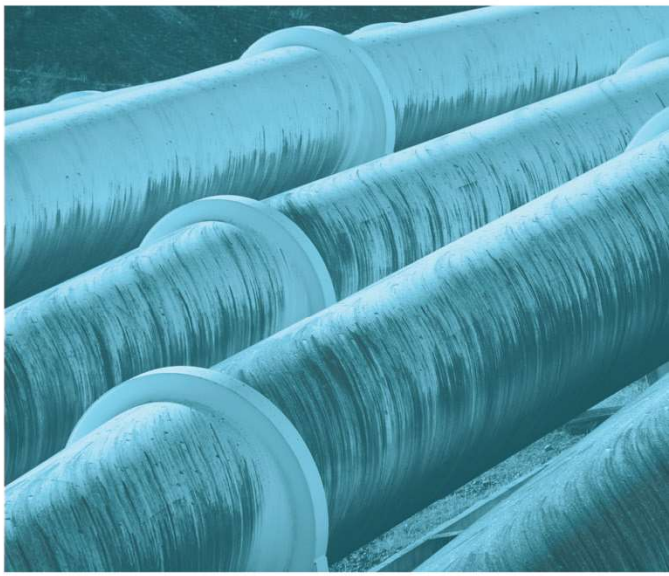



M4-M5 Link Mainline Tunnels

Operational noise and vibration review

Prepared for Acciona Samsung Bouygues Joint Venture
March 2021

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Report Number

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Client

Acciona Samsung Bouygues Joint Venture

Date

29 March 2021

Version

v14

Prepared by	**Approved by**
	
James Small/Carl Fokkema Associate 29 March 2021	**Najah Ishac** Director 29 March 2021

Executive Summary

EMM has been engaged by Acciona Samsung Bouygues Joint Venture (ASBJV) to provide operational noise and vibration design services for Stage 1 of the WestConnex 3A – M4-M5 Link Mainline tunnels project (the Project). The services cover operational road traffic and fixed facilities noise and vibration to be addressed within the Operational Noise and Vibration Review (ONVR) for the Project.

The scope of the ONVR encompasses the assessment of potential noise and vibration impacts associated with the following:

- road traffic noise impacts within the vicinity of the M4-M5 Link Mainline tunnels; and
- fixed facilities noise on adjoining development and noise sensitive receivers in accordance with E92 Conditions of Approval (CoA).

The objective of the ONVR is to document operational noise and vibration mitigation measures to minimise noise and vibration impacts to the community during operation of the Project.

ES1 Part A – Road traffic noise

The only surface road section relevant to this project that is not covered by other stages of WestConnex is a portion of Parramatta Road in the vicinity of the Parramatta Road East and West (PREW) civil sites servicing the WestConnex project. This assessment addresses potential traffic noise impacts on existing sensitive receivers due to the removal of site structures that incidentally act as noise barriers to dwellings behind the civil sites. This assessment has been undertaken to address Section 6.9 of the *Technical working paper: Noise and vibration* assessment included in Volume 2d, Appendix J of the *M4-M5 Link Environmental Impact Statement* dated August 2017.

EMM have adopted the noise targets applicable to existing roads not subject to redevelopment provided in Table 8 of the Environment Protection Authority (EPA) Road Noise Policy (RNP) as a means of determining whether mitigation measures are required to potentially affected receiver locations.

The existing case noise model has been calibrated using noise monitoring and traffic counts conducted simultaneously prior to the project construction (2014).

The noise models for projected traffic volumes have been prepared using the 2031 'design year' traffic models under a build (presence of WestConnex) and no-build (absence of WestConnex) scenario. The presence and absence of the WestConnex project will represent the presence and absence of the civil sites. The no-build scenario retains existing site structures. The build scenario includes the removal of all site structures including existing boundary fences representing the completion of the civil sites' use. A comparison of the 2031 'design year' build and no build scenarios has been undertaken to establish the level of acoustic impact from the removal of site structures and incidental acoustic screening to receivers behind.

Noise modelling indicates that traffic noise levels will generally decrease with the presence of the WestConnex project due to significant reductions in traffic volumes along Parramatta Road. The removal of site structures will however negate such benefits at currently screened receivers. Five receivers have been considered for noise mitigation due to traffic noise increases greater than 2dB(A) and where traffic noise levels exceed the RNP target noise abatement levels for existing roads.

Noise mitigation measures have been recommended in accordance with the Transport for NSW (TfNSW) noise mitigation guidelines to achieve the planning levels provided in Table 8 of the RNP.

ES2 Part B – Fixed facilities

The noise criteria outlined in the EPA's NSW Industrial Noise Policy (EPA 2000) would be met provided that the noise and vibration mitigation measures identified in this report are implemented.

The primary fixed facilities are associated with Parramatta Road Ventilation Facility (PRVF) and St Peters Interchange (SPI), including the subterranean substations. The main ventilation facilities are designed with acoustic attenuators on both the atmosphere side and the tunnel side of the fans to mitigate noise from the air path. The ventilation buildings are constructed of either precast concrete or core filled blockwork, with acoustic rated doors and fan isolation mounts to control noise and vibration levels.

Other fixed facilities including substation buildings and fire pump buildings are also constructed of precast concrete, core filled blockwork and acoustic rated doors to contain noise. Water treatment plant equipment has been selected on acoustic performance to minimise noise emissions. Rooftop mechanical plant have acoustic screens and attenuators where required.

Jet fans within the tunnel will have silencers to achieve the NR85 in tunnel noise level requirement. Fans will be selected on acoustic performance to satisfy the internal design noise level of 80dB(A) $L_{eq,1min}$ for fire isolated exits.

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ASBJVASBJV

Figures

1 Introduction

This assessment has been prepared to address potential road traffic noise impacts and environmental noise and vibration impacts from the operation of the fixed facilities on adjoining development and noise sensitive receivers within the vicinity of the WestConnex Stage 3A M4-M5 Link Mainline Tunnels (the Project). Noise and vibration impacts have been addressed in accordance with E92 of the Conditions of Approval (CoA).

The only surface road section relevant to this project that is not covered by other stages of WestConnex is a portion of Parramatta Road in the vicinity of the Parramatta Road East and West (PREW) civil site.

This assessment addresses commitments identified in Sections 6.7 and 6.9 of the *Technical working paper: Noise and vibration* assessment included in Volume 2d, Appendix J of the *M4-M5 Link Environmental Impact Statement* dated August 2017.

The aforementioned paper identifies existing structures on the proposed civil sites C1b and C3b bordering Parramatta Road which provide shielding to residential dwellings behind. These structures are to be demolished as part of the establishment of the civil sites. The potential for elevated road noise levels at residential receiver locations due to the removal of these structures is addressed in this report.

1.1 Project background and description

The WestConnex M4-M5 Link project is being constructed in two stages

- Stage 1: M4-M5 Link Mainline Tunnels; and
- Stage 2: Rozelle interchange.

WestConnex has engaged Acciona Samsung Bouygues Joint Venture (ASBJV) to design and construct Stage 1 of the project (refer Figure 1.1). The key features of the Mainline tunnels project include:

- twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel would be around 7.5 kilometres long and would generally accommodate up to four lanes of traffic in each direction;
- connections of the mainline tunnels to the M4 East project, comprising:
  - a subterranean connection to the M4 East mainline stub tunnels east of Parramatta Road near Alt Street at Haberfield;
  - entry and exit ramp connections between the mainline tunnels and the Wattle Street interchange at Haberfield (which is currently being constructed as part of the M4 East project); and
  - minor physical integration works with the surface road network at the Wattle Street interchange including road pavement and line marking.
- connections of the mainline tunnels to the New M5 project, comprising:
  - a subterranean connection to the New M5 mainline stub tunnels north of the Princes Highway near the intersection of Mary Street and Bakers Lane at St Peters;
  - entry and exit ramp connections between the mainline tunnels and the St Peters interchange at St Peters (which is currently being constructed as part of the New M5 project); and

- minor physical integration works with the surface road network at the St Peters interchange including road pavement and line marking.

- construction of tunnel stubs to provide for future underground connection of the mainline tunnels to the Rozelle interchange and Iron Cove Link;

- a motorway operations complex at St Peters (Campbell Road) (MOC5). The types of facilities that would be contained within the motorway operations complexes would include substations, water treatment plants, ventilation facilities and outlets (the Campbell Road ventilation facility), offices, on-site storage and parking for employees;

- tunnel ventilation systems, including ventilation supply and exhaust facilities, ventilation fans, ventilation outlets and ventilation tunnels;

- fit out (mechanical and electrical) of part of the Parramatta Road ventilation facility at Haberfield (which is currently being constructed as part of M4 East project) for use by the M4-M5 Link project;

- drainage infrastructure to collect surface and groundwater for treatment at dedicated facilities;

- water treatment would occur at the operational water treatment facility at the Campbell Road motorway operations complex;

- ancillary infrastructure and operational facilities for electronic tolling and traffic control and signage (including electronic signage);

- emergency access and evacuation facilities, including pedestrian and vehicular cross and long passages and fire and life safety systems;

- utility works, including protection and/or adjustment of existing utilities, removal of redundant utilities and installation of new utilities;

- temporary construction ancillary facilities to facilitate construction of the project at the following locations:

  - Northcote Street civil and tunnel site (C3a), Haberfield;

  - Haberfield civil site (C2b), Haberfield;

  - Parramatta Road East civil site (C3b), Haberfield;

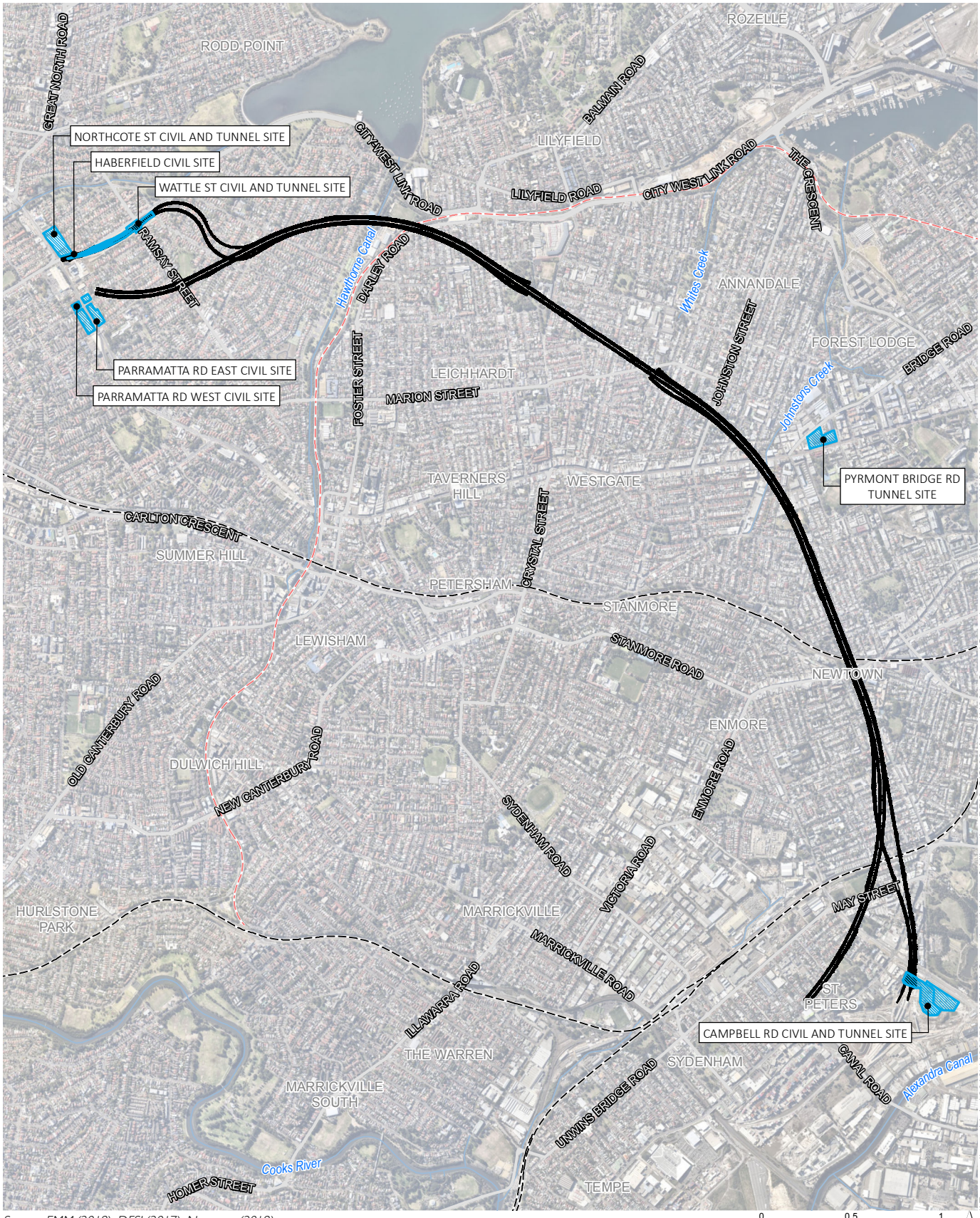
  - Parramatta Road West civil site (C1b), Ashfield;

  - Wattle Street civil and tunnel site (C1a), Haberfield;

  - Pyrmont Bridge Road tunnel site (C9), Camperdown/Annandale;

  - Campbell Road civil and tunnel site (C10), St Peters; and

  - White Bay civil site (C11), Rozelle.



Source: EMM (2019); DFSI (2017); Nearmap (2019)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Site boundary
- M4 - M5 Link tunnel alignment

Existing features

- Light rail
- Rail line
- Arterial road
- Watercourse / drainage line

M4-M5 Link

Westconnex M4-M5 Link Tunnels
Operational noise and vibration review
Figure 1.1

EMM

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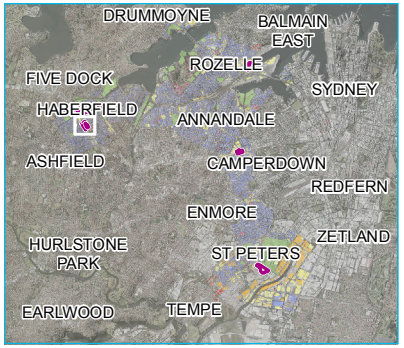
1.2 Scope of the road traffic noise assessment

A technical working paper was prepared by SLR (2017) for the M4-M5 Link EIS (herein referred to as the EIS Noise and Vibration Impact Assessment (EIS NVIA)). Section 6.9 of the paper discusses potential road traffic noise impacts associated with the demolition of structures on the Parramatta Road East (C3b) and Parramatta Road West civil sites (C1b) or collectively referred to as Parramatta Road East West (PREW). PREW comprises four areas on the eastern and western sides of Parramatta Road at the junction of Alt Street as shown in Figure 1.2.

The commercial structures on the site incidentally acted as acoustic screens to Parramatta Road traffic for residential buildings behind. The removal of these structures may potentially increase exposure to traffic noise for these residential receiver locations, as such this assessment was undertaken.

The EIS NVIA does not identify any specific measures to address noise associated with the removal of structures on the PREW sites, and requires that this be considered as part of the detail design.

This assessment identifies potential increases in traffic noise at sensitive receiver locations post the removal of existing site structures. During works, hoarding is utilised but will be removed once works are complete. The assessment assumes the worst case, that all of the structures on the site have been removed.



KEY

- Gate
- Site boundary
- Building to be demolished
- Potentially triggered receiver

Source: EMM (2019); LendLease (2019); DFSI (2017); Nearmap (2019)

0 50 100 m

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emmJobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N003_HO3bNoise_20190919_02.mxd 19/09/2019

Parramatta Road east and west – site structures and potentially triggered receivers

Westconnex M4-M5 Link Tunnels
Operational noise and vibration review
Figure 1.2

EMM

1.3 Scope of the fixed facilities assessment

The fixed facility sites considered in this report are associated with:

1. Parramatta Road Ventilation Facility (PRVF) comprising:
    a) ventilation exhaust and supply building;
    b) substation; and
    c) fire pumps and water tanks.
2. St Peters Interchange (SPI) comprising:
    a) ventilation exhaust building;
    b) fresh air supply building;
    c) substation;
    d) fire pumps and water tanks;
    e) water treatment plant; and
    f) Ancillary facilities – telecommunications, tolling, etc.

The operational fixed plant and equipment requiring consideration for noise mitigation measures are:

- tunnel ventilation plant (exhaust and supply air fans) located within buildings;
- in tunnel jet fans;
- fire isolated exit fans;
- HVAC plant associated with substations, fire pump buildings and water treatment; and
- noise breakout from operation of substations, fire pump buildings and water treatment.

1.4 Verification of ONVR

The ONVR was reviewed and endorsed by the Acoustic Advisor (Refer to Appendix E) prior to its lodgement with DPIE for review, comment and approval. Edits made to the document following the Acoustic Advisors endorsement and prior to DPIE approval have been editorial only and do not affect the outcomes of the review.

The ONVR has also been reviewed and verified by suitably qualified and experienced expert in Mr Najah Ishac consistent with the requirements of Condition E92 of the CoA. Refer to Appendix EF for Mr Ishac's CV.

2 Environmental and legal obligations

2.1 Conditions of approval

The project Conditions of Approval (CoA) E92 issued on 17 April 2018 requires that an ONVR be prepared to address noise and vibration impacts associated with the operation of the SSI. The CoA relevant to the assessment of the ONVR are highlighted in Table 2.1

Table 2.1 Project requirements for road traffic noise (CoA)

Condition no.	Requirement	Reference in this document
A2	The CSSI must be carried out in accordance with all procedures, commitments, preventative actions, performance criteria and mitigation measures set out in the documents listed in Condition A1 unless otherwise specified in, or required under, this approval.	Refer to Section 2.4.2, and Section 4
E92	The Proponent must prepare an Operational Noise and Vibration Review (ONVR) to confirm noise and vibration control measures that would be implemented for the operation of the SSI. The ONVR must be prepared in consultation with the Department, relevant council(s), other relevant stakeholders and the community and must:	Refer to Section 2.5
(a)	confirm the appropriate operational noise and vibration objectives and levels for adjoining development, including existing sensitive receivers;	Sections 3 & 8
(b)	confirm the operational noise predictions based on the final design. Confirmation must be based on an appropriately calibrated noise model (which has incorporated noise monitoring, and concurrent traffic counting, where necessary for calibration purposes). The assessment must specifically include verification of noise levels at all fixed facilities, based on noise monitoring undertaken at appropriately identified noise catchment areas surrounding the facilities;	Section 5 Verification of noise levels from fixed facilities to be conducted in accordance with E95.
(c)	confirm the operational noise and vibration impacts at adjoining development based on the final design of the CSSI, including operational daytime $L_{Aeq,\ 15\ hour}$ and night-time $L_{Aeq,\ 9\ hour}$ traffic noise contours;	Section 5 & Appendix A
(d)	review the suitability of the operational noise mitigation measures identified in the documents listed in Condition A1 and, where necessary, investigate, identify and implement additional noise and vibration mitigation measures required to achieve the noise criteria outlined in the NSW Road Noise Policy (DECCW, 2011) and NSW Industrial Noise Policy (EPA, 2000), including the timing of implementation;	Sections 6, 11 & 12
(e)	include a consultation strategy to seek feedback from directly affected landowners on the noise and vibration mitigation measures; and	Section 15
(f)	procedures for the management of operational noise and vibration complaints.	Section 16
	The ONVR is to be verified by a suitably qualified and experienced noise and vibration expert. The ONVR is to be undertaken at the Proponent's expense and submitted to the Secretary for approval prior to the implementation of mitigation measures. The Proponent must implement the identified noise and vibration control measures and make the ONVR publicly available.	Section 1.4
E95	Within 12 months of the commencement of operation of the CSSI, the Proponent must undertake monitoring of operational noise to compare actual noise performance of the CSSI against the noise performance predicted in the review of noise mitigation measures required by Condition E92. The Proponent must prepare an Operational Noise Compliance Report to document this monitoring. The Report must include, but not necessarily be limited to:	To be undertaken within 12 months of the

Table 2.1 Project requirements for road traffic noise (CoA)

Condition no.	Requirement	Reference in this document
(a)	noise monitoring to assess compliance with the operational noise levels predicted in the review of operational noise mitigation measures required under Condition E92;	commencement of operation.
(b)	a review of the operational noise levels in terms of criteria and noise goals established in the NSW Road Noise Policy 2011;	
(c)	methodology, location and frequency of noise monitoring undertaken, including monitoring sites at which CSSI noise levels are ascertained, with specific reference to locations indicative of impacts on sensitive receivers;	
(d)	details of any complaints and enquiries received in relation to operational noise generated by the CSSI between the date of commencement of operation and the date the report was prepared;	
(e)	any required recalibrations of the noise model taking into consideration factors such as noise monitoring and actual traffic numbers and proportions;	
(f)	an assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of mitigation measures; and	
(g)	identification of additional measures to those identified in the review of noise mitigation measures required by Condition E92, that would be implemented with the objective of meeting the criteria outlined in the NSW Road Noise Policy (EPA, 2011) and Industrial Noise Policy (EPA, 2000), when these measures would be implemented and how their effectiveness would be measured and reported to the Secretary and the EPA.	
	The Operational Noise Report must be submitted to the Secretary and the EPA within 60 days of completing the operational noise monitoring and made publicly available.	

2.2 Environmental Management Measures

The revised environmental management measures (REMMs) required for the project as referenced from the Submissions and Preferred Infrastructure Report (SPIR) and are detailed in Table 2.2.

Table 2.2 Environmental Management Measures for road traffic noise

REMM No.	REMM details	Reference in this document
NV10	Where reasonable and feasible, operational noise mitigation such as noise barriers, berms and at-property treatments identified during detailed design should be installed early in the project so as to provide a benefit to receivers during the construction phase of the project.	At receiver acoustic treatments have been installed as early in the project as possible as part of the NIP. This review needed to be completed in order to identify that two additional rooms of 18/115 Alt Street triggers the need for treatment. Treatment offers have been made to the owner.
NV11	Open Graded Asphalt (OGA) or equivalent will be investigated during detailed design taking into account whole life engineering considerations and the overall social, economic and environmental effects. If low noise pavement is found to be appropriate, it will be considered as a management measure when assessing operation noise impacts based on the detailed design.	Alteration of the road surface is not relevant to this study due to the project being a tunnel. The area of Parramatta Road applicable to this assessment is not being resurfaced and as such alternative road finishes are outside of available mitigation measures as discussed in Section 6.
NV13	Potential operational noise performance of the project based on the detailed design will be assessed in accordance with NSW Road Noise Policy (DECCW 2011) and appropriate management measures will be confirmed and implemented.	Section 3.1
NV14	Within 12 months of the commencement of the operation of the project, actual operational noise performance will be compared to predicted operational noise performance. The need for any additional management measures to address any identified operational performance issues and meet relevant operational noise criteria will be assessed and implemented where reasonable and feasible.	To be addressed in reporting subsequent to the commencement of operation

2.3 Legislation

Key environmental legislation relating to the management of road traffic noise includes:

- refer to conditions of approval in Section 2;
- Environmental Planning and Assessment Regulation 2000;
- Protection of the Environment Operations Act 1997;
- Protection of the Environment Administration Act 1991;
- Environment Planning and Assessment Act 1979; and
- Local Government Act 1993.

2.4 Guidelines and referenced documentation

Documentation referenced in this assessment are listed below.

2.4.1 Guidelines

- Road Noise Policy (RNP), NSW EPA, March 2011;
- Noise Criteria Guideline (NCG), NSW Roads and Maritime Services, April 2015;
- Noise Mitigation Guideline (NMG), NSW Roads and Maritime Services, April 2015;
- Noise wall design guideline, NSW Roads and Maritime Services, March 2016;
- Draft At-Receiver Noise Treatment Guideline, NSW Roads and Maritime Services, June 2017; and
- Noise Model Validation Guideline (NMVG), NSW Roads and Maritime Services May 2018.

2.4.2 Referenced project documentation

- SLR (2017) *WestConnex M4-M5 Link Technical working paper: Noise and Vibration* prepared as part of the EIS for Roads and maritime services by SLR Consulting Australia Pty Ltd (EIS NVIA);
- SLR (2015) *WestConnex M4 East Project Construction and Operational Noise and Vibration Impact Assessment – Noise and Vibration Technical Paper* prepared as part of the EIS for Roads and maritime services by SLR Consulting Australia Pty Ltd; and
- ASBJV (2019) M4-M5 Link Mainline Tunnels *Noise Insulation Program – Noise and Vibration Management Sub-plan (NIP)* prepared to satisfy Condition E89 of the CoA SSI-7485.

2.5 Preparation and Consultation of the ONVR

This ONVR was provided to the Department of Planning, Industry and Environment (DPIE), Inner West Council, TfNSW, AA and the directly affected community for consultation. The EPA turned down the offer to review the document.

Community consultation on the ONVR was carried out through a program of targeted face to face contacts with the directly affected property owners around the Parramatta Road East and West sites and the Parramatta Road Ventilation Facility.

The face to face consultation involved contacting the directly affected properties via a doorknock or email/phone to offer meetings at their premises or at the Community Information Centre to explain the ONVR findings and recommendations. This engagement occurred between 7 September and 30 November 2020.

Residents that were not at home were left a 'sorry we missed you' card requesting they contact the Project team to discuss the draft ONVR.

Further, on 30 November, letters were sent to 29 properties to advise:

- that 15 properties were not eligible for at-property acoustic treatment under the ONVR due to proposed installation of acoustic fence
- that for 8 properties previously treated under the Noise Insulation Program (NIP), no further treatments are required as part of the ONVR.
- that 6 properties are still eligible for at-property acoustic treatment as per NIP and/or the ONVR but they have not yet accepted issued offers.

All of the 29 property owners were invited to provide written feedback on the proposed noise and vibration mitigation measures by close of business 14 December 2020 so that their comments can be considered as the ONVR is progressed through the required approvals.

No written submissions were received from the community however a verbal submission has been received from a property owner in Alt Street requesting that the existing 4m tall brick wall on the boundary between their property and the current Parramatta Road East site remains in place. This request will be passed onto TfNSW for a decision.

A hard copy of the Draft ONVR was also made available at the Community Information Centre and the final version will be uploaded to the project website.

Inner West Council (IWC) was provided an update the outcomes of the ONVR consultation on 19 March 2021.

Part A

Road traffic noise assessment

3 Operational noise criteria

3.1 NSW Road Noise Policy

The NSW Government issued the Road Noise Policy (RNP) on 1 July 2011. The document identifies strategies that address the issue of road traffic noise from:

- existing roads;
- new road projects;
- road redevelopment projects; and
- new traffic-generating developments.

