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NOISE ASSESSMENT AND REVIEW OF EIS FOR NORTHCONNEX PROJECT

Independent Review

26 August 2014

Ku-ring-gai Council

TG937-01F01 (r5) NorthConnex Review_NOISE

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1 Introduction

Renzo Tonin & Associates was requested to undertake an independent review of the Noise Impact Assessment prepared for the NorthConnex Environmental Impacts Statement (EIS) with regard to the noise and vibration impact of the NorthConnex Project on the Ku-ring-gai Local Government Area. The noise and vibration assessment for the Project was prepared by AECOM and is included in Appendix F of the EIS also prepared by AECOM.

It is noted that Renzo Tonin & Associates work to date has been limited to a desktop review of information. Independent modelling and assessment of impacts has not been carried out. The following documents were reviewed:

- NorthConnex Technical Working Paper: Noise and Vibration (EIS-NV), 13 June 2014, AECOM (ref: 20140613_Noise_and_Vibration_Technical_Paper_V3_RMS.docx);
- NorthConnex Environmental Impact Statement (EIS), July 2014, AECOM

This review predominately outlines where we consider the noise and vibration report to be deficient in its assessment of impacts. The review is largely limited to the Technical Working Paper: Noise and Vibration as the EIS largely summarises its contents. The review has been structured as follows:

- Scope of Study;
- EIS Review (Technical Working Paper: Noise and Vibration);
  - Monitoring and Assessment Locations;
  - Acoustic Criteria;
  - Operational Noise Review;
  - Construction Noise Review;
- Assessment of Impacts; and
- Consultation with Local Community
- Summary of Independent Review Recommendations.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Scope of Study

2.1 Project Overview

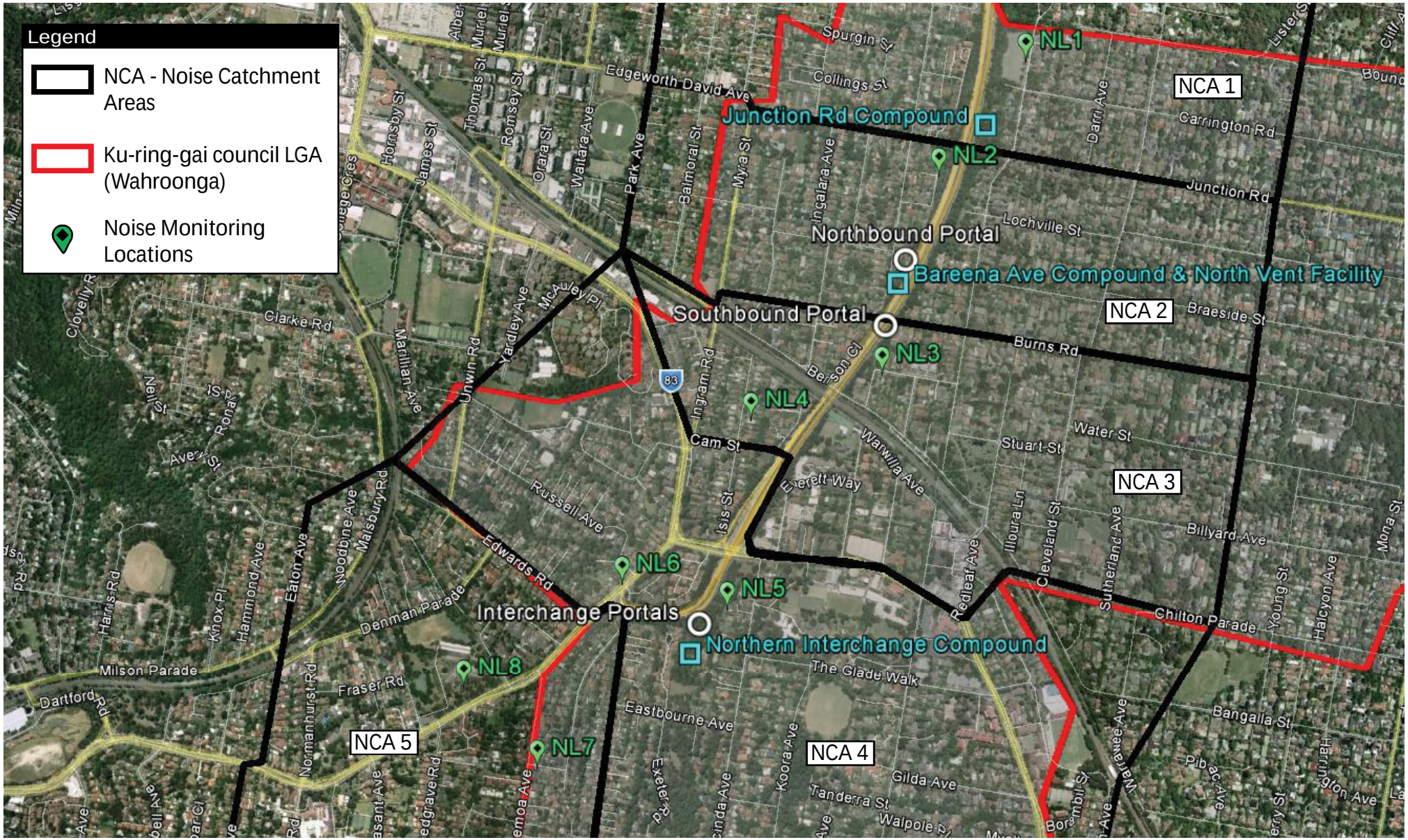
From our review of the documentation we understand that the project entails the construction and operation of a multi-lane tolled motorway linking the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at West Pennant Hills in northern Sydney (the Project). Key features of the Project relevant to the Ku-ring-gai Council Local Government Area (LGA) are:

- Twin motorway tunnels up to around nine kilometres in length with two lanes in each direction.
- A northern interchange with the M1 Pacific Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps, which also facilitate access to and from the Pacific Highway.
- Tie-in works with the M1 Pacific Motorway extending to the north of Edgeworth David Avenue.
- A northern support facility incorporating emergency smoke extraction outlets and substations.
- Ancillary facilities for motorway operation, such as electronic tolling facilities, signage, ventilation systems and fire and life safety systems including emergency evacuation infrastructure.
- Modifications to service utilities and associated works at surface roads near the northern interchange and operational ancillary facilities
- Modifications to local roads and repositioning of the Hewitt Avenue cul-de-sac near the northern interchange.
- Ancillary temporary construction facilities and temporary works to facilitate the construction of the project.

2.2 Study Area Extent

The noise assessment review is limited to the Ku-ring-gai Council Local Government Area (LGA) and the Project's activities and operations that will potentially affect the residents within. The suburb of Ku-ring-gai Council that will potentially be impacted by the Project is Wahroonga.

A location figure showing the extent of the Wahroonga suburb, EIS Noise Catchment Areas (NCAs) and monitoring locations, construction compounds, tunnel ramps and tunnel portals and surface works is show in Figure 1.



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NORTH CONNEX EIS REVIEW - NOISE MONITORING LOCATIONS

Project:	Date:	Ref:	Scale:
TG937-01	20-08-2014	TG937-01-P01(r1)	NTS

3 EIS Review (Technical Working Paper: Noise and Vibration)

3.1 Noise Monitoring and Assessment Locations

The EIS-NV divided the NorthConnex Project area into 16 Noise Catchment Areas (NCAs), representing areas of similar ambient and background noise environment. Ambient noise monitoring was undertaken at 23 locations as part of the EIS. Of these, there are 5 NCAs applicable to the Ku-ring-gai Local Government Area (KLGA) potentially impacted by the Project, with 1 representative monitoring location in each NCA. The NCAs and representative monitoring locations are shown on Figure 1.

3.1.1 Noise Catchment Areas (NCAs)

The NCAs adopted within the EIS-NV are large. For a Project with a large Study area this is a reasonable approach. However, one of the shortcomings is that it generalises the ambient noise environment across the NCA based on a single monitoring location, which may not represent the whole catchment. For example, in a NCA adjacent to a major arterial road, typically receivers within the first two of rows of houses are exposed to higher noise levels than receivers further away from the arterial road. A noise monitoring location within the first two rows of houses would provide representative noise levels for this part of the catchment, but then assumes that these potentially higher noise levels also represent the part of the NCA that is further from the road.

