed Sensor	Annually	
ASS113	Air Speed Sensor	Annually	
ASS114	Air Speed Sensor	Annually	
ASS115	Air Speed Sensor	Annually	
ASS201	Air Speed Sensor	Annually	
ASS202	Air Speed Sensor	Annually	
ASS203	Air Speed Sensor	Annually	
ASS204	Air Speed Sensor	Annually	
ASS205	Air Speed Sensor	Annually	
ASS206	Air Speed Sensor	Annually	
ASS207	Air Speed Sensor	Annually	
ASS208	Air Speed Sensor	Annually	
ASS209	Air Speed Sensor	Annually	
ASS210	Air Speed Sensor	Annually	
ASS211	Air Speed Sensor	Annually	
ASS212	Air Speed Sensor	Annually	
ASS213	Air Speed Sensor	Annually	
ASS701	Air Speed Sensor	Annually	
ASS702	Air Speed Sensor	Annually	
ASS703	Air Speed Sensor	Annually	
ASS704	Air Speed Sensor	Annually	
ASS801	Air Speed Sensor	Annually	
ASS802	Air Speed Sensor	Annually	
ASS803	Air Speed Sensor	Annually	
ASS804	Air Speed Sensor	Annually	

# All NCX Zones - Tunnel Ventilation System

## Air Quality Report Template

Equipment ID	Description	Calibration Frequency	Last Calibration
AQS101	Air Quality Sensor	Annually	
AQS102	Air Quality Sensor	Annually	
AQS103	Air Quality Sensor	Annually	
AQS104	Air Quality Sensor	Annually	
AQS105	Air Quality Sensor	Annually	
AQS106	Air Quality Sensor	Annually	
AQS107	Air Quality Sensor	Annually	
AQS108	Air Quality Sensor	Annually	
AQS109	Air Quality Sensor	Annually	
AQS110	Air Quality Sensor	Annually	
AQS201	Air Quality Sensor	Annually	
AQS202	Air Quality Sensor	Annually	
AQS203	Air Quality Sensor	Annually	
AQS204	Air Quality Sensor	Annually	
AQS205	Air Quality Sensor	Annually	
AQS206	Air Quality Sensor	Annually	
AQS207	Air Quality Sensor	Annually	
AQS208	Air Quality Sensor	Annually	
AQS209	Air Quality Sensor	Annually	
AQS210	Air Quality Sensor	Annually	
AQS701	Air Quality Sensor	Annually	
AQS702	Air Quality Sensor	Annually	
AQS703	Air Quality Sensor	Annually	
AQS801	Air Quality Sensor	Annually	
AQS802	Air Quality Sensor	Annually	
AQS803	Air Quality Sensor	Annually	
CPM011	CEMS Particulate Monitor	3 Monthly / Annually	
CPM012	CEMS Particulate Monitor	3 Monthly / Annually	
CPM071	CEMS Particulate Monitor	3 Monthly / Annually	
CPM072	CEMS Particulate Monitor	3 Monthly / Annually	
CCB011	CEMS Combined Monitor	Monthly	

# All NCX Zones - Tunnel Ventilation System Air Quality Report Template



Equipment ID	Description	Calibration Frequency	Last Calibration
CCB071	CEMS Combined Monitor	Monthly	

# Appendix B

## Air Speed Northbound



Air Speed - Northbound

Date Range: Monthly Start Date: 10/04/2019  
 Interval (hr): 24 End Date: 10/05/2019

Time	ASS101_V	ASS102_V	ASS103_V	ASS104_V	ASS105_V	ASS106_V	ASS107_V	ASS108_V
10/04/2019	5.104676569	2.596543592	3.212219947	2.740053003	5.996138146	0.247327902	4.376733816	2.66217675
11/04/2019	0.464343346	2.772273823	9.09131183	6.194527561	1.525485947	0.631324766	6.71525205	8.578795532
12/04/2019	1.434565209	9.35380595	4.846972909	3.510874061	7.365487728	9.86683188	9.333913517	3.383052983
13/04/2019	8.336425923	8.527606839	2.934418889	6.770501213	4.349113908	6.11319806	8.059369004	8.479741594
14/04/2019	6.865754884	8.754549538	3.28449602	7.606225912	5.027920816	6.773041854	2.261358082	2.071637019
15/04/2019	1.775597028	6.36123981	3.425017573	0.403996203	6.655114346	9.294200875	0.589564313	2.01640916
16/04/2019	6.79900691	0.913016195	6.098704205	5.802446024	7.357907882	6.978121429	2.770793056	6.593601235
17/04/2019	0.195202661	7.473278228	6.829012233	4.636571632	2.643600483	8.576941978	5.600631059	2.66888809
18/04/2019	1.183631355	2.073783133	1.561216222	7.920132993	5.412362826	9.193531159	2.176765769	8.460420992
19/04/2019	1.860931115	5.49698696	8.670599037	3.960715073	3.556189598	1.033950505	9.818258549	0.890097291
20/04/2019	1.495868607	1.234881348	5.96841833	0.68820417	0.799973035	8.064804457	4.119445731	7.449643479
21/04/2019	9.125677877	2.10718539	7.068839906	3.924896189	1.749538925	9.033239306	4.513444133	7.3270829
22/04/2019	5.371652221	4.242289221	2.204690639	1.990733363	2.896620861	2.855613189	3.892690353	7.38110384
23/04/2019	5.917380481	0.302947277	3.547246858	1.122888924	7.652039391	6.920003121	7.014471358	4.861853915
24/04/2019	2.006259459	2.706532798	2.393589812	2.774615711	6.450382857	8.59419374	8.529572925	8.241163671
25/04/2019	4.239538603	3.941191943	5.124959392	2.964743807	9.694850464	2.623743723	4.919730581	9.081237775
26/04/2019	4.485465521	6.699184403	4.531825198	9.290856488	5.351692451	5.470884982	6.835356599	9.912753127
27/04/2019	7.323256419	4.689914919	9.482592184	0.033498825	0.292298646	3.051851195	6.414849971	1.942491616
28/04/2019	8.621269887	5.638555659	3.18105455	1.66079657	3.393910462	7.940991315	2.310838917	1.235518721
29/04/2019	5.312063337	2.455907472	7.04853985	1.611121079	1.744561638	6.250994982	4.375016969	0.866855556
30/04/2019	2.212521782	5.852350995	5.371105565	7.707547478	0.263246472	1.191791153	6.352275925	3.457718846
1/05/2019	5.21438129	5.600134443	9.976746877	0.43823787	4.917822805	8.842301927	6.440998388	9.701202794
2/05/2019	4.021395738	6.696876864	5.2158119	2.429435248	3.573788883	7.27767025	2.845613141	8.387065929
3/05/2019	3.14325173	5.25148306	3.240160951	3.534017711	5.186501291	9.34852758	5.872591549	3.515708932
4/05/2019	0.219413002	8.42367257	2.92651674	1.339111825	8.129521505	4.406599482	3.18739541	0.330385358
5/05/2019	4.686471878	1.704733329	5.217902065	8.409559524	1.637622957	5.528706648	2.23628506	4.062115803
6/05/2019	7.73056753	7.655030804	1.319954409	0.223576599	4.778375075	0.739279252	5.019082079	8.464140472
7/05/2019	9.396516908	0.676976852	6.782828885	8.339482377	8.05542719	7.158245546	3.0396508	9.09680355
8/05/2019	0.124729046	7.779542697	8.850050952	7.660880584	8.109484423	2.510916671	8.053052806	2.134084232
9/05/2019	0.396784625	1.178265152	0.042425778	8.015500814	4.530142256	3.049492896	3.196562435	3.729100609
10/05/2019	1.143674239	8.822531187	0.047934724	4.456978562	5.000934085	6.672670712	8.376061885	0.445465553
<b>Average</b>	<b>4.071234683</b>	<b>4.77365395</b>	<b>4.822489175</b>	<b>4.134281529</b>	<b>4.648324431</b>	<b>5.685193308</b>	<b>5.137020201</b>	<b>5.078332817</b>

# Appendix C

## Air Speed Southbound

Air Speed - Southbound

Date Range: Monthly Start Date: 10/04/2019  
 Interval (hr): 24 End Date: 10/05/2019

Time	ASS201_V	ASS202_V	ASS203_V	ASS204_V	ASS205_V	ASS206_V	ASS207_V	ASS208_V
10/04/2019	2.835813848	0.844602701	1.04718005	6.591586919	3.199753268	0.047353626	4.888988391	8.652248261
11/04/2019	9.334894491	2.649729449	6.491871544	9.006244939	4.10533184	8.398351979	2.667988796	9.81147777
12/04/2019	7.015356939	1.940459899	8.302026963	5.505585904	8.531220018	8.904204552	5.843288529	3.885359951
13/04/2019	3.170133267	8.378152344	5.212671602	3.840816567	4.940997037	5.670088566	4.514335794	8.606357061
14/04/2019	9.628222091	1.218441942	1.648418495	7.67851895	8.459439776	8.009945132	3.33096122	3.498519101
15/04/2019	1.135559369	1.803796692	5.239799842	3.410844579	0.750520236	0.237632585	8.897410086	1.230151663
16/04/2019	5.772484179	3.760414582	6.959921176	6.224241147	6.769043476	9.074691249	9.032305983	8.350056148
17/04/2019	0.854946431	8.076297392	7.416119386	8.956339615	4.551328007	9.763870379	3.034600259	6.768322794
18/04/2019	3.944597393	0.990123928	6.752779628	4.214528505	2.225504368	5.065680081	2.114344391	0.027945721
19/04/2019	8.63093139	5.723960826	0.676479938	7.798730291	7.699212277	5.462494662	0.318141647	8.190903068
20/04/2019	7.252834188	2.937256224	9.089522158	9.062553742	2.737285036	7.113808627	1.242056658	5.400390986
21/04/2019	8.906582487	0.898320274	0.87905291	7.395678883	3.025833031	9.971825395	4.085242736	0.814945136
22/04/2019	5.855524197	0.007025994	0.477077393	4.451511061	7.273661976	5.368589456	3.180621144	7.605624252
23/04/2019	4.693175881	4.047145666	0.904517205	9.034274905	7.191850964	8.207306688	4.804543519	8.233764207
24/04/2019	9.807714812	7.082863591	0.205812601	0.567719449	0.095862786	1.006674345	8.927022867	2.880839417
25/04/2019	5.378401935	4.315872403	2.052404892	0.597926066	6.909337837	4.820363089	9.408247321	5.67749376
26/04/2019	2.334874667	6.266413087	0.543265735	9.639464487	1.652931361	8.726997617	6.398220917	9.398255432
27/04/2019	7.624186008	2.527161617	1.366452332	4.14112941	0.204117014	4.956076719	1.088101665	2.047025315
28/04/2019	8.687465249	9.903064029	1.241149893	4.525234073	0.723110982	7.992192778	9.335433352	2.815167437
29/04/2019	2.483061749	6.309527609	8.364005883	5.272563649	6.259213526	2.939893776	0.112805409	3.467170853
30/04/2019	2.714513682	4.389483316	1.3148368	5.621953655	8.134672617	9.73387657	5.721881675	0.242064663
1/05/2019	7.22983628	0.493584392	2.976783813	3.641287614	2.297354134	3.913962339	9.344994271	8.86193767
2/05/2019	8.231002053	6.21207598	2.365636372	1.051655394	2.566914997	8.191884541	2.644626237	1.366423612
3/05/2019	4.638983993	9.672958117	0.277755596	6.606212351	7.126823152	3.228832961	0.854511391	2.227205343
4/05/2019	2.31108811	6.674094405	0.874075708	2.963010998	0.501681478	0.922836733	1.202575005	9.001043085
5/05/2019	4.893976847	3.949336813	4.398198783	2.253794728	1.900216787	4.591215227	4.929663621	2.870955905
6/05/2019	8.437248468	1.690958271	1.94595728	1.696254729	8.339376911	4.981829688	9.713653044	7.156014729
7/05/2019	9.98884166	4.024509388	4.732996365	1.623516231	2.927826093	0.980445461	8.449217507	9.249919445
8/05/2019	4.205808031	2.964191568	7.942505833	5.55102907	9.604875317	7.121745942	6.556397902	4.249052228
9/05/2019	2.443229615	7.993614597	3.850845	2.536933376	3.040729197	4.216353361	5.366851423	9.384717552
10/05/2019	1.336599882	7.300866589	8.005839636	0.712082851	8.996599311	3.521036698	1.253023755	9.465945006
<b>Average</b>	<b>5.541222232</b>	<b>4.356332377</b>	<b>3.66309551</b>	<b>4.908813682</b>	<b>4.6046008</b>	<b>5.585227768</b>	<b>4.814905049</b>	<b>5.530235405</b>