Acoustic criteria used to address potential road noise impacts are provided in Table 3 of the RNP as shown in Table 3.1

Table 3.1 Road traffic noise assessment criteria for residential land uses (Table 3, RNP)

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m. – 10p.m.)	**Night (10 p.m. – 7 a.m.)**
Freeway / arterial / sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (15\ hour)}$ 55 (external)	$L_{Aeq,\ (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
Local roads	4. Existing residences affected by noise from new local road corridors	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)
	5. Existing residences affected by noise from redevelopment of existing local roads		
	6. Existing residences affected by additional traffic on existing local roads generated by land use developments		

Note: Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near busy roads (see Appendix C10, RNP).

Further to the above criteria, noise targets for existing roads not subject of redevelopment are provided in RNP Table 8 as shown in Table 3.2.

Table 3.2 Target noise abatement levels for existing roads not subject to redevelopment

Existing road category	Target noise level – dB(A)	
	Day (7 a.m. – 10 p.m.)	**Night (10 p.m. – 7 a.m.)**
Freeway /arterial/sub-arterial road	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
Local roads	$L_{Aeq, (1\ hour)}$ 55 (external)	$L_{Aeq, (1\ hour)}$ 50 (external)

The RNP notes the following with regard to targets provided in Table 8.

> For existing roads where no redevelopment is taking place, the primary role of the RNP is to provide a basis for measuring and defining the extent of any existing traffic noise impacts. The target levels in Table 8 are provided as a guide to assessing impacts rather than as achievable targets.

The target levels in Table 8 of the RNP may be used as a basis for addressing impacts from existing roads and, in the absence of specific criteria in the RNP, have been used to address potential noise impacts from the removal of PREW site structures. This assessment has been prepared to address a potential increase in road traffic noise post the demolition of existing structures not part of the road corridor.

3.2 RMS Noise Criteria Guideline

The NCG documents TfNSW's interpretation of the RNP and provides a consistent approach to identifying road noise criteria for TfNSW projects. Noise criteria are assigned to sensitive receivers using the NCG. The NCG provides guidance on how to implement the RNP.

The NCG follows four principles in the assessment of acoustic impacts from road projects. The principles are:

1. *Criteria are based on the road development type a residence is affected by due to the road project;*
2. *Adjacent and nearby residences should not have significantly different criteria for the same road;*
3. *Criteria for the surrounding road network are assessed where a road project generates an increase in traffic noise greater than 2dBA on the surrounding road network; and*
4. *Protect existing quiet areas from excessive changes in amenity due to traffic noise.*

Road project classifications from the NCG are provided in Table 3.3.

Table 3.3 TfNSW Road Project Classification

Road project classification	Description
New road	• A project proposes road construction in an undeveloped corridor • A road project changes the functional class of the road • A widening, curve straightening or adjustment of the corridor where the upgrade road pavement has been substantially realigned • A duplication where the new lanes have been substantially realigned from the existing corridor in which case the existing lanes are also assessed as a new road development type • A bypass where the upgraded road extends beyond the existing road corridor.
Redeveloped road	• Widening/adjustment of the corridor where the road segment (including duplicated carriageway) has not been substantially realigned • Duplication of a carriageway adjacent and parallel with the existing road corridor where the widened road has not been substantially realigned • Duplication of a carriageway wholly within an existing corridor • Introduction of on or off ramps to provide access through an intersection that was previously inaccessible for that direction.
Transition zone	A transition zone is the junction between new and redeveloped roads or different functional classes.
Minor works	Some works may be primarily to improve safety. This may include minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments. These works are not considered redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic.

3.3 Guidance on the evaluation of mitigation measures

The RMS Noise Mitigation Guideline (NMG) provides guidance in managing and controlling road traffic generated noise and describes the principles to be applied when reviewing noise mitigation. The NMG recognises that the criteria recommended by the NCG are not always practicable and that it is not always feasible or reasonable to expect that they should be achieved.

The NMG provides three triggers where a receiver may qualify for consideration of noise mitigation (beyond the adoption of road design and traffic management measures). These are:

Trigger 1

The predicted Build noise level exceeds the NCG controlling criterion and the noise level increase due to the project (ie the noise predictions for the Build minus the No Build) is greater than 2dB(A).

Trigger 2

The predicted Build noise level is 5dB(A) or more above the NCG controlling criterion (exceeds the cumulative limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the project.

Trigger 3

The noise level contribution from the road project is acute (daytime $L_{Aeq(15hour)}$ 65 dB(A) or higher, or night-time $L_{Aeq(9hour)}$ 60 dB(A) or higher) even if noise levels are dominated by a non-project road.

The eligibility of receivers for consideration of additional noise mitigation (over and above road design and traffic management measures) is determined before the benefit of additional noise mitigation (low noise pavement and noise barriers) is included. The requirement for the project is to provide feasible and reasonable additional mitigation for these eligible receivers to meet the NCG controlling criterion. As highlighted in the NMG, once noise has been minimised by feasible and reasonable methods during the corridor planning and road design stages, triggered receivers with residual exceedances of the NCG controlling criteria shall be assessed to determine if they qualify for additional noise mitigation.

4 Background studies

Traffic noise levels prior to the construction of the project were established in the EIS NVIA.

The section of Parramatta Road adjacent the PREW sites is not assessed in the EIS NVIA as it is not generally applicable to the M4-M5 Link project area. The M4 East project addresses traffic noise along Parramatta Road given the M4 East to Parramatta Road interchange south of the PREW sites.

In the absence of traffic noise levels and traffic volumes in the EIS NVIA for this section of Parramatta Road, this assessment has been based on the following:

- traffic noise levels from the M4 East SLR (2015) report which is representative of traffic volumes and traffic noise levels at the outset of the project; and
- projected traffic volumes for the 'design year' from the M4 East SLR (2015) report.

For road project assessments, it is required to assess traffic noise levels for a 10-year design period beyond the 'opening year'. Although the site will likely be redeveloped following the vacancy of the PREW sites, ie for the 'opening year', the 2031 'design year' volumes have been adopted.

4.1 Existing noise levels

Existing traffic noise levels are based on the unattended noise monitoring conducted as part of the M4 East EIS. Noise data from this monitoring period is detailed in Table 7 of the SLR (2015) report as shown in Table 4.1. Traffic noise levels recorded during this time are representative of traffic noise levels prior to construction works.

Table 4.1 Existing traffic noise levels

Location	Measured traffic noise levels, dB	
	$L_{Aeq\ 15hr}$ Day	$L_{Aeq\ 9hr}$ Night
L13 – 119 Alt Street, Ashfield	60	56
L14 – 135 Bland Street, Haberfield	68	65

Note: The L14 location is relatively more exposed to Parramatta Road traffic than L13.

The traffic noise levels presented in Table 4.1 were utilised to calibrate the existing traffic noise model established using the traffic volumes undertaken simultaneously with the unattended noise monitoring.

4.2 Traffic volume data

4.2.1 Existing traffic volumes

Traffic volumes have been adopted from the traffic surveys undertaken by SLR as part of the EIS as presented in Appendix F1a of the SLR (2015) report. Volumes relevant to the study area have been adopted from the counts conducted along Parramatta Road at Bland Street.

Table 4.2 Existing traffic volumes (counts conducted concurrently with noise monitoring between 26 March to 9 April 2014)

Location	Direction of travel	Day – 7am to 10pm			Night – 10pm to 7am		
		Vehicles	Heavy vehicles %	Speed	Vehicles	Heavy vehicles %	Speed
Parramatta Road at Bland Street	Westbound	21,056	6.5	52	4,501	7.4	56
	Eastbound	22,010	7.1	53	5,317	11.6	54

4.2.2 Projected traffic volumes

Future traffic projections for the no-build scenarios have been adopted from Appendix F2b of the SLR (2015) report. Each scenario is based on the 2031 'design year'. Volumes relevant to the study area are provided in Table 4.3.

Table 4.3 Project Traffic Volumes (SLR 2015)

Location	Day – 7am to 10pm			Night – 10pm to 7am		
	Vehicles	Heavy vehicles	Speed	Vehicles	Heavy vehicles	Speed
Parramatta Road at Bland Street (2031) – no build	41,335	3,885	60	8,428	738	60
Parramatta Road at Bland Street (2031) - build	18,566	555	60	4,400	140	60

Note: The drop in the traffic volumes for 2031 no build scenario as compared to current (Table 4.2) is not explained in previous studies.

5 Traffic noise predictions

5.1 Assessment Methodology

The assessment methodology considered several scenarios as follows:

1. 2015 (existing) scenario – Incorporates traffic volumes undertaken concurrently with unattended noise monitoring prior to works being conducted on the WestConnex project. This will provide a baseline validation for our model for determining future impacts;

2. 2031 'design year' no-build scenario - Incorporates future traffic volumes in the absence of the WestConnex project to 2031. All structures on the civil sites are retained as existing;

3. 2031 'design year' build scenario - Incorporates future traffic volumes with the incorporation of the WestConnex project to 2031. All structures on the civil sites are demolished following the completion of the project;

4. A comparison is conducted of the no-build (retaining existing structures) and build scenarios (removal of all site structures) subsequent to the 2031 'design year'; and

5. For Item 4, where noise levels exceed the 2dB(A) increase trigger, noise levels are then compared against the RNP trigger levels. Where future traffic noise levels exceed the RNP trigger levels, remedial measures should be explored in accordance with the NMG.

5.2 Road Traffic Noise Model

5.2.1 Modelling Inputs

Traffic noise along Parramatta Road has been previously modelled in the SLR (2015) study. The noise model was prepared using the SoundPlan™ noise modelling software. Modelling parameters in this assessment have been based on those included in the SLR (2015) study.

Guidance was taken from the NMVG as to standard parameters required by TfNSW in establishing a robust noise model. Modelling inputs are provided in Table 5.1.

Table 5.1 Modelling standard parameters

Modelling Parameter	Input
Model	CoRTN Australia (NSW) – adaption included for Australian conditions
Vehicle speed and volumes	EIS traffic survey and projected traffic volumes SLR (2015) – refer Table 4.2 and Table 4.3 of this document
Elevation contours	Adopted from DEM of Australia derived from LiDAR 5 metre grid
Source heights and corrections – consistent with SLR (2015)	0.5m for car exhausts (0.0dB) 0.5m for truck tyre noise (-5.4dB) 1.5m for truck engines (-2.4dB) 3.6m for truck exhausts (-8.5dB)

Table 5.1 Modelling standard parameters

Modelling Parameter	Input
Pavement correction	0dB for dense graded asphalt – as per Table 16, SLR (2015)
Receiver height	1.5m above ground for single storey / ground floor 4.3m above ground for first floor 7.1m for second floor
Ground factor (consistent with NMVG)	50% over residential areas 75% over open grass 0% over water
Noise contours	Grid space 20m 1.5m for ground level 4.3m for first floor
Façade correction	+2.5dB(A) at 1m from façade
Australian Road Research Board (ARRB)	-1.7dB(A) for façade corrections -0.7dB(A) for free-field corrections
L_{A10} to L_{Aeq} correction	-3dB(A)
Congestion	No correction has been applied for congestion consistent with Table 16 of SLR (2015)
Sensitivity allowance adopted for build/no-build models - refer Section 6.7 of EIS NVIA	+1dB(A)

5.2.2 Model Validation

Consistent with NMVG, the noise model has been compared against measured noise levels at the site to determine the acceptability of any predictive error.

Table 5.2 Road noise model validation

Location	Traffic noise level, dB(A) $L_{eq\ 15\ hour}$			Traffic noise level, dB(A) $L_{eq\ 9\ hour}$		
	Predicted	Measured	Error	Predicted	Measured	Error
L13 – 119 Alt Street, Ashfield	60.1	60.5	-0.4	56.7	56.8	-0.1
L14 – 135 Bland Street, Haberfield	67.4	67.9	-0.5	64	65.5	-1.5
Median Error	-	-	-0.5	-	-	-0.8

The median error for the road segment encompassing the civil sites falls within +/-1dB(A) and as such is considered acceptable without justification or additional calibration consistent with the NMVG.

There are no proposed changes to Parramatta Road, and as such, alterations to the modelled standard parameters are limited to:

- road traffic volumes and heavy vehicle percentages; and
- vehicle speed set to design of 60km/h consistent with the EIS.

5.3 Traffic noise predictions

Traffic noise predictions for the 2031 'build/no-build' scenarios are provided in Table 5.3. Noise predictions for the apartment blocks at 115 Alt Street, Ashfield and 124 Bland Street, Ashfield are provided for even spacing across each façade. Traffic noise levels at individual apartments within each block are provided in Section 6.

Table 5.3 Traffic noise predictions – 2031 build v no-build comparison

Receiver	Floor	Direction	Traffic noise level, dB $L_{Aeq\ 15hr}$					Traffic noise level, dB $L_{Aeq\ 9hr}$				
			2031 'no build'	2031 'build'	Change	Exceeds $L_{Aeq\ 15hr}$ criteria	Qualify for mitigation	2031 'no build'	2031 'build'	Change	Exceeds $L_{Aeq\ 9hr}$ criteria	Qualify for mitigation
142 Alt Street	GF	SE	62	61	-0.5	Yes	No	58	57	-0.8	Yes	No
142 Alt Street	GF	SW	56	63	7.6	Yes	Yes	52	59	7.4	Yes	Yes
119 Alt Street	GF	NE	56	62	6.2	Yes	Yes	52	58	6.0	Yes	Yes
119 Alt Street	GF	NW	63	59	-3.8	No	No	59	55	-4.0	No	No
115 Alt Street	GF	SE	50	61	10.9	Yes	Yes	46	57	10.7	Yes	Yes
115 Alt Street	F 1	SE	53	61	8.4	Yes	Yes	49	57	8.2	Yes	Yes
115 Alt Street	F 2	SE	56	61	5.2	Yes	Yes	52	57	4.9	Yes	Yes
115 Alt Street	GF	NW	50	63	12.1	Yes	Yes	46	58	11.9	Yes	Yes
115 Alt Street	F 1	NW	53	64	10.9	Yes	Yes	49	59	10.6	Yes	Yes
115 Alt Street	F 2	NW	56	64	8.6	Yes	Yes	52	60	8.3	Yes	Yes
115 Alt Street	GF	NW	49	57	8.1	No	No	45	53	7.9	No	No
115 Alt Street	F 1	NW	53	59	6.7	No	No	49	55	6.5	No	No
115 Alt Street	F 2	NW	57	60	3.5	No	No	53	56	3.2	Yes	Yes
115 Alt Street	GF	NE	55	57	1.4	No	No	51	52	1.3	No	No
115 Alt Street	F 1	NE	58	58	0.5	No	No	54	54	0.3	No	No
115 Alt Street	F 2	NE	60	60	-0.9	No	No	56	55	-1.2	No	No
115 Alt Street	GF	NE	51	63	12.3	Yes	Yes	47	59	12.1	Yes	Yes
115 Alt Street	F 1	NE	54	64	9.9	Yes	Yes	50	60	9.8	Yes	Yes

Table 5.3 Traffic noise predictions – 2031 build v no-build comparison

Receiver	Floor	Direction	Traffic noise level, dB $L_{Aeq\ 15hr}$					Traffic noise level, dB $L_{Aeq\ 9hr}$				
			2031 'no build'	2031 'build'	Change	Exceeds $L_{Aeq\ 15hr}$ criteria	Qualify for mitigation	2031 'no build'	2031 'build'	Change	Exceeds $L_{Aeq\ 9hr}$ criteria	Qualify for mitigation
115 Alt Street	F 2	NE	58	65	6.6	Yes	Yes	54	60	6.3	Yes	Yes
124 Bland Street	GF	NE	61	64	2.8	Yes	Yes	57	59	2.6	Yes	Yes
124 Bland Street	F 1	NE	63	64	1.6	Yes	No	59	60	1.4	Yes	No
124 Bland Street	F 2	NE	64	65	0.6	Yes	No	60	60	0.3	Yes	No
124 Bland Street	GF	NE	58	64	5.8	Yes	Yes	54	60	5.7	Yes	Yes
124 Bland Street	F 1	NE	60	64	4.1	Yes	Yes	56	60	3.8	Yes	Yes
124 Bland Street	F 2	NE	63	65	2.0	Yes	Yes	59	60	1.8	Yes	No
124 Bland Street	GF	NW	49	60	11.4	No	No	45	56	11.3	Yes	Yes
124 Bland Street	F 1	NW	52	61	9.1	Yes	Yes	48	57	8.8	Yes	Yes
124 Bland Street	F 2	NW	55	61	6.5	Yes	Yes	51	57	6.2	Yes	Yes
124 Bland Street	GF	SE	62	59	-2.8	No	No	58	55	-3.0	No	No
124 Bland Street	F 1	SE	63	60	-3.2	No	No	59	56	-3.4	Yes	No
124 Bland Street	F 2	SE	64	61	-3.5	Yes	No	60	56	-3.7	Yes	No
136 Bland Street	GF	SE	64	60	-4.6	No	No	60	56	-4.8	Yes	No
136 Bland Street	GF	SW	67	65	-2.2	Yes	No	63	60	-2.4	Yes	No
137 Alt Street	GF	NW	66	62	-3.7	Yes	No	62	58	-4.0	Yes	No
137 Alt Street	GF	SW	55	67	11.8	Yes	Yes	51	62	11.5	Yes	Yes

Note: Criteria based on 60 dB $L_{Aeq\ 15\ hr}$ and 55 dB $L_{Aeq\ 9\ hr}$

5.4 Discussion of traffic noise levels

With regard to the model we provide the following commentary:

- Reductions in the traffic volumes will result in a respective drop in noise level between the build and no-build '2031 design' noise level along Parramatta Road (ie not considering reductions in screening due to the removal of structures on the PREW site). This results in an incidental acoustic benefit of the WestConnex development as a whole whereby a proporation of surface traffic now takes the underground tunnel;

- The cause of elevated road traffic noise levels at properties adjacent the PREW is due to the removal of site structures. Whilst structures on the site will be entirely cleared, redevelopment of the sites is expected to occur promptly following the completion of the project and prior to the 2031 design year. It is envisaged that new site structures would likely reinstate or improve on screening benefits provided by existing site structures.

- Predicted noise levels indicate that the following properties are expected to experience changes in traffic noise level greater than 2dB(A) and an exceedance of the RNP target noise abatement levels for existing roads not subject to redevelopment:

    - 142 Alt Street, Haberfield;

    - 119 Alt Street, Ashfield;

    - 115 Alt Street, Ashfield;

    - 137 Alt Street, Haberfield; and

    - 124 Bland Street, Ashfield.

- The aforementioned properties will be considered for noise mitigation.

6 Noise mitigation measures

6.1 Available mitigation measures

As per Section 7.4 of the NMG, where there is no road project, noise mitigation measures are considered where feasible within the constraints of the existing road corridor and generally includes:

1. noise barriers; and

2. at-property treatments.

Surface treatments to Parramatta Road would not be considered reasonable in this instance given that there is no road project proposed for this section of Parramatta Road.

On this basis, noise mitigation considers noise barriers and at-property treatments. Predicted noise levels indicate that five properties will be eligible for consideration for noise mitigation. Consideration is also given to properties which have been offered treatment under the M4-M5 Link Mainline Tunnels *Noise Insulation Program* (NIP).

6.2 Noise barriers

Noise barriers may be utilised to mitigate traffic noise from a road project. In comparison with at-property treatments, utilising noise barriers provides benefits to maintaining acoustic amenity to external areas within the property boundary as well as maintaining suitable internal noise levels without additional treatment to the building fabric.

However, in certain circumstances noise barriers can have disadvantages, particularly when not constructed within a road reserve as is the case here.

Section 6.6 of the EIS NVIA provides discussion on such issues which may be used to determine whether a noise barrier would be a feasible and reasonable option. This includes:

- potential visual impacts;
- potential urban design impacts;
- potential community safety/crime prevention considerations such as isolated walkways;
- impacts of a barrier on traffic and pedestrian connectivity;
- potential overshadowing impacts;
- form of future development of the residual land which may itself provide a barrier to traffic noise; and
- preferences of the local community as gauged during the community consultation phase.

These factors will be explored in determining whether the implementation of a noise barrier represents a feasible and reasonable noise mitigation strategy following the barrier optimisation exercise.

The NMG has been utilised to consider the implications of using a noise barrier to mitigate road traffic noise impacts. The barrier assessment procedure provided in Section 8 of the NMG considers the most reasonable overall noise reduction for an affected community, taking into account the reduction in noise at affected receivers, incidental benefit from the barrier and weighing these outcomes against the cost of mitigation.

Noise barriers have been considered for the following locations:

- conservatively, boundary fences separating the PREW sites and residential receivers were not initially considered in the traffic noise model. It is expected that boundary fencing will be installed at the completion of the project. For ground floor receivers and single storey dwellings, it is expected that relatively standard solid boundary fence heights (ie 1800 mm-2100 mm) will be acoustically acceptable to achieve external noise requirements and are considered in Section 6.2.2; and

- receivers within the upper levels of the three-level apartment buildings at 115 Alt Street, Ashfield and 124 Bland Street, Ashfield would not experience the same benefit from standard boundary fence heights. As such, the design of a noise barrier with height sufficient to address external noise has been undertaken. TfNSW requires that noise barriers be addressed for up to two levels that are most affected (ie ground and level one in this case) to establish the acoustic benefit of the barrier. The barrier optimisation process provided in the NMG has been utilised for the assessment of these receptors.

6.2.1 Barrier optimisation

Barrier optimisation has been undertaken in accordance with Section 8 of the NMG. The outcomes from this assessment is as follows:

- the noise barrier will run along the southeast boundary to the extents provided in Figure 6.2;

- 28 receivers were reviewed which may benefit from the implementation of the noise barrier. These receivers are located within 115 Alt Street, Ashfield and 124 Bland Street, Ashfield. Only receivers on the ground and first floor are included in the assessment. Twelve receivers were predicted to have traffic noise levels above criteria prior to consideration of a noise barrier;

- all receivers will achieve the noise criteria with a barrier height of 4.5m. This is the maximum barrier height as defined in Section 8.2 of the NMG;

- consistent with step 2.1 of the barrier optimisation process (Section 8.4 of NMG) the initial barrier design height is calculated based on 2/3 of receivers not requiring at-property acoustic treatment with an acoustic barrier. The initial barrier design height was determined to be 4m;

- barrier and receiver points were calculated in accordance with Section 8.4 of the NMG;

- the barrier optimisation chart is provided in Figure 6.1. Consistent with step 5 of the barrier optimisation process, dips in the 'points' curve highlight designs with potentially higher overall community benefit and reduced weighted cost. This dip is identified at the barrier height with the lowest total points between the initial design barrier height and the maximum barrier height. The lowest point between the initial design height and maximum barrier height as shown in Figure 6.1 is at the maximum barrier height. As such the maximum design height of 4.5m is the design barrier height subject to further reasonable considerations; and

- with the maximum design height of 4.5m as the design barrier height, no residual acoustic treatments are required for receivers on the ground floor and level one. The noise barrier is capable of achieving a 5dB(A) insertion loss at representative receivers for barrier heights up to 5m high and as such is considered reasonable excepting consideration to other aspects which may be impacted by the barrier installation such as visual, urban planning, overshadowing, future development, property easement requitements, difficulty in maintenance access to the wall following sale of the land, local community preference and existing at-receiver treatments (eg mitigation provided under the NIP).

The noise barrier has been optimised with consideration to the ground and first floor receivers consistent with RNP requirements. The noise barrier would not mitigate noise impacts to second floor receivers and as such these properties are to be considered for at-property acoustic treatments.

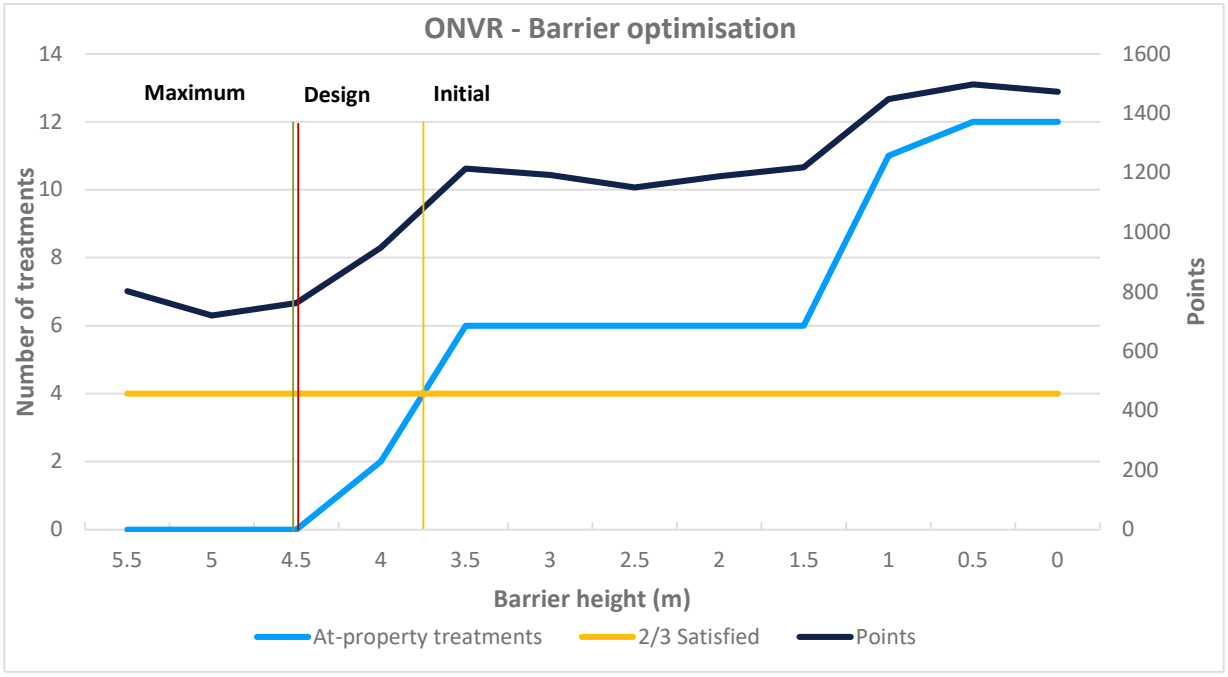


Figure 6.1 Barrier optimisation chart

6.2.2 Acoustic boundary fences

It is expected that some form of boundary fencing will be incorporated to separate the properties at the completion of the project with the demobilisation from the PREW site. Predicted noise levels incorporating a 1.8 m high solid acoustic boundary fence (similar to a typical boundary fence however with an Rw of 17) are provided in Table 6.1 and show compliance with external criteria for ground floor apartments.

