ACOUSTICS AND AIR

NORTHCONNEX PROJECT

OPERATIONAL NOISE MANAGEMENT PLAN

REPORT NO. 13245-OM
VERSION E/**REV** 04

JUNE 2020

PREPARED FOR

LEND LEASE BOUYGUES JOINT VENTURE
LEVEL 4, BUILDING C, 55 COONARA AVENUE
WEST PENNANT HILLS NSW 2125

WILKINSON MURRAY

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Draft	30 August 2019	Brian Mendieta	Neil Gross
B/Rev01	Final	13 December 2019	Brian Mendieta	-
C/Rev02	Final	17 February 2020	Brian Mendieta	
D/Rev03	Final	14 April 2020	-	Martin Howe
E/Rev04	Revised	25 May 2020	Brian Mendieta	Martin Howe

Note

All materials specified by Wilkinson Murray Pty Limited have been selected solely on the basis of acoustic performance. Any other properties of these materials, such as fire rating, chemical properties etc. should be checked with the suppliers or other specialised bodies for fitness for a given purpose. The information contained in this document produced by Wilkinson Murray is solely for the use of the client identified on the front page of this report. Our client becomes the owner of this document upon full payment of our **Tax Invoice** for its provision. This document must not be used for any purposes other than those of the document's owner. Wilkinson Murray undertakes no duty to or accepts any responsibility to any third party who may rely upon this document.

Quality Assurance

Wilkinson Murray operates a Quality Management System which complies with the requirements of AS/NZS ISO 9001:2015. This management system has been externally certified by SAI Global and Licence No. QEC 13457 has been issued.

AAAC

This firm is a member firm of the Association of Australasian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Celebrating 50 Years in 2012

Wilkinson Murray is an independent firm established in 1962, originally as Carr & Wilkinson. In 1976 Barry Murray joined founding partner Roger Wilkinson and the firm adopted the name which remains today. From a successful operation in Australia, Wilkinson Murray expanded its reach into Asia by opening a Hong Kong office early in 2006. Today, with offices in Sydney, Newcastle, Wollongong, Queensland and Hong Kong, Wilkinson Murray services the entire Asia-Pacific region.

TABLE OF CONTENTS

DEFINITIONS

Term	Definition
Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Asset	M1-M2 Tunnel and M1 & M2 Integration works and Facilities
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level.
dBA: A-weighted decibels	The ear is not as effective in hearing low frequency sounds as it is hearing middle frequency sounds. That is, low or very high frequency sounds of the same dB level is not heard as loud as middle frequency sounds. The sound level meter approximates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched in is denoted as dBA.
MCoA	Minister for Planning Condition of Approval
DPIE	Department of Planning, Industry and Environment
DRS	Disaster Recovery Site
EMP	O&M Contractor's Environmental Management Plan
ENMM	Environmental Noise Management Manual
EPA	NSW Environmental Protection Authority
EIS	Environmental Impact Statement
Impulsiveness	An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
Li	The noise level exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10 per cent of the time for which the given sound is measured.
L_{90}	The sound pressure level that is exceeded for 90 per cent of the time for which the given sound is measured.
$L_{\text{-Aeq,(period of time)}}$	The L_{Aeq} is the A-weighted equivalent continuous sound level, sometimes referred to as the "average" noise level. It represents a sound level with the same energy content as the actual varying noise level measured. The period of time for which the L_{eq} is calculated over is defined by the type of noise being measured, the time of day and the regulatory requirements.

Term	Definition
Loudness	A 3dB increase represents a doubling of the sound pressure, however an increase of about 10dB is required before the sound will subjectively appear to be twice as loud. That is, a sound of 85dB is twice as loud as a sound of 75dB which is twice as loud as a sound of 65dB and so on. That is, the sound of 85dB is four times as loud as a sound of 65dB. Typically, smallest change which can be readily heard by the average person is approximately 3dB. An increase beyond 5dB is considered to represent the level at which a change in loudness begins to be clearly perceived.
Noise Management Levels (NMLs)	The noise management levels are described in the Interim Construction Noise Guidelines (ICNG, 2009). They are typically used to assess the impacts of construction and maintenance noise; however, they can be to inform the management of general operational noise. Noise management levels are calculated by using the rating background level.
O&M	Operation and Maintenance
O&M Contractor	Undertakes the operation and maintenance of the asset under the **O&M deed**
O&M Contractor Personnel	All people employed by the **O&M Contractor** to undertake operation and maintenance work.
O&M Stakeholders	All entities undertaking operational and maintenance activities on the asset. Typically including **North Western Roads, TRANSURBAN** and **O&M Contractor** and other sub-contracted parties.
OEMP	Operation Environmental Management Plan
ONMP	Operational Noise Management Plan
OOHW	Out of Hours Work
Rating Background Level (RBL)	Peak particle velocity measured in mm/s. The Rating Background Level as defined in the INP (NSW EPA, 2000) is the median of the assessment background levels (ABL). The ABL is the lowest 10^{th} percentile noise level measured in each day, evening and night period. It is used to develop construction noise management levels.
Sensitive Receiver	Residence, education institution (e.g. school, university, TAFE college), health care facility (e.g. nursing home, hospital), religious facility (e.g. church) and children's day care facility.
SOP	Standard operating procedure
Sound	Any pressure variation that the human ear can detect.
Sound Level Meter	An instrument designed to measure sound pressure levels. Typically, sound level meters consist of a microphone, signal amplifier and processing and storage facilities. Sound Level Meters can be rated to perform to a specific standard, defined by International Standards.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power. It represents the inherent acoustic energy of a noise source and therefore does not change with distance or environment.
Sound Pressure Level	Ten times the logarithm to the base 10 of the ratio of the sound pressure of

Term	Definition
	the source to the reference sound pressure. It is the most common way of measuring the magnitude of sound at a distance from a noise source.
TfNSW	Transport for New South Wales
Tonality	Tonal noise contains one or more prominent tones (i.e. distinct frequency components) and is normally regarded as more offensive than "broadband" noise.

1 INTRODUCTION

1.1 Purpose & Application

This document comprises the **Operational Noise Management Plan** (ONMP). The ONMP forms part of the asset Operational Environmental Management Plan (OEMP). This ONMP addresses the requirements outlined in Minister for Planning Condition of Approval (MCoA) conditions E24, specifically item (e). This Sub-Plan applies to the following activities:

- Operations/Repair/maintenance works and mechanical operations that generate noise and may affect adjacent sensitive receivers.
- Operations/Repair/maintenance works that generate vibration which may cause cosmetic or structural building damage or result in amenity impacts.

ONMP also considers the following:

- Procedures to undertake the mechanical and road traffic noise compliance assessment outlined in the MCoA's conditions E25 and E26.
- Procedure to undertake to noise monitoring of surrounding road traffic noise which may experience significant increase in traffic volumes as a result of the project, as per MCoA E24 (f).
- Equipment maintenance/repair to ensure its noise and vibration performance is in line with manufacturer specifications and tolerances.
- Maintenance and the ongoing effectiveness of noise mitigation infrastructure (e.g. noise walls).

1.2 Objectives

The plan's objectives are:

- Ensure operations from ventilation facilities do not exceed established noise guideline limits.
- Ensure maintenance activities provide minimal noise and vibration impact on nearby receivers and to minimise any noise or vibration complaints.
- Ensure all noise and vibration mitigation infrastructure is maintained and effective.
- To manage road traffic noise from the project roads and surrounding roads.

1.3 Content

The plan provides for the following provisions:

- Specified mechanical equipment and noise mitigation infrastructure.
- Noise and vibration control during operational, maintenance and repair works.
- Recommendations for mechanical and road traffic operational noise compliance and assessment.

2 ASSET DESCRIPTION

2.1 Asset

The road development is a twin motorway tunnel up to around nine kilometres in length with two lanes in each direction. The tunnel links the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at West Pennant Hills.