# Appendix D

## Air Quality Northbound

NorthConnex Sydney – NorthConnex Tunnel

Air Quality - Northbound

Date Range: Monthly Start Date: 10/04/2019  
 Interval (hr): 24 End Date: 10/05/2019

Time	AQS101_CO	AQS102_CO	AQS103_CO	AQS104_CO	AQS105_CO	AQS106_CO	AQS107_CO	AQS108_CO	AQS101_NO	AQS102_NO	AQS103_NO	AQS104_NO	AQS105_NO	AQS106_NO	AQS107_NO	AQS108_NO	AQS101_VIS	AQS102_VIS	AQS103_VIS	AQS104_VIS	AQS105_VIS	AQS106_VIS	AQS107_VIS	AQS108_VIS
10/04/2019	0.903435643	0.968907367	0.546459943	0.633891551	0.582987004	0.650654913	0.055822239	0.682836662	0.326966495	0.310595679	0.33699311	0.624747303	0.800463114	0.452108995	0.27805887	0.661636376	0.090698187	0.97336566	0.511849346	0.943494105	0.900261915	0.494272111	0.27926875	0.207096874
11/04/2019	0.984047513	0.99406001	0.250367024	0.222977085	0.761201404	0.530706977	0.145847475	0.739343609	0.491556604	0.4700991752	0.474883943	0.710754844	0.532640256	0.568866811	0.861572761	0.337651656	0.232203937	0.682201191	0.864456166	0.770254317	0.54011893	0.715786254	0.325713269	0.021173247
12/04/2019	0.598557067	0.557331333	0.620947765	0.455130657	0.726580148	0.655968883	0.747100874	0.236902201	0.992625842	0.383853027	0.911099546	0.257881853	0.947726693	0.827884953	0.740575371	0.516345306	0.873599913	0.474254573	0.024060416	0.239291387	0.149644981	0.140757831	0.098157355	0.358968615
13/04/2019	0.509917339	0.485585411	0.975005369	0.469094862	0.441929226	0.368559178	0.492959845	0.770094799	0.799584667	0.351004853	0.606063549	0.204279838	0.139149812	0.546515949	0.889839766	0.137561228	0.981954983	0.687539976	0.310204821	0.60357037	0.362275709	0.905353609	0.145406435	0.373494877
14/04/2019	0.209501473	0.791259002	0.01909316	0.342914196	0.692691442	0.95177461	0.895754412	0.406729806	0.394397287	0.269806165	0.626180993	0.648270026	0.453719585	0.920988199	0.114435801	0.418336179	0.424858131	0.67791138	0.953379044	0.829793014	0.431315881	0.554635159	0.049864611	0.567683811
15/04/2019	0.474596143	0.989354589	0.047459301	0.172643584	0.856267977	0.870774437	0.028094328	0.636811924	0.421208373	0.201445135	0.490506895	0.100632002	0.886938322	0.538123068	0.959927499	0.424360417	0.563871372	0.789379301	0.437745879	0.692564483	0.44828432	0.770920864	0.794223484	0.134256706
16/04/2019	0.246539451	0.893114938	0.601125916	0.573972767	0.342886569	0.952321051	0.780695735	0.531195355	0.921204702	0.70034851	0.881234794	0.376960854	0.166571955	0.704603215	0.810303442	0.195532929	0.208067099	0.169494889	0.287874102	0.514223898	0.244389394	0.985031388	0.570139583	0.457529622
17/04/2019	0.753577019	0.760804972	0.429423766	0.718977458	0.146372453	0.12013569	0.824503039	0.777734521	0.71201216	0.414824986	0.565425075	0.369821599	0.618595179	0.00815052	0.805799851	0.247654115	0.898382472	0.00014368	0.298628273	0.282338444	0.073720262	0.286805281	0.715217638	0.881429208
18/04/2019	0.096854626	0.609840598	0.202775041	0.22146422	0.410842873	0.22048046	0.630865553	0.399810627	0.408509612	0.806363875	0.341048538	0.455721874	0.946728476	0.249955328	0.392573266	0.08666624	0.392394372	0.617209374	0.390579543	0.904112742	0.750219916	0.802834453	0.195376386	0.51962067
19/04/2019	0.438004738	0.499908143	0.031269965	0.499570536	0.094477515	0.146640819	0.134258765	0.429312281	0.199539645	0.160854059	0.826480949	0.478114489	0.915929479	0.664332723	0.347662548	0.423948892	0.292426452	0.51841681	0.216030389	0.682699305	0.400627101	0.76441128	0.785883747	0.123245332
20/04/2019	0.95257152	0.167733437	0.823854069	0.65374454	0.771762621	0.680004187	0.011244634	0.24055597	0.554291963	0.204953603	0.440887288	0.480325031	0.523399097	0.718050668	0.019608948	0.169500882	0.236830336	0.022139784	0.048047121	0.34069355	0.694575219	0.105945203	0.442750608	0.035673444
21/04/2019	0.922050991	0.348223583	0.765457891	0.007468105	0.279983287	0.216769057	0.168880806	0.872963074	0.272454253	0.524562575	0.092580565	0.533815095	0.162748046	0.726265523	0.416667634	0.659445282	0.193560528	0.064525816	0.8854863	0.137136003	0.249804793	0.488209583	0.491200711	0.9282911
22/04/2019	0.784114844	0.585221048	0.01534446	0.406688789	0.769741694	0.547663575	0.749189435	0.815687381	0.544962326	0.275570115	0.382069574	0.127813174	0.395948655	0.79030836	0.551527859	0.031885457	0.023837831	0.038647466	0.810584606	0.496246083	0.057466284	0.048592473	0.037648918	0.332842828
23/04/2019	0.0926647	0.524823383	0.949193981	0.548893701	0.878198	0.482929937	0.409801991	0.450156359	0.929478404	0.809499276	0.608722861	0.752820213	0.693980723	0.320383708	0.582532894	0.938765323	0.949279752	0.915535373	0.637897919	0.679770463	0.88552354	0.257066207	0.65560099	0.433489366
24/04/2019	0.410871018	0.892544725	0.867486745	0.841275482	0.428378582	0.919142303	0.550353343	0.296903238	0.909895587	0.761488486	0.691794415	0.689358488	0.064513829	0.443199205	0.938681355	0.634284785	0.828691436	0.695634009	0.922866345	0.32405199	0.347652917	0.923628972	0.219600836	0.610111124
25/04/2019	0.041913656	0.427253524	0.352322546	0.650882767	0.386094506	0.390256848	0.621755421	0.040904304	0.231348558	0.361184002	0.650101979	0.527649036	0.872023726	0.443303307	0.077968868	0.173709844	0.116009793	0.029595126	0.323123825	0.112316484	0.443441361	0.731309673	0.062321896	0.908612348
26/04/2019	0.230608135	0.79628063	0.262560104	0.340572372	0.616221104	0.00963897	0.116682594	0.510679448	0.393156972	0.478687366	0.238270286	0.508118488	0.321959148	0.539743255	0.51235181	0.471563308	0.004587921	0.689297188	0.402739355	0.368495827	0.652837554	0.259494423	0.49463266	0.287842046
27/04/2019	0.328413148	0.945566649	0.801786886	0.255348427	0.469979581	0.750944286	0.440437421	0.773388819	0.475727095	0.239897364	0.564092621	0.239199592	0.854292215	0.990318091	0.296279102	0.120871946	0.797178167	0.741613106	0.754570617	0.708849465	1.20119692	0.78988092	0.608962428	0.833439084
28/04/2019	0.27745801	0.803263606	0.186608367	0.317149666	0.122511244	0.52074839	0.884660821	0.809345942	0.104308694	0.788878087	0.463282304	0.723191116	0.341291016	0.519968777	0.601105734	0.442096622	0.109359998	0.739525131	0.827990618	0.512449667	0.359804603	0.525557452	0.205881067	0.035724054
29/04/2019	0.226197322	0.113840795	0.12582123	0.324411816	0.59185172	0.86426998	0.526561542	0.78531308	0.165515143	0.34699768	0.838449844	0.154906016	0.700796815	0.558549757	0.028188885	0.509277363	0.531362626	0.155605186	0.198594882	0.865749757	0.205950805	0.700560119	0.694482281	0.587121358
30/04/2019	0.080007976	0.354546437	0.619900023	0.429610138	0.864398638	0.485651836	0.061556978	0.470362155	0.599416727	0.938062461	0.691828977	0.681469111	0.976739787	0.400998971	0.561774493	0.106842925	0.265240051	0.031434683	0.793645095	0.064420597	0.175119217	0.607093888	0.64892320	0.602091008
1/05/2019	0.772950355	0.86222995	0.744372224	0.550737923	0.689894628	0.446655753	0.529496182	0.623549592	0.237456945	0.446516377	0.474938186	0.105644522	0.623211727	0.166106576	0.188938468	0.455410961	0.603310765	0.854137469	0.517672046	0.961960144	0.566436472	0.541022528	0.020391245	0.226254663
2/05/2019	0.137566233	0.821709928	0.776485748	0.111219175	0.904890344	0.842486241	0.39050432	0.976014865	0.824504286	0.775007374	0.473899599	0.333617795	0.734974565	0.539614191	0.64237314	0.362459017	0.150812981	0.568701748	0.562541794	0.946925693	0.99165775	0.738114623	0.422452955	0.592390458
3/05/2019	0.935503792	0.271492319	0.545623162	0.147398229	0.125482858	0.18228071	0.584856155	0.846921113	0.479281205	0.658351819	0.465895085	0.511050204	0.367395246	0.828388766	0.428370258	0.526054539	0.035524975	0.712209732	0.95706263	0.62054588	0.67143875	0.159805452	0.835110491	0.055637612
4/05/2019	0.568528857	0.789863709	0.042080428	0.613355187	0.687350654	0.829240298	0.147224042	0.488201491	0.736112928	0.956927022	0.17302403	0.383834853	0.91696156	0.759249225	0.612362661	0.591957674	0.639826863	0.98795843	0.50683471	0.801931881	0.133896906	0.256893458	0.377567164	0.39705691
5/05/2019	0.301405974	0.144224262	0.535142783	0.389000486	0.989100826	0.017394125	0.040632767	0.834586172	0.617256162	0.125108565	0.811742736	0.302736382	0.39363352	0.536176047	0.687501447	0.278619383	0.82691682	0.389882512	0.947638749	0.047691383	0.107366794	0.093705322	0.108046205	
6/05/2019	0.226392816	0.916412144	0.233477015	0.941669603	0.663738448	0.510279211	0.522875508	0.900361313	0.422062739	0.435527156	0.027817801	0.976288813	0.066652412	0.729125043	0.989517554	0.60509515	0.210890003	0.735489009	0.781651769	0.601197069	0.011515103	0.95890377	0.501870112	0.14129918
7/05/2019	0.517076288	0.284757648	0.093694083	0.247037221	0.668879826	0.350771101	0.385854282	0.146810739	0.201377126	0.831613989	0.400526775	0.150849912	0.642347667	0.969011555	0.744650405	0.468366075	0.820149547	0.820441962	0.916147049					

# Appendix E

## Air Quality Southbound

Air Quality - Southbound

Date Range: Monthly Start Date: 10/04/2019  
 Interval (hr): 24 End Date: 10/05/2019