The existing 4.2 m high double brick wall between the east PREW site and 137 Alt Street could be retained in lieu of demolishing the structure and reinstalling a new 1.8 m high acoustic boundary fence (subject to consultation with the resident, owner and approval of TfNSW).

The commercial properties at 201-203 Parramatta Road, Haberfield are marked for demolition at the completion of the project as indicated in Figure 1.2. The existing structures are located along the boundary to 142 Alt Street, Haberfield and provide significant acoustic screening to this property. In the event the commercial structures on the 201-203 Parramatta Road property are retained, additional acoustic boundary fences for the purposes of noise mitigation will not be required.

By nominating an acoustic type fence to these boundaries, these structures would enact the noise mitigation for these receivers.

Table 6.1 Predicted traffic noise level with acoustic boundary fencing (1.8 m high)

Receiver location	Level	Traffic noise level, dB $L_{Aeq\ 15hour}$	Noise abatement criteria, dB $L_{Aeq\ 15hour}$	Traffic noise level, dB $L_{Aeq\ 9hour}$	Noise abatement criteria, dB $L_{Aeq\ 9hour}$
115 Alt Street	Ground floor	59	60	54	55
119 Alt Street	Ground floor	58	60	53	55
137 Alt Street[1]	Ground floor	51	60	46	55
142 Alt Street	Ground floor	60	60	55	55
124 Bland Street	Ground floor	59	60	54	55

1. Fence of 1800mm from receiver ground RL.

Solid barriers are to be incorporated continuously along the boundary between receiver locations and the PREW sites as indicated in Figure 6.2. The barriers are to be constructed with no gaps. The location and height of the barriers would result in minimal ongoing maintenance.

Under normal circumstances a barrier evaluation process would be conducted to establish the cost benefit of the noise barrier and determine if the mitigation measure is feasible and reasonable. In this regard we note:

- consideration for noise mitigation would only apply to limited receivers in this instance; and
- incidental benefits of normal constructions (ie solid boundary fencing) should be considered. Upgrading boundary fencing to satisfy acoustic needs would not pose a significant imposition. This would be on the basis that acoustic boundary fence heights are within reasonable limits (ie 1.8m to 2.2m high).

The first and second (top) floors of 115 Alt Street, Ashfield and 124 Bland Street, Ashfield will not experience the same benefits by using a standard height acoustic boundary fence given the height of these receiver locations. In this regard, at-property acoustic treatments are to be considered.

6.2.3 Consideration to available acoustic treatments

In the decision-making process for noise mitigation, consideration is given to potential negative impacts of implementing a noise barrier. This is consistent with the EIS NVIA report as discussed in Section 6.2 above.

Noise barriers are preferred as they have the potential to mitigate impacts to both internal and external areas of a road noise affected receiver. However, given the heights sometimes required of these structures, these can also have negative impacts that need be considered. These are normal considerations for road side noise barriers (ie within the road corridor), whilst additional issues arise when barriers are outside the road reserve as discussed below.

Whilst a 4.5m high acoustic barrier has been deemed reasonable using the barrier optimisation process above, the process has not considered a range of potential impacts or constraints. Such impacts and constraints include visual amenity, overshadowing, urban planning, future development, noise wall maintenance, access and property easement considerations, local community preference and existing at-receiver mitigation which are discussed as follows:

- road noise barriers are typically constructed within the road corridor. In this instance, the noise barrier would be located between the existing private properties and any new building built on the PREW site, rather than within a road corridor. Upon completion of the project, separate easements would be required (and therefore sterilisation of excess land) to provide access to the noise barrier for ongoing maintenance purposes into perpetuity or life of the barrier for TfNSW;

- an acoustic barrier of 4.5 m height will have some impact on visual amenity, overshadowing and may introduce local safety concerns for receivers within 115 Alt Street, Ashfield and 124 Bland Street, Ashfield. This could be mitigated to some extent by incorporating translucent panels, however such a large structure could, for example, allow people to hide;

- consideration should not only be given to the barrier cost but also that associated with ongoing maintenance well after the project has finished. This is further exacerbated by the potential easement issues associated with access to the barrier;

- new development on the site post-project would likely reinstate screening benefits previously provided by demolished structures on the site. As such, new development would likely render the function of the noise barrier redundant;

- additional engineering concerns may need to be addressed such as potential wind tunnelling effects between two high structures (ie apartment block and 4.5m high noise barrier) and site drainage; and

- properties which require the noise barrier to comply with internal noise levels have been largely considered under the NIP. Further discussion in this regard is provided in Section 6.4.

It is noted that putting in place at-receiver treatments and the installation of “typical height” acoustic boundary fences would be more in keeping with the local urban design and as such would not need further assessment by urban designers.

In consideration of Section 6.6 of the EIS NVIA and the above disadvantages associated with implementing a 4.5m high noise barrier along the southeast boundary of the PREW, it is proposed to:

- install an acoustic boundary fence of nominally standard height (1.8 m – 2.1 m) which would mitigate noise impacts to ground floor receivers; and

- applying at-property acoustic treatments to the first and top floor of each apartment block to achieve internal road traffic noise criteria.

KEY

- Site boundary
- Retain existing brick boundary wall
- 1800 mm high acoustic fence
- 4500 mm high optimised noise barrier*
- Triggered receiver

*Refer to Section 7 for suitability of optimised noise barrier

Source: EMM (2020); Nearmap (2020); LendLease (2019); DFSI (2017)

0 50 100 m

GDA 1994 MGA Zone 56

N

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Parramatta Road east and west – recommended acoustic barriers

Westconnex M4-M5 Link Tunnels
Operational noise and vibration review
Figure 6.2

EMM

6.3 At-receiver acoustic treatments

At-receiver acoustic treatments have been considered for the multi-storey residential buildings at 115 Alt Street, Ashfield and 124 Bland Street, Ashfield.

The assessment of at-receiver acoustic treatments for first floor receivers is undertaken by ignoring the 4.5 m high noise barrier established in Section 6.2.1 and implementing a 1.8 m high acoustic boundary fence to address ground floor receivers. At-receiver acoustic treatments would be required for second floor receivers with or without such a noise barrier.

Traffic noise levels will exceed the external traffic noise targets at these locations and as such noise targets are to be achieved internally. Consistent with the EIS NVIA, internal noise targets have been established by assuming a 20dB(A) reduction across a closed façade. Applying this to the external noise targets results in internal noise targets of 40dB(A) $L_{eq\ 15\ hour}$ and 35dB(A) $L_{eq\ 9\ hour}$ respectively. These noise levels and time descriptors are consistent with the State Environmental Planning Policy (Infrastructure) 2007 (NSW).

Section 4.8.8 of the EIS NVIA refers to the RMS At-receiver Noise Treatment Guideline which requires that the following be considered:

- The build date of the property and the related conditions of consent which may require that the property has been built to account for existing high levels of road traffic noise;
- Caution should be exercised before providing treatments for buildings in a poor state of repair, as they will be less effective and may not provide any appreciable noise reduction benefit; and
- Heritage advice should be sought if the treatments have the potential to impact the heritage significance of a property. In extreme cases this could result in a decision not to proceed with a treatment on the grounds that it was not considered to be a reasonable or feasible mitigation option.

Further discussion around the implications of proposed at-receiver treatments with respect to these points is provided in Sections 6.3.1 and 6.3.2. Consistent with the At-Receiver Noise Treatment Guideline, acoustic treatments which may be considered to achieve the internal design targets of 40dB(A) $L_{eq\ 15\ hour}$ and 35dB(A) $L_{eq\ 9\ hour}$ include:

- ventilation systems that meet Building Code of Australia fresh air requirements with the windows and doors shut;
- upgraded windows, glazing and solid core doors on the exposed façades of substantial structures only (eg masonry or insulated board cladding each with sealed underfloor);
- upgrading window and door seals;
- the sealing of wall vents;
- the sealing of the underfloor below the bearers and appropriately treating sub-floors ventilation;
- roof insulation; and
- the sealing of eaves.

Guidance on suitable acoustic treatments and expected noise reduction are provided in Appendix B of the At-Receiver Noise Treatment Guideline and are reproduced in Table 6.2. The buildings at 115 Alt Street, Ashfield and 124 Bland Street, Ashfield are brick veneer construction.

Table 6.2 At-receiver acoustic treatments

Treatment category	Exceedance of noise criteria, dB(A)	Recommended acoustic treatment (where feasible and reasonable)
1	1-5	• optional ceiling fans[1] • mechanical ventilation (MV)[2,3] • new acoustic seals for windows • seal around window architraves / door jambs • seal all vents and openings
2	6-8	• as per Category 1 treatments • external solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals • upgraded laminate glazing as per Appendix B of the At-Receiver Noise Treatment Guideline.
3	9-11	• as per Category 1 treatments • external solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals • roof insulation (R4.0 215mm thick) • upgraded laminate glazing as per Appendix B of the At-Receiver Noise Treatment Guideline.
4	12-14	• as per Category 1 treatments • external solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals • roof insulation (R4.0 215mm thick) • secondary glazing as per Appendix B of the At-Receiver Noise Treatment Guideline.
5	> 14	• as per Category 1 treatments • external solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals • roof insulation (R4.0 215mm thick) • secondary glazing as per Appendix B of the At-Receiver Noise Treatment Guideline.

1 Ceiling fans may also be considered for areas in northern NSW where adverse climatic conditions prevail, as defined by Zone 2 of the Australian Building Codes Board. Road noise affected receivers in this study sit within Zone 5 and as such ceiling fans would not be considered in this instance.

2 Mechanical ventilation (MV) should be installed so that fresh air is ducted from an unaffected building facade. Mechanical fan noise should meet the recommended noise levels in AS2107.

3 Alternate means of ventilation should not provide a noise leakage path into the dwelling or create noise nuisance to surrounding receiver locations.

6.3.1 115 Alt Street, Ashfield

A detailed analysis of traffic noise levels impacting 115 Alt Street is provided in Figure 6.3. Ground floor noise levels provided in the figure do not include benefits from boundary screening provided in Table 6.1.

The residential structure is constructed from masonry. With regard to the items summarised from the RMS At-receiver Noise Treatment Guideline:

- the structure's ability to mitigate traffic noise is generally limited by noise intrusion through doors, windows and ventilation openings which can be acoustically treated under the NMG; and

- given the relatively heavy weight structure of the building façade, the condition of the building is likely suitable to adopt extensive acoustic treatment if required.

Any potential heritage impacts are to be addressed as part of the site investigation with the implementation of the ONVR.

An analysis of noise for apartments on the first and second floor of 115 Alt Street, Ashfield has been conducted using Strata Plan 3415 which was provided to EMM.

Predicted noise levels indicate several apartments will exceed the target noise abatement levels and have been considered for acoustic treatment as described in Table 6.3. Internal noise targets for the $L_{eq\ 15hour}$ and $L_{eq\ 9\ hour}$ periods have been determined assuming a 20dB(A) reduction across the façade provided by existing constructions consistent with the EIS NVIA.

Predicted external noise levels are presented for the $L_{eq\ 15hour}$ and $L_{eq\ 9\ hour}$ period. The treatment category is then determined based on the greater exceedance of the $L_{eq\ 15hour}$ or $L_{eq\ 9\ hour}$ noise target such that both are satisfied. As shown, achieving the traffic noise reductions needed for the night-time period will also mean that the internal daytime noise levels will be achieved.

KEY

- Assessment location
- 115 Alt Street
- Site boundary
- Building/structure
- Cadastral boundary

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Source: EMM (2020); Nearmap (2020); DFSI (2017)

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115 Alt Street, Ashfield
Facade noise levels

WestConnex Stage 3A
Operational noise and vibration review
Figure 6.3

EMM
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Table 6.3 At-receiver acoustic treatment requirements for 115 Alt Street, Ashfield

Level	Apartment	Facade	External noise level, dB $L_{Aeq\ 15hour}$	Internal noise requirement dB $L_{Aeq\ 15hour}$	Minimum reduction required[1]	External noise level, dB $L_{Aeq\ 9hour}$	Internal noise requirement, dB $L_{Aeq\ 9hour}$	Minimum reduction required	Acoustic treatment (refer Table 6.2)[2]
1	18	Southeast	61	40	1	56	35	1	1
		Northeast	64	40	4	59	35	4	1
	19	Northeast	63	40	3	59	35	**4**	1
	20	Northeast	63	40	3	59	35	**4**	1
	21	Northwest	59	40	-	54	-	-	-
		Northeast	63	40	3	59	35	**4**	1
2	30	Southeast	61	40	1	57	35	**2**	1
		Northeast	64	40	4	60	35	**5**	1
	31	Northeast	64	40	4	60	35	**5**	1
	32	Northeast	64	40	4	60	35	**5**	1
	33	Northwest	60	40	-	55	-	-	-
		Northeast	64	40	4	59	35	4	1

1. Minimum reduction is the exceedance of the internal noise level achieved when adopting a 20dB reduction across the existing façade.
2. Acoustic treatment category to satisfy the reduction required for the $L_{Aeq\ 15hour}$ and $L_{Aeq\ 9hour}$ internal noise level.

6.3.2 124 Bland Street, Ashfield

A detailed analysis of traffic noise levels impacting 124 Bland Street, Ashfield is provided in Figure 6.4. Ground floor noise levels provided in the figure do not include benefits from boundary screening provided in Table 6.1.

The residential structure is constructed from masonry. With regard to the items summarised from the RMS At-receiver Noise Treatment Guideline:

- the structure's ability to mitigate traffic noise is generally limited by noise intrusion through doors, windows and ventilation openings which can be acoustically treated under the NMG; and
- given the relatively heavy weight structure of the building façade, the condition of the building is likely suitable to adopt extensive acoustic treatment if required.

Any potential heritage impacts are to be addressed as part of the site investigation with the implementation of the ONVR.

An analysis of noise for apartments on the first and second floor of 124 Bland Street, Ashfield has been conducted. Predicted noise levels indicate several apartments will exceed the target noise abatement levels and have been considered for acoustic treatment as described in Table 6.4**Error! Reference source not found.**.

KEY

- Assessment location
- 124 Bland Street
- Site boundary
- Building/structure
- Cadastral boundary

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Source: EMM (2020); Nearmap (2020); DFSI (2017)

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124 Bland Street, Ashfield
Facade noise levels

WestConnex Stage 3A
Operational noise and vibration review
Figure 6.4

EMM
creating opportunities

Table 6.4 At-receiver acoustic treatment requirements for 124 Bland Street, Ashfield

Level	Apartment	Facade	External noise level, dB $L_{Aeq\ 15hour}$	Internal noise requirement dB $L_{Aeq\ 15hour}$	Minimum reduction required[1]	External noise level, dB $L_{Aeq\ 9hour}$	Internal noise requirement, dB $L_{Aeq\ 9hour}$	Minimum reduction required	Acoustic treatment (refer Table 6.2)[3]
1	3	Southeast	59[2]	N/A	N/A	55[2]	N/A	N/A	N/A
		Northeast	64	40	4	59	35	4	1
	5	Northwest	60	40	-	56	35	**1**	1
		Northeast	64	40	4	59	35	4	1
2	6	Southeast	60[2]	N/A	N/A	56[2]	N/A	N/A	N/A
		Northeast	64	40	4	60	35	**5**	1
	8	Northwest	61	40	1	56	35	1	1
		Northeast	64	40	4	60	35	**5**	1

1. Minimum reduction is the exceedance of the internal noise level achieved when adopting a 20dB reduction across the existing façade.
2. Rooms on the southeast façade do not qualify for noise mitigation as the 2031 no-build vs 2031 build does not result in a 2dB(A) increase in traffic noise level.
3. Acoustic treatment category to satisfy the reduction required for the $L_{Aeq\ 15hour}$ and $L_{Aeq\ 9hour}$ internal noise level.

6.4 Noise Insulation Program

In establishing feasible and reasonable acoustic measures to mitigate road traffic noise due to the removal of structures on the PREW sites, it is prudent to identify properties where owners have been approached and offered treatment under the NIP. The NIP identifies receivers around the site which will benefit from 'at-property' acoustic treatment due to noise sources outside the scope of this assessment.

All properties which have qualified for noise mitigation in Table 5.3, owners have been approached regarding at-property acoustic treatment under the NIP to mitigate construction noise impacts from the PREW sites. In all cases, the treatments offered under the NIP satisfy the Category 1 at-property acoustic treatments required for first floor and second floor receivers within 115 Alt Street and 124 Bland Street as discussed in Section 6.3. This factor is significant as it provides context to feasible and reasonable noise mitigation measures.

6.5 Summary of noise mitigation measures

Road noise mitigation strategies for apartments within 115 Alt Street, Ashfield and 124 Bland Street, Ashfield have been explored in Section 6.2 and Section 6.3. This has included consideration of:

- relatively standard acoustic boundary fences to mitigate road traffic noise to ground floor apartments;
- a 4.5m high noise barrier to address external road traffic noise up to the first floor apartments;
- at-property noise mitigation which may be used to achieve internal noise levels at second floor receivers and first floor receivers in lieu of a 4.5m high noise barrier.

Consideration has also been given to acoustic treatments provided to noise affected properties as part of the NIP. Properties which have been offered noise mitigation under the NIP and those requiring noise mitigation for road traffic noise are summarised in Table 6.5. Ground floor apartments have not been included as road traffic noise to these receivers would be mitigated by the installation of a solid standard height acoustic boundary fence which would typically be installed along the southwest PREW site boundary.

The summary in Table 6.5 indicates one property (Unit 18, 115 Alt Street) would require additional noise mitigation to that offered as part of the NIP. This means that the current offerings under the NIP would result in internal road traffic noise levels that would achieve the internal noise level criteria at all locations (excepting during the night period for Unit 18, 115 Alt Street) due to road traffic noise intrusion addressed under this study.

Table 6.5 Summary of road noise mitigation requirements

Property	Level	Apartment	Room	Exceeds external noise targets	External areas		Road traffic noise treatment	
					Includes balcony?	External noise levels mitigated by a 4.5m high noise barrier	Suitable at-property treatment offered under NIP	Additional at-property acoustic treatment required
115 Alt Street	1	18	Bedroom 1 & 2	Yes	No	N/A	No	Yes
			Living	Yes	Yes	Yes	Yes	No
		19	Bedroom 1 & 2	Yes	No	N/A	Yes	No
		20	Bedroom 1 & 2	Yes	No	N/A	Yes	No
		21	Living	Yes	Yes	Yes	Yes	No
	2	30	Bedroom 1 & 2	Yes	No	N/A	Yes	No
			Living	Yes	Yes	N/A	Yes	No
		31	Bedroom 1 & 2	Yes	No	N/A	Yes	No
		32	Bedroom 1 & 2	Yes	No	N/A	Yes	No
		33	Living	Yes	Yes	N/A	Yes	No
124 Bland Street	1	3	Living	Yes	Yes	Yes	Yes	No
		5	Bedroom 1 & 2	Yes	Yes	Yes	Yes	No
			Living	Yes	Yes	Yes	Yes	No
	2	6	Living	Yes	Yes	N/A	Yes	No
		8	Bedroom 1 & 2	Yes	Yes	N/A	Yes	No
			Living	Yes	Yes	N/A	Yes	No

7 Discussion

In accordance with CoA E92 d) this review has investigated and identified what additional noise mitigation measures are required due to the potential increases in traffic noise level due to the removal of structures on the PREW sites. In this regard we note:

- Given that the works are undertaken as a TfNSW project and with TfNSW's commitment to reducing traffic noise levels, the assessment has been undertaken against the target noise levels for existing roads not subject to redevelopment. It is noted that these target noise levels are provided as a guide to assessing impacts rather than as achievable targets;

- Overall traffic volumes on Parramatta Road will in fact decrease significantly overall as a result of the WestConnex project and the reduction will result in significant road traffic noise reductions for many receivers in the broader context of Parramatta Road.

  However, the absence of site structures post PREW works will negate noise benefits resulting from a reduction in traffic volumes for some receiver locations due to incidental screening benefits provided by those structures. Several receivers have been considered for noise mitigation given traffic noise levels at these locations are predicted to exceed the RNP target noise abatement levels for existing roads not subject to redevelopment;

- Target noise abatement levels will be satisfied for single level dwellings and ground floor receivers within multi-storey apartment buildings with an acoustic boundary fence of 1.8 m in height;

- A barrier optimisation analysis was undertaken for a 100m long noise barrier along the boundary separating the west PREW site and 115 Alt Street, Ashfield and 124 Bland Street, Ashfield. The analysis determined a design barrier height of 4.5 m is optimal according to the RMS NMG. No residual acoustic treatments to the ground and first floor receivers within 115 Alt Street and 124 Bland Street are required with the incorporation of this barrier. The road project is not required to meet external road traffic noise targets at the highest (second) floor of these buildings, according to the RNP. However, predicted traffic noise levels indicate that at-receiver acoustic treatment would be required.

  In consideration of Section 6.6 of the EIS NVIA, the incorporation of a 4.5m high noise barrier will likely have overshadowing, urban planning and ongoing maintenance issues.

  The noise barrier would result in road traffic noise on four residential balconies on level one of 115 Alt Street and 124 Bland Street achieving external noise targets. However, it would be unreasonable to install the noise barrier specifically for this purpose given the cost and disadvantages identified above.

- The current noise mitigation offered under the NIP will result in internal road noise meeting criteria at all properties. NIP treatment has been offered or installed at most noise affected receivers except the bedrooms of Unit 18, 115 Alt Street, Ashfield. Noise mitigation measures provided in Table 6.3 should be offered to be applied to bedrooms of this apartment to ensure that internal noise criteria are met.

- At-receiver acoustic treatment has been determined using the RMS At-Receiver Noise Treatment Guideline. Internal noise requirements will be satisfied with the noise mitigation treatments provided in Table 6.3 and Table 6.4 are implemented.

Part B

Fixed Facilities

8 Operational noise criteria

8.1 NSW Industrial Noise Policy

The EIS noise criteria for ventilation facilities are presented in Table 8.1. The location of noise catchment areas (NCAs) in relation to the project and fixed facilities is shown in the Land Use Survey in Figure 9.1 and Figure 9.2.

These criteria have been set in accordance with the NSW 'Industrial Noise Policy' (INP). The goals are for total noise from all noise sources associated with each fixed facility including:

- ventilation exhaust and supply noise;
- noise breakout from fan buildings;
- jet fan noise from portals; and
- ancillary equipment such as substation transformers, condensers and fans associated with substation buildings, fire pump buildings, and water treatment plants.

Table 8.1 Noise criteria at residences for fixed facilities, $L_{Aeq,15min}$ dB

Period	Haberfield[1]				Campbell Road[2]		
	NCA01	NCA02[3]	NCA02[4]	NCA06[5]	NCA48	NCA49	NCA50
Day	51	46	61	50	60	59	57
Evening	50	46	53	50	50	50	50
Night	43	42	47	44	45	45	44[6]

8.2 Cumulative noise

Assessment of noise emissions from the M4-M5 link fixed facilities (PRVF and SPI) has considered the noise level contributions reported for M4 East[1] and New M5[2] such that the cumulative noise levels from operation of all facilities simultaneously does not exceed the noise criteria outlined in Table 8.1. The allowable noise contributions from M4-M5 link fixed facilities (PRVF and SPI) are summarised in Table 8.2.

The predicted noise contributions reported for the M4 East ONVR results included Stage 3 (M4-M5 – this project). On the assumption that the facilities at PRVF are effectively the same for M4E and M4-M5, allowance goals for M4-M5 PRVF ventilation facilities are typically lower than the overall noise criteria. Noise contributions reported in the

1 Westconnex M4 East Operational Noise and Vibration Review dated 15 August 2018 M4E-RNZ-RP-00-440-068-001 Rev D_06, Section 9.3, Table 21

2 Westconnex New M5, Operational Noise and Vibration Review (ONVR) dated 4 July 2018 Report TH014-05F07 ONVR (r5) Rev F, Table 24 and New M5 EIS Vol 2D Appendix J, Section 4.5.5, Table 30

3 WestConnex M4 East Construction Noise and Vibration Management Plan 9 June 2017 M4E-ES-PLN-PWD-00241, Annexure B, Table B.1

4 WestConnex M4 East Construction Noise and Vibration Management Plan 9 June 2017 M4E-ES-PLN-PWD-00241 – Wattle Street residences, Annexure B, Table B.1

5 WestConnex M4 East Construction Noise and Vibration Management Plan 9 June 2017 M4E-ES-PLN-PWD-00241, Annexure B, Table B.1

6 This value has been updated based on an error found in the M4-M5 Link EIS

New M5 ONVR were less than 35dBA at Campbell Street residences (NCA48 and NCA49) and would not contribute to the overall night time noise criterion of 45dB(A).

Table 8.2 Noise allowance for M4-M5 fixed facilities, $L_{Aeq,15min}$ dB

Period	Haberfield				Campbell Road		
	NCA01	NCA02[7]	NCA02[8]	NCA06	NCA48	NCA49	NCA50
Day	51	45	61	50	60	59	57
Evening	50	45	53	50	50	50	50
Night	42	40	47	42	45	45	44

8.3 Modifying factor adjustments

Where the character of the industrial noise is assessed as particularly annoying (ie if it has an inherently tonal, low frequency, impulsive or is intermittent at night), then an adjustment is to be added to penalise the noise for its potential increase in annoyance. The INP provides definitive procedures for determining whether a penalty or adjustment should be applied.

8.4 Sleep disturbance criteria

The assessment of potential sleep disturbance at residences is required in accordance with the INP application notes where operations occur at night.

The INP application notes suggests that an $L_{A1(1min)}$ or L_{Amax} level of RBL plus 15 dB is a suitable screening criterion for sleep disturbance for the night-time period. This applies at 1 m from the most affected façade of a building.

A detailed maximum noise level event assessment is required if the screening criteria is exceeded. Further guidance on potential impact on sleep is provided in the NSW Road Noise Policy (RNP) (DECCW 2011). The RNP references several studies that have been conducted into the effect of maximum noise levels on sleep, and provides the following factors that are key in assessing the extent of impacts on sleep:

- how often high noise events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the project;
- whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods); and
- current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.