The NCAs defined for NorthConnex do not appear to take into consideration the changes in the noise environment around the Project area, in particular in relation to the existing noise generators in the area, such as the M1 Pacific Motorway, Pacific Highway, Pennant Hills Road and North Shore Rail Line.

RECOMMENDATION:

- NCAs defined in the EIS-NV should be further subdivided to ensure that each catchment represents a similar existing acoustic environment.

3.1.2 Noise Monitoring Locations

Existing noise levels were measured for the EIS-NV in order to obtain:

- Representative Background Levels (RBLs) for the purpose of setting criteria to assess construction and operational noise impact;
- Existing road traffic noise levels, to allow the validation and calibration of the road traffic noise model.

Different monitoring locations are required in order to satisfy these two objectives. Background noise levels should be measured in the free field (i.e. away from reflecting surfaces such as buildings), at the potentially worst affected location. This may not be the closest location to the noise source being

assessed. Conversely, traffic noise levels should be measured at 1 m from the facade of a building close to the road to acquire a good signal to noise ratio. For this reason a single monitoring location is not always suitable in acquiring RBLs and existing traffic noise levels, in particular where the NCAs are very large (see Section 3.1.1 above).

The EIS-NV assumes that a single monitoring location in each of the NCAs for KLGA is adequate. For NCAs 1, 2 and 3 the single noise monitoring location is on one side of the existing M1, to represent a NCA that stretches up to 1 km on either side of the motorway.

The 5 representative noise monitoring locations applicable to KLGA are all located in close proximity to major roads, with the exception of NL07. This implies that the purpose of these monitoring locations is to calibrate the traffic noise model rather than acquire background noise levels. The results within Table 58 of the EIS-NV generally support this as there is a good correlation between measured and modelled traffic noise levels at the following monitoring locations NL02, NL03, NL05, NL06 and NL08. As such, monitoring for the purpose obtaining RBLs near construction and stationary operational noise sources is recommended as part of the design development phase.

RECOMMENDATION:

- Additional noise monitoring should be carried out to determine RBLs for the revised NCAs;
- Additional noise monitoring should be carried out to determine existing traffic noise levels for the revised NCAs.

3.1.3 Summary

Table 1 following presents the 5 representative catchments, noise monitoring locations and associated Noise Management Levels (NMLs), reproduced from the EIS-NV. Table 1 also summarises the nearest construction compound and construction work area and operational noise source to each NCA along with the approximate distance to the nearest residence within the NCA.

Table 1: EIS Noise Catchment Areas, Assessment Locations, Noise Management Levels and Project Noise Sources relevant to Ku-ring-gai Council LGA

NCA	Monitoring Location	Period	RBL, dB(A)[1]	Construction NML, dB(A)[2]	Nearest Construction Compound to NCA & approx. distance to nearest KLGA residence[3]	Nearest Construction & Operational Noise Source to NCA & approx. distance to nearest KLGA residence[3]	Comment on Monitoring Location
NCA01	NL01	Day	56	66	Junction Road (30m)	Northern Ventilation Facility (400m) Surface Works (30m) Ramp (190m) Tunnel Portal (400m)	Monitoring closer to receivers located east of the Junction Rd Compound would have been more appropriate. However, since NL01 is located at a similar distance from the M1, RBLs are satisfactory for east of M1 setting construction NMLs. Additional monitoring should be carried out west of M1.
		Evening	52	57			
		Night	45	50			
NCA02	NL02	Day	56	66	Bareena Avenue (40m)	Northern Ventilation Facility (40m) Surface Works (30m) Ramp (20m) Tunnel Portal (30m)	Monitoring closer to receivers located west of the Bareena Avenue Compound would have been more appropriate. However, since NL02 is located at a similar distance from the M1, RBLs are satisfactory for setting NMLs and ENLs for residences in the first row of houses from M1. Additional monitoring required to confirm the RBLs for areas shielded from the M1. Additional monitoring should also be carried out east of M1.
		Evening	54	59			
		Night	43	48			
NCA03	NL03	Day	53	63	Bareena Avenue (110m) Northern Interchange (300m)	Northern Ventilation Facility (110m) Surface Works (220m) Ramp (20m) Tunnel Portal (20m)	Given the Tunnel Ramps and Tunnel Portal are the closest noise sources to NCA03, NL03 is considered an appropriate location. The RBLs measured at NL03 are comparable to noise data previously collected by RT&A. Note: there was an equipment failure at NL04. Additional monitoring to be carried out at NL04.
		Evening	50	55			
		Night	41	46			
NCA04	NL05	Day	51	61	Northern Interchange (adjacent)	Pennant Hills Rd Surface Works (<20m)	NL05 is appropriate to establish NMLs and ENLs for the Northern Interchange Compound, Surface Works, Tunnel
		Evening	47	52			

NCA	Monitoring Location	Period	RBL, dB(A)[1]	Construction NML, dB(A)[2]	Nearest Construction Compound to NCA & approx. distance to nearest KLGA residence[3]	Nearest Construction & Operational Noise Source to NCA & approx. distance to nearest KLGA residence[3]	Comment on Monitoring Location
		Night	41	46		Pennant Hills Rd Ramp (<20m) Pennant Hills Rd Tunnel Portal (40m)	Ramps and Tunnel Portals. In addition a conservative approach has been adopted by assigning NL05 to represent NCA04, as opposed to NL06 which was also measured within NCA04. However, previous RT&A noise level monitoring data suggests that background noise levels at receivers located south of the Northern Interchange Compound are significantly lower than those measured at NL05. Additional monitoring should also be carried out to determine appropriate NMLs south of the compound, in particular as the Northern Interchange Compound is to provide tunnel support and 24 hour operations are proposed. Further, additional monitoring should be carried out on the north-western side of the M1 to confirm existing traffic noise levels in this area.
NCA05	NL07	Day	41	51	Northern Interchange (180m)	Pennant Hills Rd Surface Works (<20m) Pennant Hills Rd Ramp (90m) Pennant Hills Rd Tunnel Portal (210m)	NL07 is considered an appropriate location to represent NCA05. In addition, a conservative approach has been adopted by assigning NL07 to represent NCA05 as opposed to NL08 which was also measured within NCA05. Lower day, evening and night background noise levels were measured at NL07.
		Evening	40	45			
		Night	35	40			

Notes:
1. Rating Background Level (RBL)
2. Construction Noise Managment Level (NML)
3. Distance in brackets is indicative only, based on Figures 1 and 3 and Appendix C within the EIS Noise and Vibration Technical Working Paper and Chapter 5 of the EIS

3.2 Operational Noise Review and Assessment

3.2.1 Operational Fixed Noise Sources

Operational fixed noise sources associated with the project and relevant to KLGA include the:

- Northern Ventilation Facility; and
- Northern tunnel portals.

The EIS appropriately assessed stationary in accordance with the NSW Industrial Noise Policy (INP, NSW Environment Protection Authority 2000).

3.2.1.1 Project Specific Environmental Noise Levels

The NCAs potentially affected from the Northern Ventilation Facility and the Northern Tunnel Portals are NCA02, NCA03 and NCA04. The EIS-NV (section 3.5.2) classifies NCA02 and NCA03 as Urban noise amenity areas, in accordance with the INP. The Environmental Noise Levels (ENLs) for NCA02, NCA03 and NCA04 are reproduced from the EIS-NV in Table 2 below. In addition, the sleep disturbance screening criteria for fixed noise sources have been determined in accordance with EPA guidelines and are also reproduced from the EIS-NV in Table 2 below.