Time	AQS201_CO	AQS202_CO	AQS203_CO	AQS204_CO	AQS205_CO	AQS206_CO	AQS207_CO	AQS208_CO	AQS201_NO	AQS202_NO	AQS203_NO	AQS204_NO	AQS205_NO	AQS206_NO	AQS207_NO	AQS208_NO	AQS201_VIS	AQS202_VIS	AQS203_VIS	AQS204_VIS	AQS205_VIS	AQS206_VIS	AQS207_VIS	AQS208_VIS
10/04/2019 0.090764061	0.456441513	0.9049971	0.664476179	0.936338914	0.583660397	0.392154277	0.577875268	0.085066647	0.02166413	0.873052094	0.270466677	0.933110716	0.345188555	0.782736051	0.33549176	0.515423508	0.116080573	0.904613583	0.047057292	0.98449484	0.019266366	0.486547455	0.830980381	
11/04/2019 0.498587515	0.246195715	0.543220649	0.65204693	0.265747982	0.27885379	0.886634191	0.917242027	0.804766866	0.417925109	0.59830867	0.576657837	0.596548303	0.512378351	0.876961591	0.28858991	0.984838723	0.019070491	0.391959475	0.655797462	0.819361296	0.783800668	0.69768539	0.595548504	
12/04/2019 0.584912121	0.835365847	0.467745317	0.25772561	0.952150164	0.474437387	0.251377876	0.752374259	0.681395451	0.131384422	0.255794053	0.751933061	0.748690177	0.13885006	0.484675308	0.190282691	0.493650884	0.557459738	0.65285918	0.170273487	0.114286415	0.699618642	0.469979046	0.899515197	
13/04/2019 0.113806094	0.694753758	0.509529796	0.582985296	0.550122505	0.808315231	0.745296534	0.963378811	0.32401949	0.769317382	0.220061719	0.671710586	0.711699919	0.432699958	0.685582969	0.045936522	0.200158938	0.533326766	0.151579142	0.437182298	0.75736018	0.51783148	0.415109368	0.387507952	
14/04/2019 0.84882681	0.623544516	0.278900099	0.046331866	0.710926529	0.944870125	0.669768586	0.219826688	0.261211747	0.918231755	0.293514067	0.013167573	0.390227635	0.282273408	0.542624264	0.370581684	0.140314163	0.241610326	0.312572595	0.995192414	0.051121001	0.422389112	0.076419258	0.928079929	
15/04/2019 0.814483827	0.833869154	0.481922323	0.856718274	0.261127127	0.022678845	0.677391752	0.009598198	0.440381294	0.648961645	0.114637434	0.285070147	0.841557546	0.490006643	0.045719495	0.338520135	0.467932729	0.970646139	0.340400607	0.986657744	0.807584051	0.612320239	0.157938077	0.930979195	
16/04/2019 0.074073902	0.99675534	0.827841915	0.349466006	0.388434769	0.106480853	0.663426866	0.899661089	0.646080716	0.317410949	0.710213799	0.294498035	0.495323196	0.730258731	0.504514002	0.89422305	0.291906407	0.047806461	0.17245542	0.874837286	0.005601095	0.358353489	0.659879235	0.218027428	
17/04/2019 0.832266579	0.696631676	0.196168944	0.242900585	0.676568412	0.729133467	0.421142333	0.163545357	0.998260058	0.008676015	0.35665572	0.473120132	0.473585914	0.299394023	0.817695363	0.295528435	0.434373107	0.667344137	0.99764344	0.646978929	0.342612736	0.801302323	0.412472235	0.196388333	
18/04/2019 0.19454771	0.565254622	0.881784175	0.577867075	0.759763498	0.956316925	0.630587874	0.191199694	0.464608253	0.057369888	0.13241316	0.089696288	0.612296482	0.568421945	0.044226244	0.988278086	0.67961136	0.847791452	0.979484445	0.76260582	0.453567729	0.183072343	0.487535789	0.86775068	
19/04/2019 0.387518991	0.1916977	0.958168025	0.222991739	0.125798537	0.602913284	0.77441023	0.458134479	0.911503984	0.749645481	0.374646098	0.738168921	0.123545324	0.563662778	0.669608607	0.798664668	0.645328653	0.451856001	0.236397024	0.895996607	0.1861217	0.294800083	0.261032006	0.58132367	
20/04/2019 0.547548156	0.263245971	0.29483074	0.633817626	0.198509161	0.802560591	0.193751895	0.477427846	0.618054152	0.807665631	0.487178138	0.867269899	0.371257034	0.42627908	0.642373258	0.57289102	0.644395012	0.026186988	0.266157496	0.823556004	0.086521379	0.140621793	0.352521258	0.896127056	
21/04/2019 0.807809159	0.20428831	0.734216902	0.917877032	0.468121412	0.933726349	0.002436372	0.852146924	0.451239949	0.392793586	0.365342298	0.88620828	0.657398966	0.886149937	0.339701999	0.229854624	0.523126551	0.059723414	0.00823379	0.518190764	0.599637038	0.673562548	0.991762635	0.71863618	
22/04/2019 0.634889527	0.303718869	0.680886886	0.921535501	0.892941012	0.69059192	0.720271833	0.458954033	0.024434728	0.052619958	0.362018803	0.581374082	0.393806646	0.991128461	0.110659264	0.558372389	0.24375828	0.527460767	0.998409184	0.679755349	0.17231563	0.214041164	0.816671135	0.806708911	
23/04/2019 0.872966184	0.023988033	0.254993657	0.49754425	0.143356313	0.894552491	0.97705117	0.4204846	0.241364069	0.875939305	0.728693749	0.872295942	0.90523077	0.376935141	0.715781431	0.095597653	0.424912503	0.947075113	0.54211777	0.367240044	0.76909106	0.515212855	0.085735373	0.03635801	
24/04/2019 0.115537326	0.798422532	0.227665914	0.56090409	0.497910452	0.843665788	0.73095651	0.530838504	0.4328311	0.620846649	0.595917765	0.929156125	0.249762249	0.170426868	0.679075303	0.965316486	0.27323377	0.335352299	0.627877549	0.18915911	0.725546694	0.92981677	0.890916704	0.902539357	
25/04/2019 0.339187616	0.972713463	0.005224084	0.215687047	0.980784232	0.975715698	0.926350514	0.219066284	0.368734737	0.36726856	0.90197397	0.938899157	0.481777243	0.304978335	0.498847502	0.20060769	0.379454244	0.533949544	0.514200686	0.948178342	0.668930639	0.028159367	0.999416448	0.480778298	
26/04/2019 0.132883596	0.089592059	0.903409351	0.262968215	0.091217238	0.533058767	0.17843307	0.839376289	0.681366137	0.458106243	0.906766504	0.175697608	0.148720995	0.345105083	0.692050912	0.495074098	0.90136439	0.85305082	0.160067405	0.190305086	0.536042173	0.565471151	0.142135405	0.904251256	
27/04/2019 0.808209295	0.551487847	0.694706736	0.313814613	0.605192616	0.239726794	0.674573639	0.245997436	0.721341371	0.10687634	0.788912979	0.238140101	0.027518925	0.045399667	0.261566401	0.036340039	0.10453838	0.495587937	0.848899759	0.672258283	0.751961067	0.185180833	0.791372374	0.520446825	
28/04/2019 0.699819415	0.050804462	0.889932094	0.020591471	0.292815844	0.716886459	0.030661305	0.82451492	0.08542861	0.510644437	0.216095966	0.088692652	0.79405959	0.668983084	0.693659251	0.132052465	0.48688785	0.41946888	0.600661275	0.738843061	0.81362995	0.028159367	0.385049849	0.833600455	
29/04/2019 0.267788107	0.350681276	0.628861498	0.324820103	0.866615235	0.442792795	0.669865775	0.295790319	0.095791905	0.839664664	0.216093418	0.190365857	0.998388516	0.628362774	0.336315363	0.888649086	0.763131948	0.820790154	0.547407506	0.578940393	0.140058086	0.513692012	0.475495071	0.971610985	
30/04/2019 0.300401047	0.567748006	0.560745266	0.190150427	0.866079961	0.406938419	0.142022323	0.489065039	0.456687696	0.150557064	0.632837306	0.21740838	0.562208399	0.632734433	0.221964749	0.74538689	0.849070285	0.492810756	0.601189561	0.891456568	0.046017416	0.646651549	0.612231682	0.749656303	
1/05/2019 0.160962651	0.399683818	0.42383794	0.247260958	0.779401975	0.272678843	0.70621093	0.856753294	0.667586182	0.220900227	0.925067418	0.97557041	0.268748405	0.394365958	0.066724182	0.940166341	0.084653645	0.059539559	0.656446686	0.411535852	0.453037978	0.918856426	0.918856426		
2/05/2019 0.686378808	0.280105129	0.441569034	0.517262635	0.621037289	0.308811922	0.361391512	0.789941401	0.957738055	0.943064369	0.852728835	0.529366006	0.896771555	0.532338333	0.620519526	0.851401557	0.656495741	0.344903627	0.837214707	0.812843092	0.449686813	0.471073356	0.171841583	0.311751159	
3/05/2019 0.692937027	0.823252551	0.014803532	0.2252816	0.81121448	0.655475932	0.054552935	0.1119752	0.848570669	0.009535839	0.964879202	0.45936377	0.329609058	0.862807753	0.425572297	0.513323693	0.065416231	0.517459172	0.218764263	0.219246855	0.161012336	0.62389048	0.442607514		
4/05/2019 0.556436235	0.593573892	0.275765868	0.198256288	0.109497013	0.63843629	0.476153612	0.346437778	0.164988532	0.190375923	0.579530424	0.307299991	0.767491535	0.076847807	0.76439674	0.099846447	0.631614975	0.333729845	0.095784948	0.781308125	0.494521798	0.204625322	0.630135453		
5/05/2019 0.137399025	0.457565528	0.771890067	0.770396242	0.322155482	0.024887162	0.484681208	0.930907043	0.134642124	0.426589192	0.282650014	0.062950078	0.841543036	0.456406665	0.91908664	0.163817021	0.162163376	0.359523943	0.41146191	0.209148842	0.640475944	0.307625169	0.666381826	0.138521014	
6/05/2019 0.899431407	0.976336019	0.377873088	0.325853311	0.378460548	0.436607036	0.239040889	0.755802683	0.348051503	0.57853101	0.03269897	0.025297062	0.064843821	0.065023847	0.794727373	0.851009555	0.272531943	0.79227417	0.757050892	0.45238256	0.51545089	0.757067793	0.315687981	0.985398786	
7/05/2019 0.732182026	0.001675483	0.8443883	0.38255288	0.678074935	0.987500888	0.527600611	0.686647521	0.697021523	0.299590091	0.811049478	0.789694667	0.439612239	0.03177692	0.82853537	0.113606066	0.44530681	0.240605908	0.594858325	0.617439443	0.211908644	0.010765127	0.131611349	0.855292393	
8/05/2019 0.329458229	0.23731964	0.50512898	0.394861901	0.964689347	0.756675724																			

# Appendix F

## Air Quality Northern Outlet





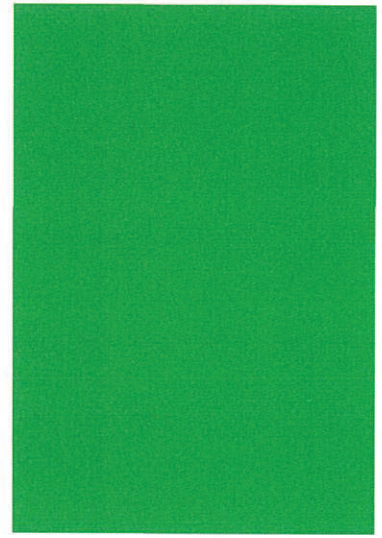
# Appendix G

## Air Quality Southern Outlet

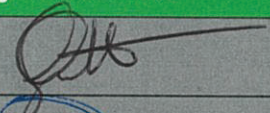
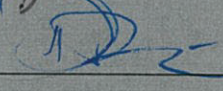


# Appendix C: Ambient Above-Goal Reading Protocol

# Ambient Above-Goal Reading Protocol



## NorthConnex Project Mechanical & Electrical

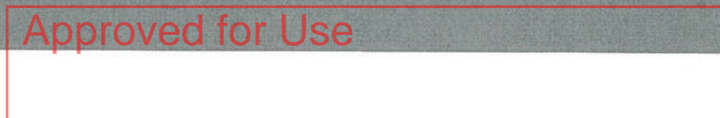
	Name	Position	Date	Signed/Authorised
Reviewed	Charles Giuttari	M&E and ITS Manager	20/9/19	
Authorised	Daniel Banovic	Project Director	20/9/19	

**Document Number:**

NCX-NCXCO-01-5200-KM-PL-0001

**Revision: 04**

Approved for Use



# Ambient Above-Goal Reading Protocol

## Document Control

A person using Project documents or data accepts the risk of:

- a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.
- b) Using the documents or data for any purpose not agreed to in writing by the NorthConnex Project Company.

## Revision

Revision	Date	Description	Prepared By
Revision A	30/07/2018	Issued for Information	Adam Wawrzyniak
Revision B	20/09/2018	Issued for Information	Adam Wawrzyniak
Revision 01	23/01/2019	Updated based on AQCCC and EPA feedback	Ryan Butler
Revision 02	29/07/2019	Updated based on DPIE feedback	Ryan Butler
Revision 03	19/08/2019	Updated based on DPIE feedback	Ryan Butler
Revision 04	20/09/2019	Updated based on DPIE feedback	Ryan Butler

# Ambient Above-Goal Reading Protocol

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# Ambient Above-Goal Reading Protocol

## 1 Introduction

This Protocol has been developed for the Planning Secretary's approval to evaluate a potential measurement that exceeds the ambient air pollutant monitoring goals outlined in Table 4-1 below. This Protocol shall also define extraordinary events that provide exemption from further notification or reporting as specified under Condition of Approval CoA E9. The Protocol also includes other information about the notification and reporting process that would be followed in the event of an ambient above-goal reading.