7 WestConnex M4 East Construction Noise and Vibration Management Plan 9 June 2017 M4E-ES-PLN-PWD-00241, Annexure B, Table B.1

8 WestConnex M4 East Construction Noise and Vibration Management Plan 9 June 2017 M4E-ES-PLN-PWD-00241 – Wattle Street residences, Annexure B, Table B.1

World Health Organisation (WHO) Night Noise Guideline indicates that L_{Amax} of 42 dB inside a bedroom aligns with the lowest observable adverse effect level that may cause awakenings from sleep. Based on the conservative consumption of a 10 dB(A) noise reduction across a façade with a partially opened window, this results in an external level of L_{Amax} of 52 dB.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade of a residential building of standard construction including a partially open window will reduce external noise levels by 10dB.

Project sleep disturbance screening criteria are provided in Table 8.3.

Table 8.3 Project sleep disturbance criteria at residences, L_{Amax} dB

Period	Haberfield[2]				Campbell Road[2]		
	NCA01	NCA02	NCA02[4]	NCA06	NCA48	NCA49	NCA50
Night[1]	53	52	57	54	55	55	54[3]

1. Night period is 10pm to 7am
2. Noise criteria taken from the M4-M5 Link EIS
3. This value has been updated based on an error found in the M4-M5 Link EIS.
4. WestConnex M4 East Construction Noise and Vibration Management Plan 9 June 2017 M4E-ES-PLN-PWD-00241 – Wattle Street residences

8.5 In tunnel noise levels

Noise levels have been assessed against the requirements of SWTC (App B.3 9.8 (a) and (b)) to satisfy the NR85 design noise curve measured at 1.5m above the road levels inside the tunnel.

8.6 Tunnel cross passages

The noise level in tunnel cross passages and long egress passages (fire isolated exits) shall not exceed 80 dB(A) $L_{eq,1min}$. (Ref: AS1668.1-2015 Fire and smoke control in buildings).

8.7 Vibration

The potential for vibration associated with the operation of the ventilation facilities and ancillary mechanical plant and equipment is considered low given the separation of the buildings from sensitive receivers is greater than 20 metres and the proposed vibration mitigation measures. Notwithstanding the ONVR has considered the requirements of Assessing Vibration: a technical guideline (DEC, 2006).

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC, 2006) is based on guidelines contained in British Standard BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz). The Guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The Guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 8.4.

Table 8.4 Examples of types of vibration (from Table 2.1 of the guideline)

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, eg occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

Appendix C of the Guideline outlines acceptable criteria for human exposure to continuous vibration (1-80 Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 8.5 reproduces the preferred and maximum criteria relating to measured velocity.

Table 8.5 Criteria for exposure to continuous vibration

Place	Time	RMS velocity[1,2]	
		Preferred	Maximum
Critical working areas (eg hospital operating theatres, precision laboratories)	Day or night-time	0.10	0.20
Residences	Daytime	0.20	0.40
	Night-time	0.14	0.28
Offices	Day or night-time	0.40	0.8
Workshops	Day or night-time	0.80	1.60

Notes: 1. Root mean square velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s).
2. Values given for most critical frequency >8 Hz assuming sinusoidal motion.

9 Design inputs

9.1 Design drawings

The acoustic assessment has been based on Project three-dimensional computer model and design drawings listed below:

- M4M5_LSBJ-PRW-GEN-DE01-M3D-0001_200224.nwd;
- M4M5_LSBJ-SPI-GEN-DE01-M3D-0001_200224.nwd;
- Substation 2 3 4 ME05_200228.nwd;
- M4M5-JAJV-SPI-STR-BU02-CDG-001[D];
- 20200221 Subs 06 ESS26060 Mark Ups;
- 200306 Substation 2_3_4; and
- M4M5 - LSBJ - PRW - MES - ME05 - CDG – 0001[C].

EMM has worked with ASBJV to ensure that the final design satisfies the commitments of the SWTC, CoA and allowance noise criteria presented for WestConnex 3A – M4-M5 Link Mainline tunnels project EIS.

9.2 Ventilation fan noise levels

The noise assessment for the main ventilation fans and tunnel jet fans is based on the fan sound power data presented in Table 9.1 for each ventilation facility.

Table 9.1 Ventilation fan data (Source: as supplied by ASBJV)

Site	Description	ID	Quantity (D+S)	Sound Power Level multiple fans^ - in duct (dB(Lin))								
				63	125	250	500	1K	2K	4K	8K	SWL dB(A)*
PRVF	Clarage 2100Pa Anti-stall ring	XFN	6 (5+1)	121	129	129	134	134	130	125	120	138
	Clarage 1350Pa Anti-stall ring	SFN	3 (2+1)	114	122	122	127	127	123	118	113	131
SPI	Clarage 1650Pa Anti-stall ring	XFN	7 (6+1)	119	127	127	132	132	128	123	118	136
	Clarage 1500Pa Anti-stall ring	SFN	3 (2+1)	115	123	123	128	128	124	119	114	132

Table 9.1 Ventilation fan data (Source: as supplied by ASBJV)

Site	Description	ID	Quantity (D+S)	Sound Power Level multiple fans^ - in duct (dB(Lin))								
				63	125	250	500	1K	2K	4K	8K	SWL dB(A)*
Tunnel Jet Fans	in tunnel	TJF	3^^	92	107	101	96	100	96	95	89	104^^

* Sound Power Level (SWL) incorporates number of Duty fans operating
D = duty fan; S = standby fan
^ multiple duty fans as noted
^^ SWL for 3 fans in parallel + 2450mm silencer and blade frequency correction (Appendix B) – total of 210 jet fans in Project

Fan specifications and noise data considered for the ventilation facilities and tunnel jet fans are presented in Table 9.1 and Appendix B.

9.3 Ancillary plant and equipment

With respect to ancillary fixed mechanical plant for PRVF and SPI, the assessment has considered air-conditioning condensers, exhaust fans, and supply fans which are described in Appendix C.

Selections of the AC condensers provided by ASBJV and considered in the assessment are:

- PRVF:
  - ACU 250101 – ACU 250108 Temperzone OSA 950 (x8); and
  - RTP 250101 – RTP 250104 Temperzone OPA 960 (x4).
- SPI:
  - ACU 260101 – ACU 260103 Temperzone OSA 950 (x3);
  - ACU 260104 – ACU 260105 Diamond Air SD050 (x2);
  - ACU 260106 – ACU 260107 Diamond Air SD060 (x2);
  - ACU 260108 – ACU 260109 Diamond Air SD070 (x2);
  - ACU 260110 – ACU 260111 Diamond Air SD075 (x2);
  - RTP 260601 – RTP 260603 Temperzone OPA855 (x3);
  - RTP 260604 – RTP 260605 Temperzone OPA705 (x2);
  - RTP 260606 – RTP 260609 Temperzone OPA855 (x4); and
  - CRAC 1 – CRAC 2 Stulz / NQAC1700-R134a-EBM-AC (x2);
- tunnel substations SS02, SS03and SS04:

- ACU 01 – ACU 04 Diamond Air SD150 (x4); and
- ACU 05 – ACU 05 Diamond Air SD260 (x2);
- ACU 07 Diamond Air SD390 (x1); and

- tunnel substation SS05:
  - ACU 01 – ACU 02 Diamond Air SD150 (x2);
  - ACU 03 – ACU 04 Diamond Air SD170 (x2);
  - ACU 05 – ACU 08 Diamond Air SD300 (x4);
- transformers (8 – 4 duty / 4 standby – Lw78 dBA each);
- variable speed drives (VSDs) 1 per fan – Lw 85 dBA each; and
- harmonic filters – 1 per fan – Lw 70 dBA each.

9.3.1 Tunnel cross passages

ASBJV have provided fan selections for cross passages and long egress passages (fire isolated exits) as presented in Table 9.2.

Table 9.2 Fan data (Source: ASBJV - Fantech)

Fan	Fan selection (Fantech)	Side	Sound Power Level per fan - in duct (dB(Lin))								
			63	125	250	500	1K	2K	4K	8K	SWL dB(A)
Long Egress Tunnel	AP1404FA12/19 (EPF212081/081) (EPF214081/082)	Inlet	102	99	106	110	109	107	101	94	111
		Outlet	104	100	105	109	109	107	101	93	111
Emergency Egress Passage - Supply	AP0314AP10/10	Inlet	63	73	75	67	67	63	56	43	72
		Outlet	71	70	74	66	64	63	59	46	71
Emergency Egress Passage - Pressurisation	AP0634LP12/21	Inlet	78	78	75	77	77	77	71	61	85
		Outlet	82	80	75	78	77	77	71	63	87

Note: Sound Power Level (SWL) per fan unless stated otherwise

9.4 Site and assessment locations

The location of the fixed facilities and assessment locations are presented in Figure 9.1 and Figure 9.2. These were considered in the assessment and design of noise mitigation measures. The closest assessment locations and distances to closest noise source on the respective sites are presented in Table 9.3.

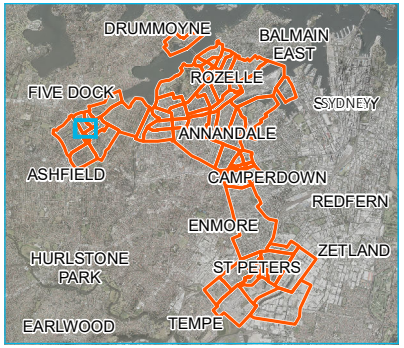
Table 9.3 Assessment locations

Facility	Receiver Type	Address	Distance to closest noise source (m)
PRVF	Residential	19 Earle Street	160
		14-16 Wattle Street	125
		18 and 1-7 Walker Avenue	27
		306 Parramatta Road	110
SPI	Residential	53 Barwon Park Road[1]	70

1. Assessed to upper floor of building

For assessment of noise from SPI fixed plant and equipment, 53 Barwon Park Road was selected as the most exposed assessment location due to proximity and height of this residential building (four levels) and located directly opposite facility. If the project noise criteria is satisfied at 53 Barwon Park Road (upper floor) then the criteria would also be satisfied at Campbell Street residences and beyond.

Figure 9.1 PRVF, NCA and assessment locations



KEY

- Noise logger location
- Noise assessment location
- Indicative site boundary
- Site layout
- Noise catchment boundary
- Heritage item (LEP/SHR)

Source: EMM (2019); DFSI (2017); GA (2011)

0 50 100 m

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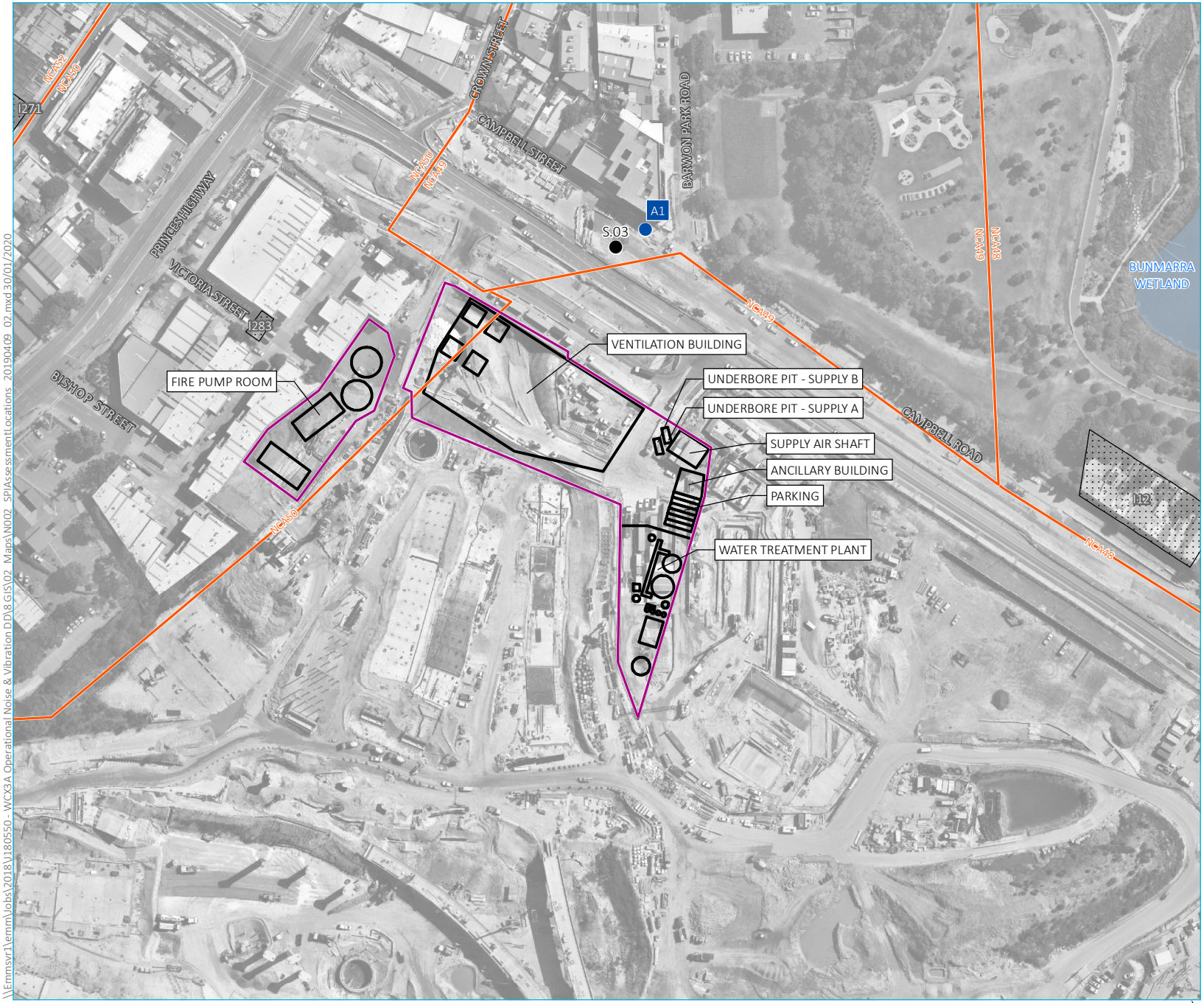
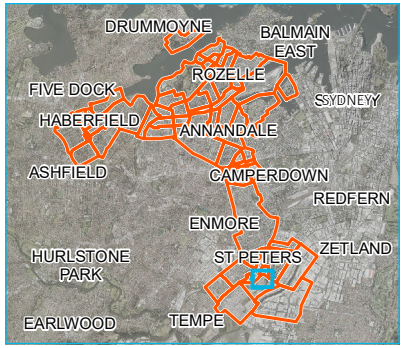
Paramatta Road Ventilation Facility (PRVF) - NCAs and assessment locations

Westconnex M4-M5 Link Tunnels
Operational noise and vibration review
Figure 9.1

EMM creating opportunities





Source: EMM (2019); DFSI (2017); GA (2011)

0 50 100 m

GDA 1994 MGA Zone 56

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St Peters Interchange (SPI)
- NCAs and assessment locations

Westconnex M4-M5 Link Tunnels
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Figure 9.2

EMM
creating opportunities

10 Assessment

10.1 Assessment procedure

Noise from PRVF and SPI ventilation facilities were assessed considering the following:

- operating sound power level of fans (exhaust and supply) calculated for number of fans running simultaneously;
- reduction in noise levels along airpaths including bends, duct dimensions, duct length and directivity. Calculation assumed bare or rough concrete finishes for air pathways subject to location in building / formed shaft or excavated tunnel;
- insertion loss of proposed attenuator selections. Regenerated noise assessment has been considered with supplier data confirmed that regenerated noise is 10dB or more below the resultant attenuated fan levels and would not contribute to the overall levels;
- consideration of low frequency noise components from ventilation fans. A review of the A and C weighted source noise levels confirmed that the level difference was not 15dB or more and hence a 5dB correction was not applied to the calculations; and
- prediction of noise levels to residential assessment locations and incorporation of noise controls and alternative attenuator insertion losses to ensure that project noise contributions were satisfied.

In addition to the main ventilation plant, noise from ancillary plant and equipment associated with these facilities was considered and includes air conditioning condensers, exhaust and supply fans, transformers, switch gear, VSDs, pumps, natural ventilation openings for buildings and water treatment plant. Accordingly, the assessment considered all plant and equipment contributions to ensure the total noise level from the site satisfied the project target levels at all residential assessment locations.

Assessment has considered both direct noise from sources and breakout noise from building walls, roofs, doors and other building components. Furthermore, the assessment has considered cumulative noise from the M4 East (PRVF) and New M5 (SPI) aimed at the total noise from the operation of both ventilation facilities operating simultaneously satisfies the requirements of CoA E92. A review of the final design model iteration of the SPI building confirms that the proposed building cladding ensures ‘line of sight’ acoustic screening from top of condensers to assessment locations 1.5m above the top occupied floor level of 53 Barwon Park Road, St Peters. Due to perforated cladding in some areas of the northern and eastern facades, secondary impervious screening would be provided on the roof deck side of the SPI building parapet to maintain acoustic screening requirements.

The assessment of fire pumps operating under emergency conditions has been designed to comply with the night target noise levels considering that testing or an emergency could occur at any time. This approach is consistent with adjacent M4 East and New M5 projects fire pump facilities. The principle noise source associated with the fire pump buildings are diesel powered fire deluge pumps and hydrant pumps. Based on pump information, mitigation in the form of concrete or core filled block walls and roof, solid core acoustic rated doors, inlet and discharge attenuators for fans and rectangular attenuators for air relief were recommended.

10.2 Operational noise modelling

Noise contributions from the ventilation and ancillary plant and equipment were modelled utilising the source noise data contained in Section 9, Appendix B and Appendix C and taking into account receiver locations, intervening buildings / topography and noise mitigation treatments outlined in this report. Screening and calculation of noise level contributions from each source and building component was used to determine individual and cumulative noise level contributions for the reference residential assessment locations.

Operational noise levels were predicted using DGMR Software proprietary modelling software, iNoise (from the developers of Bruel & Kjaer's Predictor software). The model allows prediction under the ISO9613-2 *"Acoustics – Attenuation of Sound during Propagation Outdoors – general method"* algorithm. This algorithm is accepted by the EPA. Features which affect the predicted noise level that are considered in the noise modelling include:

- equipment sound power levels and locations;
- screening from structures;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

The model was populated with 3-D topography of the project and surrounding area, extending out past nearest assessment locations and 3-D massing of buildings provided by ASBJV. Calculations were conducted using empirical formulae and include inputs related to duct effects, reverberant internal noise levels and transmission through building structures to develop source noise levels used to populate the noise model.

10.3 Maintenance activities

There is the potential for on-site light vehicles, light trucks (<4.5t) or heavy trucks to access PRVF and SPI for scheduled maintenance during the day or evening. Access by vehicles for PRVF would be infrequent with a typical maximum of four vehicles per day anticipated comprising light vehicle, light truck (<4.5t) or heavy truck. For SPI ventilation facility access and egress for up to six movements per day for delivery of chemicals and removal of sludge for water treatment plant (WTP) is anticipated. It has been confirmed that scheduled maintenance would be conducted during daytime hours only.

Assessment of noise from envisaged activities considered light truck (Lw96 dBA) and heavy truck (Lw103 dBA) taking into account route of vehicle through site, vehicle speed of 10km/h and cumulative noise from ongoing operation of the mechanical plant and equipment associated with the ventilation facility. For the SPI facility assessment, assessment also considered the continuous operation of a large pump (Lw95 dBA) for removal of sludge.

The results of the modelling confirmed one heavy truck or up to six light trucks could access and egress the PRVF site within a 15-minute assessment period and result in noise complying with the PSNL (day) for the closest and most exposed residential assessment location at 1-7 Walker Avenue, Haberfield.

The SPI noise modelling confirmed access and egress of two heavy trucks or up to 20 light trucks and continuous operation of a pump to remove sludge within a 15-minute assessment period would mean site noise complies with the PSNL (day) at the closest and most exposed residential location (53 Barwon Park Road, St Peters).

10.4 Maximum noise levels

Mechanical and electrical plant and equipment typically operate with a consistent noise profile without significant fluctuations that could result in L_{Amax} noise events. For the operation of the plant and equipment to give rise to potential sleep disturbance effects, the maximum noise level would need to be 10dB higher than the normal operating noise level. A review of the schedule of plant and equipment, normal operating procedures and noise contributions at residential assessment locations has indicated that sleep disturbance is highly unlikely.

The incorporation of noise mitigation to satisfy the $L_{Aeq,15min}$ project specific noise levels (<45dB(A)) would also address any potential for maximum noise level events that could give rise to sleep disturbance. Furthermore, the model has considered all plant and equipment operating under full load / high speed conditions resulting in a typical maximum noise level contribution including emergency fire pumps. This scenario is not expected to occur in practice.

Scheduled maintenance would be conducted during day or evening hours and would not impact sleep at night.

11 Ventilation facilities noise mitigation

Taking account of the sound power data (Section 9, number of fans operating and final design configuration, attenuator insertion loss requirements have been calculated for tunnel and air side ventilation pathways. Noise levels have been assessed against the requirements of SWTC and CoA (Condition 92) considering the INP and NR85 design noise curve.

11.1 Attenuator selections

Table 11.1 provides a summary of the insertion losses for selected design attenuators on the tunnel side attenuation of exhaust and supply fans from supplier IAC. Where relevant, options for Standard and "*Improved"* are provided to allow further flexibility for ASBJV to manage competing interest in noise, efficiency and airflow requirements.

Table 11.1 Design attenuator insertion loss requirements (Tunnel Side)

Site	Location	Insertion loss (dB)							
		63	125	250	500	1K	2K	4K	8K
PRVF	Exhaust Fan Attenuator (tunnel) VT05 – XAT25008	10	28	39	54	59	37	27	20
		14	*34*	*51*	*66*	*68*	*42*	*29*	*21*
	Exhaust Fan Attenuator (tunnel) VT04 – XAT25007	10	28	39	54	59	37	27	20
		14	*34*	*51*	*66*	*68*	*42*	*29*	*21*
	Supply Tunnel Attenuator (tunnel) VT11 – SAT25004	10	28	39	54	59	37	27	20
SPI	Exhaust Fan Attenuator (tunnel) – XAT26001	10	22	37	44	45	34	24	17
		10	*28*	*39*	*54*	*59*	*37*	*27*	*20*
	Supply Cavern Attenuator (tunnel) – SAT26002	10	28	39	54	59	37	27	20

Improved IAC selection shown in *Italics*

Table 11.2 provides a summary of the insertion losses for selected design attenuators on airside attenuation of exhaust and supply fans. These are required to satisfy noise targets at assessment locations.

Table 11.2 Design attenuator insertion loss requirements (Airside)

Site	Location	Insertion loss (dB)							
		63	125	250	500	1K	2K	4K	8K
PRVF	Exhaust Fan Attenuators XAT25001-6	24	49	68	74	75	56	32	26
	Supply Fan Attenuator SAT25001-3	33	62	78	84	79	68	39	32

Table 11.2 Design attenuator insertion loss requirements (Airside)

Site	Location	Insertion loss (dB)							
		63	125	250	500	1K	2K	4K	8K
SPI	Exhaust Fan Attenuator XAT26002	24	49	68	74	75	56	32	26
	Supply Cavern Attenuator SAT26001	20	44	62	69	78	55	34	23

The above attenuator insertion loss requirements (Table 11.1 and Table 11.2) are based on final design fan selections and supplier attenuator data including their acoustic performance requirements. Potential impacts from regenerated noise were considered and contributions were found to be at least 10dB below the resultant attenuated fan noise levels and did not contribute to overall noise levels at assessment locations. Should the attenuator selections be altered, regenerated noise should be 10dB or more below the post attenuator fan noise level in all octave bands to avoid additional noise contribution. This includes appropriate consideration of the spectral content of the noise to ensure no tonal components that require further consideration.

11.2 Additional acoustic requirements

In addition to the above tunnel side and airside preliminary attenuator selections, the following mitigation measures are required for incorporation:

11.2.1 PRVF

- PRVF buildings pre-existing and not determined by M4-M5 Link Mainline Tunnels Project. Construction to be consistent with M4 East[9] ONVR, specifically:
  - Exhaust building:
    - walls min. 200mm precast concrete;
    - roof precast concrete at podium level;
    - doors and access panels – hinged Speedpanel;
    - personnel doors – min. 30mm solid timber core with acoustic seals (Rw30); and
    - fan service hatches – rebated concrete hatch to match panel thickness.
  - Supply building:
    - walls min. 200mm precast concrete;
    - roof min. 150mm precast concrete; and
    - soffit lined with 50mm Reapor or similar.

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- fans installed to include anti vibration mounts providing a minimum isolation efficiency of 95%;
- provision of flexible/resilient connections between the flanges of each fan casing duct/attenuator so that axial or transverse forces are mitigated between the two. Flexible connections must be of the minimum length required to accommodate any vibration movement and thermal expansion.; and
- infill panel/s required at fan room level B01, B02 and B03 for unused floor fan penetrations (it is assumed service access shaft levels are sealed off with concrete planks as per drawings) shall be provided to satisfy the following acoustic performance:
  - B01 Rw + Ctr 30;
  - B02 Rw + Ctr 40; and
  - B03 Rw + Ctr 55.