Table 2: Project Specific Environmental Noise Levels (ENLs) for KLGA

NCA	Assessed Receiver	Project Specific ENLs dB(A)				Applicable Facility
		Day[1]	Evening[2]	Night[2]	Sleep	
NCA02	50 Woonona Ave North, Wahroonga	61	50	45	58	Northern ventilation facility and main alignment portals
NCA03	9-10 Benson Close, Wahroonga	58	50	45	56[3]	
NCA04	11A Lucinda Avenue, Wahroonga	56	50	45		Northern interchange on and off-ramp portals

Notes
1. $L_{Aeq(15min)}$ Intrusiveness criterion, dB(A)
2. $L_{Aeq(9\ hour)}$ Amenity criterion, dB(A)
3. Sleep disturbance screening criterion for NCA03 not included in EIS-NV

Our review of the EIS-NV found the following in relation to the ENLs adopted for the operation of the Northern Ventilation Facility:

- For NCA02, the marginally more stringent daytime amenity criterion of 60 dB(A) should have been adopted rather than 61 dB(A), which is based on the intrusiveness criteria. Note that this should have negligible impact on the assessment as the night period is the determining period with regard to assessment of impact and design of noise mitigation measures.
- The remaining criteria for NCA02, NCA03 and NCA04 have been correctly applied.

- Note that based on Section 2.2.3 of the INP there is argument for the application of an amenity criterion of $L_{Aeq,\ period(traffic)}$ minus 10 dB(A). This would result in slightly higher Project Specific criteria for some periods. In this regard the EIS is conservative.
- The sleep disturbance screening criteria have been determined in accordance with the relevant EPA guideline document. Note that the sleep disturbance screening criteria for NCA 03 was not included in the EIS-NV.
- The large NCAs defined in the EIS-NV assume a single noise monitoring location to be representative of background levels across the NCA (see Section 3.1 above for more detail). This may have resulted in high ENLs for some receivers in the NCA, particularly during the critical night period.

RECOMMENDATIONS:

- See recommendations in Section 3.1 above.

3.2.1.2 Assessment

Our review of the EIS-NV found the following in relation to the noise assessment of the operation of the Northern Ventilation Facility:

- The sound power levels (SWLs) of 121 dB(A) for each ventilation fan (see Table 62 of EIS-NV) and for the tunnel jet fans are similar to data in our own RT&A source level databases and are considered suitable for the purpose of this assessment.
- The EIS assessed the Northern Ventilation Facility against three (3) operational scenarios, 'Normal operation', 'Congested and low speed traffic operation' and Emergency conditions' for three (3) different weather conditions, 'neutral weather conditions', 'F class inversions' and '3m/s source to receiver wind speeds'. In all cases the predicted noise level was less than 30 $L_{Aeq\ (15min)}$ dB(A) and well below the most stringent night-time criterion. These predictions are indicative to what RT&A have previously predicted and is considered suitable.
- The EIS-NV states that noise emissions from the operation of the ventilation fans would not contain any "annoying characteristics", such as prominent tonal components and dominant low-frequency content (as described in the INP). It is not clear whether an assessment to identify any "annoying characterises" has been undertaken. However, since the make and model of the ventilation fans within the EIS-NV is likely to be indicative only, it is reasonable that an assessment to identify any "annoying characterises" will be undertaken for the detailed design stage.
- There was no investigation of potential sleep disturbance impacts from the Northern Ventilation Facility.

Our review of the EIS-NV found the following in relation to the assessment of jet fan noise from the Northern Tunnel Portals:

- The approach to determining the SWL of the jet fans at the tunnel portals is reasonable.
- Portal noise from the M1 Pacific Motorway on and off-ramps (NCA04) and the main alignment (NCA02 & NCA03) were assessed against the INP and were predicted to be well below the most stringent night-time criterion for all weather conditions.
- The EIS-NV states that noise emissions from the operation of the jet fans would not contain any "annoying characteristics", such as prominent tonal components and dominant low-frequency content (as described in the INP). It is not clear whether an assessment to identify any "annoying characterises" has been undertaken. However, since the make and model of the jet fans within the EIS-NV is likely to be indicative only, it is reasonable that an assessment to identify any "annoying characterises" will be undertaken for the detailed design stage.

3.2.1.3 Proposed Mitigation and Effectiveness

Our review of the EIS-NV found the following in relation to the noise assessment of the operation of the Northern Ventilation Facility:

- A high performance attenuator (see Table 63 of EIS) proposed for the intake and discharge sides of the ventilation fans is reasonable and similar to attenuators RT&A have previously adopted. This will reduce fan noise emissions significantly.
- In regard to the construction of the ventilation building the EIS states*:*

  The assessment assumes that the building fabric (ie walls, roof, doors, louvers, etc) housing the ventilation equipment will reduce the noise emission from the building to be at least 10 dB(A) less than the contribution from the outlets. The final noise emission from the building fabric may change subject to the detailed design but in any case when considered in combination with the noise from the outlets will be controlled to satisfy the appropriate noise criteria.

  RT&A agree that there is sufficient scope to design the building fabric that will house the ventilation equipment to achieve the noise criteria.
- Airborne noise emission from the Northern Ventilation Facility is shown to comply with the Project specific ENLs. Care will need to be taken when installing the fans and supporting structure to ensure ground-borne noise is not an issue.
- Potential impact and possible changes to noise mitigation requirements will need to be reviewed once additional noise monitoring has been completed, as recommended above.

3.2.2 Operational Road Traffic Noise

3.2.2.1 Road Noise Assessment Criteria

The EIS-NV appropriately references the EPA's NSW Road Noise Policy (RNP, NSW Department of Environment, Climate Change and Water 2011) and the Roads and Maritimes' Environmental Noise Management Manual (ENMM, NSW Roads and Traffic Authority 2001). According to the ENMM, the EIS appropriately applies the RNPs 'redeveloped road' to receivers along the M1 Pacific Motorway, Pacific Highway and Pennant Hills Road.

3.2.2.2 Assessment

The Study area, based on the Roads and Maritime Services (RMS) advice, was based on an area considered to be where the project adds no more than 2.0 dB(A) to the total noise level. RT&A agree that a study area 600 metres from the centre line of the outermost traffic land on each side of the Project Rd in urban environments can be excessive. However, it is not clear how the study area was derived and the boundary of the study area has not been defined within the EIS. Furthermore, the study areas do not relate to the NCAs identified in the EIS-NV, which are extensive at up to 1 km from the Project boundary.

The RTA's ENMM requires a traffic noise assessment for road upgrades to include, as a minimum, noise contours, generally for intervals of 5 dB(A), clearly identified with the contour value (ENMM, p172). Appendix J of the EIS-NV presents tabulated operational noise results for the Project. No noise contours for road traffic noise are presented in the EIS-NV. This is considered to be a significant deficiency in the EIS-NV.

In addition to the above, our review of the EIS-NV found the following in relation to the assessment of operational road traffic noise:

- Noise affected receiver heights were not identified in the EIS-NV. It is not clear whether second storey premises have been accounted for. It is not clear if the At-property treatments identified within Table 59 of the EIS are applicable to the ground floor and/or first floor of multi-storey dwellings. This may affect the outcomes of the noise barrier assessment.
- It is not clear whether a correction for Australian conditions (Australian Road Research Board (ARRB)) has been applied to the $L_{Aeq,15hr}$ and or $L_{Aeq,9hr}$ predictions. Section 5.1.3 of the EIS states that correction factors of -1.4 dB and -1.1 dB for the daytime and night-time respectively were found to most accurately correlate with the measured noise levels for the northern interchange. For the noise logger calibration process it appears specific ARRB conditions corrections have been derived. It is not clear whether these corrections have been applied to all predictions.
- It appears that a calibration factor (separate to the corrections stated above) and a safety factor have not been applied.