## 2 Protocol Requirements

The Protocol requirements are specified in the relevant CoA listed below:

E8 *Should ambient monitoring of air pollutants exceed the following goals, the provisions of Condition E9 shall apply:*

- (a) CO – 8 hour rolling average of 9.0 ppm (NEPM);*
- (b) NO<sub>2</sub> – One hour average of 0.12 ppm (245 µg/m<sup>3</sup>) (NEPM);*
- (c) PM10 – 24 hour average of 50 µg/m<sup>3</sup> (NEPM); and*
- (d) PM2.5 – 24 hour average of 25 µg/m<sup>3</sup> (proposed NEPM).*

*Only monitoring station(s) that meet the requirements of Australian Standard AS2922 – 1987 shall be used for the purposes of assessing compliance with the ambient goals specified in this condition, unless otherwise agreed by the Secretary. A Protocol for the evaluation of a potential measurement that exceeds the criteria shall be developed by the Proponent and approved by the Secretary in consultation with the EPA, Ministry of Health and the AQCCC.*

E9 *Should the results of monitoring required under condition E7 show that any of the goals specified in Condition E8 have been exceeded for any given event (excluding extraordinary events such as bushfires, dust storms, etc (as to be defined in the Protocol required under condition E10)), the Proponent shall immediately notify the Secretary, EPA and Ministry of Health. The notification shall be followed up with a detailed report within 20 working days, which shall be prepared by the Proponent, reviewed by a suitably qualified and experienced independent specialist(s), and submitted to the Secretary, on the cause and major contributor of the exceedance and the options available to prevent recurrence. The Secretary shall approve the independent person/organisation prior to the commencement of operation, or at some other time prior to preparation of the report.*

*Where the operation of the tunnel is identified to be a significant contributor to the recorded exceedance, this report shall include consideration of improvements to the tunnel air quality management system so as to achieve compliance with the ambient air quality goals, including but not limited to installation of the additional ventilation management facilities allowed for under condition B5, and discussion of whether those improvements are feasible and reasonable.*

*The Proponent shall comply with any requirements arising from the Secretary's review of the Report.*

Further to the above requirements, CoA E14 outlines the obligations in relation to Emergency Discharge, as follows:

*Conditions E2, E3, E4, E8 and E11 do not apply in an emergency to prevent damage to life or limb.*

*The Proponent shall, as soon as reasonably practicable, notify the Secretary and the EPA of any such discharge.*



# Ambient Above-Goal Reading Protocol

It is noted that CoA E9 in line 3 refers to the protocol required under CoA E10. It is assumed this reference is incorrect, as CoA E10 does not specify a requirement for a protocol, and should be read as CoA E8.

## 3 Definitions

Term	Definition
AGR	Above Goal Reading
AQCCC	Air Quality Community Consultative Committee
MoH	Ministry of Health (NSW Health)
DPIE	Department of Planning, Industry and Environment
EPA	Environmental Protection Authority
CoA	Minister's Condition of Approval
NEPM	National Environmental Protection Measure <sup>1</sup>
NorthConnex	NorthConnex Project
Operator	NorthConnex Company Pty Ltd
TfNSW	Transport for NSW - Roads and Maritime Services

<sup>1</sup> Refers to the National Environment Protection (Ambient Air Quality) Measure dated 25 February 2016. This Measure aims to set out ambient air quality goals that allow for the adequate protection of human health and wellbeing by setting the standards and processes to be followed in measuring and assessing the concentration of pollutants in the air.

## 4 Ambient Air Quality Goals

The ambient air quality goals are specified in CoA E8 and reproduced below.

Table 4-1 : Ambient Air Quality Goals (CoA E8)

Pollutant	Averaging Period	Goal	Reference
CO	8-hour (rolling)	9ppm	NEPM
NO <sub>2</sub>	1-hour	0.12ppm (245ug/m <sup>3</sup> )	NEPM
PM <sub>10</sub>	24-hour	50ug/m <sup>3</sup>	NEPM
PM <sub>2.5</sub>	24-hour	25ug/m <sup>3</sup>	NEPM

## 5 Monitoring

### 5.1 Monitoring methodologies

The Operator will monitor the pollutants and parameters, using the sampling method, units of measures and frequency specified in CoA E7 and provided in Table 5-1 below.

# Ambient Above-Goal Reading Protocol

Table 5-1 - Ambient Air Quality Monitoring Methodologies

Pollutant	Units of measurement	Averaging Period	Frequency	Method <sup>1</sup>
NO	pphm	1-hour	Continuous	AM-12
NO <sub>2</sub>	pphm	1-hour	Continuous	AM-12
NO <sub>x</sub>	pphm	1-hour	Continuous	AM-12
PM10	µg/m <sup>3</sup>	24-hour	Continuous	AS3580.9.8-2008 <sup>2</sup>
PM2.5 <sup>5</sup>	µg/m <sup>3</sup>	24-hour	Continuous	AS3580.9.13-2013 <sup>3</sup> or as otherwise agreed by the Secretary in consultation with the EPA
CO	ppm	1-hour,8-hour	Continuous	AM-2 & AM-6
Parameter <sup>4</sup>	Units of measurement	Averaging Period	Frequency	Method <sup>1</sup>
Wind Speed @ 10m	m/s	1-hour	Continuous	AM-2 & AM-4
Wind Direction @ 10 m	°	1-hour	Continuous	AM-2 & AM-4
Sigma Theta @10m	°	1-hour	Continuous	AM-2 & AM-4
Temperature @ 2m	K	1-hour	Continuous	AM-4
Temperature @ 10m	K	1-hour	Continuous	AM-4
Other	Units of measurement	Averaging Period	Frequency	Method <sup>1</sup>
Siting	NA	NA	NA	AM-1 & AM-4

Notes:

1. *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*  
i. (EPA 2007).
2. AS3580.9.8-2008, *Methods for the Sampling and Analysis of Ambient Air – Determination of Suspended Particulate Matter – PM<sub>10</sub> Continuous Direct Mass Method using Tapered Element Oscillating Microbalance Analyser* (Standards Australia 2008).
3. AS3580.9.13-2013, *Methods for the Sampling and Analysis of Ambient Air – Determination of Suspended Particulate Matter – PM<sub>2.5</sub> Continuous Direct Mass Method using a Tapered Element Oscillating Microbalance Analyser* (Standards Australia 2013).
4. TBD - location for meteorological monitoring station(s) to be representative of weather conditions likely to occur in the vicinity of the northern and southern ventilation outlets.
5. Appropriately modified to include size selective inlet for PM<sub>2.5</sub> or as otherwise approved by the Secretary.

The ambient air quality monitoring stations were established and are operated by Ecotech Pty Ltd. Ecotech Pty Ltd were approved by the Secretary on 10<sup>th</sup> April 2018 (after satisfactory consultation with the EPA and AQCCC) as being an organisation sufficiently skilled and accredited by the National Association of Testing Authorities Australia to supply and monitor the air quality monitoring station as required under condition E7.

## 5.2 Monitoring Locations

Ambient air quality monitoring occurs at six monitoring locations which were selected in consultation with the AQCCC. These are described in Table 5-2 and shown in Figure 5-1.

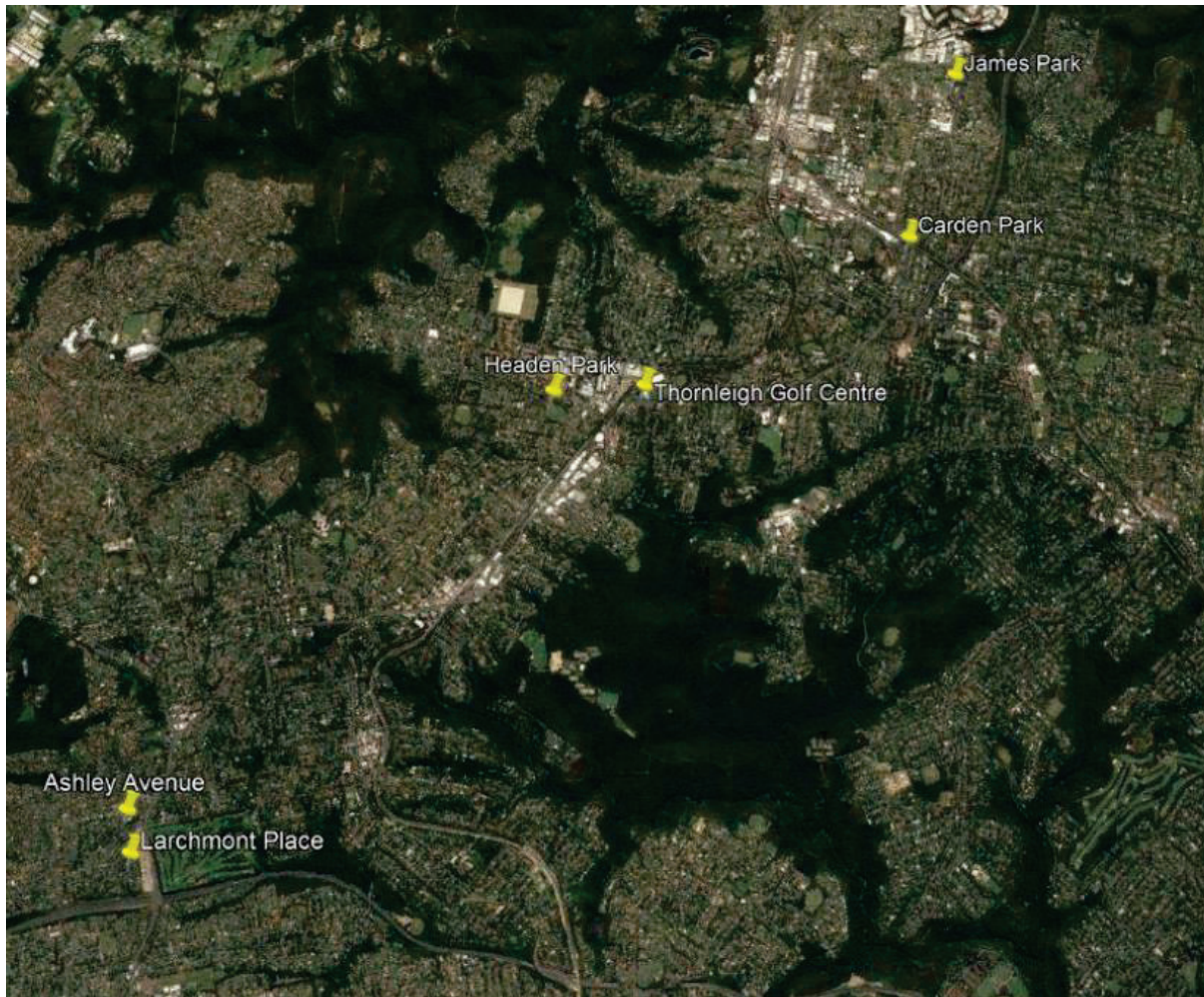
Table 5-2 - Ambient air quality monitoring locations

Site name	Condition E7 Criteria	Geographical Coordinates
Ashley Avenue	Southern ventilation outlet	33°45'13.87" S, 151°2'45.11" E

## Ambient Above-Goal Reading Protocol

Carden Park	Northern ventilation outlet	33°42'48.15" S, 151° 6'33.10" E
Headen Park	Background reference data	33°43'29.42" S, 151° 4' 44.38" E
James Park Hornsby	Northern ventilation outlet	33°42'2.28" S, 151°6'48.59" E
Larchmont Place	Southern ventilation outlet	33°45'24.12" S, 151°2'46.97" E
Thornleigh Golf Centre	Pennant Hills Road roadside	33°43'28.06" S, 151°5'11.99" E

Figure 5-1 - Ambient air quality monitoring locations



## 6 Extraordinary Event Definition

As outlined in CoA E9, an exceedance may be caused by an Extraordinary Event and these events need to be documented in the protocol. The following are defined as Extraordinary Events:

A Sydney-wide ambient air quality event that can be determined through comparing data with other ambient air quality monitoring stations in the Sydney Basin for the concurrent monitoring period. If the monitored above-goal reading is widespread across the Sydney Basin, it can be determined that there was an external cause, such as:

- Bushfires and prescribed burning (PM<sub>2.5</sub> and PM<sub>10</sub>);
- Natural causes such as dust storms (PM<sub>2.5</sub> and PM<sub>10</sub>) and sea fog, taking into account sensitivity and difference in measuring techniques;

## Ambient Above-Goal Reading Protocol

- Photochemical smog events across the Sydney Basin airshed (NO<sub>2</sub>);
- A fire involving attendance by emergency services;
- Illegal activities such as backyard burning or kerbside fires; and
- Firework displays.