The first access portal of the tunnel is located at the northern interchange with the M1 Pacific Motorway and Pennant Hills Road. The second access portal of the tunnel will be located at the southern interchange with the Hills M2 Motorway and Pennant Hills Road. There are tolling gantries at the entrance and exit of the tunnel. There are also two Pennant Hills Road Truck enforcement gantries. The southern gantry is located in West Pennant Hills at the intersection of Pennant Hills Road with Oratava Avenue and Hannah Street. The northern gantry is located in Normanhurst near the intersection of Pennant Hills Road and Campbell Avenue.

The project will be located within The Hills, Hornsby and Ku-ring-gai local government areas about 20 kilometres north-west of the central business district of Sydney.

The project involve operation and maintenance of a 24-hour manned Motorway Control Complex (MCC), located near the southern interchange on the corner of Pennant Hills Road and Eaton Road, West Pennant Hills. The MCC includes facilities necessary for the monitoring, maintenance and control of tunnel services including tunnel safety, ventilation, power, lighting and other road systems required for the safe and efficient operation of the main alignment tunnels. Facilities include a tunnel control room, training / incident response room, workshop space, emergency vehicle depot, garage, storage and parking facilities.

Two tunnel support facilities are situated at Wilson Road, Pennant Hills and Trelawney Street, Thornleigh. Each tunnel support facility include an emergency smoke extraction facility. The tunnel support facility at Wilson Road also include a Disaster Recovery Site (DRS). In addition to this, a northern ventilation facility located above the cut and cover section of the northbound main alignment near the connection with the M1 Pacific Motorway will be constructed.

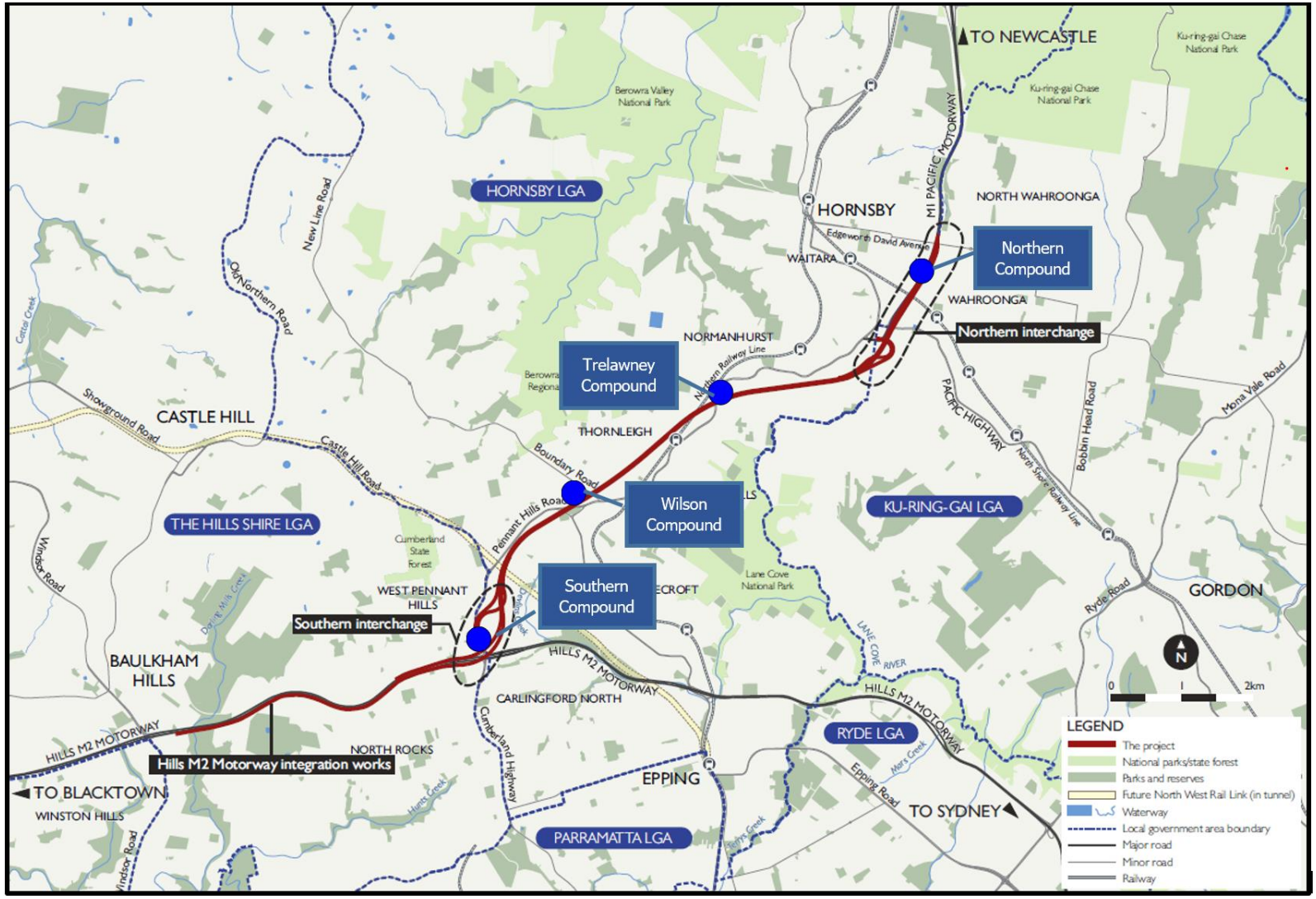
Electricity supply infrastructure are installed to supply power to the main alignment tunnels and associated mechanical and electrical equipment on the south-west side of the Pennant Hills Road / Hills M2 Motorway interchange on Coral Tree Drive.

During operations, the ventilation system draw fresh air into the tunnels and emit air from within the tunnels via two ventilation facilities. During emergency conditions, depending on the location of the incident, the ventilation system extract smoke from the tunnels which emits from one or more of the following locations:

- VSO1: Southern ventilation facility located within the MCC.
- VSO2: Wilson Road tunnel support facility, occasionally only.
- VSO3: Trelawney Street tunnel support facility, occasionally only.
- VSO4: Northern ventilation facility located primarily above the northbound main alignment near the connection with the M1 Pacific Motorway.

The general location of the proposed tunnel and key features of the project are shown Figure 2-1. The ONMP addresses any noise and vibration activities related to the operation/ maintenance/repair of the asset.

Figure 2-1 Project Area & Location of Facilities/Compounds



3 EXISTING ENVIRONMENT

3.1 Noise Sensitive Receivers

Table 3-1 provides a list of the surrounding noise-sensitive receivers near the asset footprint.

Table 3-1 Sensitive Receiver Types

Sensitive receiver type
Considered sensitive to construction noise (i.e. maintenance and repair work)
• Commercial premises
• Industrial facilities
• Other (such as cinemas, theatres).
Considered sensitive to construction and operational noise (i.e. maintenance and repair and road traffic work)
• Residents
• Educational institutions
• Childcare centres
• Hospitals and other medical facilities
• Places of worship
• Recreational areas

Given the high number of sensitive receivers adjacent to the asset footprint they were grouped into Noise Catchment Areas (NCAs). Each NCA contained a representative number of similar receivers (i.e. commercial properties or residential properties). Rather than assessing the potential impact at each receiver, the impact was assessed at the closest receiver in the NCA. Table 3-2 summarises the NCAs within this project.

Table 3-2 Sensitive Receivers

Description	Revised NCAs	Reason for NCA Selection
West of M1	NCA-1A	Noise environment dominated by traffic on M1 & within 150m of M1.
	NCA-1B	Noise environment dominated by traffic on M1 & 150m to 600m from M1.
	NCA-1C	Noise environment dominated by traffic on M1 & 150m to 600m from M1. Also, contribution from Pacific Hwy.
	NCA-1D	Noise environment dominated by traffic on M1 & within 150m of M1. Also, contribution from Pacific Hwy.
East of M1	NCA-2A	Noise environment dominated by traffic on M1 & within 150m of M1.
	NCA-2B	Noise environment dominated by traffic on M1 & 150m to 600m from M1.
	NCA-2C	Noise environment dominated by traffic on M1 & 150m to 600m from M1. Also, contribution from Pacific Hwy.
	NCA-2D	Noise environment dominated by traffic on M1 & within 150m of M1. Also, contribution from Pacific Hwy.