- The existing road surface on the M1 Motorway including ramps is open-graded asphalt (OGA). For calibration purposes OGA corrections of -3.0 dB(A) for light vehicles and -4.9 dB(A) for heavy vehicles has been applied for the northbound carriageway. The EIS-NV states the southbound carriageway has a deteriorated surface and a correction of +2.0 dB(A) was applied to both the light vehicle and heavy vehicle type emissions. More information is required as to how the OGA corrections for the M1 southbound carriageway were derived.
- Ramp portals have been modelled with stone mastic asphalt (SMA), using corrections of -2.2 dB(A) for light vehicles and -4.3 dB(A) for heavy vehicles which is in accordance with the ENMM.
- With regard to pavement corrections it should be clarified whether the corrections were applied equally for each vehicle emission string (car exhaust/engine; car/truck tyre noise; truck engines and truck exhaust) or just for the car/truck tyre noise emission string.
- EIS assessment has assumed that the road surface on the M1 Motorway southbound carriageway would be re-surfaced for the No Build scenario for the Opening and Design years. The Build scenario maintains OGA on the main carriageways for the M1 Motorway and Stone-mastic asphalt (SMA) for the portal ramps.
- The EIS-NV states that portal noise from road traffic within the main tunnels has been modelled using SoundPLAN's tunnel algorithm (EIS-NV section 5.1.6). This approach is reasonable; however it is not clear from the EIS how portal noise affects the overall predicted road traffic noise levels. More information is required with regard to the portal correction used in noise assessment. Note that road traffic noise contours may have made the portal noise impact more obvious.
- The EIS maximum noise level assessment has only considered existing maximum noise levels at the M1 portals and not the Pennant Hills Road portals.
- Section 5.1.9 of the EIS-NV states that the number of maximum noise level events near the southbound main carriageway portal is likely to increase as trucks engage their engine brakes as they descend into the portal. There is no discussion of the likely change in maximum noise levels on the northbound carriageway as a result of heavy vehicles accelerating to climb out of the northbound tunnel and then potentially braking with the gradient change once outside the tunnel. More detailed assessment of maximum noise level impacts associated with the Northern Interchange should be provided.

3.2.2.3 Proposed Mitigation and Effectiveness

Noise barrier analysis was conducted in accordance with Practice Note (iv) of the ENMM. A summary of the 'assessed' barrier, 'target' barrier and recommended barrier heights is reproduced from the EIS in the below table.

Table 3: Noise Barrier Assessment Summary

Noise Barrier	Target Barrier Height (m)	Assessed Barrier Height (m)	Recommended Barrier Height (m)
NWM1NB02	>8	3.0	Existing barrier height
NWM1NB04	>8	3.5	Existing barrier height
NWM1SB02	>8	3.5	Existing barrier height
NWM1SB04	>8	3.5	3.5

Our review of the EIS-NV found the following in relation to the proposed mitigation and effectiveness:

- NCAs used for the purpose of assessing cost effectiveness of noise barriers are not clearly identified in the EIS-NV.
- The EIS-NV states that existing noise barriers on the M1 Pacific Motorway range from 2.5 metres to 5.5 metres in height. The EIS also states that where 'existing barrier height' has been recommended, the top (RL) of the new noise barrier should be no lower than the top (RL) the existing noise barriers which is reasonable. It is recommended that the RL of the existing noise barriers should be based on multiple points along the length of the barrier(s) and not be based on the average RL of the barrier.
- A reasonable and feasible noise barrier analysis has not been conducted for Lucinda Avenue properties located north east of the on and off-ramp portals. The EIS has recommended five (5) closely grouped Lucinda Avenue properties (IDs 1617, 1626, 1648, 1656 & 1661) for At-property treatment within Table 59 of the EIS. In accordance with ENMM Practice Note (iv) a reasonable and feasible noise barrier analysis should be conducted for this area as part of the EIS submission.
- The EIS-NV needs to provide more information to ensure the receivers affected by the Northern Interchange where noise barriers are to be replaced are provided with replacement noise barriers of at least the equivalent performance of the existing barriers.
- Architectural treatment is recommended for 82 Properties near the Northern Interchange.

3.3 Construction Noise Review and Assessment

3.3.1 Airborne Construction Noise

The main sources of airborne construction noise that may potentially affect Ku-ring-gai Council residents are:

- Northern Interchange compound – Tunnel support site and proposed 24 hour operations (NCA04)
- Bareena Avenue compound – Site offices, amenities, storage and laydown (NCA02)
- Junction Road compound – Site offices and amenities (NCA01)

- M1 Pacific Motorway on and off ramps, tunnel portals and surface works (NCA01, NCA02 & NCA03)

- M1 Pacific Motorway main alignment ramps, tunnel portals and surface works (NCA03, NCA04 & NCA05)

3.3.1.1 Airborne Construction Noise Criteria

The EIS appropriately references and appropriately applies the NSW Interim Construction Noise Guideline (ICNG, NSW Department of Environment and Climate Change 2009) for the assessment of airborne construction noise.

The large NCAs defined in the EIS-NV assume a single noise monitoring location to be representative of background levels across the NCA (see Section 3.1 above for more detail). This may have resulted in high Construction Noise Management Levels (NMLs) for some receivers in the NCA, particularly during the critical night period.

3.3.1.2 Assessment

The Sound Power Levels (SWLs) adopted for construction equipment are identified in Table 28, Table 29 and Table 30 of the EIS-NV. It was noted that SWLs were taken from Australian Standard AS2436-2010 and DEFRA, which are credible data sources, however the source noise levels for some plant items appear to be low. Table 4 following compares the SWLs reported in the EIS-NV to those commonly adopted by RT&A for similar construction projects.

Table 4: EIS Vs RT&A Construction Equipment Sound Power Levels, dB(A)

Item of Equipment	EIS SWLs	Commonly Adopted RT&A SWLs	Difference RT&A - EIS
Delivery truck	98	108	10
Truck and dog	98	108	10
25t Articulated dump truck	98	108	10
Jack hammer	108	113	5
30t Excavator w/Hammer	112	119	7
Concrete saw	110	118	8
Bored pilling rig	103	110	7
Jumbo drill	110	120	10
Rockbolting rig	115	120	5
Skid steer loaders	104	107-110	3-6

Table 4 above identified that the EIS adopted noise levels are potentially 10 dB(A) lower than typical noise levels adopted by RT&A for similar construction noise assessments. For example, the EIS adopted SWL of 98 L_{Aeq} dB(A) for delivery trucks, truck and dogs and articulated dump trucks cannot be sourced within Australian Standard AS2436-2010 and/or DEFRA. It is not clear from the EIS whether this is a time weighted noise level. 24hr truck operations are proposed for the Northern Interchange compound. The

low SWLs adopted for delivery trucks, truck and dogs and articulated dump trucks are of concern as the EIS could be significantly under predicting noise impacts, in particular during the night period. Further justification and explanation of the EIS-NV noise source data is required.

Further to the above, our review of the EIS-NV found the following in relation to the airborne construction noise assessment:

- It is not clear whether a penalty has been applied to noise sources identified in the ICNG (p16) as having particularly annoying characteristics, including jackhammering, rock hammering or rockbreaking. Confirmation of this is required.
- The number of spoil truck movements occurring during the day, evening and night has not been quantified in the EIS, nor has the number of trucks only the number of articulated trucks that will operate underground. This makes it difficult to gain an understanding of potential impacts at night as predicted noise contours show significant exceedance of the night NMLs. Heavy vehicle movements on site will potentially generate sleep disturbance impacts from braking on site, especially at the entry/ exit to the site. Further review is required.
- At the community consultation workshop by KMC several residents indicated they had been informed that surface miners would be used to construct the first part of the tunnel where on and off-ramps emerge to the surface, until sufficient depth was reached to allow safe operation of the Roadheaders. Review of the EIS-NV found that the excavation methodology for the construction of the tunnels near portals has not been provided. Further information is required as due to the close proximity of these works to residential receivers, this stage of construction may cause significant noise impact.

As expected during the daytime there are a significant number of receivers where NMLs are exceeded for the Northern Interchange (road works) and M1 Pacific Motorway tie-in works (Table 32 of EIS), Northern Interchange compound (Table 39 of EIS), Bareena Avenue compound (Table 40 of EIS) and Junction Road compound (Table 41 of EIS). Also, for many of the construction stages there is predicted to be a number of highly noise affected receivers predicted. A summary of the exceedances for each construction operation and associated stage is summarised in Table 5.