Evidence indicating the occurrence and correlation of the above events must be provided and made available on request and may be sourced from the following:

- a) NorthConnex Tunnel ambient and in-tunnel monitoring data;
- b) NorthConnex Tunnel ventilation operational history and operational data;
- c) Other Sydney based ambient monitoring stations;
- d) Bureau of Meteorology;
- e) FRNSW and/or Police;
- f) Local Councils; or
- g) Other, as appropriate, such as photographs.

Such evidence will be included as attachments to the report notification (Appendix A).

## 7 Consultation

As required by CoA E8, this protocol has been developed in consultation with the EPA, Ministry of Health and the AQCCC for the approval by the Secretary. A summary of the consultation with these stakeholders is provided below.

An overview of the draft protocol was presented to the AQCCC on Tuesday 4<sup>th</sup> December 2018. The AQCCC recommended that the protocol clarify that it only applies to operation and that a brief explanation be provided in the document on the NEPM guidelines. These suggestions were added to the protocol in Revision 01 dated 23<sup>rd</sup> January 2019. Once approved, a final version of the protocol will be provided to the AQCCC.

The protocol was provided to the EPA on 15<sup>th</sup> November 2018. The EPA responded on 8<sup>th</sup> January 2019, noting that the Protocol contains information broadly in line with the requirements of the CoA, however does not set out a detailed process for determining whether the operation of the tunnel was a significant contributor in the event of any exceedance. This comment was addressed in Revision 01 dated 23<sup>rd</sup> January 2019 and returned to EPA on 23<sup>rd</sup> January 2019 for further review. The EPA responded on 1<sup>st</sup> May 2019 stating that they had no further comments and noted that they do not review or endorse environmental management plans.

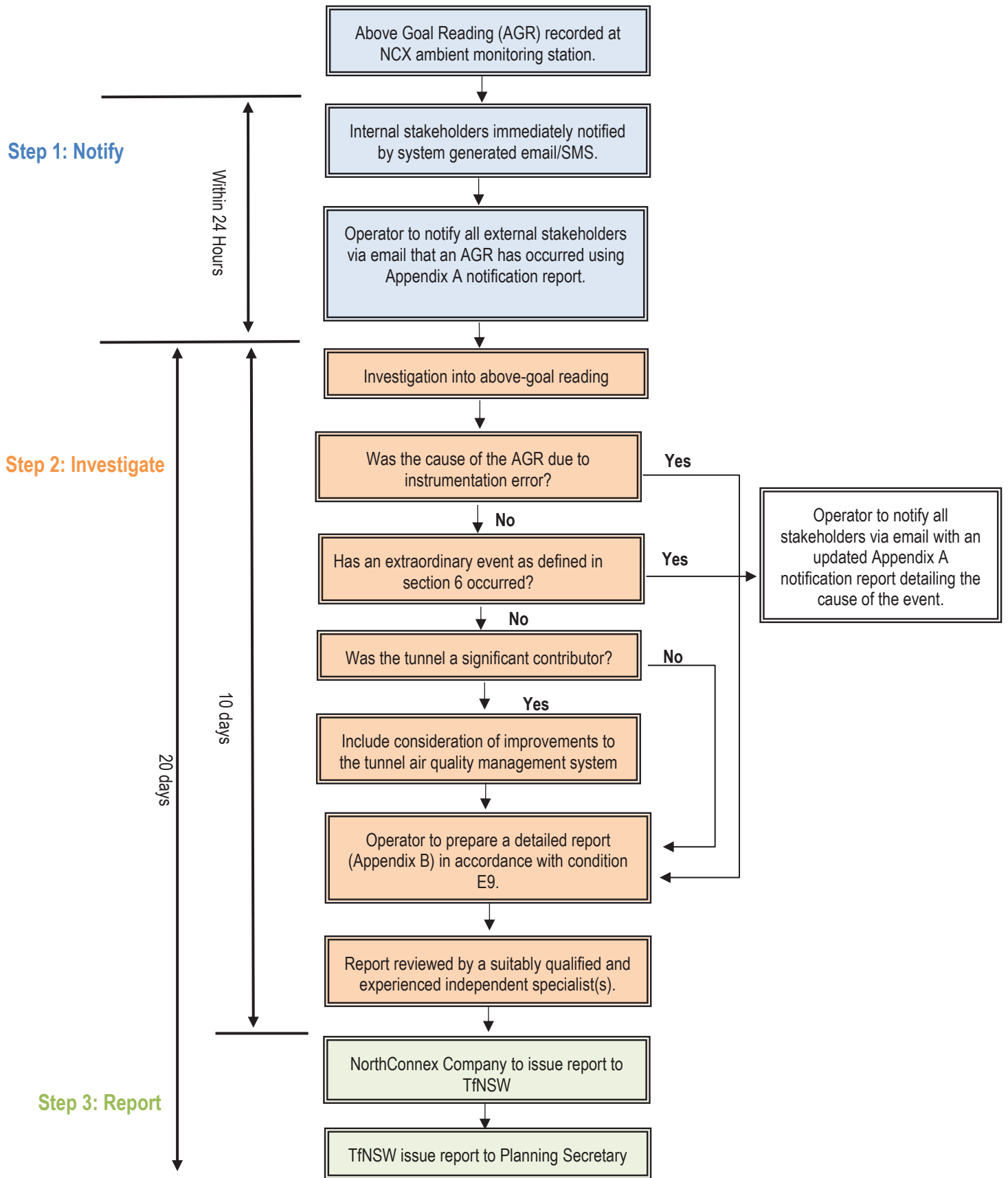
The protocol was provided to the Ministry of Health (NSW Health) on 29<sup>th</sup> November 2018. Health NSW responded on 19<sup>th</sup> February 2019 confirming that they did not have any comments on the protocol.

## 8 Flow Chart

The flowchart below describes the notification and reporting process associated with any ambient above-goal reading;

# Ambient Above-Goal Reading Protocol

Figure 8-1 : Notifications and Reporting Flow Chart



# Ambient Above-Goal Reading Protocol

Notifications using form included in Appendix A will be via email as follows:

**Table 8-1 : Notifications**

Organisation	Title	Email Address
<b>Internal</b>		
TfNSW	NorthConnex Motorway Manager (Motorway Partnerships and Planning)	
NorthConnex Company Pty Ltd	NorthConnex Asset Manager	
<b>External</b>		
DPIE	Planning Secretary	compliance@planning.nsw.gov.au infrastructure.notifications@planning.nsw.gov.au
NSW HEALTH	Director, Environmental Health	Moh-ehp@health.nsw.gov.au
NSW EPA	Environmental Line – 133 555	info@environment.nsw.gov.au

## 9 Investigate the above-goal reading

To determine whether an above-goal reading is attributable to external phenomena or extraordinary events or emissions from the NorthConnex tunnel outlets, the below investigations will be undertaken.

### 9.1 Validate results

Within two days of the above-goal reading, the data will be quality validated. If the data validity checks confirm that the recorded above-goal reading was not valid and was due to an instrument fault or data error, the Report for Above-Goal Reading (Appendix B) will be prepared and reviewed by a suitably qualified and experienced independent specialist(s). The final report will be submitted to TfNSW within 10 days. TfNSW will submit the report to Department of Planning, Industry and Environment (DPIE) within a further 10 days to meet the 20 day timeframe specified in CoA E9.

A copy will also be placed on the NorthConnex website. If the data validity checks confirm that the recorded above-goal reading was valid, the operator will proceed to section 9.2.

### 9.2 Extraordinary Event

In accordance with Section 6, an exceedance may be caused by an Extraordinary Event. The two steps outlined below will be followed to determine whether an exceedance has been caused by an Extraordinary Event. Evidence indicating the occurrence and correlation of the event will be included as attachments to the report notification (Appendix A).

#### Sydney-wide events

Obtain data for other ambient air quality monitoring stations in the Sydney Basin for concurrent monitoring periods to determine whether the above-goal reading is a Sydney-wide event. If the monitored above-goal reading is widespread, it is likely that there was an external cause. In this instance, the tunnel operator will

# Ambient Above-Goal Reading Protocol

contact relevant authorities such as the Bureau of Meteorology and State Emergency Services to determine if a regional event has occurred consistent with the recorded above-goal reading.

## Locally specific events

If the above-goal reading is not widespread throughout the Sydney basin, a local cause is possible and supplementary investigations should be undertaken, such as consulting with relevant stakeholders such as (for example) EPA or relevant Councils, with the aim of establishing whether a specific localised source may have affected one or more monitoring stations. Localised activity (e.g. rubbish burning or unusually high emissions from an industrial premise (with unfavourable weather conditions)) may adversely affect the readings.

## 9.3 Assess whether an emergency occurred

In the event of an emergency, the tunnel operator shall, as soon as reasonably practicable, notify the Secretary and the EPA in accordance with E14. If applicable, this notification should also include an ambient above-goal reading notification (Appendix A).

A detailed report for above-goal reading (Appendix B) will be prepared by the tunnel operator to confirm the investigation (i.e. that the exceedance was due to an emergency). The report will be reviewed by a suitably qualified and experienced independent specialist(s) and submitted to DPIE in accordance with condition E9.

## 9.4 Further investigation of valid results

If the investigation confirms that the data is valid, and an extraordinary event or emergency does not appear to have occurred, further investigations will be undertaken, and the tunnel operator will begin preparing a Report on Above-Goal Reading (Appendix B). Further investigations of the potential cause may include the below steps.

### Monitoring equipment calibration

In the circumstance where the investigations are unable to identify a logical cause of the above-goal reading, further investigations may be undertaken to investigate whether the monitoring equipment is calibrated and functioning effectively.

### Assessment of outlet emissions

A review of the ventilation outlet emissions data will be checked to determine whether emissions are higher or considerably different to emissions over previous periods, with similar traffic conditions within the tunnel.

### Assessment of background data

An assessment against background data (or pre-operational data) may also occur.

## 9.5 Report the above-goal reading

The tunnel operator will prepare a Report on Above-Goal Reading (Appendix B) in accordance with CoA E9. The Report on Above-Goal Reading (Report) will be reviewed by a suitably qualified and experienced independent specialist(s), and detail the cause and major contributor of the above-goal reading and options available to prevent recurrence.

Where the operation of the tunnel is identified as a significant contributor to the recorded above-goal reading, the Report on Above-Goal Reading must include consideration of improvements to the Air Quality Management

## Ambient Above-Goal Reading Protocol

System to achieve compliance with the ambient air quality goals. Considerations should include, but not limited to, installation of the additional ventilation management facilities allowed for under condition B5 and discussion of whether or not those improvements are reasonable and feasible.

The Report will be submitted within 20 working days of the initial Notification of Above-Goal Reading and the Proponent will comply with any requirements arising from the Planning Secretary's review of the Report.

### 10 Documentation

The following documentation is included with this report.