11.2.2 SPI

i Ventilation building (fan room and plenums)

- SPI walls, roof and suspended floor to be constructed of 300mm thick in-situ concrete, 300mm thick precast concrete (eg Austral precast or equivalent) (2,340-2,400kg/m^3) with a transmission loss (TL) not less than the specification in Table 11.3:

Table 11.3 Wall, roof and floor transmission loss requirements (300mm concrete 2340kg/m^3)

	Transmission loss (dB)						
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
48	47	54	61	67	71	76	76

- access hatches / panels to be rebated and match the TL requirements of Table 11.3 and provided with perimeter acoustic seals;
- jointing in wall, roof or floor slabs to be detailed to ensure that the acoustic performance of the structure is maintained and not de-rated. EMshield (or equivalent has been recommended) as follows:
  - PJ – Typical Precast Double Wall Panel Joint Detail:
    - minimum 260mm thick solid concrete at panel joints (PJ) with a maximum width of 35mm; and
    - remainder of wall 300mm thick solid concrete excluding the IJ throughout.
  - WEJ – Typical Precast Double Wall Expansion Joint Detail (35mm)
    - Attenuated area:

      Rw / STC 62-64 Emshield (100-150mm depth) or Seismic Colorseal (150mm depth) one side of wall;

Other side backing rod and sealant;

- Fan Room (Grid 4-11):

  Rw / STC 68 – Seismic Colorseal (65mm depth both sides of wall);

- IJ1 – Typical Precast Double Wall Isolation Joint Detail (50mm):
  - Attenuated area:

    Rw / STC 62-64 Emshield (100-150mm depth) or Seismic Colorseal (150mm depth) one side of wall;

    Other side backing rod and sealant;

  - Fan Room (Grid 4-11):

    Rw / STC 68 – Seismic Colorseal (65mm depth both sides of wall);

- IJ1 – Typical Precast Double Wall Joint Detail 1 (50mm) Not Fan Room:
  - Attenuated area:

    Rw / STC 62-64 Emshield (100-150mm depth) or Seismic Colorseal (150mm depth) one side of wall;

    Other side backing rod and sealant;

- IJ2 – Double Wall Head Isolation Joint 2 Detail (35mm):
  - Attenuated area:

    Rw / STC 62-64 Emshield DRF2 (100-150mm depth) or Seismic Colorseal (150mm depth) one side of wall;

    Other side backing rod and sealant;

  - Fan Room (Grid 4-11):

    Rw / STC 68 – Emshield DRF2 or Seismic Colorseal (65mm depth both sides of wall);

    Other side backing rod and sealant;

- HOB – Precast Double Wall Base to Slab Interface (35mm):
  - cast in-situ with filled concrete joint to hob (assuming 35mm gap would fill with concrete);
  - base of the wall will bear full width of the wall on concrete/grout;

- BJ – Typical Building Joint - marked as IJ on drawings BD02-1204 (100mm)
  - Fan Room (Grid 7-8):

Rw / STC 68 – Seismic Colorseal (65mm depth both sides of wall)

- Building Roof Joint – Details 2 & 3:

  Rw / STC 62-64 Emshield (100mm depth) or Seismic Colorseal (100mm depth) vertically;

  150mm thick concrete capping (min. 80-100mm concrete or 10mm steel for acoustic);

  20mm rubber bearing / modified Hercules Slip Joint;

- Corner details for jointing typically 50mm and complying with recommendations as relevant for the respective wall areas:
  - PJ – attenuated / fan room;
  - WEJ – attenuated / fan room;
  - IJ1 – attenuated / fan room;
  - IJ2 – attenuated / fan room; and
  - BJ – attenuated / fan room.
- infill above doors between fan room and service corridor, attenuator room and service corridor, and external service corridor door comprise:
  - 2 x 16mm Fyrchek (or eq.) fan room side;
  - staggered steel studs (300mm centres) except at periphery;
  - min 186mm gap between inner linings (total wall thickness 250mm);
  - cavity insulation min. 100mm glasswool 10kg/m3; and
  - 2 x 16mm Fyrchek (or eq.) corridor side.
- solid core doors with perimeter acoustic seals and the following acoustic performance:
  - Rw40 specified for access doors between fan room and service corridors, airlock, stairwells, etc.;
  - Rw30 between attenuator chamber, service corridor and atmosphere; and
  - Rw35 VSD and damper control room and corridor.
- fans installed to include anti vibration mounts providing a minimum isolation efficiency of 95% exhaust fan room and 90% for cavern supply fans; and
- provision of flexible/resilient connections between the flanges of each fan casing duct/attenuator (SPI cavern), so that no axial or transverse forces are transmitted between the two. Flexible connections must be of the minimum length required to accommodate any vibration movement and thermal expansion.

To account for breakout noise through ventilation building, the review has considered the adoption of 300mm Austral precast concrete, 300mm thick concrete floors and roof of buildings (2,340-2,400kg/m^3). Reverberant internal noise levels were determined for ventilation buildings and considered the transmission loss and surface area of each building component to determine noise contributions emanating from each building element.

SPI ventilation building roof has been confirmed as an inclined 300mm structural concrete roof structure comprising Austral floor (or equivalent).

SPI ventilation building walls are confirmed with metal cladding for the architectural treatment of structural concrete walls of the building. Potential for structural borne noise is addressed through the mass on building elements and isolation of plant and equipment outlined in this section (11.2.1, 11.2.2).

ii Supply building

- Lower walls of supply air building to comprise 190mm masonry blockwork;
- Upper walls to comprise downward facing metal weather louvres; and
- roof of supply air (fresh air) building to be minimum Kliplok 0.48mm BMT laid on Bradford Anticon 130 MD Thermofoil building blanket.

iii Workshop and amenities building

- Lower level 190mm masonry blockwork (precast concrete to rear - eastern boundary);
- Upper level steel framing, metal clad, insulated and internally lined with plasterboard/fibrous cement; and
- Metal deck roof Kliplok 0.48mm BMT laid on Bradford Anticon 130 MD Thermofoil building blanket.

12 Fixed mechanical plant

Additional mechanical and electrical plant associated with tunnel operation and ancillary facilities at PRVF and SPI include tunnel jet fans, air conditioning plant and exhaust / supply fans (substations, battery rooms, miscellaneous ventilation, transformer heat rejection, VSD heat rejection, water treatment and fire pump rooms).

The following section addresses preliminary noise mitigation recommendations for each component based on current design and equipment selections.

12.1 PRVF

12.1.1 Substation air-conditioning (SS01)

Condensers for the substation building (SS01) are proposed to be installed on the western portion of the roof with a perimeter acoustic screen (Appendix A.1). Considering the source noise levels provided in Appendix C and review of manufacturer data we recommend the following:

- acoustic screens shall extend from roof level (or not less than below level of building parapet) and to a height not less than:
  - 1000mm above ACU 250101 – ACU 250108; and
  - 800mm above RTP 250101 – RTP 250104.
- acoustic screens be constructed of a material with an acoustic performance of not less than Rw26;
- acoustic screens to be internally lined with absorptive treatment comprising 50mm Stratocell Whisper, 50mm Pyrotek Reapor or equivalent material with an NRC 0.90 or greater;
- variable speed fans providing a minimum 4dB reduction in noise level at low speed (night); and
- condensing units installed on anti-vibration mounts providing a minimum isolation efficiency of 90%.

12.1.2 Substation building (SS01)

Transformers within substation buildings will be required to satisfy the specifications of Australian/New Zealand Standard AS/NZS60076.10:2009, Power transformers - Determination of sound levels. ASBJV has provided preliminary specification for transformers for the substations at PRVF and confirmed up to eight transformers would be required of 2.3MVA with rated noise level of 78dB(A) each. We are advised that 50% of transformers would operate at any one time. Construction of the substation building shall consist of:

- walls and roof cast in-situ, precast or core fill blockwork not less than 200mm thick;
- solid core doors with perimeter acoustic seals and acoustic performance of not less than Rw35;
- all building penetrations to be reviewed by acoustic consultant prior to final specification; and
- acoustic rated hinged or roller service doors (0.6-0.8mm BMT slat thickness) with an acoustic performance of not less than Rw30.

12.1.3 Substation ventilation (SS01)

- EAF250101 – EAF250102 incorporate not less than 800mm long internally acoustically lined (50mm) duct (700mm x 700mm) and plenum box (1600mm x 900mm x 450mm);
- SSF250101– duct mounted (internal to building) to incorporate inlet rectangular attenuator equivalent to Fantech RT15B Table 12.1;

Table 12.1 Rectangular attenuator insertion loss (eg Fantech RT15B)

	Insertion loss (dB)						
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
4	8	15	25	31	28	18	13

- fresh air plenums on northern elevation to be internally acoustically lined (50mm);
- penetrations to be reviewed by acoustic consultant prior to final specification; and
- ducting not less than 0.6mm base metal thickness.

12.1.4 Fire pump room

- walls and roof cast in-situ, precast or core fill blockwork not less than 150mm thick;
- acoustic rated hinged service doors with an acoustic performance of not less than Rw35;
- SSF250001 – inline duct mounted (internal to building) supply air fan and inline attenuator ATT250001 equivalent to Fantech RS12F with an insertion loss (IL) not less than shown in Table 12.2;

Table 12.2 Rectangular attenuator insertion loss (Fantech RS12F)

	Insertion loss (dB)						
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
8	17	35	50	50	50	43	30

- ducting not less than 1.6mm base metal thickness between fans and louvres and internally lined with 50mm acoustic insulation;
- fresh air louvres (ATT250003 and ATT250004) and exhaust fan intake to incorporate rectangular attenuator (installed in wall of building) equivalent to Fantech RS12F with an insertion loss (IL) not less than shown in Table 12.2; and
- minimum of 2m internally lined acoustic duct (50mm perforated foil facing) or 2d inline attenuator between fan and room registers.

12.2 SPI

12.2.1 Substation air-conditioning (SS06)

Condensers for the substation building (SS06) will be installed on the eastern portion on a lower roof with a perimeter screening provided by building parapet and metal architectural cladding (Appendix A.1) providing 'line of sight' acoustic screening to 53 Barwon Park Road. Due to perforated cladding in some areas of the northern and eastern facades, secondary impervious screening (metal or fibrous cement with acoustic performance Rw 20) would be provided on the roof deck side of the SPI building parapet to maintain acoustic screening requirements. The northern screen is to be internally lined with absorptive treatment (Stratocell Whisper 50mm or equivalent with NRC 0.90). Considering the source noise levels provided in Appendix C and review of manufacturer data we recommend the following:

- Variable speed fans providing a minimum 4dB reduction in noise level at low speed (night); and
- Condensing units installed on anti-vibration mounts providing a minimum isolation efficiency of 90%.

12.2.2 Substation building (SS06)

Transformers within substation buildings will be required to satisfy the specifications of Australian/New Zealand Standard AS/NZS60076.10:2009, Power transformers - Determination of sound levels. ASBJV has provided current specification for transformers for the substation at SPI and confirmed up to eight transformers would be required of 2.3MVA with rated noise level of 78dB(A) each. Only 50% of transformers would operate at any one time.

Based on current design, the building is to be constructed of:

- walls and roof cast in-situ, precast or core fill blockwork not less than 200mm thick;
- steel doors incorporating penetrations for ventilation equivalent to 5.5m^2 for each room (TXA and TXB); and
- acoustic rated hinged service doors with an acoustic performance of not less than Rw28.

12.2.3 Substation ventilation (SS06)

Ventilation fans for SPI substation (SS06) to incorporate the following:

- EAF260601 – EAF260602 – roof mounted (horizontal discharge) incorporate discharge attenuator (ATT260601 and ATT260602) equivalent to Fantech RS15B with an insertion loss (IL) not less than shown in Table 12.3;

Table 12.3 Rectangular attenuator insertion loss (Fantech RS15B)

	Insertion loss (dB)						
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
4	8	15	25	31	28	18	13

- EAF260603 – EAF260604 to incorporate minimum 1000mm long internally lined acoustic duct (50mm perforated foil facing) prior to discharge (west);

- EAF260605 – EAF260606 incorporate discharge attenuator (ATT 260605 and ATT 260606) equivalent to Fantech RS15B with an insertion loss (IL) not less than shown in Table 12.3;
- SSF 260601 and SSF 260602 (Ground Floor LV room supply) – roof mounted incorporate inlet attenuator (ATT260609 and ATT260610) equivalent to Fantech RS15B with an insertion loss (IL) not less than shown in Table 12.3;
- SSF260603 and SSF260604 (Basement supply) – duct mounted (internal to building) to incorporate minimum 1000mm long internally lined acoustic duct (50mm perforated foil facing) from intake filter; and
- Ducting not less than 1.2mm base metal thickness.

12.2.4 Water treatment plant

Final details for water treatment plant are not confirmed, however based on available information the following was considered in noise modelling:

- EAF 01 – EAF 02 – inline duct mounted (on roof) to incorporate attenuator providing noise reduction not less than 15dB overall;
- up to ten pumps with a sound power level Lw 68 dBA each; and
- dosing pumps, aerators and submersible pumps providing minimal noise output (ie 10dB lower than dominant sources).

The water treatment plant contribution is low relative to the overall noise levels at the SPI. Accordingly, there will be some flexibility in the specification and final design of plant and equipment without exceedance of noise limits. Water treatment plant pumps and aerators will be selected on acoustic performance and reviewed by acoustic consultant prior to final specification.

12.2.5 Fire pump room

Based on current design, the building is to be constructed of:

- Walls and roof cast in-situ, precast or core fill blockwork not less than 150mm thick;
- Acoustic rated hinged service doors with an acoustic performance of not less than Rw30.

Ventilation for fire pump room to incorporate the following:

- SSF260001 – inline duct mounted (roof) supply air fan intake to incorporate minimum of minimum 2000mm internally lined acoustic duct and 90 degree elbow (50mm perforated foil facing) OR intake attenuator (ATT260001) equivalent to Fantech RS15B Table 12.4;

Table 12.4 Rectangular attenuator insertion loss (Fantech RS15B)

			Insertion loss (dB)				
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
4	8	15	25	31	28	18	13

- SSF260001 to incorporate minimum of 2m internally lined acoustic duct (50mm perforated foil facing) OR discharge attenuator (ATT260002) equivalent to Fantech RS15B Table 12.4 between fan and room registers;
- Air release vents to incorporate rectangular attenuator (ATT260003, ATT260004 and ATT260005) installed in wall of building equivalent to Fantech RS12E with an insertion loss (IL) not less than that shown in Table 12.5; and

Table 12.5 Rectangular attenuator insertion loss (Fantech RS12E)

Insertion loss (dB)							
63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
7	15	31	47	50	48	40	28

- Ducting not less than 1.2mm base metal thickness between fans / attenuators and louvres.

12.3 Tunnel jet fans

Tunnel jet fans proposed are manufactured by Witt and Sohn and referred to as 'banana jet fans' with acoustic performance referenced in Table 9.1. Additional factory acceptance testing (FAT) conducted for a revised fan and attenuator configuration was supplied by Witt and Sohn (Appendix B).

A review of the supplied data for operation of two fans or three fans running in parallel with 2450mm long inlet and discharge attenuators confirm octave band noise levels that satisfy NR85 assessment criteria at a distance of 4m and 5m and 45° from the installed fans corresponding to a position 1.5m above road level within the tunnel roadway. The assessment has considered nominal tunnel cross sectional areas of 13m x 6.5m and 7m x 5m and reverberant tunnel volumes to evaluate various installed configuration comprising single fans as well as banks of two and three fans.

To avoid potential cumulative noise, tunnel jet fans shall be:

- separated from adjacent banks of jet fans by a distance not less than 60m;
- separated from the main tunnel ventilation system (exhaust / supply system) in tunnel locations by not less than 50m;
- separated from in tunnel substations by not less than 20m; and
- located no closer than 100m to tunnel portals.

12.4 Fire isolated exits

Table 12.6 provides a summary of the minimum insertion losses required for cross passages fans for occupied and tunnel side attenuation.

Table 12.6 Attenuator insertion loss requirements

Site	Location	Insertion loss (dB)							
		63	125	250	500	1K	2K	4K	8K
Emergency Egress Passage - Pressurisation	Cross passage – egress passage	1	2	4	10	10	8	7	6
	Cross passage - tunnel	1	1	2	5	5	4	3	3

The fan attenuator insertion loss requirements in Table 12.6 are based on final design and can be achieved with:

- EEP Occupied side 1D circular attenuator OR 1m of internally lined duct; and
- EEP Tunnel side internally lined transition duct.

Requirements for the long egress tunnel fans are:

- minimum length 12 metres of 2300mm x 1100mm internally lined (50mm) acoustic duct;
- plenum box on either side of fans internally lined (50mm);
- ducting incorporates two 90-degree elbows (without turning veins – either side of fans);
- externally lag fan and plenum box with Pyrotek 4512, 4525C or equivalent; and
- duct material between fan and tunnels to be of minimum 1.6mm BMT.

12.5 In-tunnel substations (SS02, 03, 04 and 05)

In tunnel substation plant and equipment is associated with air conditioning condensers, exhaust and supply fans. The type of plant and equipment are assessed against the SWTC and CoA specified criteria of NR85. A review of the underground substations (SS02, 03, 04 and 05) confirmed that the operation of the associated plant and equipment satisfy the requirements of NR85 at 1.5m above the tunnel roadway.

13 Fixed facilities noise compliance

Based on the current design and equipment noise levels presented in Section 9, Appendix B and Appendix C, roof layouts in Appendix D, assessment procedures of Section 10 and noise mitigation measures outlined in Section 11 and Section 12, predicted noise levels at the closest and/or most exposed locations are presented in Table 13.1 for the night assessment period. The night assessment period represents the most stringent assessment criteria and if the night noise goals are satisfied, then day and evening level targets would also be satisfied.

Table 13.1 Fixed facilities noise compliance

Assessment Location	Noise level contribution, L_{Aeq} (dB(A))				Cumulative predicted noise level, dB(A)	M4-M5 allowance criteria (night)
	Tunnel ventilation exhaust	Tunnel ventilation supply	Substation	Fire pump room		
PRVF						
19 Earle Avenue	28	26	21	9	31	42
14-16 Wattle Street	32	29	30	16	37	47
18 Walker Avenue	33	34	34	23	38	40
1-7 Walker Avenue	33	34	39	19	42	42
306 Parramatta Road	33	31	32	21	37	42
SPI						
53 Barwon Park Road[1]	40	31	40	32[2]	44	45

1. Assessed to upper floor of building
2. Incorporates fire pump building and water treatment plant

The results of the predicted noise levels confirm cumulative noise from the operation of the fixed facilities satisfies the noise criteria outlined in Table 8.1. Furthermore, the final design and mitigation ensures that the cumulative noise emissions from the M4-M5 Link Mainline Tunnels fixed facilities at PRVF and SPI do not exceed the noise criteria taking into account the predicted noise contributions of the operations of the M4 East and New M5 facilities as reported in their respective ONVRs.

14 Vibration assessment

The operation of the main ventilation fans (exhaust and supply) and tunnels jet fans are the main items that could generate vibration at residential receivers based on their mass and rotational operational characteristics. Data supplied by ASBJV confirmed potential displacement of 0.6mm for fan run down from an operating speed of 750rpm equating to an RMS 16.7mm/s (12.5Hz) velocity level at the fan.

Under the recommendations of Section 11.2 of the ONVR the fans are to be installed on anti-vibration mounts providing a minimum isolation efficiency of 95%. This type of recommendation is typical and reduces the likelihood of damage to equipment and connected structures. Considering the provided fan vibration data and isolation, this results in a level of vibration at fan in the order of 0.84mm/s. Resultant predicted vibration levels are in the order of 0.04mm/s and 0.03mm/s at reference distances of 40m and 60m respectively, representing the range of potential sensitive receivers.

Under the requirements of the SWTC Section 7.4 Condition Monitoring of Assets is required, specifically:

- the instrumentation specified in clause 4.4 of RMS Specification RMS D&C R163 (Tunnel Ventilation Axial Fans) provide continuous analogue signals from the vibration and temperature sensors to the OMCS for data recording and trending. In addition, the vibration monitoring must include fan motor drive and non-drive end bearing shock pulse sensors terminated outside the fan room to provide for local connection of portable vibration analysis equipment; and

- the instrumentation specified in clause 4.4 of RMS Specification RMS D&C R164 (Tunnel Jet Fans) provide continuous analogue signals from the vibration and temperature sensors to the OMCS for data recording and trending.

Taking account of distance separation from the ventilation and tunnel jet fans, recommended fan isolation, predicted vibration levels and condition monitoring requirements under the SWTC, assessment has indicated that the vibration goals for human comfort criteria will be satisfied. The risk of vibration impacts is considered very low and potential for exceedance of human comfort criteria is insignificant.

Part C

Community consultation and complaints handling procedures

15 Community consultation strategy

Community consultation on the proposed noise and vibration mitigation measures has been carried out through a program of targeted face to face contacts with the directly affected community members around the Parramatta Road East and West sites, Parramatta Road Ventilation Facility and the Campbell Road Ventilation Facility, as identified by the ONVR.

The face to face consultation has involved contacting the directly affected properties via a doorknock or email/phone to organise a meeting at their premises or at the Community Information Centre to explain what the ONVR findings and recommendations are.

Residents that were not at home, were left a 'sorry we missed you' card requesting they contact the project to discuss the draft ONVR. As presented in Section 2.5 further letters were sent out on 30 November 2020.

Residents have been asked to provide official written feedback on the proposed noise and vibration mitigation measures over a 14-day period which will then be considered as the ONVR is progressed through the required approvals.

A hard copy of the Draft ONVR was also be made available at the Community Information Centre as well as uploaded to the project website.

16 Complaints handling

A Complaints Management System, consistent with AS/NZS 10002:2014 Guidelines for Compliant management in Organisations will be implemented by the O&M Contractor during the operational life of the Asset.

There are several pathways to make a complaint or enquiry. These include the following:

- 24-hour phone number (1800 660 248) answered by the O&M Contractor's Stakeholder and Community Manager or delegated on-site supervisor during out of hours works
- postal address (Locked Bag 3905 GPO Sydney NSW 2001)
- email address (info@westconnex.com.au).

Community members can access the above resources, as required, to address any complaints or enquires they have.

All enquiries, feedback and complaints received through the above pathways or received by personnel working on the project will be forwarded to the O&M Contractor's Stakeholder and Community Manager, and to the O&M Contractor's QSE Manager (where appropriate) for issues relating to management of the environment.

Information on all complaints received, including the means by which they were addressed, whether resolution was reached, and whether mediation was required, will be included in a complaints register by the O&M Contractor's Stakeholder and Community Manager. The information contained within the register will be made available to DPIE on request.

The O&M Contractors Community Relations Plan provides the framework to manage and resolve complaints that arise from a number of communication methods, with this framework summarised in Table 16.1, Figure 16.1 and Figure 16.2.

All complaints should be closed off in the complaints register. The stakeholder(s) will also be kept informed of when they will receive a response.

The O&M Contractor will manage, record and respond to all complaints. Complaints will be reported to Project Company through regular Asset reporting.

Table 16.1 Response processes for complaints, enquiries and feedback

Item	Response Process
Enquiries from Federal, State and local government representatives via email, telephone or written correspondence	• O&M Contractor notifies the SMC Representative immediately of all enquiries from Federal, State and local government representatives relating to the O&M Services. • O&M Contractor acknowledges the correspondence / contact within 48 hours of its receipt. A draft response (if required) is provided to WestConnex for approval within 5 working days of the correspondence/contact. • Any briefings for these representatives will be arranged by the WestConnex
Calls (complaints/enquiries/ feedback)	• All calls or enquiries will be responded to immediately or within two working hours. Calls will be answered by the O&M Contractor's Stakeholder and Community Manager or a delegated on-site supervisor at the MCC during out of hours works.

Table 16.1 Response processes for complaints, enquiries and feedback

Item	Response Process
	• When a complaint or enquiry cannot be responded to immediately a follow up verbal response on what action is proposed will be provided to the complainant / enquirer within 24 hours of the complaint or enquiry being received. • A written response to the complainant / enquirer will be made within 10 business days if the complaint or enquiry cannot be resolved by the initial or follow up verbal response. • A draft response will be provided to WestConnex (if required) before responding to the contact.
Written correspondence or representation	• Any representation is acknowledged within 5 business days of receipt by the O&M Contractor. • Draft responses to be approved by WestConnex. • The written response will be issued within 15 business days of receipt by FHEOM.

Complaints and enquiries received in relation to operational noise during the first 12 months of operation will be detailed in the Operational Noise and Compliance Report in accordance with E95(d).