Table 5: EIS Receiver Exceedance Summary for Construction Operations and Stages Affecting Ku-ring-gai Council residences

Construction Operation and Stage	Total Number of Receivers where NMLs are exceeded	Total Number of Highly Noise Affected Receivers
Northern Interchange (road works) and M1 Pacific Motorway tie-in works – Table 32 of EIS		
Traffic management, set-up and line marking	171	48
Demolition	134	26
Road widening	134	26
Earthworks, pavement and temporary median works	212	60
Re-surfacing asphalt works	234	53

Construction Operation and Stage	Total Number of Receivers where NMLs are exceeded	Total Number of Highly Noise Affected Receivers
Northern Interchange Construction Compound - Table 39 of EIS		
Site establishment and earthworks	60	12
Tunnel support	37	0
Bareena Avenue Construction Compound - Table 40 of EIS		
Site establishment and earthworks	28	9
Building construction	20	1
Ventilation shaft	16	1
Junction Road Construction Compound - Table 41 of EIS		
Site establishment and earthworks	22	7

- No highly noise affected receivers are predicted to occur for the tunnel support stage of the Northern Interchange compound which is of importance since this stage will occur over numerous years.
- The out of hours work for the evening period has not been predicted within the EIS only out of hours work for the night-time. This leads to the conclusion that operations (i.e. number of truck movements) are not differentiated between evening and night.
- During the night-time there is predicted to be eight (8) exceedances for the Northern Interchange compound (Table 43 of EIS) but none of these are predicted to be highly noise affected. It is not specified what operations cause the exceedances, how many truck off-site truck movements are proposed and why increasing the perimeter barrier heights was not investigated.
- It is not clear in the EIS-NV whether existing noise walls earmarked for replacement have been included in the construction noise assessment. Where possible, new noise walls should be constructed prior to or as soon as practical after the commencement of construction.

3.3.1.3 Proposed Mitigation and Effectiveness

- The EIS states that 3m barriers have been assumed on the perimeter of ancillary construction compounds where residential development is located adjacent to the construction compound. It is recommended that further consideration of the noise benefits of increasing the height of compound perimeter barriers be explored to address the high number of exceedances predicted within the EIS-NV.
- The EIS states acoustic sheds have been assumed to have an insertion loss of 25 dB which is reasonable. The EIS also states that acoustic sheds will cover all tunnelling operations and loading of trucks with tunnel spoil. This is a reasonable approach but it is envisaged that in order to accommodate 24 hour operations that sheds may have to be extended to cover all on-site truck movements and/or perimeter barrier heights increased.

3.3.2 Ground-borne Construction Noise

3.3.2.1 Ground-borne Construction Noise Criteria

The EIS appropriately references and appropriately applies the NSW Interim Construction Noise Guideline (ICNG, NSW Department of Environment and Climate Change 2009) for the assessment of airborne construction noise.

3.3.2.2 Ground-borne Construction Noise Assessment

Excavation of the main tunnel alignments and sections of the on and off-ramps will be undertaken using a number of Roadheaders and surface miners. The number of Roadheaders and the location of their deployment are not stipulated within the EIS. Excavation of cross passages will be undertaken using small Roadheaders, excavators with rock hammers and/or drilling and blasting.

The EIS states the prediction of ground-borne noise has been based on previous measurements of tunnelling activities from Roadheaders in Sydney, using methods in accordance with ISO14837: Mechanical vibration – Ground-borne noise and vibration arising from rail systems, which is a reasonable approach. Based on this approach, the EIS predicted maximum exceedances of up to 5 dB(A) at 28 receivers during the evening period and up to 10 dB(A) at 90 receivers during the night period.

The EIS states that with a Roadheader progression rate of 7 metres per day it is likely that ground-borne noise would be discernible for up to five (5) days at each affected receiver with exceedances occurring for up to two days. Furthermore, Roadheader progression rates would reduce to 2 – 5 metres per day around the portals, which may increase the duration of exposure for receivers in these areas. The Roadheader progression rate is reasonable but the duration of exceedances in the EIS appears low. Further information to justify the extent of impacts is required.

There is some reservation about the GBN predictions. They are satisfactory for the EIS stage but will need to be more comprehensive for the detailed design stage, to ensure impacts are adequately quantified and receivers notified prior to tunnelling.

Excavators with rock hammers will be used in unison with Roadheaders to excavate the cross passages. Ground borne noise associated with rock hammers is typically higher than that associated with Roadheaders. The EIS does not provide any predictions associated with cross passages. It is recommended that these predictions be undertaken as part of the detailed design.

3.3.2.3 Proposed Mitigation and Effectiveness

The EIS does not specify any specific mitigation measures related to ground borne noise. The Construction Noise and Vibration Management Plan (CNVMP) will need to provide details and protocols for the management of ground-borne noise impact, including provision of alternative accommodation where required.

3.3.3 Construction Vibration

3.3.3.1 Ground-borne Construction Noise Criteria

The EIS-NV appropriately references and appropriately applies the *German Standard DIN 4150* for structural damage, *Assessing Vibration: A technical Guideline* for Human comfort (tackle vibration) and the ICNG for Human comfort (regenerated noise – see Section 3.3.2 above) for the assessment of construction vibration.

3.3.3.2 Construction Vibration Assessment

The EIS-NV does not provide an assessment for construction surface works, including potential impacts from heavy vehicles. The EIS-NV only provides indicative safe working distances for vibration intensive plant. With regard to heritage properties, the EIS-NV notes that '*More stringent conditions may apply to heritage or other sensitive structures. Any heritage property would need to be considered on a case by case basis*'. This is not unreasonable, given the limited information available regarding construction methodology at the EIS stage.

The EIS vibration assessment for tunnelling activities relates only to human comfort. The EIS states that structural damage would not be exceeded by tunnelling activities. From our review of the information available in the EIS and EIS-NV, the risk of structural damage from Roadheader tunnelling is low. This would need to be confirmed during the detailed design stage of the Project, in particular in relation to excavation of the cross passages.

3.3.3.3 Proposed Mitigation and Effectiveness

The EIS does not specify any specific mitigation measures related to surface and tunnel vibration other than safe working distances for vibration intensive plant. The Construction Noise and Vibration Management Plan (CNVMP) will need to provide details and protocols for minimising the risk of vibration impacts from construction activity.

4 Consultation with Local Community and CAPS

KMC held a Community Consultation Workshop on 18 August 2014 to assist in identifying the key areas of concern for the community in relation to the Project.

The key issues raised by the community in relation to noise and vibration are summarised in Table 6 below.

Table 6: Key Noise & Vibration Issues Raised by the Community in Relation to NorthConnex

Issue Number	Issue Raised by Community	Communities Reason for concern	Community Suggested Possible Solutions	RT&A Responses
1	Is the ventilation noise in addition to traffic noise	Additional and constant noise	Noise attenuation measures required	The criteria for ventilation facility and portal noise is 45 $L_{Aeq,15min}$ dB(A) and for traffic noise at night-time it is 55 $L_{Aeq,9hr}$ dB(A). Although the assessment periods differ, the difference in noise level is 10 dB(A). If the ventilation facility/portal noise criterion is adhered to, ventilation facility/portal noise it is unlikely to contribute to traffic noise. In addition, the EIS-NV predict a noise level from the ventilation facility and portal noise to be significantly below the criterion of 45 $L_{Aeq,15min}$ dB(A). See section 3.2.1.3 of this report for review of proposed ventilation facility attenuation measures. Regardless the EIS-NV should include a Cumulative Noise Assessment.
2	Construction noise is expected for 4 years	Hours of construction noise	Noise attenuation measures required	See section 3.3.1.3 of this report for comment regarding the proposed construction noise attenuation measures. The noise attenuation measures adopted for the detailed design will be subject to site limitations and the extent of proposed 24 hour operations (i.e. number of truck movements during the evening and night-time). There is limited detail regarding the mitigation and management of construction noise in the EIS-NV. Construction noise management and mitigation measures will have to be comprehensively covered within the Construction Noise and Vibration Management Plan.
3	Tunnel located under residential properties	Noise and vibration within residential homes	Dilapidation surveys required	As stated within Section 6.2.1 of the EIS-NV, prior to the commencement of tunnelling of other vibration intensive work, dilapidation surveys will be conducted within the preferred project corridor (the zone on the surface equal to 50 meters from the outer edge of the tunnels) and within 50 metres from surface works. Vibration management, mitigation measures and monitoring will have to be comprehensively covered within the Construction Noise and Vibration Management Plan.