Description	Revised NCAs	Reason for NCA Selection
West of Pennant Hill Rd at intersections with M1 & Pacific Hwy	NCA-3	Noise environment dominated by Pennant Hills Rd.
South east of junction of Pennant Hills Rd & M1	NCA-4A	Across M1 from Northern Portal. Noise environment dominated by end of M1.
	NCA-4B	South-east of Pacific Hwy and Pennant Hills Rd junction.
South east of junction of Pennant Hills Rd & M1	NCA-5A	Nearest to Northern Portal. Dominated by M1, traffic slowing to enter Pennant Hills Rd.
	NCA-5B	Near Northern Portal but less influenced by Pennant Hills Rd and other roads.
Around Trelawney & Pioneer Compounds	NCA-6A	Near Trelawney Compound where background noise dominated by Pennant Hills Rd.
	NCA-6B	Near Trelawney Compound where background noise not dominated by Pennant Hills Rd. Local noise environment.
	NCA-6C	Near industrial estate and Pioneer Compound. Background noise dominated by Pennant Hills Rd.
Around Wilson Compound	NCA-7A	Near Wilson Compound where background noise dominated by Pennant Hills Rd.
	NCA-7B	Near Wilson Compound where background noise is less influenced by Pennant Hills Rd. Local noise environment.
	NCA-7C	Mount St Clair Benedict College. Background noise dominated by Pennant Hills Rd.
North of Southern Compound	NCA-8A	Across Pennant Hills Rd from Southern Compound. Background noise dominated by Pennant Hills Rd.
	NCA-8B	Area close to the exit of Southern Compound. Background noise dominated by Pennant Hills Rd.
South-west of Pennant Hills Rd & M2 junction	NCA-9A	Area close to Pennant Hills Rd. Background noise dominated by M2 and Pennant Hills Rd.
	NCA-9B	Area close to M2. Background noise dominated by M2.
West of junction of M2 & Pennant Hills Rd	NCA-10A	Near Southern Compound, background noise influenced by Pennant Hills Rd and M2.
	NCA-10B	North of M2. Traffic noise environment from M2.
	NCA-10C	South-west of junction of M2 & Pennant Hills Rd. Traffic noise environment from M2. Influenced by M2 and Pennant Hills Rd.
	NCA-10D	South-west of junction of M2 & Pennant Hills Rd. Traffic noise environment from M2. Influenced mainly by M2.
M2 from Oakes Rd to North Rocks Rd	NCA-11A	North of M2. Traffic noise environment from M2.
	NCA-11B	South of M2. Traffic noise environment from M2.
South of M2 from North Rocks Rd to Barclay Rd	NCA-12	No subdivision of NCA required. Traffic noise environment from M2.
North of M2 along Mill Dr	NCA-13	No subdivision of NCA required. Traffic noise environment from M2.
South of M2 from North Rocks Rd to Barclay Rd	NCA-14	No subdivision of NCA required. Traffic noise environment from M2
M2 from Dremeday St to Canyon St	NCA-15A	North of M2. Traffic noise environment from M2.
	NCA-15B	South of M2.

Figure 3-1 Noise Catchment Area (1A – 2B)

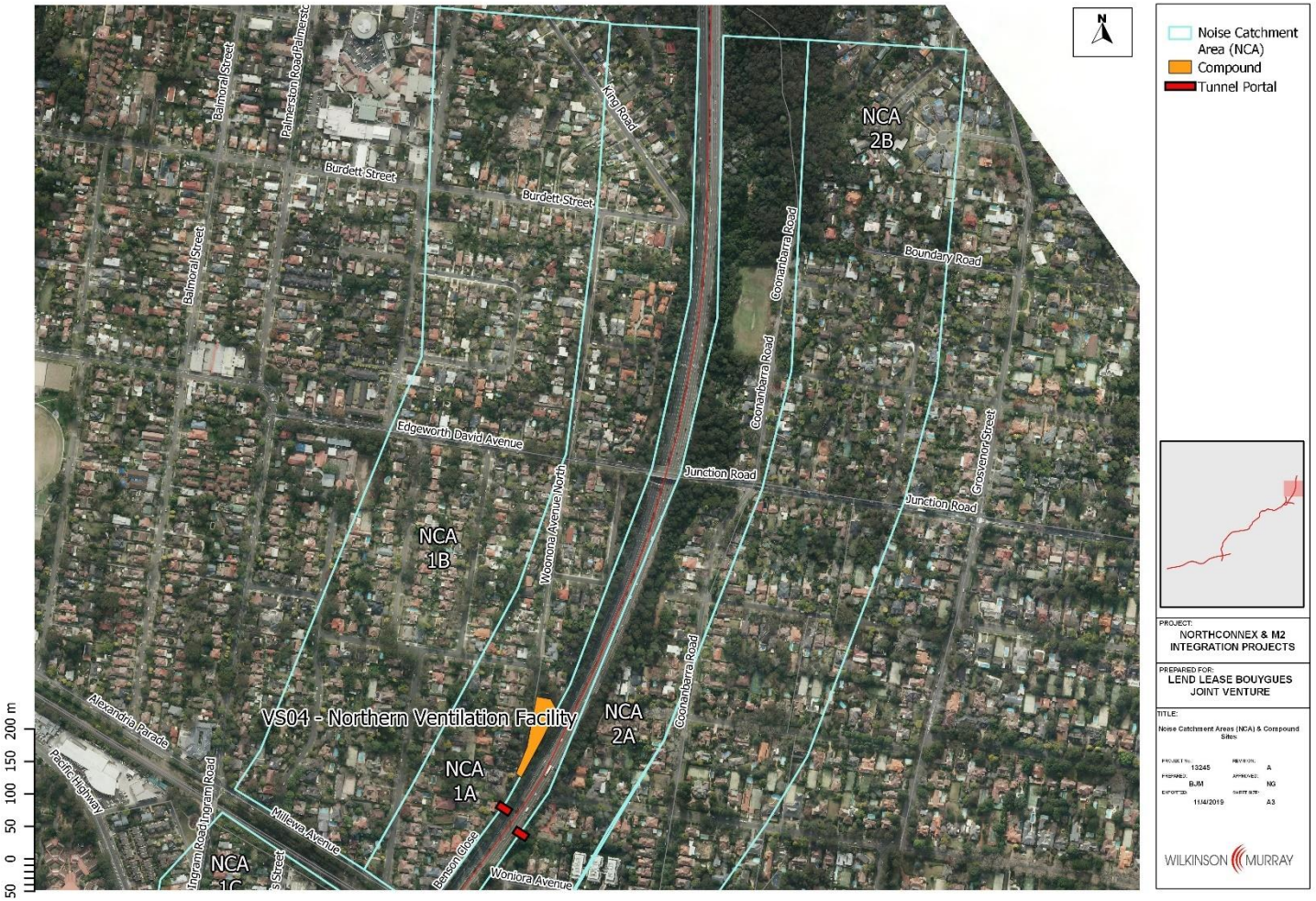


Figure 3-2 Noise Catchment Area (1C – 5B)