**Table 10-1 - Documentation**

Appendix	Description
Appendix A	Notification of Ambient Air Quality Above-Goal Reading
Appendix B	Report on Above-Goal Reading



**Appendix A**  
**Notification of Ambient Air Quality**  
**Above-Goal Reading**

# Ambient Above-Goal Reading Protocol

<b>Notification of Ambient Air Quality Above-Goal Reading (AGR) – Unvalidated NorthConnex Tunnel</b>			
To be notified immediately to NCX Project Company and TfNSW. NCX Project Company is to notify DPIE, EPA and NSW Health within 24 hours.			
<b>Date:</b>			
<b>Time:</b>			
<b>Monitoring Station Location</b>	<input type="checkbox"/>	James Park, Hornsby	<input type="checkbox"/>
	<input type="checkbox"/>	Headen Park, Thornleigh	<input type="checkbox"/>
	<input type="checkbox"/>	Ashley Avenue, West Pennant Hills	<input type="checkbox"/>
			Jaycee Park, Hornsby
			Thornleigh Golf Centre
			Larchmont Place, West Pennant Hills
<b>Relevant Goal</b>	<input type="checkbox"/>	CO (9ppm – 8 hr rolling average) (NEPM)	
	<input type="checkbox"/>	NO <sub>2</sub> (0.12ppm (245 ug/m <sup>3</sup> ) – 1hr average) (NEPM)	
	<input type="checkbox"/>	PM <sub>10</sub> (50ug/m <sup>3</sup> – 24hr average) (NEPM)	
	<input type="checkbox"/>	PM <sub>2.5</sub> (25ug/m <sup>3</sup> – 24hr average)(proposed NEPM)	
<b>Above-Goal Reading</b> Detail the above-goal reading that was received			
<b>Duration of AGR</b> Detail the duration of the above-goal reading or event	Date/time commenced: ___/___/___ ___:___am/pm		
	Date/time finished: ___/___/___ ___:___am/pm		
<b>Detail of Suspected / Validated Cause</b> Detail nature of the event that contributed to the above-goal reading			
<b>Measures employed</b> Detail measures employed to minimise the concentration levels, if possible			
<b>Commitment to prepare and submit a Report on Above-Goal Reading</b>			
A Report on Above-Goal Reading will be prepared in accordance with CoA E9 for this notification. Please note that a Report is not required in the event of an extraordinary event.			
<b>Person responsible for notification</b>	Name		
	Position		
	Organisation		

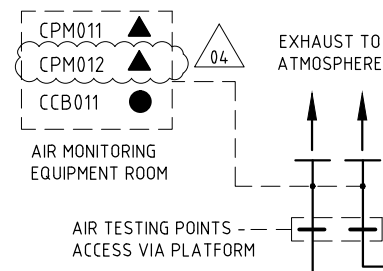
# **Appendix B**

## **Report on Above-Goal Reading**

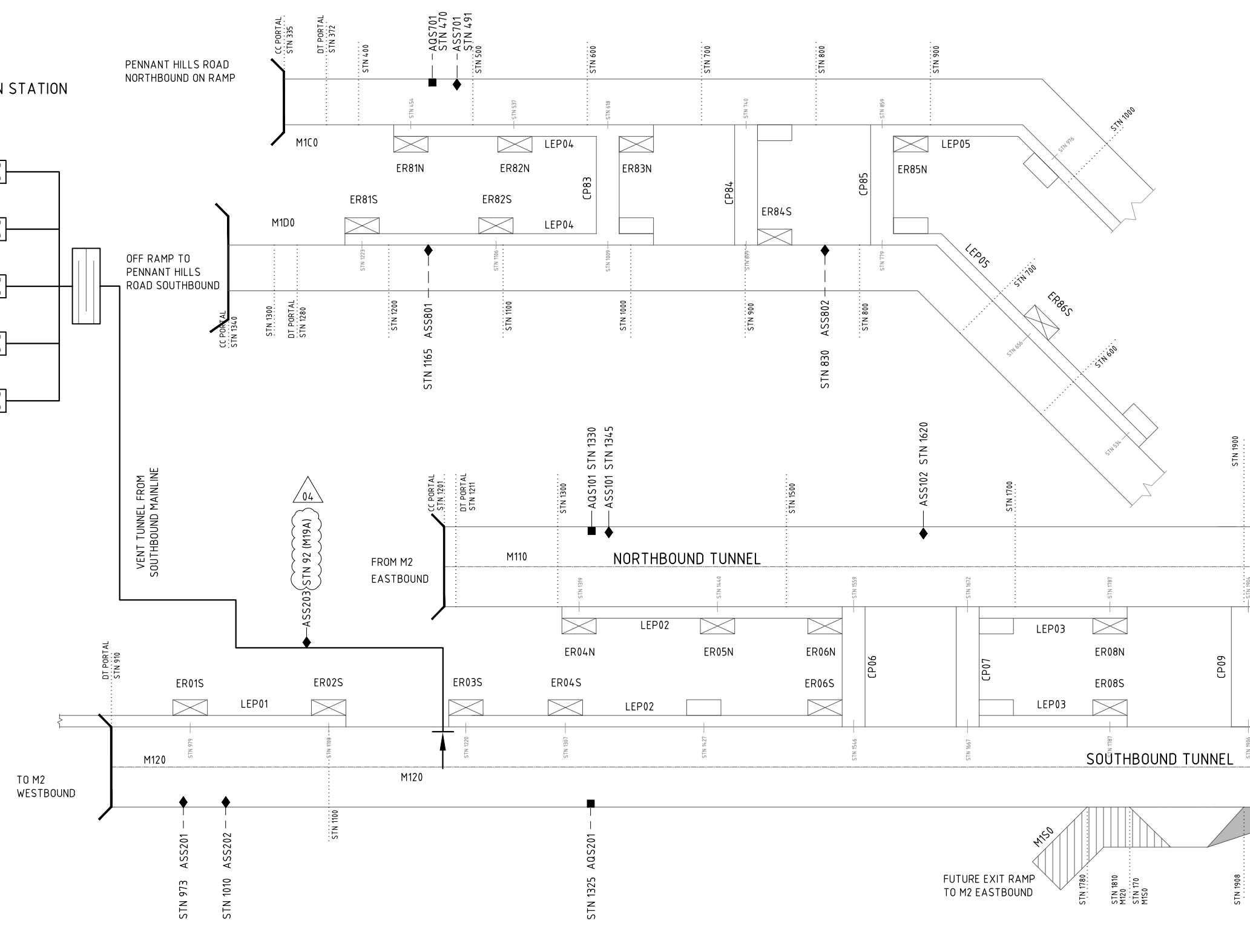
# Ambient Above-Goal Reading Protocol

<b>Report on Ambient Air Quality Above-Goal Reading (AGR)</b> <b>NorthConnex Tunnel</b>									
To be submitted to TfNSW within 10 days of the Notification of Above-Goal Reading. TfNSW to submit to DPIE within further 10 days.  Please note that this report is not required in the event of an extraordinary event.									
<b>Details of the Above-Goal Reading</b> Attach relevant Notification of Above-Goal Reading									
<b>Was the data valid?</b> If invalid, include any details or justifications for the invalidity.									
<b>Comparison with long term monitoring trends and background air quality data</b> This is not required to be completed, however if available.									
<b>Cause or major contributor of the Above-Goal Reading</b> If the cause or major contributor are not able to be determined, then known facts of what was occurring at the time should be included (eg traffic information, ventilation outlet monitoring records etc)									
<b>Options to prevent recurrence</b> This is to include consideration of improvements to the tunnel air quality management system so as to achieve compliance with the ambient air quality goals, including but not limited to installation of the additional ventilation management facilities allowed for under condition B5, and discussion of whether those improvements are feasible and reasonable.									
<b>Person responsible for report</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;"></td> <td style="width: 20%;">Name</td> </tr> <tr> <td></td> <td>Position</td> </tr> <tr> <td></td> <td>Organisation</td> </tr> <tr> <td></td> <td>Date</td> </tr> </table>		Name		Position		Organisation		Date
	Name								
	Position								
	Organisation								
	Date								

## Appendix D: Air Quality Monitoring Locations



**SOUTHERN VENTILATION STATION (VS01)**



**LEGEND**

- ◆ ASSxxx AIR SPEED SENSOR
- AQSxxx COMBINED CO/NO<sub>2</sub>/VISIBILITY SENSOR
- ▲ CPMxxx TSP CEMS
- CCBxxx COMBINED CO, NO, NO<sub>2</sub>, VOC, TEMPERATURE & MOISTURE CEMS
- ← AIR FLOW

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NCX - MEA - 01 - 2820 - ME - DG - 2101						

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	02	21.07.16	ISSUED FOR SDD SUBMISSION		
	03	07.08.17	ISSUED FOR FDD SUBMISSION		
	04	02.02.18	ISSUED FOR CONSTRUCTION		

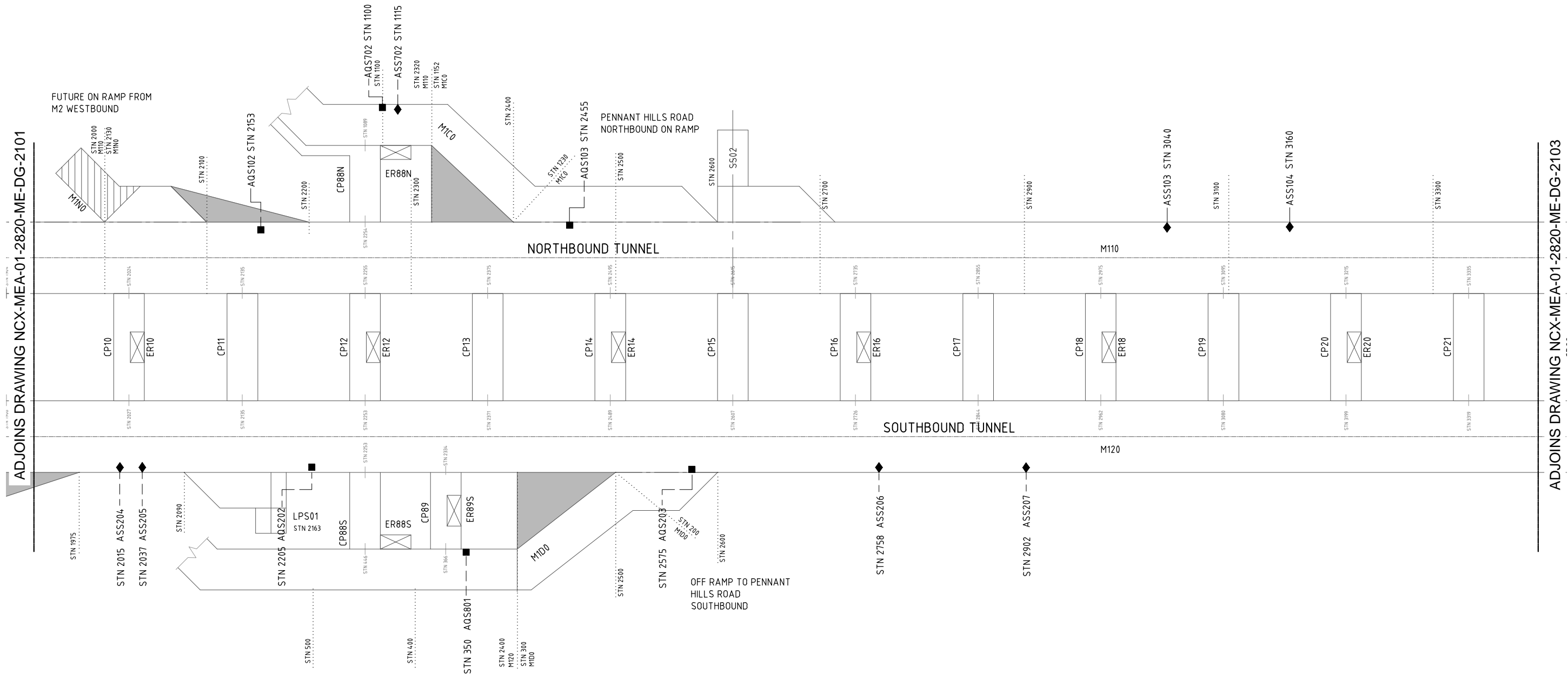
TITLE	NAME
DRAFTING	SP
DRAFTING CHECK	AT
DESIGNER	AW
DESIGN CHECK	AJ
DESIGN MANAGER	TM



<b>NCX ALL PROJECT WORKS TUNNEL AIR MONITORING SYSTEM EQUIPMENT LOCATION</b>				A1		
<b>BLOCK DIAGRAM - SHEET 1 OF 7</b>						
REGISTRATION No OF PLANS		ISSUE STATUS		BRIDGE No	SHEET No	ISSUE
		IFC				04

**LEGEND**

- ◆ ASSxxx AIR SPEED SENSOR
- AQSxxx COMBINED CO/NO<sub>2</sub>/VISIBILITY SENSOR
- ▲ CPMxxx TSP CEMS
- CCBxxx COMBINED CO, NO, NO<sub>2</sub>, VOC, TEMPERATURE & MOISTURE CEMS
- ← AIR FLOW



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02	21.07.16	ISSUED FOR SDD SUBMISSION
03	07.08.17	ISSUED FOR FDD SUBMISSION
04	02.02.18	ISSUED FOR CONSTRUCTION