Issue Number	Issue Raised by Community	Communities Reason for concern	Community Suggested Possible Solutions	RT&A Responses
4	Proposed night work for road integration at M1/Pacific Highway junction	Constant noise, lights and traffic	Reduce working hours at this location	Construction noise management and mitigation measures will have to be comprehensively covered within the Construction Noise and Vibration Management Plan. Depending on the issued EPA Project licence, there will typically be restrictions with regard to the number of consecutive night-time works and the number of total night-time works within any given week and month.
5	Will existing noise walls be removed during construction		Build new acoustic walls before removing old existing ones	The issue of replacing noise barriers is addressed in Section 6.1.8 of the EIS-NV. In circumstances where existing noise walls or parts of existing noise walls have to be demolished before new walls can be constructed, an assessment of feasible and reasonable noise mitigation measures would be undertaken. Where reasonable and feasible, the use of temporary noise walls would be investigated.
6	Traffic noise	Heading south – gradient steep, possible increase in air braking. Heading north – heavy acceleration		The Calculation of Road Traffic Noise (CoRTN) algorithm was utilised for the EIS operational traffic noise assessment which is reasonable and standard practice for road projects. CoRTN incorporates a calculation to address varying noise levels associated with gradients (i.e. an increase in engine noise associated with an incline). However CoRTN does not take into account noise from heavy vehicle engine braking. Review of potential sleep disturbance impacts is provided in Section 3.2.2.2 above. More detailed assessment of maximum noise level impacts associated with the Northern Interchange should be provided.
7	Road surface	Surface required to reduce tyre noise and continued maintenance	Open grade asphalt pavement required.	As part of the design it is proposed to resurface the northbound and southbound main carriageways for the M1 Motorway with OGA - see section 3.2.2.2 of this report for comment. The EIS-NV should include a commitment to provide a road surface with similar acoustic performance to OGA when the road is resurfaced in future.

Key noise issues raised by the Community against Polluting Stacks (CAPS) organisation are summarised in Table 7 below. A letter from CAPS addressed to Ku-ring-gai Council is attached in Appendix B.

Table 7: Key Noise & Vibration Issues Raised by CAPS in Relation to NorthConnex

Issue Number	Issue Raised by CAPS	CAPS Suggested Possible Solutions	RT&A Responses
1	The requirement for and the design of operational noise walls it only based upon traffic numbers ten years after opening (2029). The noise walls should be designed for a higher traffic through put.	1) The noise walls and other mitigation measures should be based upon the approved maximum capacity of the project, rather 10 years after opening. 2) If NorthConnex is permitted to install noise walls based upon the 10 years after opening traffic numbers the following approval condition should be provided "After opening, an operational noise assessment should be undertaken every 10 years. Based upon the outcomes of the noise assessment, operational noise mitigation measures such as noise walls and property treatments should be reviewed and updated to ensure that noise levels at sensitive receivers meet the Road Noise Policy.	The EIS-NV appropriately references the EPA's NSW Road Noise Policy (RNP) and the Roads and Maritimes' Environmental Noise Management Manual (ENMM). The RNP has a design year 10 years after opening, there are no requirements after this period.
2	The requirements of the Road Noise Policy (RNP) have not been strictly complied with	A map and justification for reducing the RNP assessment boundary in specific locations needs to be provided.	See Section 3.2.2.2 of this report
3	The cumulative noise impacts from operational traffic and the operation of mechanical equipment (such as the ventilation building) has not been assessed.	A cumulative impact assessment of all operational noise sources from the project should be undertaken especially around the ventilation stacks and noise mitigation requirements reassessed.	See RT&A comment for issue 1 within Table 6.
4	There is little information on the design and visual appearance of noise walls.	Noise walls are to be designed in consultation with the affected community and Council.	See Section 3.2.2.3 of this report regarding noise wall RL heights. Noise wall design will be finalised during the Detailed Design stage.
5	Noise impact assessments have not been undertaken for two storey residences (ie upper storey).	Additional information needs to be provided on the ground truthing of the noise model and the identification of 2+ storey houses in impacted areas. The modelling may be repeated if this has not been undertaken in sufficient detail.	See Section 3.2.2.2 of this report.
6	The condition and height of many of the existing noise walls along the M1 are substandard and the EIS does not contain an adequate assessment of their existing condition.	A condition assessment of the existing noise walls needs to be undertaken and areas where new noise walls are required due to the condition of the existing noise walls need to be identified.	See Section 3.2.2.3 of this report regarding noise wall RL heights. It is recommended that existing noise walls within the Project area that are not proposed to be replaced with new walls undergo a condition report and be repaired where required.

7	The EIS does not clearly identify which existing noise walls will need to re-located or replaced – and has not undertaken a noise assessment for sensitive receivers where their noise walls are temporarily removed.	1) Existing noise walls that are to be temporarily removed and or re-located need to be clearly identified 2) A noise impact assessment for sensitive receivers that are in locations where existing noise walls are removed and not immediately replaced with a similar performing structure need to be undertaken.	See RT&A comment for issue 5 within Table 6.
8	The mitigation measures for construction vibration do not specifically mention heritage items and the assessment and mention of heritage structures in the noise assessment report is rudimentary.	The Noise and Vibration Assessment needs to be updated to specifically address the impacts of vibration on heritage items and specifically where heritage items are impacted by both vibration from surface works and tunnelling. Appropriate mitigation measures also need to be detailed in the Noise and Vibration Assessment.	The EIS-NV states within Table 55 of the EIS-NV that potential vibration impacts on heritage properties will need to be considered on a case by case basis. It is recommended that, should the Project proceed, assessment of impact on heritage properties be included in the Conditions of Approval.
9	No out of hours assessment for the M1 integration works has been undertaken.	A condition should be imposed similar to "All pre-construction and construction works for the M1 integration and M1 portal works will be undertaken within standard construction hours."	For some construction activities night-time works is unavoidable. Vibration management, mitigation measures and monitoring will have to be comprehensively covered within the Construction Noise and Vibration Management Plan. In addition specific Out of Hours Works noise assessments are typically required for night-time works.
10	The construction traffic impacts for spoil transport have not been assessed.	A construction traffic noise assessment for spoil disposal locations needs to be undertaken	Construction traffic impacts on public roads have been assessed in section 4.3 of the EIS-NV. For the Northern Interchange & Bareena Ave compounds, during peak traffic periods the increase in traffic noise due to construction traffic are less than 2 dB(A) and within the recommended construction traffic noise goal. During the quietest periods of the night-time, increases in road traffic noise in some instances are greater than 2 dB(A) on Pacific Hwy, Pennant Hills Rd and M1 Motorway. For the Northern Interchange compound access and egress will not occur on local roads so the impact may not be discernible. Considering the possible soil disposal location(s) have not been finalised, RT&A considers the assessment reasonable. However, the EIS should clarify if Woonoona Ave will be utilised for access to Bareena Ave compound and if so an assessment should be included in the EIS-NV. Construction traffic noise impacts have not been adequately addressed in the EIS-NV. See Section 3.3.1 of this report for more detail.

11	Many residents will be exposed to both construction site noise and construction traffic noise however the cumulative impact of this is not assessed.	A cumulative assessment of construction site noise and construction traffic noise needs to be undertaken to ensure that all highly effected residences are identified and appropriate mitigation measures implemented	See comments in Item 10 above with regard to construction traffic on/ off site. Cumulative construction noise impacts from construction site and construction traffic noise has been assessed in section 4.6 of the EIS-NV. RT&A considers the assessment reasonable.
12	Not all sources of construction noise and vibration from tunnelling have been assessed.	A comprehensive noise and vibration assessment of the impact of rock bolting, rock hammering and other similar activities in the tunnel needs to be undertaken.	See Section 3.3.2 of this Report.