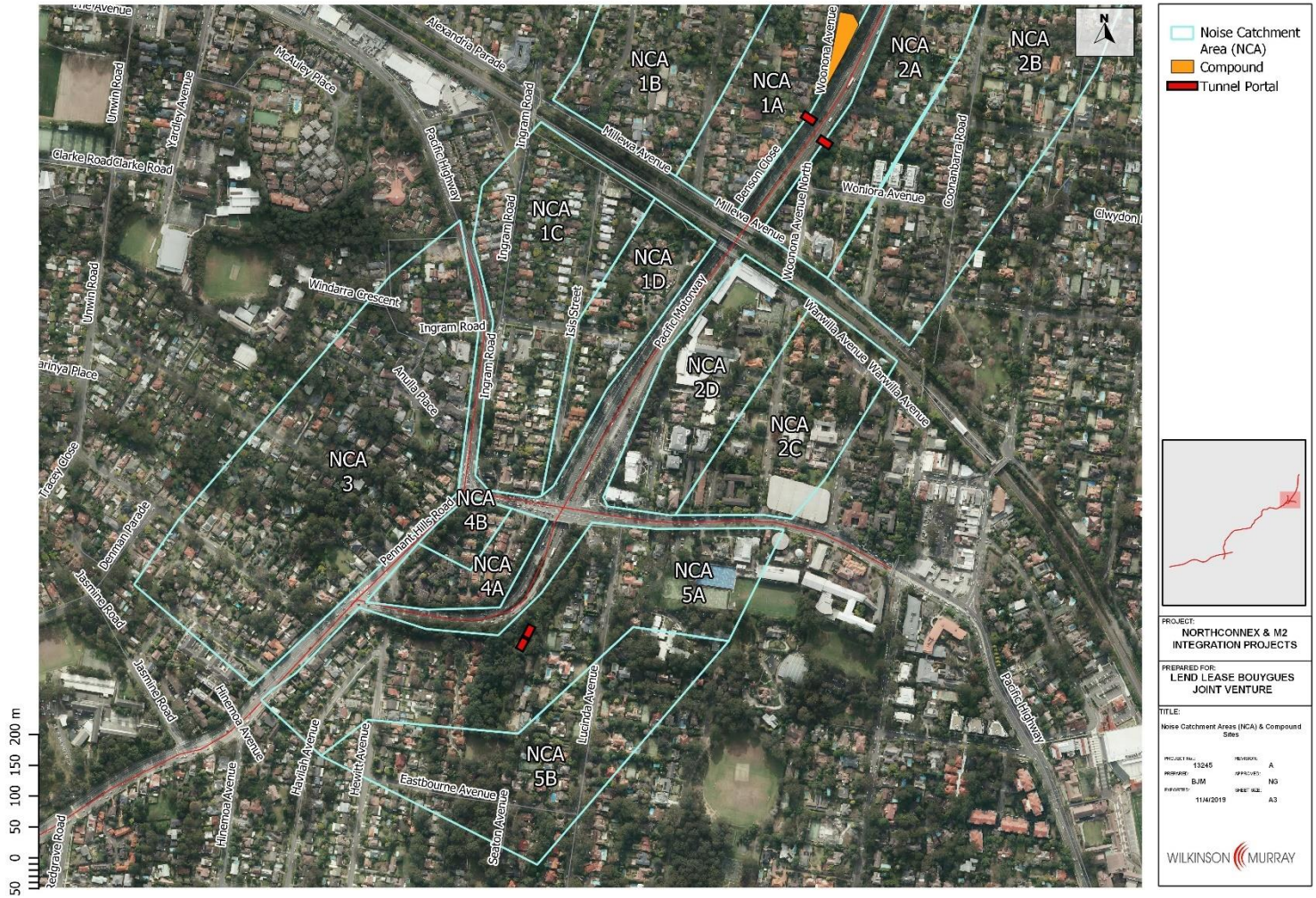


Figure 3-3 Noise Catchment Area (6A - 6C)

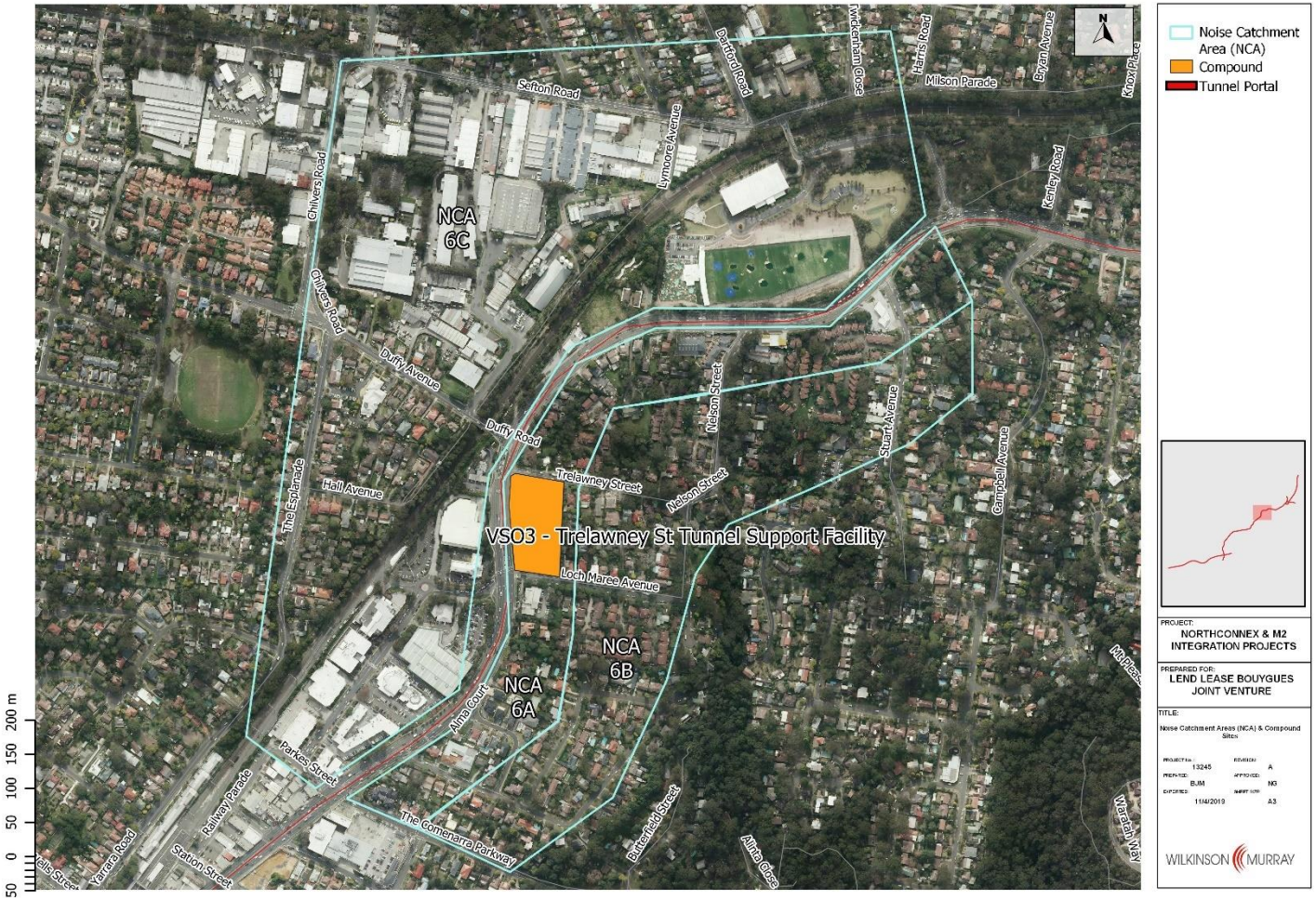


Figure 3-4 Noise Catchment Area (7A - 7C)