PRF No	APPROVAL	TITLE	NAME
		DRAFTING	SP
		DRAFTING CHECK	AT
		DESIGNER	AW
		DESIGN CHECK	AJ
		DESIGN MANAGER	TM

DATUM : MGA / AHD

SCALES ON A1 SIZE DRAWING



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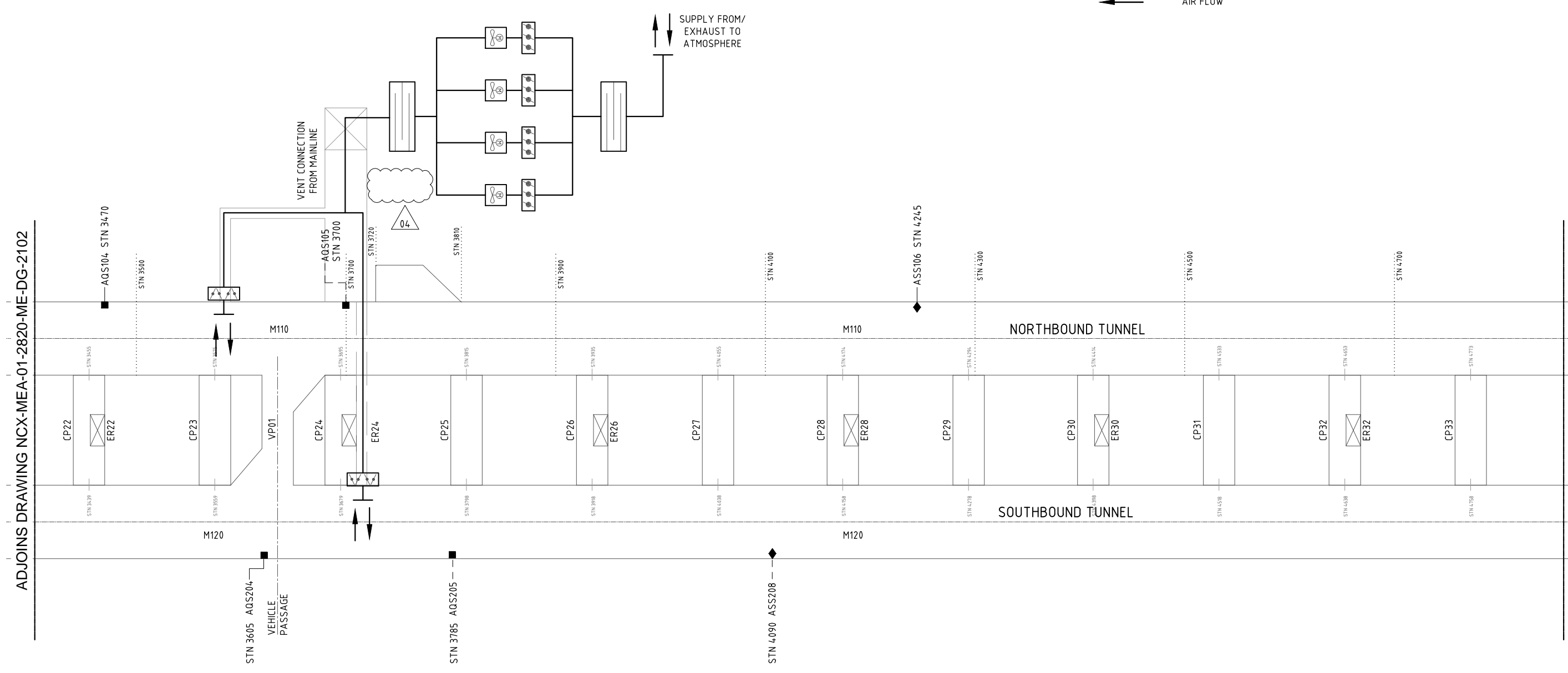
NCX ALL PROJECT WORKS  
TUNNEL AIR MONITORING SYSTEM  
EQUIPMENT LOCATION  
BLOCK DIAGRAM - SHEET 2 OF 7

REGISTRATION No OF PLANS	
ISSUE STATUS	IFC
BRIDGE No	
SHEET No	04

**LEGEND**

- ◆ ASSxxx AIR SPEED SENSOR
- AQSxxx COMBINED CO/NO<sub>2</sub>/VISIBILITY SENSOR
- ▲ CPMxxx TSP CEMS
- CCBxxx COMBINED CO, NO, NO<sub>2</sub>, VOC, TEMPERATURE & MOISTURE CEMS
- ← AIR FLOW

**WILSON ROAD VENTILATION STATION (VS02)**



ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2102

ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2104

DRAWING FILE LOCATION / NAME  
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EXTERNAL REFERENCE FILES

REV	DATE	AMENDMENT / REVISION DESCRIPTION	PRF No	APPROVAL
01	01.12.15	ISSUED FOR DCD SUBMISSION		
02	21.07.16	ISSUED FOR SDD SUBMISSION		
03	07.08.17	ISSUED FOR FDD SUBMISSION		
04	02.02.18	ISSUED FOR CONSTRUCTION		

DATUM : MGA / AHD

TITLE	NAME
DRAFTING	SP
DRAFTING CHECK	AT
DESIGNER	AW
DESIGN CHECK	AJ
DESIGN MANAGER	TM

SCALES ON A1 SIZE DRAWING



PROJECT	ORIGINATOR	ZONE	DOC LOT	DISCIPLINE	TYPE	DRG No
NCX - MEA - 01 - 2820 - ME - DG - 2103						

NCX ALL PROJECT WORKS  
TUNNEL AIR MONITORING SYSTEM  
EQUIPMENT LOCATION  
BLOCK DIAGRAM - SHEET 3 OF 7

REGISTRATION No OF PLANS

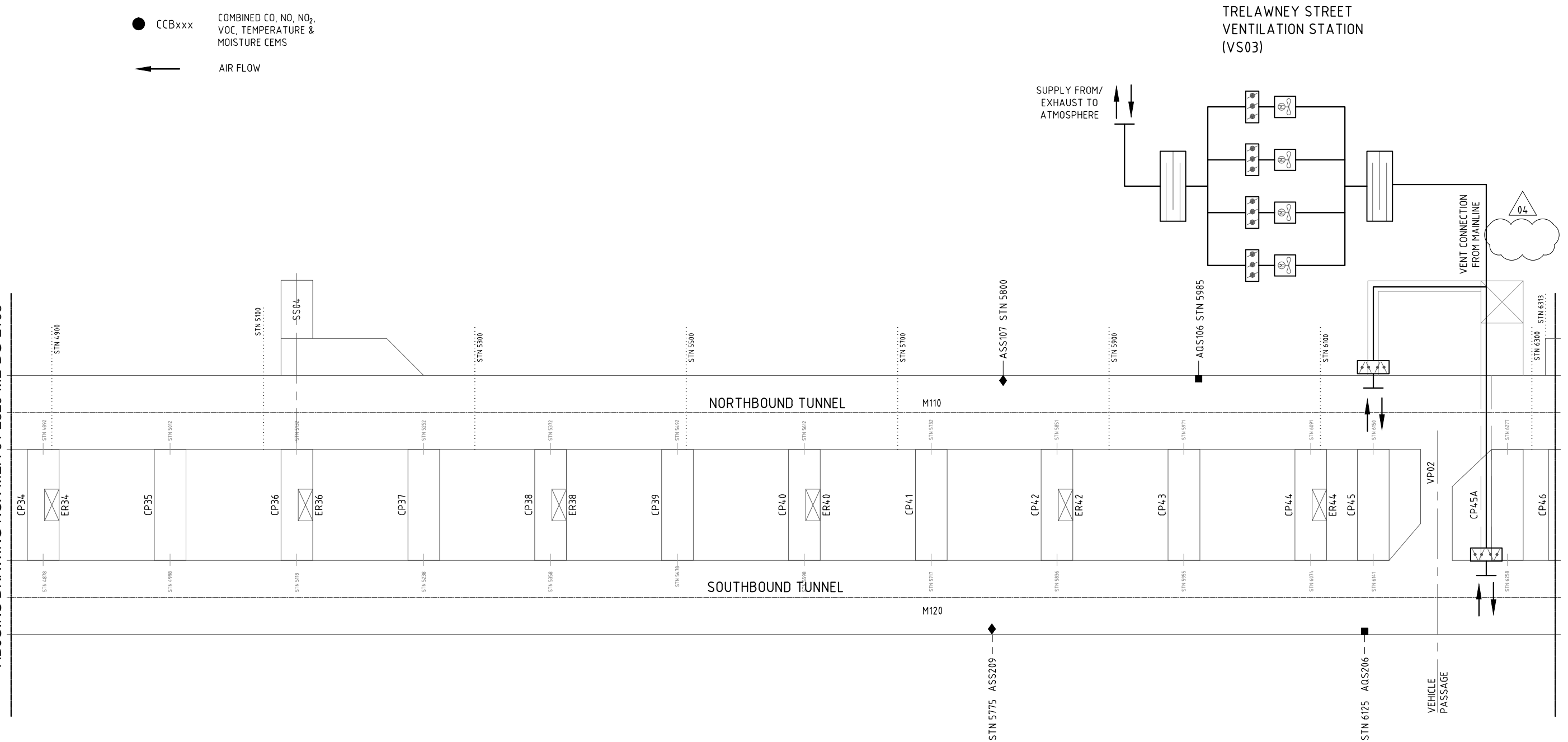
ISSUE STATUS	BRIDGE No	SHEET No	ISSUE
IFC			04



**LEGEND**

- ◆ ASSxxx AIR SPEED SENSOR
- AQSxxx COMBINED CO/NO<sub>2</sub>/VISIBILITY SENSOR
- ▲ CPMxxx TSP CEMS
- CCBxxx COMBINED CO, NO, NO<sub>2</sub>, VOC, TEMPERATURE & MOISTURE CEMS
- ← AIR FLOW

ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2103



ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2105

PROJECT	ORIGINATOR	ZONE	DOC LOT	DISCIPLINE	TYPE	DRG No
NCX - MEA - 01 - 2820 - ME - DG - 2104						

DRAWING FILE LOCATION / NAME  
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EXTERNAL REFERENCE FILES

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02	21.07.16	ISSUED FOR SDD SUBMISSION		
03	07.08.17	ISSUED FOR FDD SUBMISSION		
04	02.02.18	ISSUED FOR CONSTRUCTION		

DATUM : MGA / AHD

SCALES ON A1 SIZE DRAWING

TITLE	NAME
DRAFTING	SP
DRAFTING CHECK	AT
DESIGNER	AW
DESIGN CHECK	AJ
DESIGN MANAGER	TM



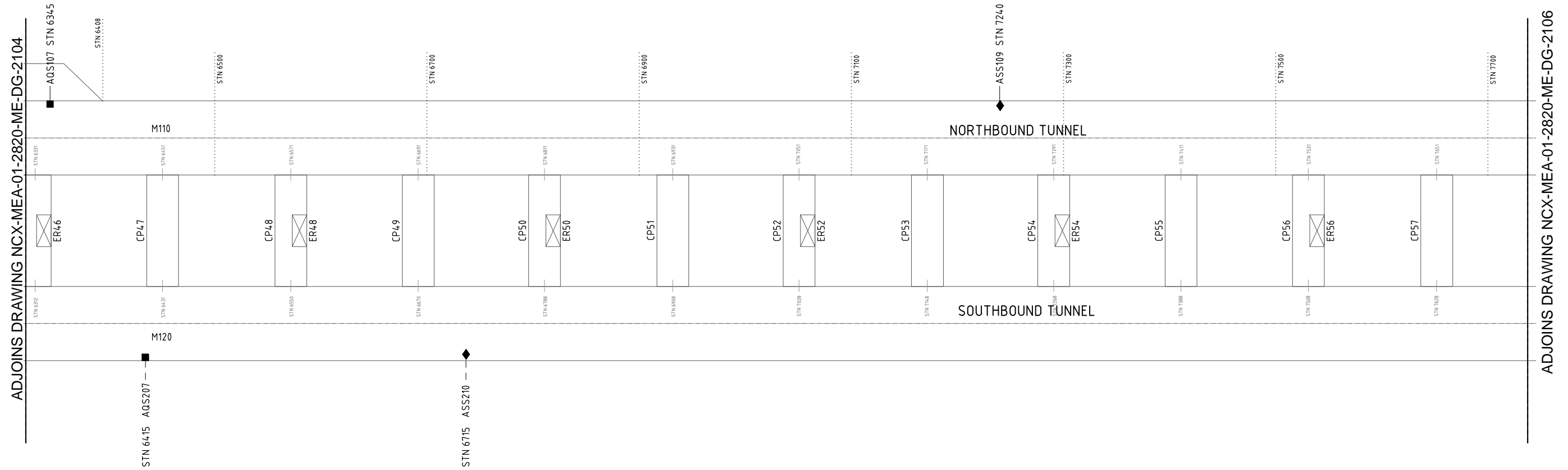
NCX ALL PROJECT WORKS  
TUNNEL AIR MONITORING SYSTEM  
EQUIPMENT LOCATION  
BLOCK DIAGRAM - SHEET 4 OF 7