5 Summary of Peer Review Recommendations

Further to our review, we make the following recommendations:

5.1 EIS Submission Recommendations and Information Requests

5.1.1 Noise Monitoring & Assessment

1. NCAs defined in the EIS-NV should be further subdivided to ensure that each catchment represents a similar existing acoustic environment.
2. Additional noise monitoring should be carried out to determine RBLs for the revised NCAs;
3. Additional noise monitoring should be carried out, where required, to determine existing traffic noise levels for the revised NCAs.

5.1.2 Operational Noise Impacts

4. Further information should be provided regarding the Northern Ventilation Facility and tunnel portal jet fans and a review of potential sleep disturbance from the operation of the Northern Ventilation facility.
5. Detail should be provided to clarify how the study area was derived (i.e. how was it calculated that the Project adds no more than 2.0 dB(A) to the total noise level) and the boundary of the study area should be defined.
6. Operational daytime $L_{Aeq,15hr}$ and night-time $L_{Aeq,9hr}$ traffic noise contours should be provided.
7. Detail should be provided to clarify what receiver heights were assessed as part of the operational assessment. Confirmation will be required as to whether this affects the outcomes of the noise barrier assessment.
8. More information is required as to how the open graded asphalt (OGA) corrections for the M1 southbound carriageway were derived.
9. With regard to pavement corrections it should be clarified whether the corrections were applied equally for each vehicle emission string (car exhaust/engine; car/truck tyre noise; truck engines and truck exhaust) or just for the car/truck tyre noise emission string.
10. It is not clear why the southbound carriageway of the M1 Motorway has assumed to be resurfaced with open graded asphalt (OGA) for the No Build Opening year and Design year scenarios. This would imply that the resurfacing is not project related and has perhaps already been undertaken post EIS noise monitoring (i.e. after December 2013).
11. Details should be provided to clarify whether ARRB corrections or any other calibration corrections and safety factors have been applied to operational traffic noise predictions.

12. More information is required with regard to the portal correction used in noise assessment.

13. More detailed assessment of maximum noise level impacts associated with the Northern Interchange should be provided.

14. A reasonable and feasible noise barrier analysis in accordance with ENMM Practice Note (iv) should be conducted for Lucinda Avenue properties (including IDs 1617, 1626, 1648, 1656 & 1661) which are located north-east of the on and off-ramp portals.

15. The EIS-NV needs to provide more information to ensure the receivers affected by the Northern Interchange where noise barriers are to be replaced are provided with replacement noise barriers of at least the equivalent performance of the existing barriers

16. A cumulative noise assessment should be included in the EIS to address operational (Northern Ventilation Facility, portal noise) and operational traffic noise.

17. Details should be provided to clarify whether the property treatments identified within Table 59 of the EIS are applicable to the ground floor and/or first floor of multi-storey dwellings.

18. The EIS-NV should include a commitment to provide a road surface with similar acoustic performance to OGA when the road is resurfaced in future.

5.1.3 Construction Noise and Vibration Impacts

19. The literature source of the sound power level (SWL) of 98 L_{Aeq} dB(A) adopted for delivery trucks, truck and dogs and articulated dump trucks should be stated. Justification should be provided as to why this seeming low SWL is applicable.

20. Confirmation is required as to whether a penalty has been applied to noise sources identified in the ICNG (p16) as having particularly annoying characteristics, including jackhammering, rock hammering or rockbreaking.

21. The number of spoil truck movements proposed to occur during the daytime, evening and night-time for the Northern Interchange compound should be quantified. The number of spoil truck movements which have been assumed for the construction noise predictions should be clearly stated. Deciphering the data within the construction road traffic noise assessment, section 4.3 of the EIS, shouldn't have to be relied on to acquire this information.

22. Review of the EIS-NV found that has not been provided. Further information is required regarding the excavation methodology for the construction of the tunnels near portals. Due to the close proximity of these works to residential receivers, this stage of construction may cause significant noise impact.

23. It is not clear in the EIS-NV whether existing noise walls earmarked for replacement have been included in the construction noise assessment. There should be a commitment in the EIS-NV that where possible, new noise walls should be constructed prior to or as soon as practical after the commencement of construction.

24. Further consideration of the noise benefits of increasing the height of compound perimeter barriers to be explored to address the high level of construction noise impacts predicted within the EIS-NV.

25. A review of on-site heavy vehicle movements at the Northern Interchange compound outside of standard construction hours required to identify potential impacts and confirm that proposed compound mitigation and shed structure will satisfactorily mitigate noise.

5.2 Detailed Design Stage Recommendations and Information Requests

1. For the Detailed Design stage background noise monitoring at a receiver located west of the Bareena Avenue Compound should be conducted.

2. Care will need to be taken when installing the Northern ventilation Facility and supporting structure to ensure ground-borne noise is not an issue.

3. For the ventilation fans and jet fans an assessment to identify any "annoying characterises" such as tonality/ low frequency noise will need to be undertaken.

4. For the Detailed Design stage ground-borne noise predictions will need to be more comprehensive and include predictions associated with cross passage excavation and rock hammers.

5. It is recommended that existing noise walls within the Project area that are not proposed to be replaced with new walls undergo a condition report and be repaired.

6. EIS should clarify if Woonoona Ave will be utilised for access to Barenna Ave compound and if so a construction traffic noise assessment should be undertaken.

7. The Construction Noise and Vibration Management Plan (CNVMP) will need to provide details and protocols for minimising and managing the risk of noise and vibration impacts from construction activity. Construction noise management and mitigation measures will have to be comprehensively covered within the CNVMP.

8. Assessment of impact on heritage properties should be included in the Conditions of Approval.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.

L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B CAPS Initial Noise & Vibration Issues with EIS

Greg Piconi
Director of Operations
Ku-ring-gai Council

Initial identification of issues with the noise and vibration assessment

Greg,

Please find attached in Attachment A the initial issues that CAPS has identified with the noise and vibration assessment for NorthConnex. There may be others identified as our review of the document progresses. We would appreciate if you could forward these on to your noise expert. I talked to her at the forum last night and she asked if they could be provided to her.

If you have questions about any of the issues raised please do not hesitate to contact me.

Regards

Jonas Ball

CAPS

Ph: 0419 297 436

ATTACHMENT A

1.1 Operational noise

1.1.1 Operational noise assessment scenario

Issue: The requirement for and the design of operational noise walls it only based upon traffic numbers ten years after opening (2029). The noise walls should be designed for a higher traffic through put.

As Transurban have a concession period of longer than 10 years, it is ridiculous to base the design of noise walls on only 10 years after opening. After the 10 years it is likely that the traffic numbers will be higher than predicted - and there will be numerous peak traffic days when the tunnel and M1 is operating at maximum capacity (eg. public holidays).

While noise levels could conceivably re-assessed after 10 years and the noise walls modified appropriately, this would involve additional construction works and impacts on residences – and the destruction of adjacent landscaping only planted 10 years beforehand.

To avoid the impacts of additional works and to provide guaranteed protection to sensitive receivers for peak traffic days, the noise walls and other mitigation measures should be based upon the maximum capacity of the approved project.

Solution:

1) ***The noise walls and other mitigation measures should be based upon the approved maximum capacity of the project, rather 10 years after opening.***
2) ***If NorthConnex is permitted to install noise walls based upon the 10 years after opening traffic numbers the following approval condition should be provided "After opening, an operational noise assessment should be undertaken every 10 years. Based upon the outcomes of the noise assessment, operational noise mitigation measures such as noise walls and property treatments should be reviewed and updated to ensure that noise levels at sensitive receivers meet the Road Noise Policy.***

1.1.2 Reduction in noise study area

Issue: The requirements of the Road Noise Policy (RNP) have not been strictly complied with.