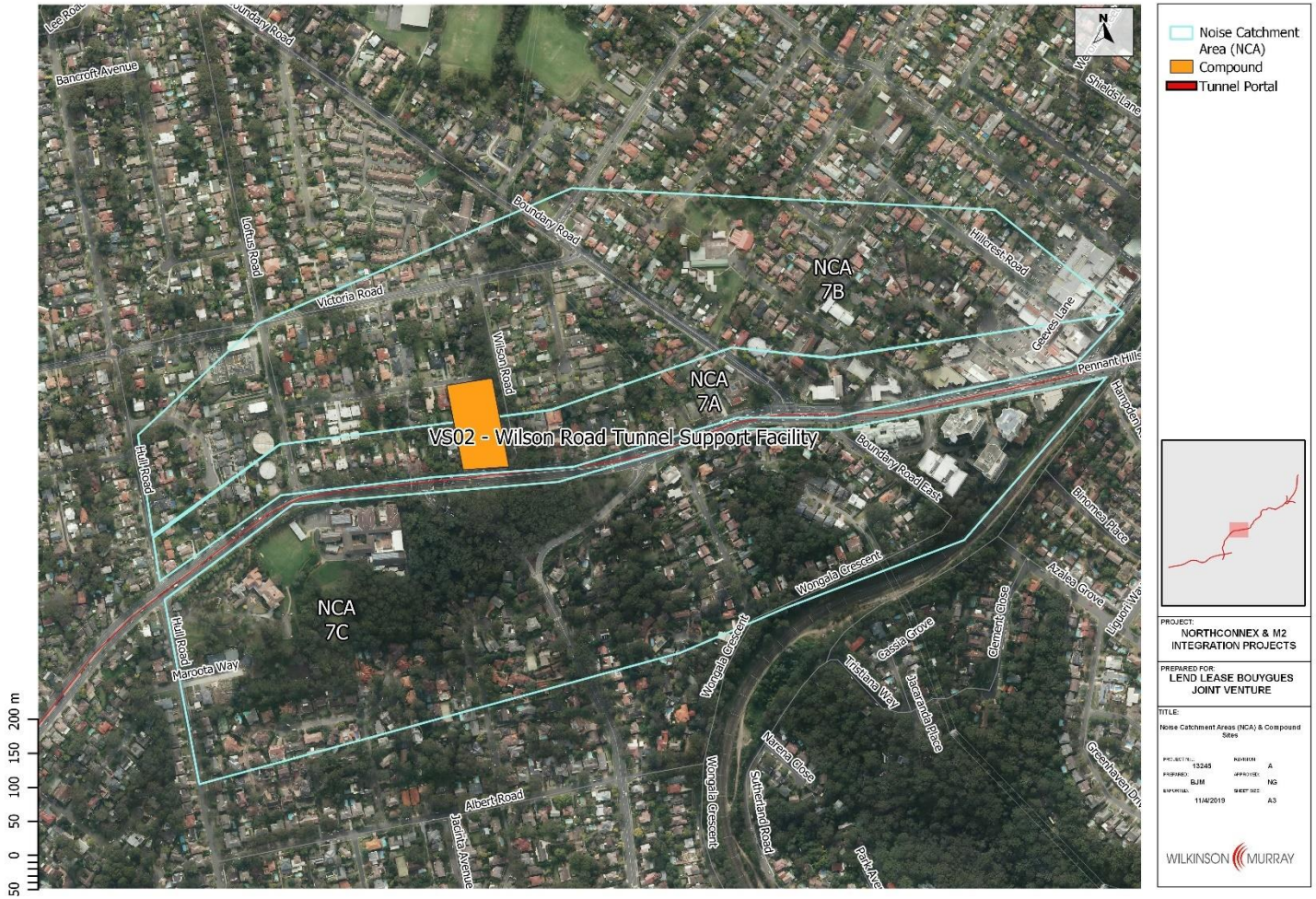


Figure 3-5 Noise Catchment Area (8A – 10B)

Figure 3-6 Noise Catchment Area (10A – 11B)

Figure 3-7 Noise Catchment Area (12 – 15B)

4 ENVIRONMENTAL OBLIGATIONS

This section summarises the legal, environmental, and contractual obligations covered by this ONMP.

4.1 Statutory Obligations

This section describes the statutory and other obligations covering the operation and maintenance of the asset.

4.1.1 Ministerial Conditions of Approval

Table 4-1 summarises the relevant conditions relating to the operational noise management plan.

Table 4-1 Relevant Operational Ministerial Conditions of Approval

MCoA	Details	Addressed
E24	A detailed Operational Noise Management Plan shall be prepared as part of the OEMP, to the satisfaction of the Secretary. The Plan shall provide details of noise and vibration control measures to be undertaken during the operation stages, sufficient to address the technical requirements of the EPA, and generally in accordance with the Road Noise Policy (DECCW 2011) and the Industrial Noise Policy (EPA 2000). The Plan shall include, but not be limited to:	
	(a) tests for ascertaining acoustic parameters;	Wilkinson Murray's Operational Noise Assessment Report (ONAR) report (reference: 13245-O Ver J) in Appendix F
	(b) predicted noise levels;	
	(c) noise criteria for operation of the project;	Wilkinson Murray's ONAR report (reference: 13245-O Ver J) & summary of the relevant criteria is outlined in Appendix B
	(d) location, type and timing of erection of permanent noise barriers and/or other noise mitigation measures demonstrating best practice including silencers and building treatments for associated plant rooms and enclosures for exposed plant;	Wilkinson Murray's ONAR report (reference: 13245-O Ver J) Noise Barrier Details: Section 6.9.1 & 6.9.2 Architectural Treatment: Section 6.10 & Appendix F & G Mechanical Noise: Appendix K Building Treatment: Appendix K Summary of the treatments are found in Appendix A of this ONMP.
	(e) specific physical and managerial measures for controlling noise; and,	Section 5 of this Operational Noise Management Plan
	(f) noise monitoring, reporting and response procedures including the monitoring on surrounding roads which experience significantly increased traffic volumes as a result of the project, including but not limited to North Rocks Road.	Section 6 of this ONMP outlines the procedures to undertake the monitoring assessments

It should be noted conditions a) to d) have already been addressed in the Wilkinson Murray ONAR report (reference: 13245-O Ver J). A summary of the implemented noise mitigation treatment outlined in the Wilkinson Murray ONMP report for the road, ventilation facilities and architectural treatments is provided in Appendix A of this report. The ONAR is available on the NorthConnex Project Website for further information.

Table 4-2 Relevant Noise Compliance Monitoring Ministerial Conditions of Approval

MCoA	Details
E25	For the purpose of assessment of noise criteria specified in the Operational Noise Management Plan required under condition E24, noise from the development shall be: a) measured at the most affected point on or within the site boundary at the most sensitive locations to determine compliance with $L_{Aeq,T}$ noise limits; b) measured in the free field at least 3-5m from any vertical reflecting surface in line with the worst-affected dwelling facade to determine compliance with L_{Amax} noise limits; and c) subject to the modification factors provided in Section 4 of the NSW *Industrial Noise Policy* (EPA 2000), where applicable Notwithstanding, should direct measurement of noise from the fixed facilities be impractical, the Proponent may employ an alternative noise assessment method deemed acceptable by the EPA [refer to Section 11 of the NSW *Industrial Noise Policy* (EPA 2000)]. Details of such an alternative noise assessment method accepted by the EPA shall be submitted to the Secretary prior to the implementation of the assessment method.
E26	Monitoring of operational noise shall be undertaken in accordance with the Operational Noise Management Plan. The Proponent shall, in consultation with the EPA, assess the adequacy of the traffic noise and ventilation noise mitigation measures within one year of operation, with regard to the criteria specified in the Operational Noise Management Plan. Should assessment indicate a clear trend in traffic noise levels on surrounding roads which exceed Operational Noise Management Plan defined noise criteria as approved by the EPA, the Proponent shall implement further reasonable and feasible mitigation measures in consultation with affected landowners and/or occupiers.