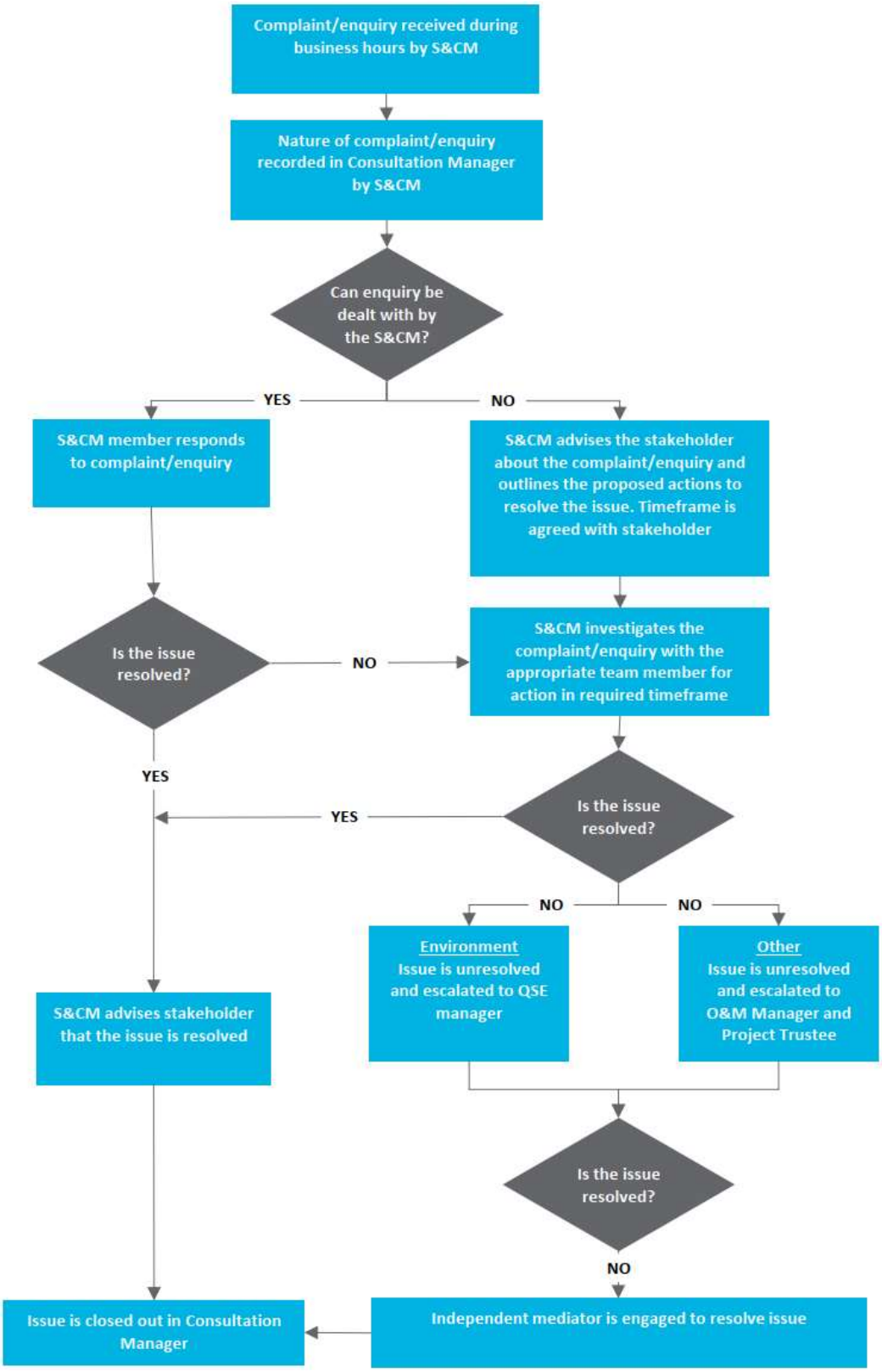


Figure 16.1 Process for enquiries and complaints received during business hours

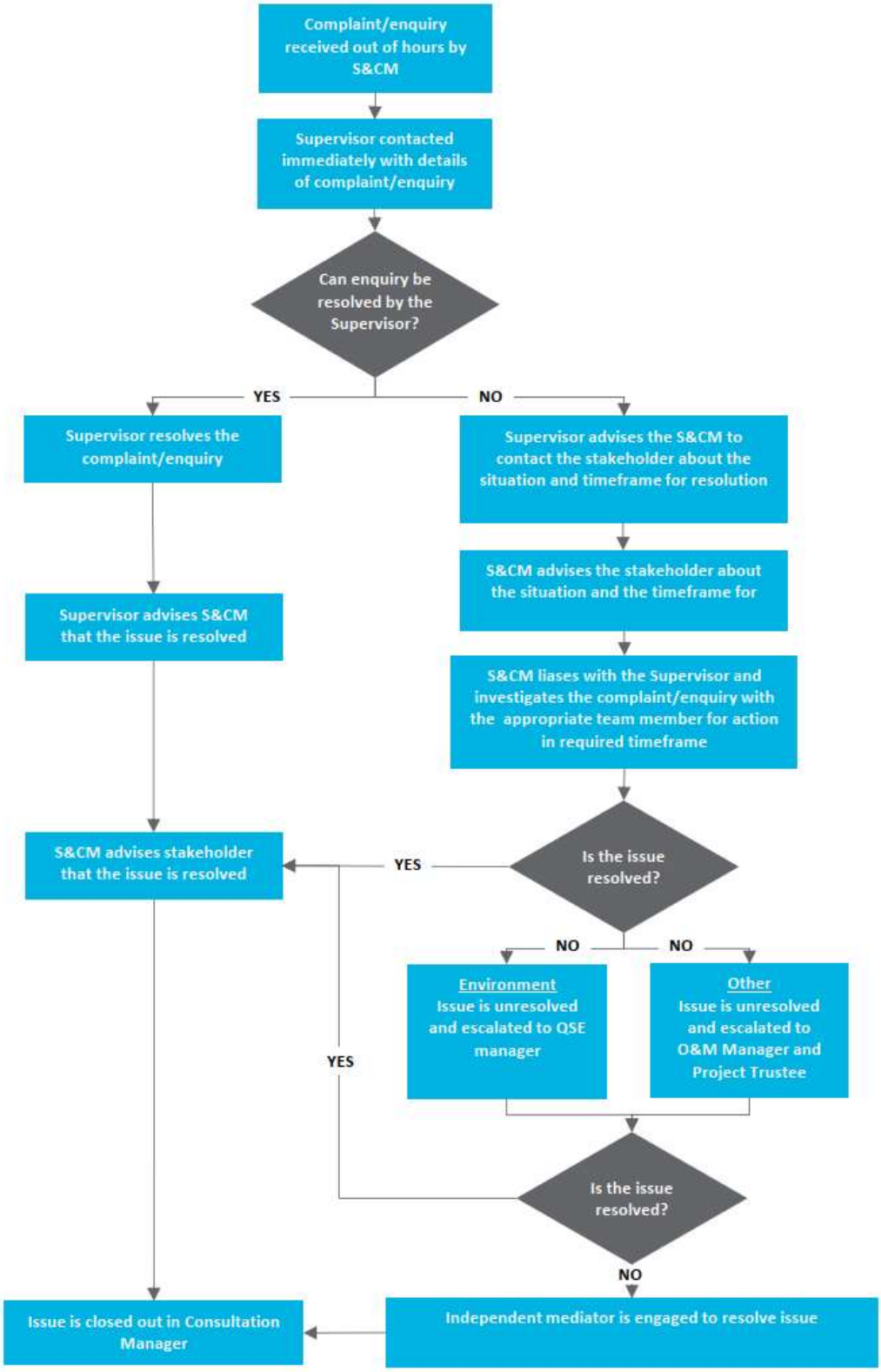


Figure 16.2 Process for enquiries and complaints received outside of business hours

Appendix A

Traffic noise contours

KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 15\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67
- 69
- 71
- 73

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

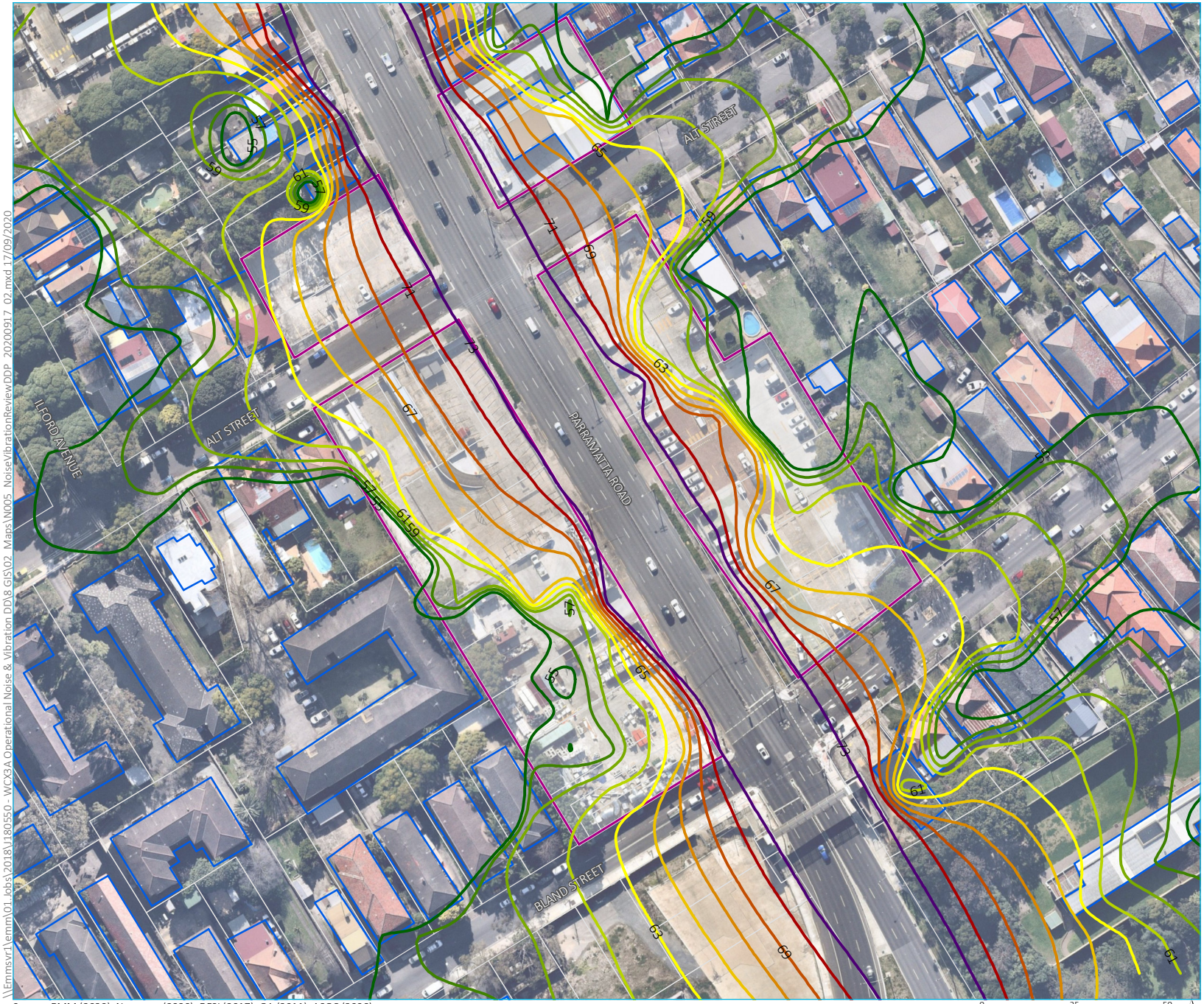
N

Future 2031 - no build
Daytime traffic noise contours
Contours 1.5 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.5

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02 Maps\N005 NoiseVibrationReviewDDP 20200917 02.mxd 17/09/2020



KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 15\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67
- 69
- 71
- 73

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

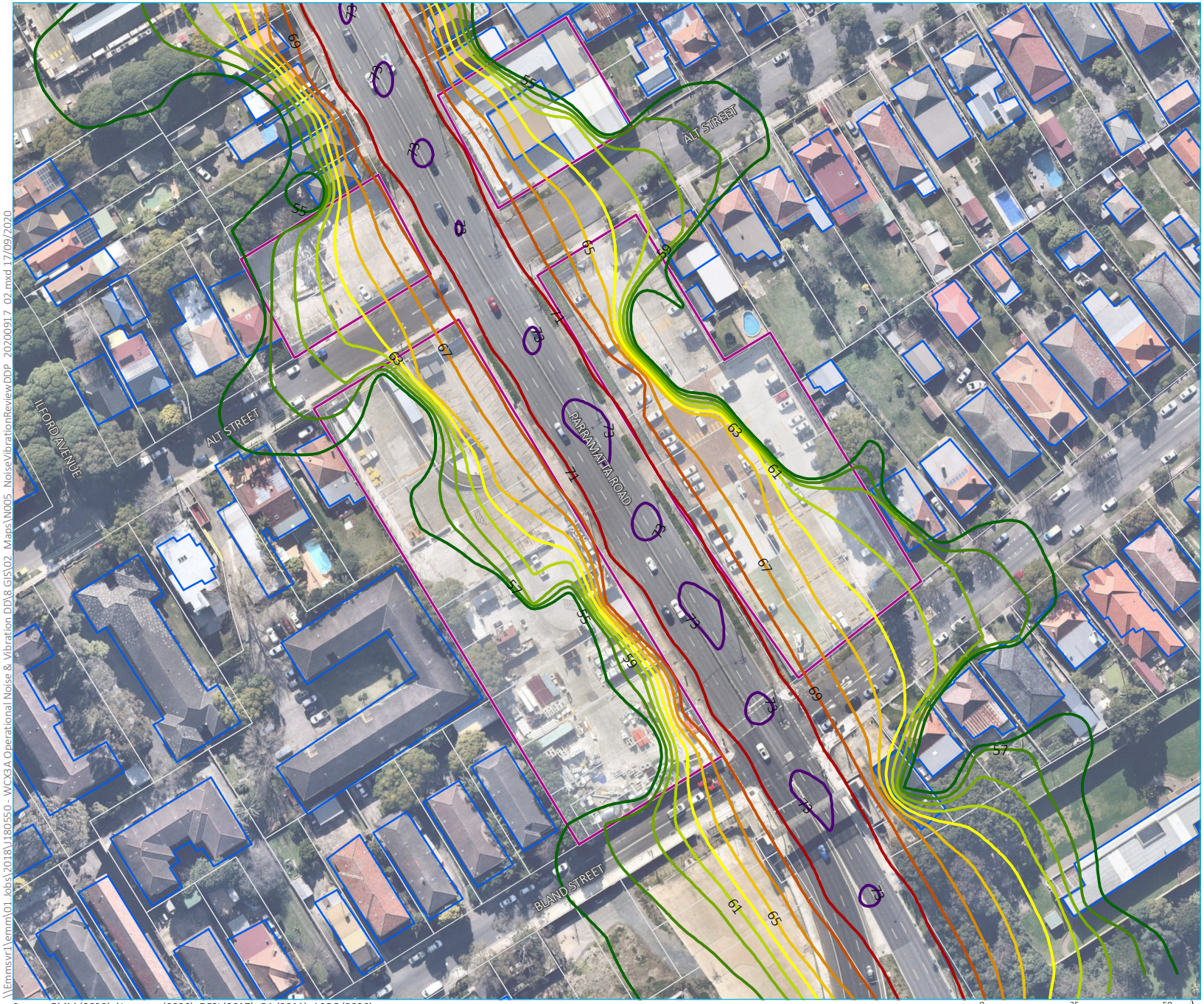
N

Future 2031 - no build
Daytime traffic noise contours
Contours 4.3 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.6

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020



KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 9\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67
- 69
- 71
- 73

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

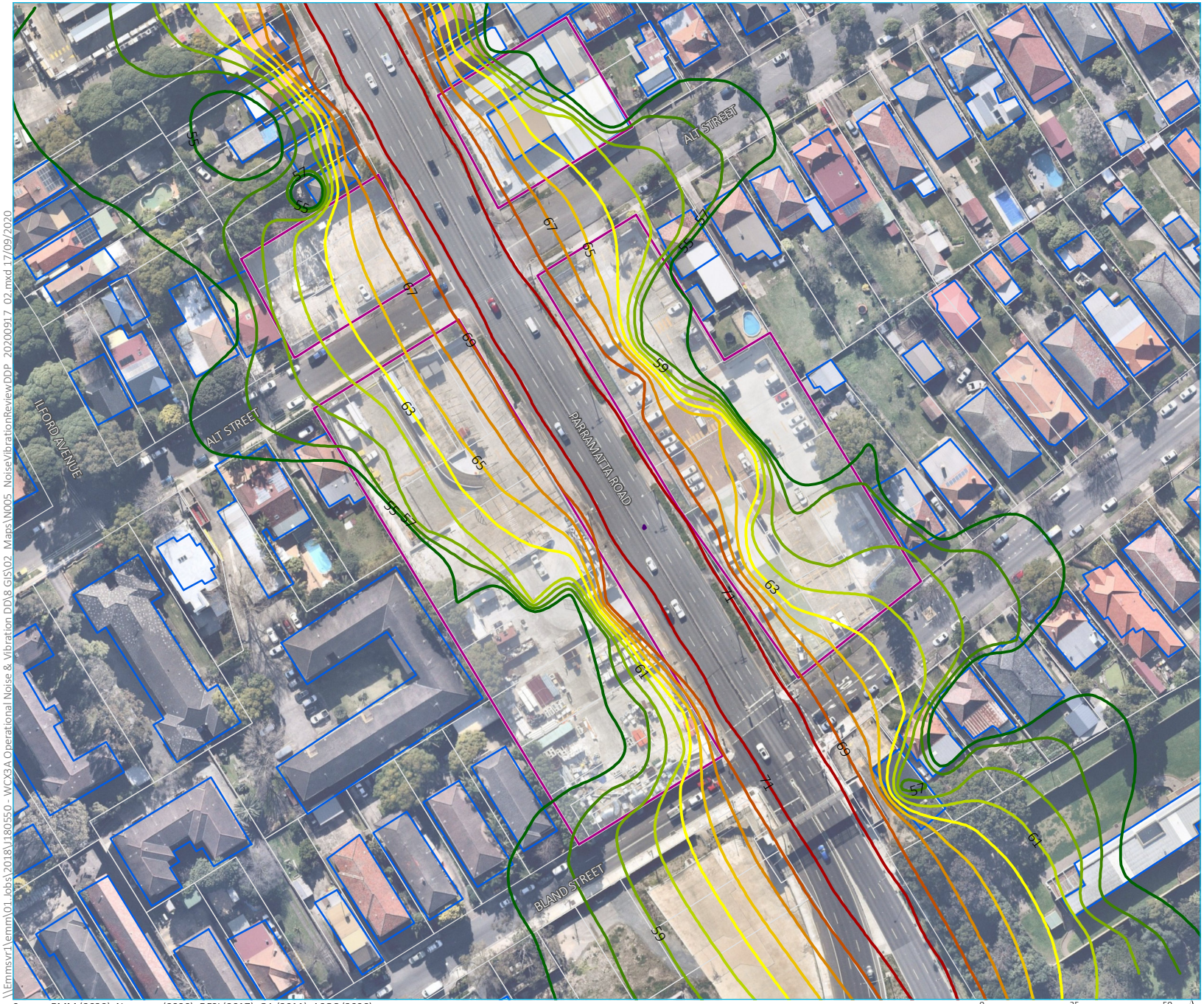
N

Future 2031 - no build
Night traffic noise contours
Contours 1.5 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.7

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020



KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 9\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67
- 69
- 71
- 73

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

N

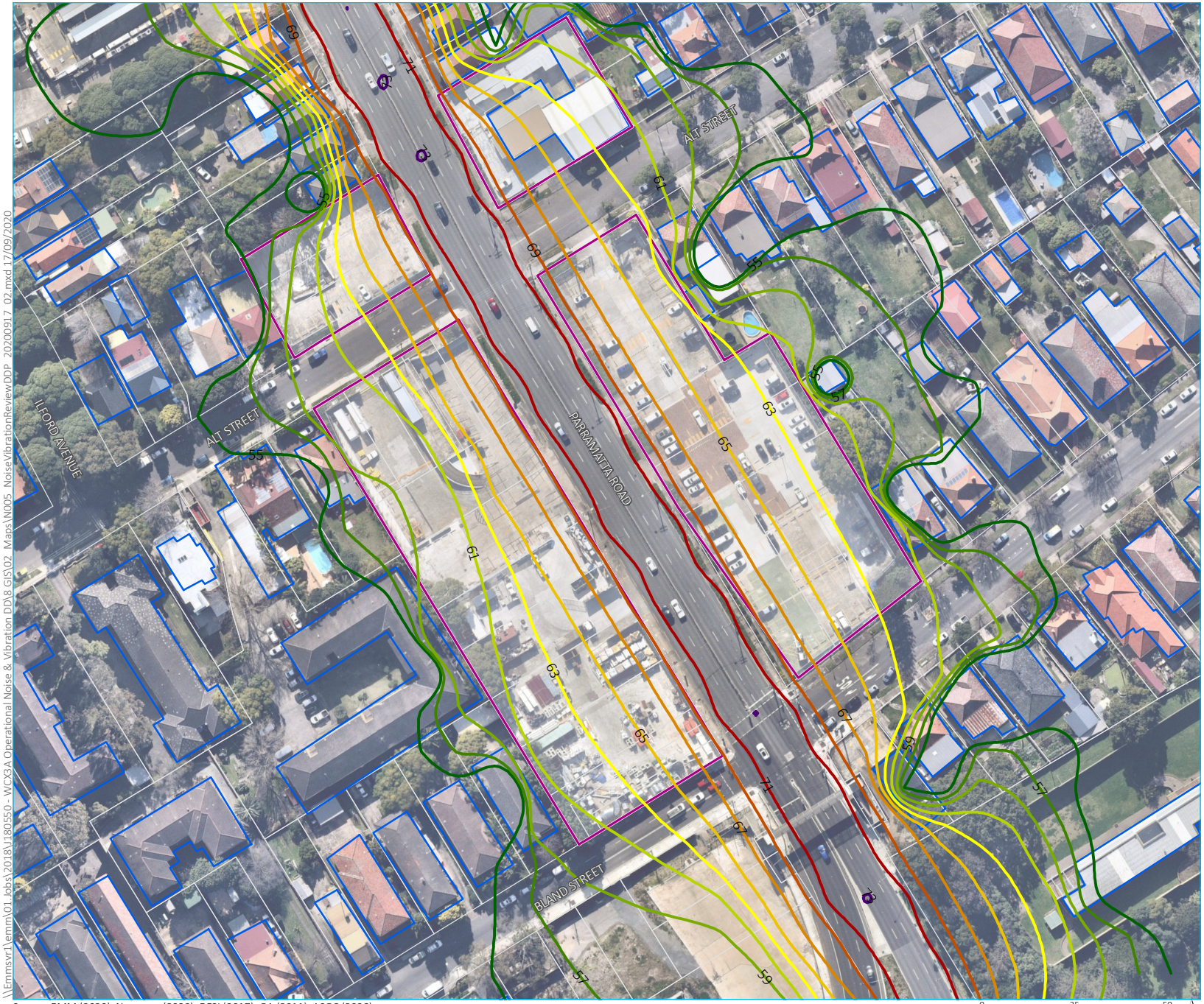
Future 2031 - no build
Night traffic noise contours
Contours 4.3 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.8

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020

A.2 Future 2031 – ‘Build’



KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 15\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67
- 69
- 71
- 73

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

N

Future 2031 - build
Daytime traffic noise contours
Contours 1.5 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.1

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020

KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 15\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67
- 69
- 71

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

N

Future 2031 - build
Daytime traffic noise contours
Contours 4.3 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.2

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020

KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 9\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

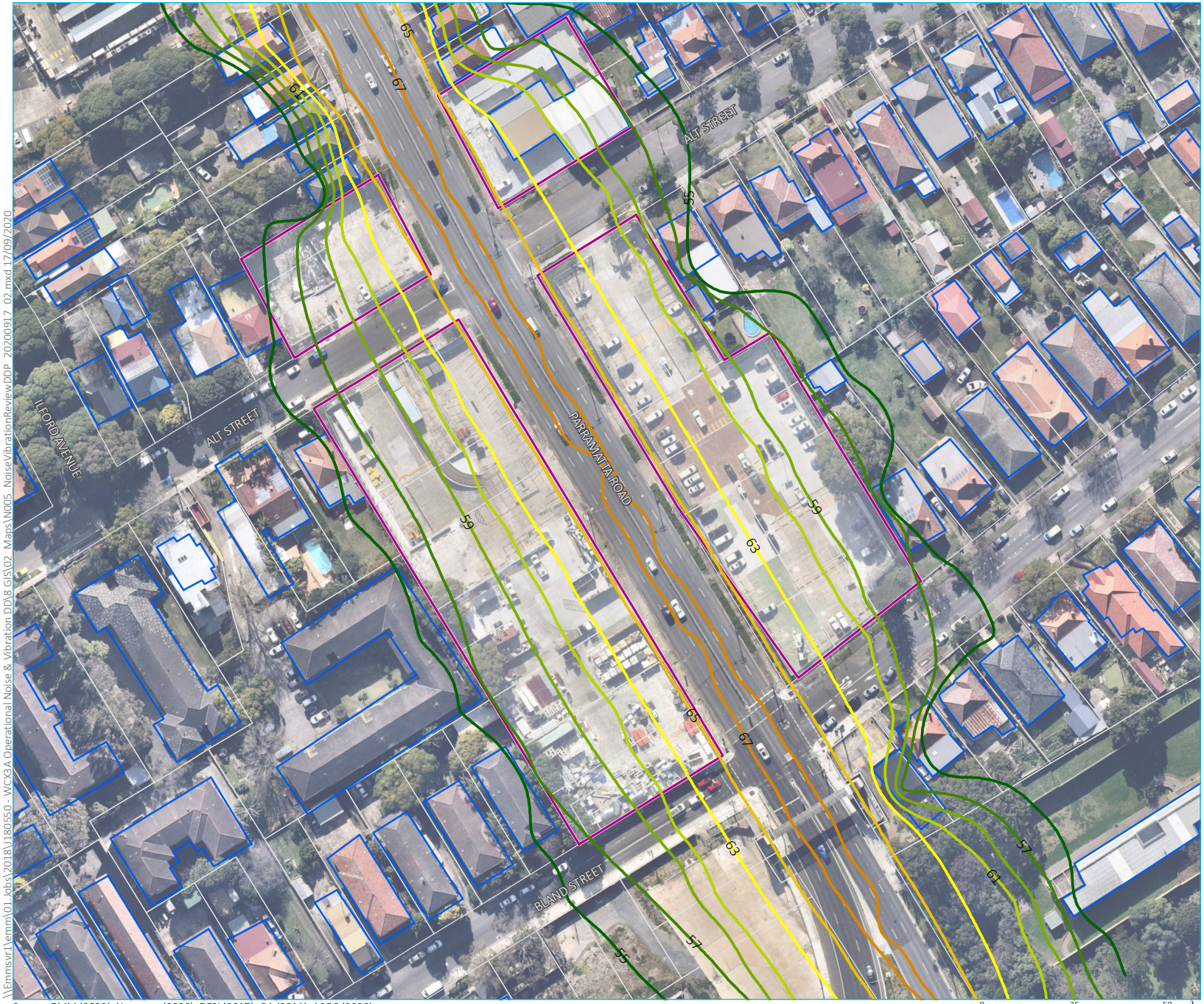
N

Future 2031 - build
Night traffic noise contours
Contours 1.5 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.3

EMM
creating opportunities

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020



KEY

- Site boundary
- Building/structure
- Cadastral boundary

Traffic noise level dB(A) $L_{eq,\ 9\ hr}$

- 55
- 57
- 59
- 61
- 63
- 65
- 67

Future 2031 - build
Night traffic noise contours
Contours 4.3 m above RL

WestConnex Stage 3A
Operational noise and vibration review
Figure A.4

EMM
creating opportunities

Source: EMM (2020); Nearmap (2020); DFSI (2017); GA (2011); ASGC (2006)

0 25 50 m

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emm\01_Jobs\2018\J180550 - WCX3A Operational Noise & Vibration DD\8 GIS\02_Maps\N005_NoiseVibrationReviewDDP_20200917_02.mxd 17/09/2020

Appendix B

Fan data

Table B.1 W & S Tunnel jet fan data

Supplier Measured Data	Octave band levels (Hz)								Total dBA
	63	125	250	500	1000	2000	4000	8000	
octave s. pressure level with 2300mm silencer, linear, Free Field, 3m @ 45°	71	82	79	77	79	75	73	67	83
Supplier data on silencer insertion losses and blade frequency penalties									
silencer insertion losses with 2300mm long silencers (Fan Measured)	5	6	13	18	17	13	11	10	-
blade frequency (to be added to noise at this frequency)	0	5	0	0	0	0	0	0	-
Silencer insertion losses with 2450mm long silencers (Fan to be supplied)	6	8	13	21	18	14	11	10	-
Design selection									
3 x fans with amended silencer (2450mm) + blade frequency (Lw)	92	107	101	96	100	96	95	89	104
3 x fans with amended silencer (2450mm) + blade frequency (SPL) @3m	75	90	84	79	83	79	78	72	87

Appendix C

Ancillary fixed mechanical plant

Project:	West Connex FAT data
Contract no.:	95471A1-A8
Item no.:	1 - **operated in FORWARD mode, 2 FANS RUNNING IN PARALLEL**
Fan type:	P-T5NR8JT5/V0.1/1250/GR/6 with 2300mm silencers,
Date:	ó.2017, FAT