The RNP requires an assessment of operational noise impacts for a minimum of 600 metres from the subject road. The operational noise assessment indicates that on advice from RMS this minimum distance has been reduced in some locations. However the report provides no details of where this has occurred. While this may be appropriate in some locations, without knowing which areas have had a reduced envelope it is impossible to know whether all reductions are justified. For example in east Wahroonga the M1 is audible over 1 km from the road corridor – and it would not be appropriate to adjust the assessment boundary.

Solution: A map and justification for reducing the RNP assessment boundary in specific locations needs to be provided.

1.1.3 Cumulative operational impacts of multiple project noise sources

Issue: The cumulative noise impacts from operational traffic and the operation of mechanical equipment (such as the ventilation building) has not been assessed.

Many sensitive receivers around the ventilation stacks are going to experience a noise from the operation of the ventilation building as well as increased operational traffic noise. While the impact on sensitive receivers of these two noise sources have be assessed individually, there is no cumulative assessment of the impacts. Without a cumulative assessment, the full operational noise impacts of the project on some sensitive receivers may be underestimated.

Solution: A cumulative impact assessment of all operational noise sources from the project should be undertaken especially around the ventilation stacks and noise mitigation requirements reassessed.

1.1.4 Design of noise walls

Issue: There is little information on the design and visual appearance of noise walls.

Many of the locations of new noise walls are in or adjacent to heritage conservation areas or heritage items. The visual appearance of the noise walls in these locations are important otherwise they will result in heritage impacts. To ensure that visual impacts of noise walls are minimized consultation with property owners and the Council is required.

Solution: Noise walls are to be designed in consultation with the affected community and Council.

1.1.5 Noise impacts assessment on two storey residences

Issue: Noise impact assessments have not been undertaken for two storey residences (ie upper storey).

It is unclear from the noise assessment report whether the report has modelled the operational noise impacts at the upper storeys of two or more floored premises. It appears that in some locations with a large proportion of two storey residence this has not occurred – and insufficient ground truthing for the modelling has been undertaken. This may significantly underestimate the number of houses requiring treatment or the height of noise walls.

Solution: Additional information needs to be provided on the ground truthing of the noise model and the identification of 2+ storey houses in impacted areas. The modelling may be repeated if this has not been undertaken in sufficient detail.

1.1.6 Condition of existing noise walls

Issue: The condition and height of many of the existing noise walls along the M1 are substandard and the EIS does not contain an adequate assessment of their existing condition.

Many of the noise walls along the M1 are in poor condition, constructed of materials that provide minimal noise mitigation, are of insufficient height and/or have gaps. This results in poor noise mitigation and unacceptable noise impacts on adjacent residential areas. The EIS does not contain an assessment of the condition of these existing noise walls and assumes that the condition of the noise walls comply with relevant standards. Consequently the noise walls in these locations have not been identified for replacement when clearly in many areas they are substandard.

Solution: A condition assessment of the existing noise walls needs to be undertaken and areas where new noise walls are required due to the condition of the existing noise walls need to be identified.

1.2 Construction impacts

1.2.1 Relocation of noise walls

Issue: The EIS does not clearly identify which existing noise walls will need to re-located or replaced – and has not undertaken a noise assessment for sensitive receivers where their noise wall are temporarily removed.

The EIS notes that some existing noise walls may have to be temporarily removed to allow construction access – and in some cases may need to be relocated to allow for the new layout. However the EIS does not provide any information on which walls may need to relocated or removed especially around Wahroonga. This information needs to be provided to provide the community with a full picture of the potential impacts and new infrastructure. Also there may be significant periods between the removal of an existing noise wall and the replacement with an equivalent performing wall. Sensitive receivers in locations where existing noise walls are to be removed will experience significantly increase noise impacts both from construction activities and the existing road traffic. The impact on these sensitive receivers has not been assessed in the EIS.

Solution:

1) ***Existing noise walls that are to be temporarily removed and or re-located need to be clearly identified***
2) ***A noise impact assessment for sensitive receivers that are in locations where existing noise walls are removed and not immediately replaced with a similar performing structure need to be undertaken.***

1.2.2 Vibration impacts on heritage items

Issue: The mitigation measures for construction vibration do not specifically mention heritage items and the assessment and mention of heritage structures in the noise assessment report is rudimentary.

There are many heritage items that are potentially impacted by vibration from construction of the project. This is particularly the case for heritage items that will be both impacted by tunneling vibration and vibration from surface works. However, the noise and vibration impact assessment is virtually silent on the impacts of vibration on heritage items, with two fleeting references to heritage structures and no mitigation measures proposed. While the Non-Aboriginal heritage assessment attempts to address the impacts of vibration on heritage structures, because it uses the Noise & Vibration Assessment as it's basis (and this document does not specifically address this issue), the impact assessment is substandard and qualitative.

Solution: The Noise and Vibration Assessment needs to be updated to specifically address the impacts of vibration on heritage items and specifically where heritage items are impacted by both vibration from surface works and tunneling. Appropriate mitigation measures also need to be detailed in the Noise and Vibration Assessment.

1.2.3 Out of hours noise assessment – M1 integration works

Issue: No out of hours assessment for the M1 integration works has been undertaken.

NorthConnex claims that there will no works outside standard construction hours for the M1 integration works and the portal construction – and consequently had used this as a justification for not presenting an out of hours noise assessment in the EIS for these works. An email detailing their claim is attached

While the community thinks this is a great outcome – they are dubious that this promise can be delivered on giving their experiences with previous works on the M1 – which have resulted in extended and noisy out of hours works.

If NorthConnex was to later decide that out of hours works are required and they could address this through the Construction Noise & Vibration Management Plan – this would totally disenfranchise the community as they would not had the opportunity to review and comment on the impacts of the works via the EIS process.

Consequently to protect the community from this situation and to hold NorthConnex to their promise, it is recommended that the Department of Planning impose a condition specifically limiting any out of hours works for the M1 integration and M1 portal construction works.

Solution: A condition should be imposed similar to "All pre-construction and construction works for the M1 integration and M1 portal works will be undertaken within standard construction hours."

1.2.4 Construction traffic – spoil removal

Issue: The construction traffic impacts for spoil transport have not been assessed.

The location for the disposal of spoil has not been defined in the EIS – and consequently the impacts of construction traffic noise from spoil transport on sensitive receivers near the spoil disposal locations has not been assessed. As spoil transport may involve over 2000 truck movements a day, the traffic noise from these truck movements will be significant – especially as out of hours spoil transport is proposed. The locations for spoil disposal need to be defined and a construction traffic noise assessment for affected sensitive receivers needs to be undertaken as part of the EIS process.

Solution: A construction traffic noise assessment for spoil disposal locations needs to be undertaken.

1.2.5 Cumulative construction noise assessment

Issue: Many residents will be exposed to both construction site noise and construction traffic noise however the cumulative impact of this is not assessed.

Some residential areas especially around the tunnel support sites are going to experience high levels of both construction site noise and construction traffic noise – especially outside of standard working hours. While an assessment of each type of noise impacts has been undertaken, a cumulative assessment needs to be undertaken to ensure that all highly effected residences are identified and appropriate mitigation measures implemented.

Solution: A cumulative assessment of construction site noise and construction traffic noise needs to be undertaken to ensure that all highly effected residences are identified and appropriate mitigation measures implemented

1.2.6 Incomplete tunnel noise and vibration assessment

Issue: Not all sources of construction noise and vibration from tunneling have been assessed.

While the noise and vibration assessment includes an assessment of the noise from the operation of the road headers, this is not the only source of noise and vibration from tunneling activities. Based on experience from other tunneling projects, rock bolting and use of rock hammers in the tunnel (eg. To create a trough for drainage) have caused significant number of groundborne noise and vibration complaints – especially at night time. These activities have not been assessed in the EIS and given that in some locations the tunnel will only be 9m below ground level this is a significant omission.

Solution: A comprehensive noise and vibration assessment of the impact of rock bolting, rock hammering and other similar activities in the tunnel needs to be undertaken.