4.1.2 Legislation

The following legislation is relevant to ONMP**.**

Table 4-3 Legal Obligations

Legislation	Relevance
General	
Environmental Planning & Assessment Act 1979	Application of penalty notices where MCoA are breached including noise exceedances and complaints
Local Government Act 1993	Prevention of public nuisance from noise pollution
Noise & Vibration	
Protection of the Environment Act 1997 Protection of the Environment (Noise Control) Regulation 2008 (as amended)	• Defines and controls noise pollution • Noise and vibration management • Regulates vehicle emissions including exhaust noise and

	car alarms

4.1.3 Preferred Infrastructure Report

Table 4-4 summarises the relevant conditions outlined in the Preferred Infrastructure Report

Table 4-4 Noise Requirement – Preferred Infrastructure Repot

Section	Details	Addressed
OpNV1	Feasible and reasonable mitigation measures would be developed and implemented to minimise noise impacts consistent with the requirements of the NSW Road Noise Policy and the Environmental Noise Management Manual. Specific noise mitigation measures for the project may include, where feasible and reasonable: • Low noise road surfaces. • Noise barriers. • At property acoustic treatments.	Wilkinson Murray's ONAR report (reference: 13245-O Ver J) Low Noise Road Surface: Section 5.4 and 6.4 of the ONAR Noise Barrier: Section 6.9.1 & 6.9.2 Architectural Treatment: Section 6.10 & Appendix F & G
OpNV2	Operational traffic noise would be monitored at sensitive receivers between six months and one year after opening. If the traffic noise levels are above the predicted levels, consideration of additional feasible and reasonable mitigation measures would be undertaken.	Section 6.3 of the ONMP
OpNV3	Operational ancillary facilities would be designed to meet project specific noise criteria derived in accordance with the NSW Industrial Noise Policy.	Section 6.5 of the ONMP

4.2 Other Obligations

4.2.1 Environmental Policies, Guidelines & Principles

TfNSW and other Government agencies have developed guidance and policy for managing noise and vibration. The O&M Stakeholders will work under this guidance and policy.

Table 4-5 Environmental Policies, Guidelines & Principles

Legislation	Relevance
Ventilation Facilities maintenance works + Road & Noise Barrier maintenance/repair works	
• *Interim Construction Noise Guidelines* (*ICNG*, NSW DECC, 2009) • *Construction Noise Strategy* (*CNS*, Transport for NSW, 2013) • *Construction Noise & Vibration Guideline* (*CNVG*, Roads and Maritime, 2016)	Noise management when undertaking site work
• *Assessing Vibration: A Technical Guideline* (NSW DECC, 2006) • British Standard BS 7385-2:1993 *Evaluation and Measurement for Vibration in Buildings, Guide to Damage Levels from Groundborne Vibration* (British Standards Institution, 1993, adopted in the absence of equivalent local criteria) • German Standard DIN 4150-3:2016 *Vibration in buildings – Part 3 Effects on structures*	Vibration management when undertaking site work
Ventilation Facilities Mechanical noise operation	
• *Industrial Noise Policy* (INP, NSW EPA, 2000)	Compliance Test of fixed mechanical equipment
Road traffic noise	
• *Environmental Noise Management Manual (ENMM), Practice Note II and III* (*ENMM,* Roads and Maritime, 2001) • *Road Noise Policy* (*RNP*, NSW DECCW, 2011) • *Noise Criteria Guidelines* (*NCG,* Roads and Maritime, 2015) • *Noise Mitigation Guidelines* (*NMG,* Roads and Maritime, 2015) • *RMS Model Validation Guideline (2018)*	Compliance Test of Road Traffic Noise
Note: the NCG (Roads and Maritime, 2015) are Roads and Maritime's interpretation of the RNP (NSW DECCW, 2011). The NCG (Roads and Maritime, 2015), NMG (Roads and Maritime, 2015) and CNVG (Roads and Maritime, 2016) replace the ENMM (Roads and Maritime, 2001) except for Practice Note II and III.	

5 OPERATION & MAINTENANCE NOISE & VIBRATION MANAGEMENT MEASURES

5.1 Overview

The infrastructure associated with the NorthConnex project will require ongoing maintenance to ensure efficient and safe operation. Consistent with many Sydney tunnels it is expected there will be a quarterly planned night time shutdown at the VSO1 Southern and VSO4 Northern compound.

There are five compound sites which require regular maintenance. The VSO1 Southern Compound consists of a ventilation/Substation building, Maintenance Centre & Detention Basin, Water Treatment Plant (WTP) and Motor Control Centre building. Permanent staff are only located at VSO1 and will visit the other sites as required.

Extraction buildings are located at VSO2 and VSO3 compound, VSO2 also has a DRS building and a WTP. VSO4 Northern Compound consists of a Northern Ventilation Facility, Substation, Pump facility and Deluge Tanks. Coral Tree Drive Substation building comprises of four transformer rooms, two Low Voltage switch rooms and two cable rooms.

The noise management plan for the operation and maintenance works for the five compound sites (as outlined above), the project road, tunnel and barrier are provided in this section. Operational noise is associated with the fixed mechanical plant (e.g. fan units) at each of the compound sites.

The **O&M Contractor** will implement controls to ensure noise and vibration is managed for all maintenance works. Responsibilities for maintaining the asset includes:

- Ensuring the asset and its associated equipment and infrastructure operates to its environmental performance specifications to control and abate noise and vibration.
- Allowing for noise and vibration monitoring in instances where there is a substantiated complaint or there is evidence of any equipment and/or infrastructure fault or failure.
- Allowing for revision in the mitigation controls following persistent issues and complaints.
- Determining the need to maintain and replace the noise mitigation infrastructure/controls if they are found to be unsatisfactory

5.2 Summarised Maintenance Activities

Table 5-1 presents a summary of the proposed noisy maintenance works of the project asset. The table also includes the likely occurrence of each activity and the section of this plan where it has been addressed. Detailed description of the proposed maintenance works is outlined in the Management Plan Sections of each compound.

Each O&M Stakeholder is to annually review a schedule of activities that require the use of noise and vibration-generating equipment amending the information outlined in Sections 5.3, 5.4 and 5.5. Any additional noisy work not found in any of these sections should be included. The purpose of the schedule is to ensure all noisy works are addressed in order to minimise noise impact on surrounding neighbours.

Table 5-1 Summarised Noise Generating Activities

Compound/Site	Activity	Frequency	Section (NMP)
All Sites	Noise Management Measures at all sites	-	Section 5.3
• Coral Tree Drive Substation • VSO1 • Motorway Operation/ Control Centre • VSO2 • VSO3 • VSO4	Maintenance Work	Weekly inspection and routine tasks undertaken monthly during the day	Section 5.4
	Outdoor routine maintenance works: • Maintaining Landscaped areas • Cleaning out drains • Remove graffiti and unauthorised posters	Maintenance as required following annual inspection for drains and weekly inspections for graffiti and unauthorised posters	
	Truck and vehicle movements	Weekly inspection and routine tasks undertaken monthly during the day	
	Minor Tunnel Fan maintenance	Weekly inspection and routine tasks undertaken monthly during the day	
	Major Quarterly Tunnel Fan maintenance	Work to occur during quarterly nightly closures	
	Outdoor routine maintenance works: • Maintaining landscaped areas • Cleaning out drains Remove graffiti and unauthorised posters	Maintenance as required following annual inspection for drains and weekly inspections for graffiti and unauthorised posters	
	Truck and vehicle movements	Weekly inspection and routine tasks undertaken monthly during the day	
VSO1	Inspection and maintenance of coalescing oil separator (car wash bay)	Maintenance as required following annual inspection	Section 5.4
VSO2	Cleaning out On-site Stormwater Detention (OSD) tank	Maintenance as required following annual inspection	Section 5.4
VSO2	Maintain DRS facility: • Computer/control system • Air conditioning system	Maintenance occurrence: Computer/Control – Fortnightly Air Conditioning – Quarterly	Section 5.4
Tolling / Truck Enforcement Gantries	General structural inspection, calibration and maintenance of the tolling and camera equipment	Maintenance as required following annual inspection	Section 5.4
NorthConnex Road & Tunnel	Tunnel Washing	Quarterly – during permitted night closure	Section 5.5
	Maintenance of pavement, roadside and medians	Pavement maintenance as required following daily inspection Roadside and median maintenance on monthly basis – during night time	
	Maintenance of mechanical and electrical system	Mechanical and electrical maintenance on monthly basis – during night time	
M2 Motorway & M1 Pacific Motorway	Noise Barrier and/or road repair works	Maintenance/repair work as required	Section 5.6
	Non-routine (incident/emergency) work	Works when as required	

The recommended construction noise and vibration control measures within Sections 5.3 to 5.5 are consistent with the construction and maintenance noise and vibration management options outlined in Section 5 of the RMS' Environmental Noise Management Manual.