Sound power level without silencer, free field

octave band	63	125	250	500	1000	2000	4000	8000	Hz
basic sound									dB
blade frequency									dB
octave s.power level without silencer, linear	0	0	0	0	0	0	0	0	dB
							total:	**9**	dB

Sound power level without silencer, free field, A-weighted

octave band	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	*Hz*
A-correction									*dB*
octave s.power level without silencer, linear									*dB*
							total:	*9*	*dB*

Sound power level with silencer, free field

length of silencer:	2300	mm							
octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
insertion loss									dB
octave s.power level with silencer, linear	89,2	91,4	95,3	92,3	91,1	91,3	87,4	82,3	dB
							total:	**100,3**	dB

Sound power level with silencer, free field, A-weighted

octave band	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	*Hz*
A-correction	*-26*	*-16*	*-9*	*-3*	*0*	*1*	*1*	*-1*	*dB*
octave s.power level without silencer, linear	*63*	*75*	*86*	*89*	*91*	*92*	*88*	*81*	*dB*
							total:	*97*	*dB*

Sound pressure with silencer, free field

1) 1m/45°:	89	dB(A)
2) 3m/45°:	**80**	dB(A)
3) 10m/45°:	69	dB(A)

Sound power level with silencer, inside tunnel

octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
tunnel correction (2 fans in parallel + reverberation) ~ +6,5 dB	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	dB
octave s.power level in tunnel	96	98	102	99	98	98	94	89	dB
							total:	**107**	dB

Sound power level with silencer, inside tunnel, A-weighted

octave band	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	*Hz*
A-correction	*-26*	*-16*	*-9*	*-3*	*0*	*1*	*1*	*-1*	*dB*
octave s.power level without silencer, linear	*70*	*82*	*93*	*96*	*98*	*99*	*95*	*88*	*dB*
							total:	*104*	*dB*

Sound pressure level with silencer, inside tunnel

octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
conversion to SPL (SPL~ SWL-17,5 dB)	-17,5	-17,5	-17,5	-17,5	-17,5	-17,5	-17,5	-17,5	dB
octave s.power level in tunnel	78	80	84	81	80	80	76	71	dB
							total:	**89**	dB

Comparison with NR85

octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
NR85	103	96	91	88	85	83	81	80	dB
							total:	**104**	dB

Sound pressure level with silencer, inside tunnel, A-weighted

octave band	***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	*Hz*
A-correction	*-26*	*-16*	*-9*	*-3*	*0*	*1*	*1*	*-1*	*dB*
octave s.power level without silencer, linear	*52*	*64*	*75*	*78*	*80*	*81*	*77*	*70*	*dB*
							total:	*86*	*dB*

Uncertainty of total levels at undisturbed inlet flow: Standard deviation 4 dB / octave band 6dB

Project:	West Connex FAT data
Contract no.:	95471A1-A8
Item no.:	1 - **operated in FORWARD mode, 3 FANS RUNNING IN PARALLEL**
Fan type:	P-T5NR8JT5/V0.1/1250/GR/6 with 2300mm silencers,
Date:	ð.2017, FAT

Sound power level without silencer, free field

octave band	63	125	250	500	1000	2000	4000	8000	Hz
basic sound									dB
blade frequency									dB
octave s.power level without silencer, linear	0	0	0	0	0	0	0	0	dB
							total:	**9**	dB

Sound power level without silencer, free field, A-weighted

octave band	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	*Hz*
A-correction									*dB*
octave s.power level without silencer, linear									*dB*
							total:	*9*	*dB*

Sound power level with silencer, free field

length of silencer:	**2300**	mm							
octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
insertion loss									dB
octave s.power level with silencer, linear	89,2	91,4	95,3	92,3	91,1	91,3	87,4	82,3	dB
							total:	**100,3**	dB

Sound power level with silencer, free field, A-weighted

octave band	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	*Hz*
A-correction	*-26*	*-16*	*-9*	*-3*	*0*	*1*	*1*	*-1*	*dB*
octave s.power level without silencer, linear	*63*	*75*	*86*	*89*	*91*	*92*	*88*	*81*	*dB*
							total:	*97*	*dB*

Sound pressure with silencer, free field

1) 1m/45°:	89	dB(A)
2) 3m/45°:	**80**	dB(A)
3) 10m/45°:	69	dB(A)

Sound power level with silencer, inside tunnel

octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
tunnel correction (3 fans in parallel + reverberation) ~ +8 dB	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0	dB
octave s.power level in tunnel	97	99	103	100	99	99	95	90	dB
							total:	**108**	dB

Sound power level with silencer, inside tunnel, A-weighted

octave band	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	*Hz*
A-correction	*-26*	*-16*	*-9*	*-3*	*0*	*1*	*1*	*-1*	*dB*
octave s.power level without silencer, linear	*71*	*83*	*94*	*97*	*99*	*100*	*96*	*89*	*dB*
							total:	*105*	*dB*

Sound pressure level with silencer, inside tunnel

octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
conversion to SPL (SPL~ SWL-17,5 dB)	-17,5	-17,5	-17,5	-17,5	-17,5	-17,5	-17,5	-17,5	dB
octave s.power level in tunnel	80	82	86	83	82	82	78	73	dB
							total:	**91**	dB

Comparison with NR85

octave band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	Hz
NR85	103	96	91	88	85	83	81	80	dB
							total:	**104**	dB

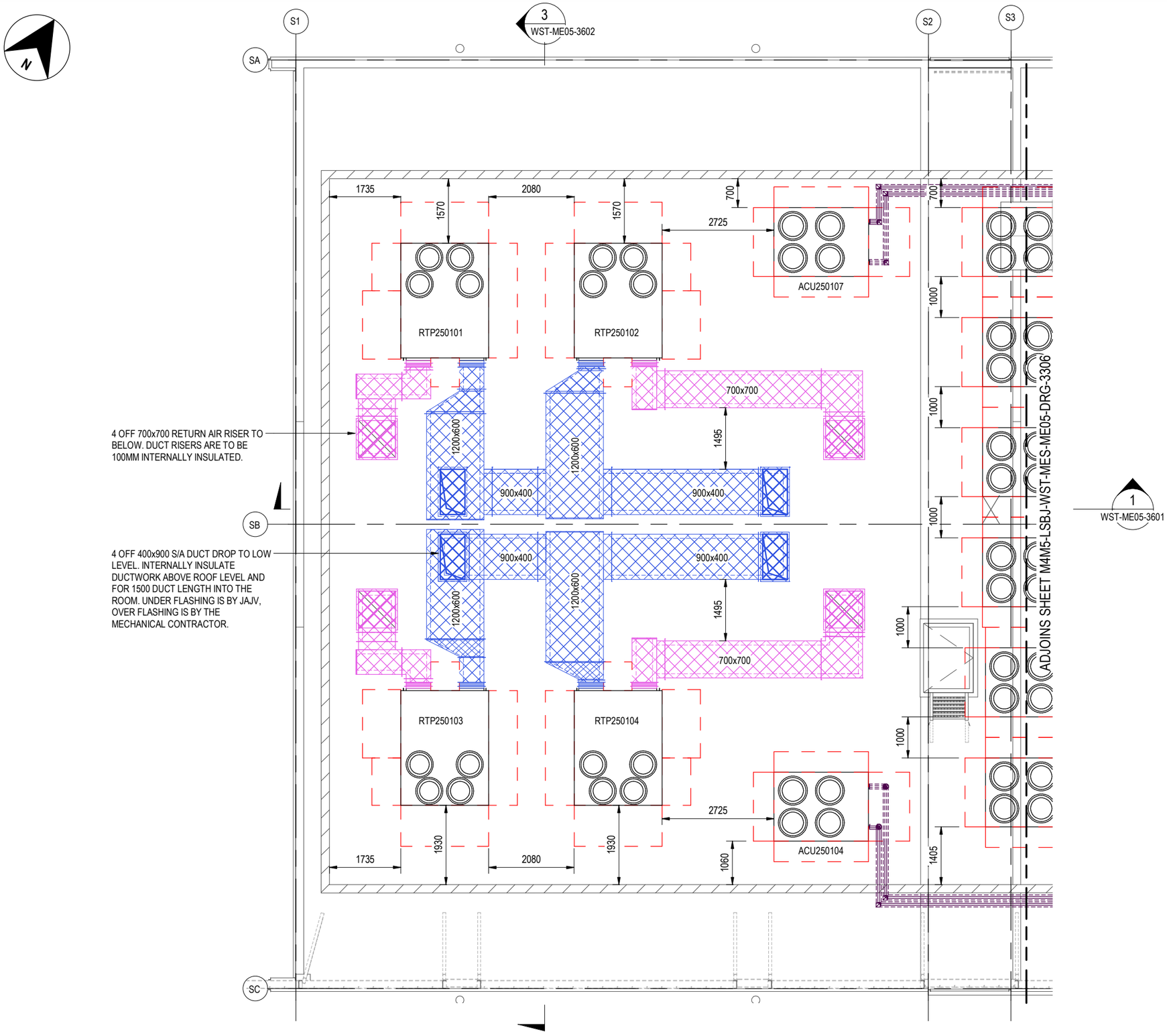
Sound pressure level with silencer, inside tunnel, A-weighted

octave band	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*	*Hz*
A-correction	*-26*	*-16*	*-9*	*-3*	*0*	*1*	*1*	*-1*	*dB*
octave s.power level without silencer, linear	*54*	*66*	*77*	*80*	*82*	*83*	*79*	*72*	*dB*
							total:	*88*	*dB*

Uncertainty of total levels at undisturbed inlet flow: Standard deviation 4 dB / octave band 6dB

Appendix D

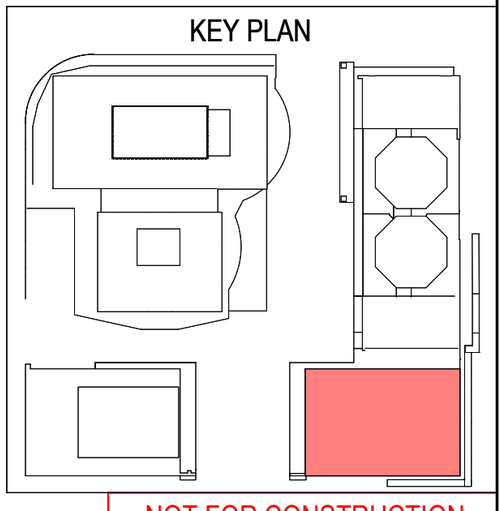
Roof plans



NOTES:

1. FOR GENERAL NOTES, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1011.
2. FOR LEGEND, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1031.
3. FOR MVAC SCHEMATIC LAYOUT, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1101.
4. FOR ESS25010 EQUIPMENT SCHEDULE, REFER TO DRAWING No. M4M5-LSBJ-WST-MES-ME05-DRG-7001.

KEY PLAN



NOT FOR CONSTRUCTION

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	A	08.10.2019	ISSUED FOR SUBSTANTIAL DETAILED DESIGN	D. WASHBURN
	B	23.04.2020	ISSUED FOR FINAL DESIGN	D. WASHBURN

DESIGN PACKAGE CODE: M4M5-LSBJ-PRW-MES-ME05-DPK-0001

SCALE ON THIS A3 SIZE DRAWING: 0.5 0 1 2m — 1:100

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WestConnex M4-M5 Link Tunnels — lendlease — SAMSUNG C&T — BOUYGUES CONSTRUCTION AUSTRALIA

TITLE	NAME	DATE
DRAWN	J. RIVERA	23.04.2020
DRG CHECK	B.CREEK	23.04.2020
DESIGN	Y. AGUDELO	23.04.2020
DESIGN CHECK	A. HOPKINSON	23.04.2020
DESIGN VERIFIER	A. HOLLOWAY	23.04.2020
DESIGN MNGR	D. WASHBURN	23.04.2020
PROJECT MNGR	S. LEATHER	23.04.2020

CLIENT: Sydney Motorway Corporation — WestConnex

DOCUMENT NUMBER: M4M5 - LSBJ - WST - MES - ME05 - DRG - 3305

M4-M5 LINK MAIN TUNNEL WORKS

A3

WATTLE ST INTERCHANGE

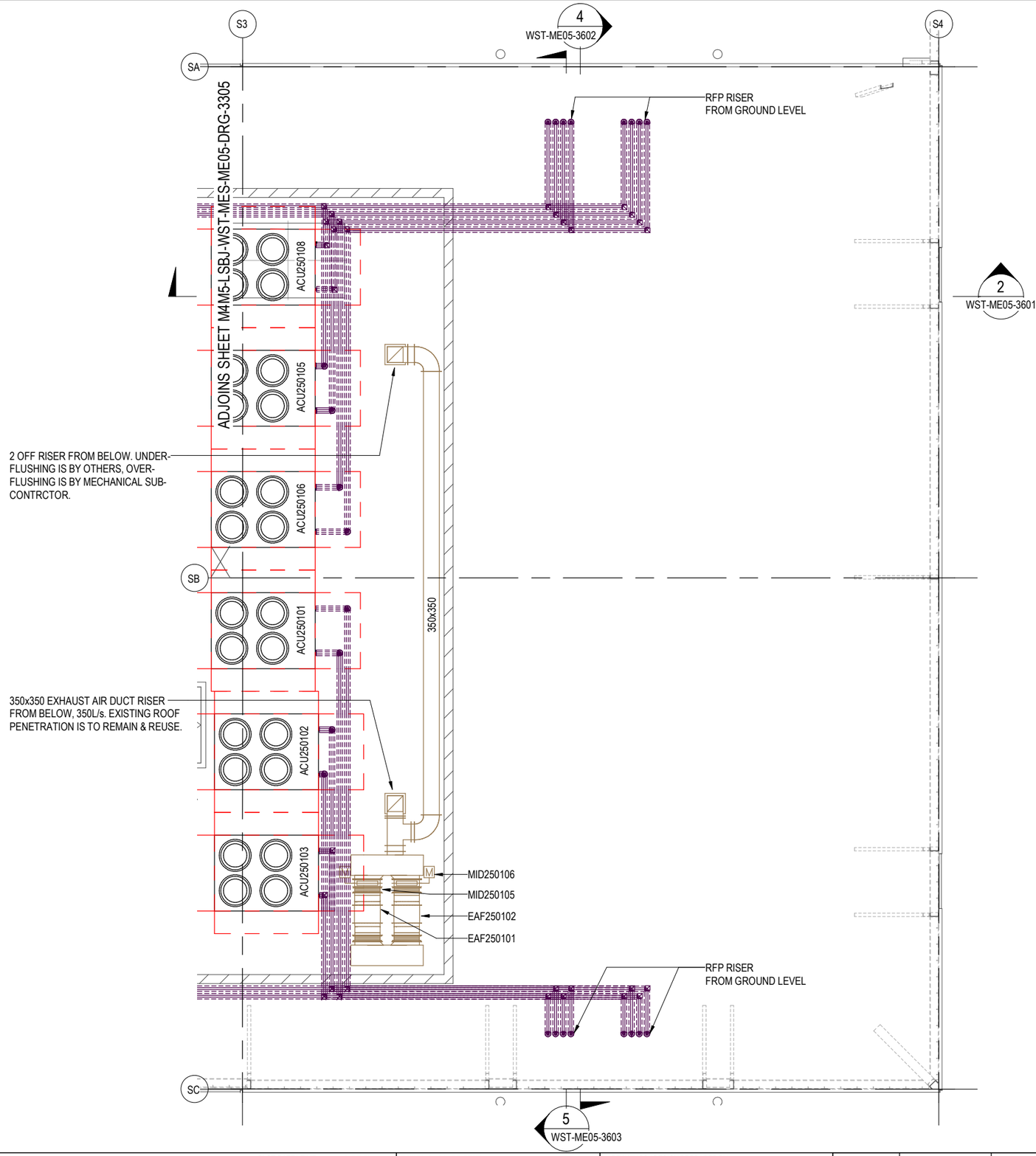
MECHANICAL SYSTEMS - MVAC

WST ESS25010 ROOF LEVEL LAYOUT PLAN

SHEET 1 OF 2

RMS REGISTRATION No. - | PART

ISSUE STATUS	EDMS No.	SHEET No.	REV
FINAL DESIGN	-	WST - ME05 - 3305	B



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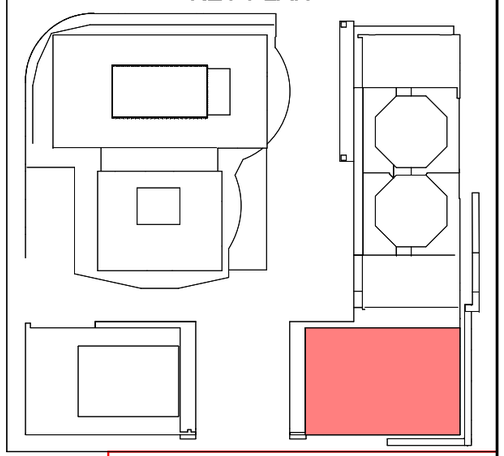
2. FOR LEGEND, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1031.
3. FOR MVAC SCHEMATIC LAYOUT, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1101.
4. FOR ESS25010 EQUIPMENT SCHEDULE, REFER TO DRAWING No. M4M5-LSBJ-WST-MES-ME05-DRG-7001.

KEY PLAN



NOT FOR CONSTRUCTION

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CO-ORDINATE SYSTEM	MGA ZONE 56
HEIGHT DATUM	AHD

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

REV	DATE	AMENDMENT/ DESCRIPTION REVISION	APPROVAL
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B	23.04.2020	ISSUED FOR FINAL DESIGN	D. WASHBURN

DRAWINGS / DESIGN PREPARED BY

WestConnex M4-M5 Link Tunnels — lendlease — SAMSUNG C&T — BOUYGUES CONSTRUCTION AUSTRALIA

TITLE	NAME	DATE
DRAWN	J. RIVERA	23.04.2020
DRG CHECK	B.CREEK	23.04.2020
DESIGN	Y. AGUDELO	23.04.2020
DESIGN CHECK	A. HOPKINSON	23.04.2020
DESIGN VERIFIER	A. HOLLOWAY	23.04.2020
DESIGN MNGR	D. WASHBURN	23.04.2020
PROJECT MNGR	S. LEATHER	23.04.2020

CLIENT: Sydney Motorway Corporation — WestConnex

DOCUMENT NUMBER
M4M5 - LSBJ - WST - MES - ME05 - DRG - 3306

M4-M5 LINK MAIN TUNNEL WORKS

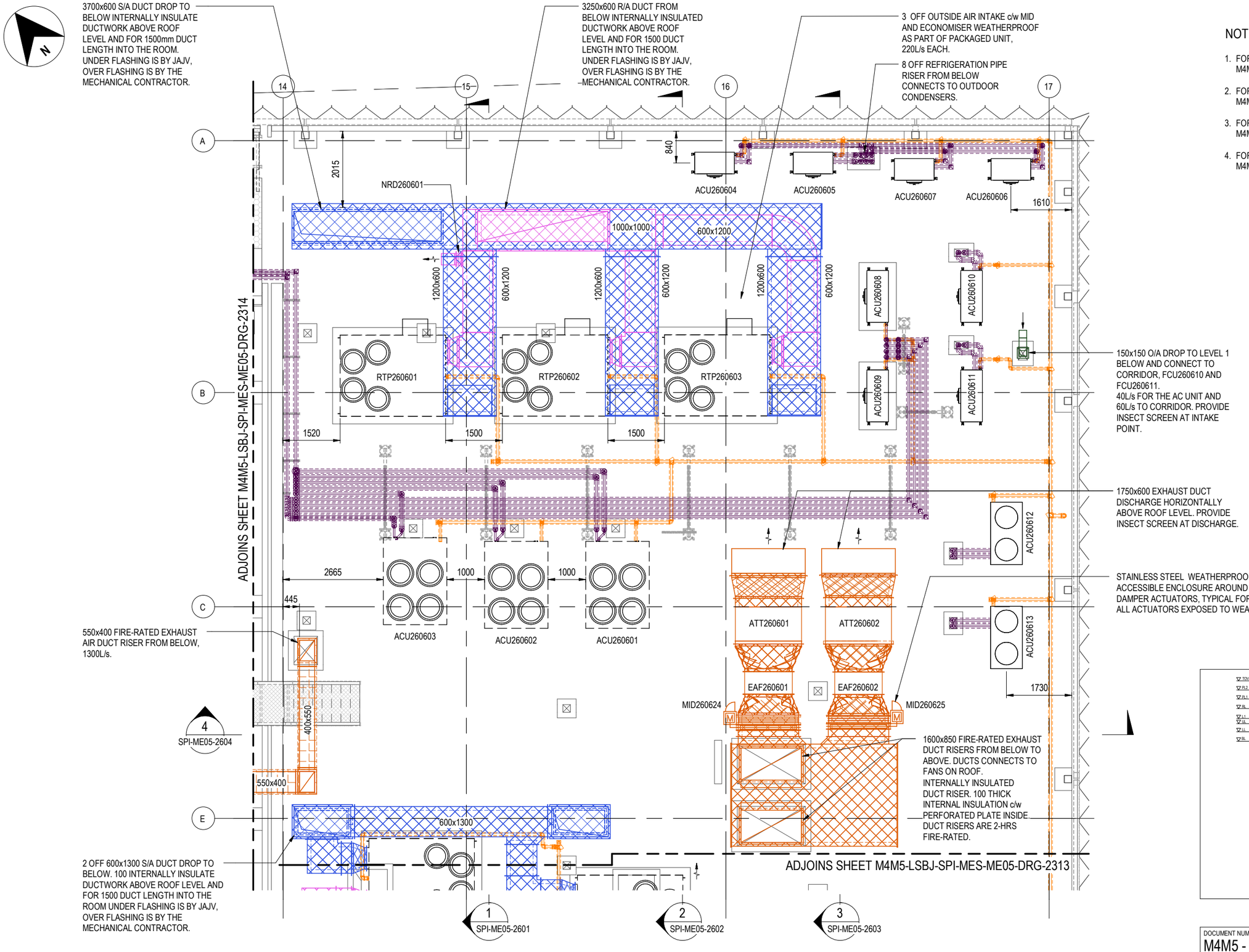
A3

WATTLE ST INTERCHANGE
MECHANICAL SYSTEMS - MVAC
WST ESS25010 ROOF LEVEL LAYOUT PLAN

SHEET 2 OF 2

RMS REGISTRATION No. _ PART

ISSUE STATUS	EDMS No.	SHEET No.	REV
FINAL DESIGN	-	WST - ME05 - 3306	B



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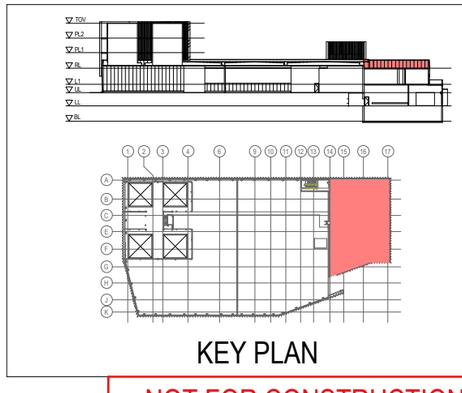
2. FOR LEGEND, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1031.
3. FOR CROSS PASSAGE SCHEMATICS, REFER TO DRAWING Nos. M4M5-LSBJ-PRW-MES-ME05-DRG-1161 TO 1162, 1186 TO 1190.
4. FOR EQUIPMENT SCHEDULE, REFER TO DRAWING. Nos. M4M5-LSBJ-TUN-MES-ME05-DRG-5801 TO 5830.



KEY PLAN

NOT FOR CONSTRUCTION

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED 50mm ON A3 SIZE ORIGINAL

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	B	23.04.2020	ISSUED FOR FINAL DESIGN	D. WASHBURN

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SCALE ON THIS A3 SIZE DRAWING: 0.5 0 1 2m — 1:100

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WestConnex M4-M5 Link Tunnels — lendlease — SAMSUNG C&T — BOUYGUES CONSTRUCTION AUSTRALIA

TITLE	NAME	DATE
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DESIGN	Y. AGUDELO	23.04.2020
DESIGN CHECK	A. HOPKINSON	23.04.2020
DESIGN VERIFIER	A. HOLLOWAY	23.04.2020
DESIGN MNGR	D. WASHBURN	23.04.2020
PROJECT MNGR	S. LEATHER	23.04.2020

CLIENT: Sydney Motorway Corporation — WestConnex

DOCUMENT NUMBER: M4M5 - LSBJ - SPI - MES - ME05 - DRG - 2312

M4-M5 LINK MAIN TUNNEL WORKS

A3

ST PETERS INTERCHANGE

MECHANICAL SYSTEMS - MVAC

SPI BUILDING ROOF LEVEL LAYOUT PLAN

SHEET 1 OF 3

RMS REGISTRATION No. - PART

ISSUE STATUS	EDMS No.	SHEET No.	REV
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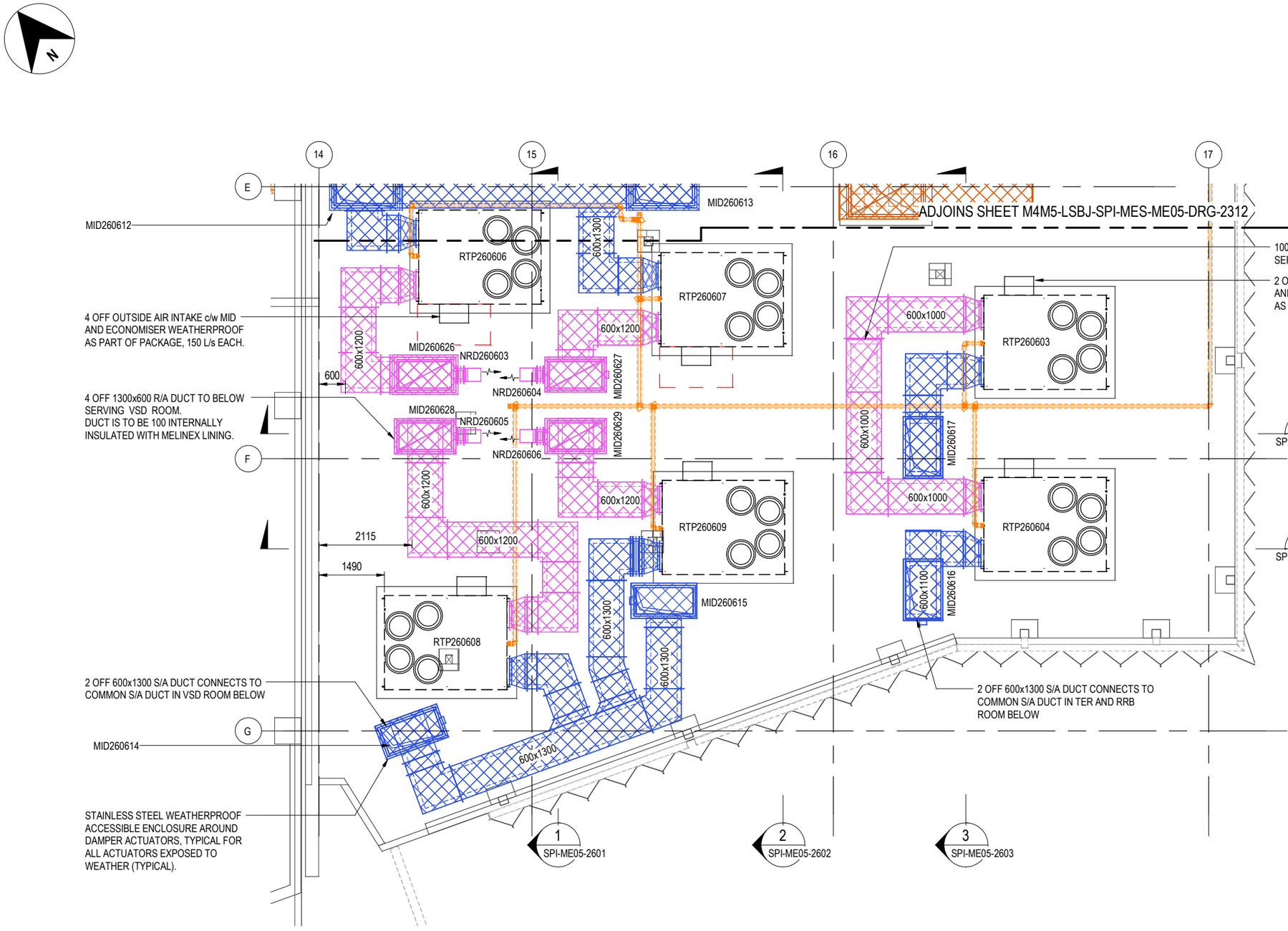

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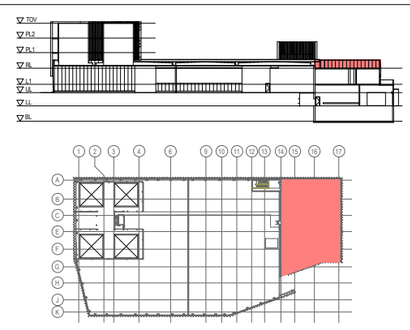
2. FOR LEGEND, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1031.
3. FOR CROSS PASSAGE SCHEMATICS, REFER TO DRAWING Nos. M4M5-LSBJ-PRW-MES-ME05-DRG-1161 TO 1162, 1186 TO 1190.
4. FOR EQUIPMENT SCHEDULE, REFER TO DRAWING. Nos. M4M5-LSBJ-TUN-MES-ME05-DRG-5801 TO 5830.