REGISTRATION No OF PLANS

ISSUE STATUS	BRIDGE No	SHEET No	ISSUE
IFC			04

**LEGEND**



- ◆ ASSxxx AIR SPEED SENSOR
- AQSxxx COMBINED CO/NO<sub>2</sub>/VISIBILITY SENSOR
- ▲ CPMxxx TSP CEMS
- CCBxxx COMBINED CO, NO, NO<sub>2</sub>, VOC, TEMPERATURE & MOISTURE CEMS
- ← AIR FLOW



PROJECT	ORIGINATOR	ZONE	DOC LOT	DISCIPLINE	TYPE	DRG No
NCX - MEA - 01 - 2820 - ME - DG - 2105						

DRAWING FILE LOCATION / NAME C:\PDF IN\2820\NCX-MEA-01-2820-ME-DG-2105_04		DATUM : MGA / AHD		SCALES ON A1 SIZE DRAWING	
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	02	21.07.16	ISSUED FOR SDD SUBMISSION		
	03	07.08.17	ISSUED FOR FDD SUBMISSION		
	04	02.02.18	ISSUED FOR CONSTRUCTION		

TITLE	NAME
DRAFTING	SP
DRAFTING CHECK	AT
DESIGNER	AW
DESIGN CHECK	AJ
DESIGN MANAGER	TM

 	
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<b>NCX ALL PROJECT WORKS</b> <b>TUNNEL AIR MONITORING SYSTEM</b> <b>EQUIPMENT LOCATION</b>	
<b>BLOCK DIAGRAM - SHEET 5 OF 7</b>	
REGISTRATION No OF PLANS	
ISSUE STATUS	BRIDGE No
IFC	
SHEET No	ISSUE
	04

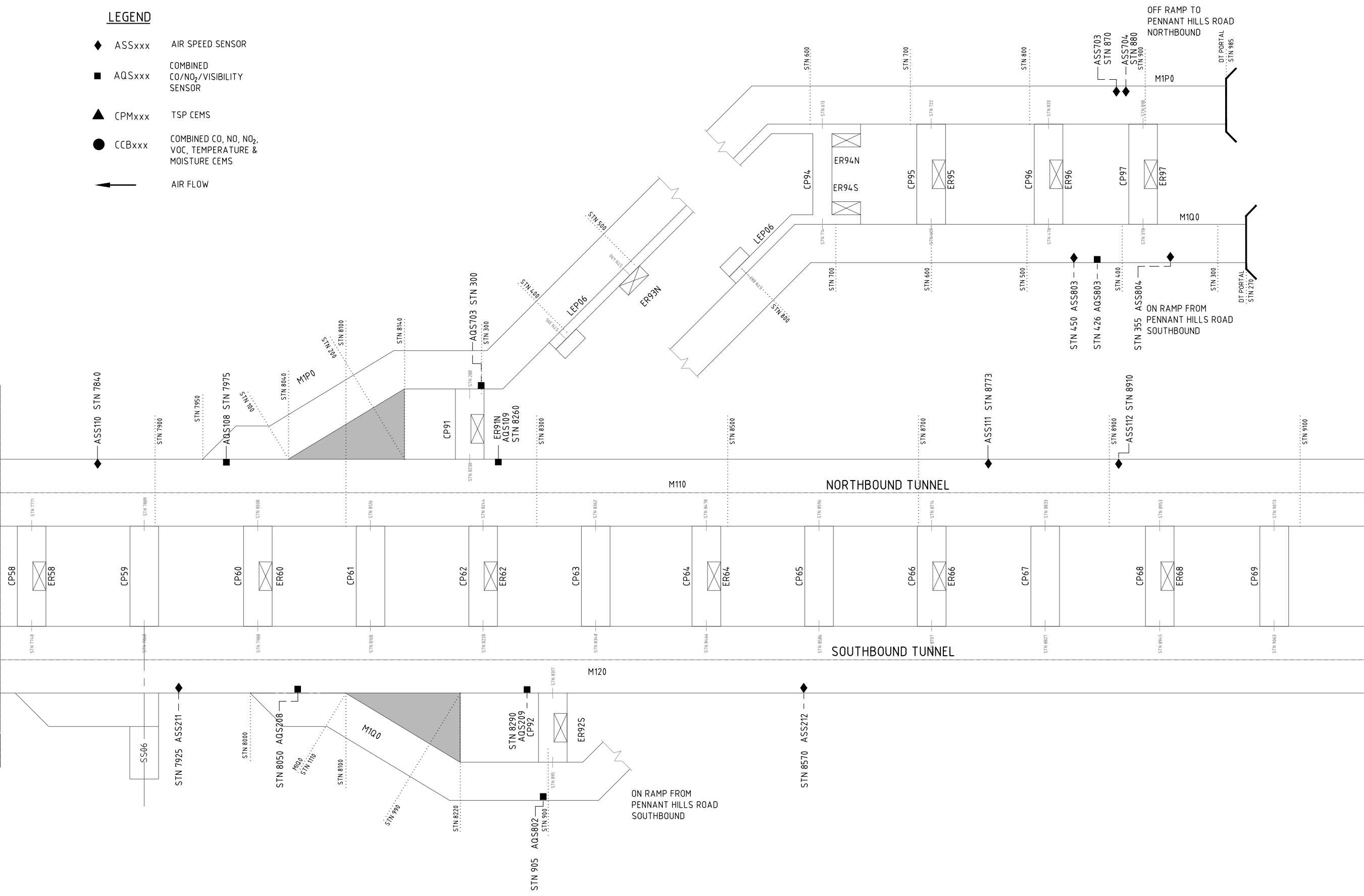
A1	
REGISTRATION No OF PLANS	
ISSUE STATUS	BRIDGE No
IFC	
SHEET No	ISSUE
	04

**LEGEND**

- ◆ ASSxxx AIR SPEED SENSOR
- AQSxxx COMBINED CO/NO<sub>2</sub>/VISIBILITY SENSOR
- ▲ CPMxxx TSP CEMS
- CCBxxx COMBINED CO, NO, NO<sub>2</sub>, VOC, TEMPERATURE & MOISTURE CEMS
- ← AIR FLOW

ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2105

ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2107



PROJECT	ORIGINATOR	ZONE	DOC LOT	DISCIPLINE	TYPE	DRG No
NCX - MEA - 01 - 2820 - ME - DG - 2106						

DRAWING FILE LOCATION / NAME C:\PDF\IN2820\NCX-MEA-01-2820-ME-DG-2106_04		DATUM : MGA / AHD		SCALES ON A1 SIZE DRAWING	
EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	PRF No	APPROVAL
	01	01.12.15	ISSUED FOR DCD SUBMISSION		
	02	21.07.16	ISSUED FOR SDD SUBMISSION		
	03	07.08.17	ISSUED FOR FDD SUBMISSION		
	04	02.02.18	ISSUED FOR CONSTRUCTION		

TITLE	NAME
DRAFTING	SP
DRAFTING CHECK	AT
DESIGNER	AW
DESIGN CHECK	AJ
DESIGN MANAGER	TM

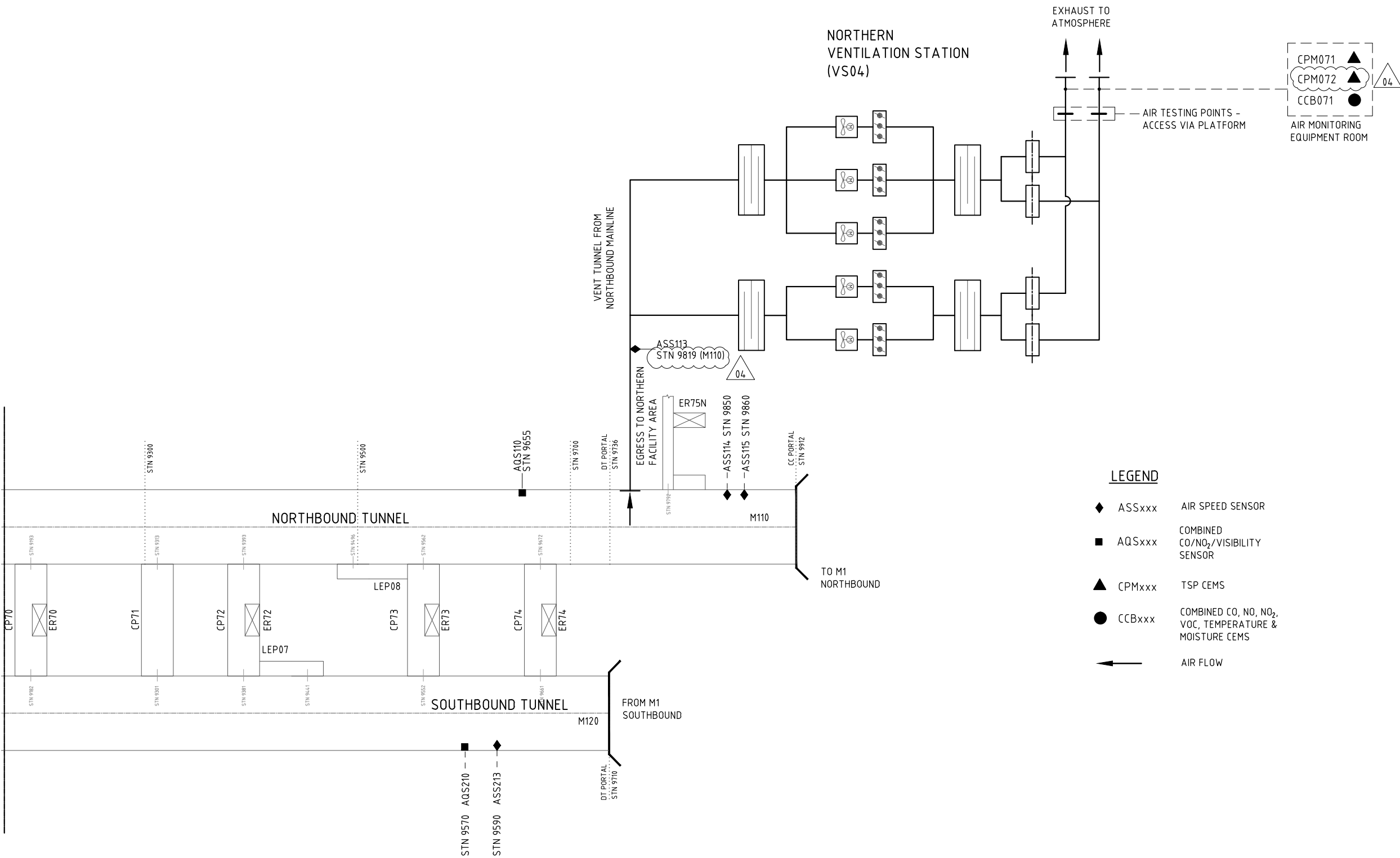


**NCX ALL PROJECT WORKS  
TUNNEL AIR MONITORING SYSTEM  
EQUIPMENT LOCATION**

**BLOCK DIAGRAM - SHEET 6 OF 7**

REGISTRATION No OF PLANS			
ISSUE STATUS	BRIDGE No	SHEET No	ISSUE
IFC			04

ADJOINS DRAWING NCX-MEA-01-2820-ME-DG-2106



PROJECT	ORIGINATOR	ZONE	DOC LOT	DISCIPLINE	TYPE	DRG No
NCX - MEA - 01 - 2820 - ME - DG - 2107						

DRAWING FILE LOCATION / NAME C:\PDF\IN2820\NCX-MEA-01-2820-ME-DG-2107_04		DATUM : MGA / AHD		SCALES ON A1 SIZE DRAWING	
REV	DATE	AMENDMENT / REVISION DESCRIPTION	PRF No	APPROVAL	TITLE
01	03.12.15	ISSUED FOR DCD SUBMISSION			DRAFTING
02	21.07.16	ISSUED FOR SDD SUBMISSION			DRAFTING CHECK
03	07.08.17	ISSUED FOR FDD SUBMISSION			DESIGNER
04	02.02.18	ISSUED FOR CONSTRUCTION			DESIGN CHECK
					DESIGN MANAGER

TITLE	NAME
DRAFTING	SP
DRAFTING CHECK	AT
DESIGNER	AW
DESIGN CHECK	AJ
DESIGN MANAGER	TM



<b>NCX ALL PROJECT WORKS TUNNEL AIR MONITORING SYSTEM EQUIPMENT LOCATION</b>				A1
<b>BLOCK DIAGRAM - SHEET 7 OF 7</b>				
REGISTRATION No OF PLANS				
ISSUE STATUS	IFC	BRIDGE No	SHEET No	ISSUE
				04