5.3 Noise Management Control at all NorthConnex Sites

Table 5-2 presents the relevant noise controls to be implemented at all ventilation facilities and relevant assets.

Table 5-2 Noise Management Control at all sites

Item	Description
Scheduling Work	When possible, organise work to be undertaken during the recommended standard hours (Monday to Friday 7.00am to 6.00pm, Saturday 8.00am to 1.00pm and no work on Sundays or public holidays unless otherwise approved).
Site Personnel	Site personnel are required to adhere to the following: • Avoid the use of radios or stereos outdoors. • Avoid shouting and minimise talking loudly and slamming vehicle doors. • Avoid dropping material from high height
Noise Monitoring	Annual noise monitoring program as prescribed in Section 6.6 of the ONMP is to be undertaken to ensure noise level satisfy relevant noise standard.
Community Consultation	Consultation with and the provision of information to the surrounding community is regarded as a major factor in controlling the negative reaction to the inevitable impacts associated with operational/maintenance works. Contact details on the site boundary wall is required.
Training and Complaint Handling	Site induction training will include a noise awareness component, community consultation and response to complaints. Nearby residents are to be provided with site contact details and all ventilation facilities shall maintain a complaint register. When complaints arise, the following details are to be recorded: • The name and location of the complainant (if provided); • The time and date the complaint was received; • The nature of the complaint and the time and date it occurred; • The name of the employee who received the complaint; The following actions are to be taken after complaint: • Investigate the complaint, and a summary of the results of the investigation; • Required remedial action, if required; • Validation of the remedial action; and • Summary of feedback to the complainant

It should be noted, not all works will be carried out during standard hours, for example the major fan maintenance works at VSO1 and VSO4 and the NorthConnex tunnel maintenance works.

A summary of the implemented building treatment and mechanical noise control at each Ventilation Facility is outlined in Appendix A (Sections A – 4 & A – 5).

5.4 Noise Management for Substation & Ventilation Facilities/Compounds

Table 5-3 presents the proposed activities and the relevant noise controls to be implemented at all relevant Substations and Ventilation Facilities/Compound.

Table 5-3 Noise Management Control for Substations and Ventilation Facilities /Compound

Sites	Activity	Noise Management Plan
• **Coral Tree Drive Substation** • **VSO1,** • **Motorway Operation/ Control Centre** • **VSO2,** • **VSO3** • **VSO4**	**Minor Maintenance of ventilation plant, facilities and monitoring equipment** (e.g. fans, ventilation facilities, monitors etc) including: • Visual inspection and testing fan ventilation system and Water Treatment Plant • Condition monitoring system to detect wear and tear and out of balance fans. • Use of power tools and scissor lift to repair of ventilation plant and run mechanical plant test. General maintenance is undertaken within the facilities. However, any maintenance work undertaken outside, are to implement the proposed noise management control.	• Include in tenders, employment contracts, sub-contractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise. • Ensure site managers periodically check the site for noise problems during minor maintenance works. This is to ensure solutions to noise problems can be quickly applied. Noise solutions may include, but not limited to, the following: ○ If noisy works are undertaken inside the facility, make sure facility doors are kept closed. ○ For VSO1 facility, when possible, undertake repair works inside the workshop. ○ When working outside, provide noise respite from long period intense works. An example of noise intensive work period would be to conduct intensive work between 9 am to 12 pm Monday to Saturday and 2 pm to 5 pm Monday to Friday to provide respite to surrounding residents. ○ When working outside and a complaint arises then the complaint is to be investigated and recorded in complaint register. If possible, implement quieter alternative maintenance work.
• **Coral Tree Drive Substation** • **VSO1,** • **Motorway Operation/ Control Centre,** • **VSO2** • **VSO3** • **VSO4**	**Major Quarterly Maintenance of ventilation facilities** (e.g. replacement of fans) • Quarterly shut down of the compound/ventilation facilities. It should be noted, quarterly shutdowns are generally for scheduled inspection and maintenance. • On some occasions fan replacement may occur, this would be considered the worst-case scenario. Approximately 50 personnel could work on site. Trucks and heavy vehicles (e.g. crane) to enter, operate and depart from the site.	• Notify nearby residents of forthcoming works that are likely to produce noise impacts. A programme of community liaison and complaint response will be implemented. • Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details. Information update relating to major maintenance works could be provided on the NorthConnex website. • Plant and equipment will be selected to minimise noise/vibration emission, where possible, whilst maintaining efficiency of function. • Where possible, crane and heavy vehicles are to be positioned as far away as from the residential receivers. If placement of machinery/tool is exposed to residential receiver(s), then a temporary noise barrier obstructing line of sight needs to be constructed/installed. • Vibration emitting machines are required to adhere to the safe working distances as outlined in Table 5-7. Vibration monitoring of the first quarterly major maintenance works need to be undertaken to confirm buffer zones at locations if residential buildings are close to vibration machines.

Sites	Activity	Noise Management Plan
		• If possible, minimise working in the same location or using the same plant equipment on consecutive day/night, in order to provide respite. • Where possible, trucks and other machinery are to be fitted with a 'quacker' reverse alarm. • Include in tenders, employment contracts, sub-contractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise.
• **Coral Tree Drive Substation** • **VSO1** • **Motorway Operation/ Control Centre** • **VSO2** • **VSO3** • **VSO4**	**Outdoor Routine maintenance works**: • Maintaining landscaped areas including vegetation trimming, grass mowing and replanting using equipment, such as tractor slashers, ride on mowers, hand mowers, brush cutters, blower/vacs, small skids steer, augers, water carts, etc. • Cleaning out drains which may require the use of various machines (sweeper, vacuum truck, high pressure water machine). • Removal of graffiti and unauthorised posters from the assets. Personnel may use high-pressure water machine and may potentially re-paint the walls.	• Plant and equipment will be selected to minimise noise emission, where possible, whilst maintaining efficiency of function. • If possible, minimise working in the same location or using the same tool/machine on consecutive day, in order to provide respite. Where possible, noise intensive works are to be conducted between 9am to 12pm Monday to Saturday and 2pm to 5pm Monday to Friday to provide respite to surrounding residents.
• **Coral Tree Drive Substation** • **VSO1** • **Motorway Operation/ Control Centre** • **VSO2** • **VSO3** • **VSO4**	**Truck and vehicle movements onsite**: • Removal of sludge produced a by-product of the treatment process using one skip bin truck. • Rubbish removal. • Refuelling for emergency breakdowns (24 hours). Southern Compound Vehicle movement: • Daily entry and exit from Motorway Control Centre (MCC), of up 45 per day. Some may enter site for night shift/24-hour shifts. • Daily entry and exit from	• Avoid extended periods of engine idling outside the compound site in question. If possible, situate operational site vehicles away from residential properties. • Instruct all night staff (working between 10pm and 7am) about entering and exiting the site quietly. This may include: ○ Do not raise voices outside the Motorway Control Centre (MCC) or outside the site compound ○ Ensure staff enter and exit the site compound in a quiet manner.