KEY PLAN

NOT FOR CONSTRUCTION

DOCUMENT NUMBER
M4M5 - LSBJ - SPI - MES - ME05 - DRG - 2313

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	B	23.04.2020	ISSUED FOR FINAL DESIGN	D. WASHBURN

DESIGN PACKAGE CODE
M4M5-LSBJ-PRW-MES-ME05-DPK-0001

SCALE ON THIS A3 SIZE DRAWING
0.5 0 1 2m
1:100

CO-ORDINATE SYSTEM: MGA ZONE 56
HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY
WestConnex M4-M5 Link Tunnels
lendlease | SAMSUNG C&T | BOUYGUES CONSTRUCTION AUSTRALIA

TITLE	NAME	DATE
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DESIGN VERIFIER	A. HOLLOWAY	23.04.2020
DESIGN MNGR	D. WASHBURN	23.04.2020
PROJECT MNGR	S. LEATHER	23.04.2020

CLIENT
Sydney Motorway Corporation
WestConnex

M4-M5 LINK MAIN TUNNEL WORKS

A3

ST PETERS INTERCHANGE
MECHANICAL SYSTEMS - MVAC
SPI BUILDING ROOF LEVEL LAYOUT PLAN

SHEET 2 OF 3

RMS REGISTRATION No. -

PART

ISSUE STATUS	EDMS No.	SHEET No.	REV
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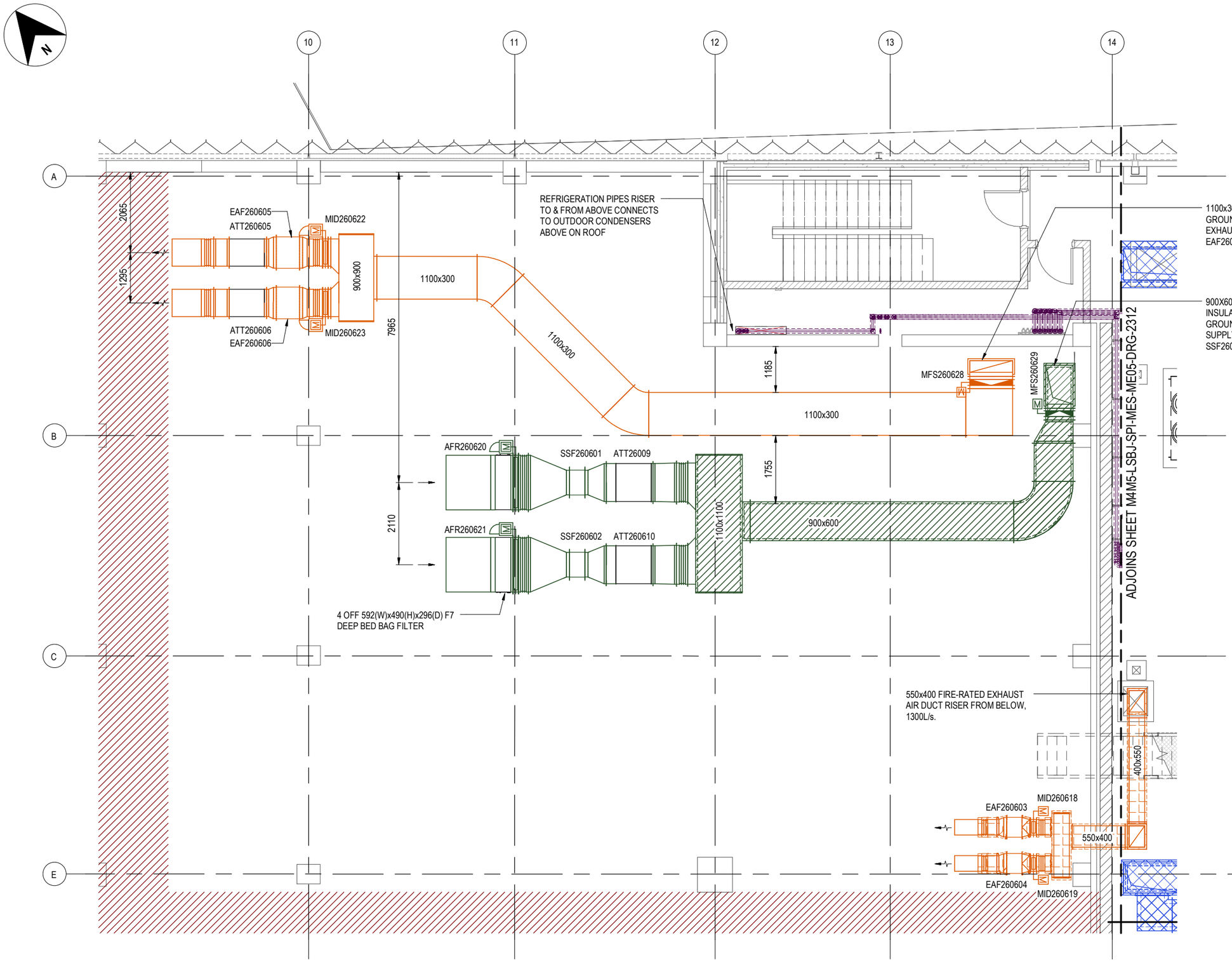

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2. FOR LEGEND, REFER TO DRAWING No. M4M5-LSBJ-PRW-MES-ME05-DRG-1031.
3. FOR CROSS PASSAGE SCHEMATICS, REFER TO DRAWING Nos. M4M5-LSBJ-PRW-MES-ME05-DRG-1161 TO 1162, 1186 TO 1190.
4. FOR EQUIPMENT SCHEDULE, REFER TO DRAWING. Nos. M4M5-LSBJ-TUN-MES-ME05-DRG-5801 TO 5830.

NOT FOR CONSTRUCTION

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DESIGN PACKAGE CODE: M4M5-LSBJ-PRW-MES-ME05-DPK-0001

SCALE ON THIS A3 SIZE DRAWING: 0.5 0 1 2m — 1:100

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WestConnex M4-M5 Link Tunnels; lendlease; SAMSUNG C&T; BOUYGUES CONSTRUCTION AUSTRALIA

TITLE	NAME	DATE
DRAWN	J. RIVERA	23.04.2020
DRG CHECK	B. CREEK	23.04.2020
DESIGN	Y. AGUDELO	23.04.2020
DESIGN CHECK	A. HOPKINSON	23.04.2020
DESIGN VERIFIER	A. HOLLOWAY	23.04.2020
DESIGN MNGR	D. WASHBURN	23.04.2020
PROJECT MNGR	S. LEATHER	23.04.2020

CLIENT: Sydney Motorway Corporation; WestConnex

DOCUMENT NUMBER: M4M5 - LSBJ - SPI - MES - ME05 - DRG - 2314

M4-M5 LINK MAIN TUNNEL WORKS

A3

ST PETERS INTERCHANGE

MECHANICAL SYSTEMS - MVAC

SPI BUILDING ROOF LEVEL LAYOUT PLAN

SHEET 3 OF 3

RMS REGISTRATION No. - | PART

ISSUE STATUS	EDMS No.	SHEET No.	REV
FINAL DESIGN	-	SPI - ME05 - 2314	A

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0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50mm ON A3 SIZE ORIGINAL

Appendix E

Acoustic advisor confirmation

hutchison weller

Jake Shackelton
Acting Director, Infrastructure Management
Department of Planning, Industry and Environment
GPO Box 39
Sydney, NSW, 2001

29 March 2021 18023-LT-ED-016-2

Dear Jake

WestConnex M4-M5 Link Mainline Tunnels
Operational noise and vibration review

The Acoustic Advisor has reviewed the *M4-M5 Link Mainline Tunnels Operational noise and vibration review Revision 14* dated 29 March 2021 *(ONVR),* prepared by the Lend Lease Samsung Bouygues Joint Venture.

The latest revision addresses further comments by the Department of Planning, Industry and Environment. I am satisfied the ONVR meets the requirements of Condition E92 and has been verified by a suitably qualified and experienced noise and vibration expert.

I am satisfied the ONVR was prepared in accordance with relevant guidelines and in consultation with the relevant stakeholders.

As required by Condition of Approval A26(d), I endorse the ONVR as being generally compliant with the requirements outlined in the Infrastructure Approval (SSI 7485).

Kind Regards

John Hutchison
Acoustic Advisor
WestConnex M4-M5 Link Project

Appendix F

CV of Najah Ishac

Najah Ishac

Director, National Technical Leader Acoustics

Curriculum vitae

Najah is a co-founder and Director of EMM Consulting. Najah is a leading acoustic engineer in Australia with over 25 years' consulting experience for private and public sector clients. Najah leads expert acoustic teams in large-scale mining and infrastructure projects, and in urban and regional construction projects. His specialisations include architectural acoustics, environmental noise, noise control and vibration and dynamics.

Najah has served on the NSW Department of Planning and Infrastructure's Independent Hearing and Assessment Panel (IHAP), and has provided evidence as an expert witness in the NSW Land and Environment Court.

Qualifications and memberships

- Master of Engineering Science, University of NSW, 1998
- Bachelor of Engineering (Mechanical), University of NSW, 1994
- Land and Environment Court Expert Witness Accreditation Certificate, 2000
- Member Engineers Australia (MEAust), since 2005
- Member Australian Acoustical Society (MAAS), since 2005
- Australian Institute of Company Directors course, 2014
- Elected committee member of NSW Australian Acoustical Society, 2010–2014

Career

- EMM Consulting, 2010–present
- Director EMGA Mitchell McLennan, 2009–2010
- Director, Environmental Management Group Australia (EMGA), 2008–2009
- Senior Acoustic Engineer and Manager, Environmental Resources Management Australia (ERM), 1997–2008
- Project Acoustic Engineer, Renzo Tonin and Associates, 1995–1997

Representative experience

Environmental impact statements and environmental noise and vibration

- State Environmental Planning Policy (Kurnell Peninsula), amendment aircraft noise study, Sydney NSW (Department of Planning and Environment and Urbis)
- The Star Casino, independent noise review, Sydney NSW (Star Casino)

EMM
creating opportunities

- Dunmore Quarry, noise management plan, Dunmore NSW (Boral)
- Cawdor rezoning, acoustics, Cawdor NSW (Country Garden)
- Overseas Passenger Terminal, construction works noise and vibration, Sydney NSW (Ridgemill)
- 101 Waterloo Rd Macquarie Park residential development, acoustics, Sydney NSW (JQZ)
- Marsden Park industrial development, noise and vibration, Sydney NSW (Logos)
- Moorebank Precinct East and West, independent noise review, Sydney NSW (Department of Planning and Environment)
- Western Sydney Priority Growth Area (WSPGA), strategic noise assessment, Sydney NSW (Department of Planning and Environment)
- Clermont Mine, noise compliance monitoring, Clermont Qld (Glencore)
- Mangoola Coal Mine Modification 6, noise impact assessment, Mangoola NSW (Glencore)
- North West Rail Link Early Works, noise and vibration, Sydney NSW (Baulderstone)
- Terminal 4 (T4) Project, off-site rail noise study, Port Waratah NSW (PWCS)
- Collector Wind Farm, noise review, Collector NSW (RATCH)
- Minimbah Bank Third Track, rail noise and vibration review, Minimbah NSW (GHD)
- Mount Pleasant Project Modification, noise and vibration, Mount Pleasant NSW (Coal & Allied)
- Warkworth Mine, noise and vibration, Mount Thorley NSW (Rio Tinto Coal Australia)
- Abbey Green North Modification, noise and vibration, Mount Thorley NSW (Coal & Allied)
- Kurnell, land use development and aircraft noise, Kurnell NSW (Besmaw)
- North West Bankstown, local area plan, Bankstown NSW (Bankstown City Council)
- Mangoola Coal Mine, independent review, Mangoola NSW (NSW DP&I)
- Integra Mine, independent review, Singleton NSW (NSW DP&I)
- Wollert Quarry and residential development, noise and vibration, Wollert Vic (Boral)
- Peppertree Quarry Modification 3, noise and vibration, Marulan South NSW (Boral Cement)
- Holcim mine and cement plant, noise and vibration, Indonesia (Holicm)
- Hunter Valley Operations South Coal Project, noise and vibration, Hunter Valley NSW (RTCA)
- Bombala Quarry, noise assessment, Bombala NSW (Boral)
- Sydney Desalination Pipeline Project, noise and vibration, Sydney NSW (Water Delivery Alliance)
- Sydney Gas Treatment Plant, noise and vibration, Mount Gilead NSW (AGL)
- Rasp Mine, noise and vibration, Broken Hill NSW (CBH Resources)
- Garden Island Maintenance Dredging Project, noise and vibration, Sydney NSW (Department of Defence)
- Holsworthy Military Training Area, acoustics, Sydney NSW (Department of Defence)
- Gloucester Gas Project, noise and vibration, Upper Hunter Valley NSW (AGL)
- RAAF Base development, acoustics, East Sale NSW (Department of Defence)
- Bankstown Airport, noise assessment, Bankstown NSW (Bankstown Airport)
- Parklife Music Festival, noise surveys, Sydney NSW (Centennial Parklands Trust)
- Southern Sydney Freight Line, noise review, Sydney NSW (ARTC)
- Southern Highlands Shooting Complex IHAP update, Southern Highlands NSW (NSW DP&I)
- West Pit, extension and minor modifications noise and vibration, Hunter Valley NSW (Coal & Allied)

- Mount Thorley Warkworth Mine Extension, noise and vibration, Hunter Valley NSW (Rio Tinto Coal Australia)
- Hunter Valley Operations South Modification, noise and vibration, Hunter Valley NSW (Rio Tinto Coal Australia)
- Mount Arthur North Coal Mine, noise and vibration, Hunter Valley NSW (Mt Arthur Coal)
- Mount Pleasant Project Modification, noise and vibration, Mount Pleasant NSW (Coal & Allied)
- Ravensworth East Coal Mine, noise and vibration, Hunter Valley NSW (Xstrata)
- Centennial Parklands, noise survey, Sydney NSW (Centennial Parklands Trust)
- SCG and SFS Noise Management Plans, Sydney NSW (Centennial Parklands Trust)
- Anvil Hill Coal Mine, IHAP appointment, Hunter Valley NSW (Xstrata)
- Warragamba Dam Spillway, noise and vibration impact assessment, Sydney NSW (Sydney Catchment Authority)
- Woronora & Illawarra Water Filtration Plants, noise and vibration impact assessment, Sydney NSW (Sydney Water)
- Homebush Storage & Warehouse Facility, noise and vibration impact assessment, Sydney NSW (Linfox Properties Group)
- Coles Myer Distribution Centre, noise and vibration impact assessment, Erskine Park NSW (Coles Myer)

Energy and utilities

- Kogarah Substation, noise and vibration, Sydney NSW (Energy Australia)
- Hornsby Substation Transformer Installation, noise and vibration, Sydney NSW (Energy Australia)
- Potts Hill Substation, noise and vibration, Sydney NSW (AusGrid)
- Turramurra 33kV feeder replacement and Warringah to Brookvale 33kV feeder installation construction noise and vibration assessments, Sydney NSW (AusGrid)
- Homebush Zone Substation Upgrade, noise and vibration, Sydney NSW (AusGrid)

Transportation noise

- Parramatta Rail Link EIS, noise and vibration assessment, Sydney NSW (PPK)
- Western Sydney Interim Transitway, road traffic noise assessment, Sydney NSW (Department of Transport)
- M2 Post, opening traffic noise assessment, Sydney NSW (RTA)
- Sydney Airport Baseline Noise Study - North East Sector, Sydney NSW (Federal Airport Corporation)
- Muswellbrook Rail Strategy, noise measurement and assessment, Hunter Valley NSW (Muswellbrook Council)
- M5 East Motorway, traffic noise assessment, Sydney NSW (RTA)
- Second Sydney Airport ANEF, contours for supplementary EIS documentation, Sydney NSW (Federal Airport Corporation)
- Heavy Vehicle Noise Reduction Study, research and development project, NSW (RTA)
- Hong Kong Rail Noise, modelling and assessment, Hong Kong (ERM Hong Kong)
- Orchard Hills Traffic Noise Investigation, M4 upgrade project, Sydney NSW (RTA)
- Captain Cook Cruises, water vessel noise impacts, Sydney NSW (N.G Cassim & Co. Solicitors)

Architectural and building acoustics

- Larrakeyah Barracks Redevelopment, acoustics, Darwin NT (Laing O'Rourke)
- HMAS Cerberus Redevelopment, acoustics, Cerberus VIC (Lend Lease)
- RAAF East Sale redevelopment, acoustics, East Sale Vic (Department of Defence)
- RAAF Williamstown Redevelopment, acoustics, Williamstown NSW (Department of Defence)
- RAAF Colleges Relocation, acoustics, Wagga and East Sale NSW (Department of Defence)
- 171 Aviation Squadron Relocation Holsworthy, acoustics, Holsworthy NSW (Department of Defence)

- Sydney International Shooting Centre, acoustics, Cecil Park NSW (Gazzard Sheldon Architects)
- Arnotts Huntingwood Facility, acoustics, Huntingwood Sydney NSW (Civil & Civic)
- ADF School of Languages RAAF, acoustics, Hunter Valley NSW (Group GAS P/L)
- HMAS Albatross Redevelopment Stage 1, acoustics, Nowra NSW (Lend Lease)

Legal

- Bannerman vs Coffs Harbour City Council Land & Environment Court matter 2020/00029499
- Strathfield Municipal Council vs Aussie Industries Land & Environment Court case 2018/328340.
- Boral vs. Camden Council Class 1 Appeal – Concrete Batching Plant, Bringelly NSW.
- Aqualand vs. Channel 7 Sydney construction noise dispute, NSW.
- Liverpool City Council v Moorebank Recyclers & Ors and Benedict Industries & Ors v Minister for Planning & Ors - L&EC Proceedings No 2016/159652 and 2016/157848, NSW.
- Rosaria Maria & Mimma Barca (for Barca Metals) vs. Wollondilly Shire Council / Allied Mills / Sell & Parker for the Maldon Resource Recovery Facility, in the NSW Land and Environment Court, 2015.
- Bulga Milbrodale Progress Association Inc vs. Minister for Planning and Infrastructure and Warkworth Mining Limited in the NSW Land & Environment Court, 2012.
- Kempsey Shire Council vs. Mobbs 2006. Providing expert witness testimony in the NSW Land and Environment Court proceedings in relation to potential industrial noise impacts on proposed dwelling in South Kempsey NSW.
- Shire of Serpentine-Jarrahdale Council WA vs. Big Country Australia 2005-2006. Providing expert witness testimony in the State Administrative Tribunal proceedings in respect of noise from upgraded tunnel ventilation chicken sheds, WA.
- Coca Cola Amital vs. Aquilina 2005. Providing expert witness testimony in the NSW Land and Environment Court proceedings in relation to potential noise impacts from extension of operations of bottling plant on neighbouring dwelling Peats Ridge NSW.
- Sydney Gas Company vs. Mt Gilead. Representing applicant in a third party appeal hearing for a new Gas Plant. A complete noise and vibration impact assessment (including design control) was undertaken. Expert advice provided to the NSW Land and Environment Court in the form of a consolidated report between myself and the respondent's acoustic expert to assist the court with its assessment.
- Dixon Sands vs. Diamond (3rd Party Appeal). Representing applicant in a third party appeal hearing for a sand extraction quarry. A complete noise and vibration impact assessment (including design control) was undertaken, Maroota NSW.
- Owens vs. Mosman Council. Representing applicant in obtaining approval for domestic air-conditioning and pool equipment installations. A complete noise assessment (including design control) was undertaken, NSW.
- Fishermans Village vs. Port Stephens Council. Representing applicant in Supreme Court in respect of aircraft noise impacts on the Fishermans Village eco-tourist resort development, NSW.
- Sell & Parker Metal Recyclers / Blacktown Council. Representing applicant in obtaining approval for a metal recycling facility. A complete noise and vibration impact assessment (including design control) was undertaken, NSW.
- Bonfoal / Botany Council. Representing applicant in obtaining approval for a concrete batching plant. A complete noise and vibration impact assessment (including design control) was undertaken, NSW.
- Fernance Holdings P/L / Newcastle Council. Providing advice on behalf of Council (Respondent) in relation to pub crowd noise. A complete noise impact assessment was undertaken, NSW.

Publications

- Karantonis, P, Ishac, N & Tonin R 1997, Heavy vehicle noise reduction study, paper presented at *5th International Congress on Sound and Vibration*, Adelaide SA 15–18 December 1997.
- Ishac, N & Bullen, R 2006, Experimental Outdoor Sound Propagation, paper presented at *Australian and New Zealand Acoustic Society Conference*, Christchurch NZ, 20–22 November 2006.
- Ishac, N 2007, Experimental Outdoor Sound Propagation and ENM, paper presented at *14th International Congress on Sound and Vibration*, Cairns Qld, 9–12 July 2008.
- Ishac, N & Manion, J 2008, Sound vs Noise in the Community, paper presented at *Australian Acoustical Society Conference*, Geelong Vic, 2008.
- Ishac, N 2015, Low frequency noise and environmental assessment, paper presented at *Australian Acoustical Society Conference*, Hunter Valley NSW, 15–18 November 2015.

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Appendix G

Glossary of Acoustic Terms

Glossary of acoustic terms and abbreviations

Abbreviation or term	Definition
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{A90} statistical noise levels.
Amenity noise criteria	The amenity noise criteria relate to the overall level of industrial noise. Where existing levels of industrial noise (excluding the subject development) approach the acceptable amenity noise criteria, then noise levels from new industries need to demonstrate that they will not be an additional contributor to existing industrial noise.
A-weighting	There are several different weightings utilised for describing noise, the most common being the 'A-weighting'. This attempts to closely approximate the frequency response of the human ear.
CEMP	Construction environment management plan
C-weighting	There are several different weightings utilised for describing noise, with the 'C-weighted' scale typically used to assess low frequency noise and is also utilised in the assessment of occupational noise.
Day period	Monday–Saturday: 7.00 am to 6.00 pm, on Sundays and public holidays: 8.00 am to 6.00 pm.
dB	Noise is measured in units called decibels (dB).
DP&E	Department of Planning and Environment
EA	Environmental assessment
EMM	EMM Consulting Pty Limited
EP&A Act	*Environmental and Planning Assessment Act 1979* (NSW)
EPA	The NSW Environment Protection Authority (formerly the Department of Environment, Climate Change and Water).
Evening period	Monday–Saturday: 6.00 pm to 10.00 pm, on Sundays and public holidays
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
Intrusive noise criteria	The intrusive noise criteria refers to noise that intrudes above the background level by more than 5 dB. The intrusiveness criterion is described in detail in Section 3.1.1.
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The A-weighted noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The A-weighted noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The A-weighted energy average noise level. This is the equivalent continuous sound pressure level over a given period. The $L_{Aeq(15\text{-}minute)}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
Linear peak	The peak level of an event is normally measured using a microphone in the same manner as linear noise (i.e. unweighted), at frequencies both in and below the audible range.
L_{Amax}	The maximum A-weighted sound pressure level received during a measurement interval.
Night period	Monday–Saturday: 10.00 pm to 7.00 am, on Sundays and public holidays: 10.00 pm to 8.00 am.
NMP	Noise management plan
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)

Glossary of acoustic terms and abbreviations

Abbreviation or term	Definition
PSNL	The project-specific noise level (PSNL) is criteria for a particular industrial noise source or industry. The PSNL is the lower of either the intrusive noise criteria or amenity noise criteria.
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
RNP	Road Noise Policy
SEARs	Secretary's environmental assessment requirements
Sound power level (L_w)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.