Sites	Activity	Noise Management Plan
	Maintenance Centre, maximum permanent staff of approximately 28 with night operations of approximately 6 staff members.	
VSO1	**Coalescing oil separator in the carwash bay:** • Weekly inspection and maintained • Waste oil collection tank/container is to be emptied and disposed of. Quarterly maintenance (as a guide) to include drainage of the sludge, removal and washing of the plates/filtration system and the disposal of the contents of the tank.	• Plant and equipment will be selected to minimise noise emission, where possible, whilst maintaining efficiency of function. • If possible, minimise working in the same location or using the same tool/machine on consecutive day, in order to provide respite.
VSO2	**Cleaning OSD tank:** • Routine inspection • Cleaning OSD tank which may require the use of various machines (sweeper, vacuum truck, high pressure water machine) **Maintaining DRS Facility**: • Computer/Control Systems • Air Conditioning systems: Maintenance and repair of mechanical plant. Cleaning filters and checking operations of mechanical units.	• Include in tenders, employment contracts, sub-contractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise. • Ensure site managers periodically check the site for noise problems during maintenance works. This is to ensure solutions to noise problems can be quickly applied. Noise solutions may include, but not limited to, the following: ○ If noisy works are undertaken inside the facility, make sure facility doors are kept closed. ○ When working outside, provide noise respite from long period intense works. Where possible, noise intensive works should be conducted between 9am to 12pm Monday to Saturday and 2 pm to 5pm Monday to Friday to provide respite to surrounding residents. ○ When working outside and complaints arise then, if possible, implement quieter alternative maintenance work
VSO4	**Diesel Deluge Pump**	• Operation of the diesel deluge pump at VS04 for maintenance purposes is limited to the daytime only.
Tolling / Truck Enforcement Gantries	**Toll Maintenance:** General structural inspection, calibration and maintenance of the tolling and camera equipment. Elevated Work Platform (EWP) are likely to be used.	• Where possible, trucks and EWP are to be fitted with a 'quacker' reverse alarm. Especially if works are to be undertaken at night. • Ensure site managers periodically check the site for noise problems during maintenance works. Noise solutions may include, but not limited to, the following: ○ When working outside, provide noise respite from long period intense works. Where possible, noise intensive works are to be conducted between 9am to 12pm Monday to Saturday and 2pm to 5pm Monday to Friday to provide respite to surrounding residents. ○ When working outside and complaints arise then, if possible, implement quieter alternative maintenance work.

5.5 NorthConnex Road & Tunnel

Table 5-4 presents the proposed activities and the relevant noise controls to be implemented at the NorthConnex Road & tunnel. The following noise control plan is applicable for the operation of the tunnel in a 2 or 3 lane configuration.

Table 5-4 NorthConnex Road & Tunnel – Activities & Relevant Noise Control Measures

Activity	Noise Management Control
Cleaning Tunnel Wall: • Redirecting traffic to de-tour/alternative roads and closure of tunnel road. • Cleaning Tunnel Walls which may require the use of various machines (sweeper, signage truck, high pressure water cleaner).	• Plant and equipment will be selected to minimise noise/vibration emission, where possible, whilst maintaining efficiency of function. • If possible, minimise working in the same location or using the same tool/machine on consecutive day, in order to provide respite. • Where possible, trucks and other machinery are required to be fitted with a 'quacker' reverse alarm. Especially if works are to be undertaken at night. • Ensure site managers periodically check the site for noise problems during maintenance of pavement (including fences and retaining walls), roadside and medians. This is to ensure solutions to noise problems can be quickly applied. Noise Solutions may include, but not limited to, the following: ○ Providing noise respite from long period intense works ○ Providing noise shielding from noise source using existing structure, barrier or mound ○ When complaints arise, if practical, implement quieter alternative maintenance work
Maintenance of pavement (including fences and retaining walls), roadside and medians: • Routine Visual Inspection - Driving along alignment. • Maintenance and repair work may require the use of tools and machinery.	
Maintenance of mechanical and electrical system: • Routine Visual Inspection - Driving along alignment. • Maintenance and repair work may require the use of tools and machinery.	

5.6 M2 Motorway & M1 Pacific Motorway Noise Management Control Plan

5.6.1 Major Noise Barrier and/or Road Repair

This section sets out a control plan to be implemented to manage noise and potential vibration impacts from the activities related to the repair of noise barrier and/or M1 and M2 road. These controls address Condition (e) of MCoA E24. The Operation Environment Management Plan (OEMP) will be reviewed and updated annually.

Table 5-5 Major Noise Barrier and/or Road Repair Works – Noise Control Plan

Step	Requirement
1	Map the proposed works and the surrounding receivers likely to be affected by noisy activities. *Note: The location and type of receivers may have changed due to development in the area. Therefore, there is the requirement to confirm the location and validity of all noise sensitive receivers.*
2	Establish the noise criteria of the surrounding receivers based on either available background noise data of the area or undertake noise monitoring of the area. Depending on the date of the available noise data or the changes of the local environment impacting on the background noise level, an updated background noise measurement is to be undertaken.
3	Establish ambient conditions and associated noise management levels for the relevant catchment area/receiver as per the *ICNG, and CNVG* (Roads and Maritime, 2016). If vibration emissions are likely to impact surrounding receivers, vibration criterion of the receivers is to be established as well.
4	Prepare a schedule of all noise and vibration generating activities associated with the planned routine operations and site. Determine the duration and location where the noise-generating activities are planned to take place.
5	Determine the noise impact of the noisy work of the planned routine activities on the surrounding receivers. Identify any specific activities/area of work likely to exceed the Noise Management Level and which may potentially cause sleep disturbance if works are to be taken outside standard hours.
6	Establish safe working distances as described in the CNVG (Roads and Maritime, 2016) and the vibration limits within Assessing Vibration: A Technical Guidelines, BS 7385 and DIN 4150. Confirm if any planned routine work would take place closer than the safe working limits or would exceed vibration limits that may cause structural damage to receiver's property.
7	The proposed noise control plan to manage predicted planned routine noise exceedances are to either be updated in the O&M Contractor's EMP or to be prepared in an **activity specific Standard Operating Procedure (SOP)**. *Note: The level of assessment required by the CNVG (Roads and Maritime, 2016) varies according to the number of receivers affected and the duration of the works.*
8	Include noise management measures in the O&M Contractor's **EMP** or **activity specific SOP** as required. These measures need to respond to the work schedule and the requirements for out of hours work. Generally, the provisions of the procedure to avoid noise and vibration impacts will involve control measures outlined in Section 1.1.1 and any specific noise control measures.
9	Noise/vibration monitoring during the work is to be undertaken to ensure the activities achieve the predicted noise levels.
10	Undertake additional monitoring in locations where routine work requires the prolonged removal of noise walls and barriers to determine the impact on adjacent receivers; as per the *CNVG* (Roads and Maritime, 2016), and the *RNP* (NSW DECCW, 2011) for road traffic noise. Introduce additional controls such as restricted working hours and/or the use of temporary shields or walls where the assessment predicts likely impacts on the affected receivers.
11	If noise monitor show noisy work to significantly exceed the noise management level, safeguard and management measures is required be reviewed and potentially amended.
12	Any out of hours work is required comply with the *CNVG* (Roads and Maritime, 2016), or the relevant standards at the time.

5.6.2 Major Noise Barrier and/or Road Repair – General Noise & Vibration Mitigation Measures

Table 5-6 provides general noise and vibration mitigation measures to be implemented by the building contractor during repair of noise barrier and/or M1 and M2 road.

Table 5-6 Noise & Vibration Mitigation Measures

Item	Description
Standard Construction Hours	Works will be carried out within the approved construction hours. If night work is required, undertake intensive work activities during the day (if possible) and limit the use of certain noisy machine/tools at night.
Deliveries	Deliveries will be carried out within the approved construction hours, except during quarterly shutdown periods where equipment may need to be delivered to the site when the tunnels are closed. If possible, ensure loading and unloading is situated far away from residential receivers.
Site Layout & Scheduling	Where possible, plant and equipment will be located and orientated to direct noise away from sensitive receivers. If possible, minimise working in the same location or using the same plant equipment on consecutive day/night, in order to provide respite. Limit the use of noisy equipment operating simultaneously.
Temporary Noise barrier	Provide temporary noise barriers from maintenance/construction work, particularly during intensive works or works relatively close to residential receivers.
Quietest Suitable Equipment	Plant and equipment will be selected to minimise noise/vibration emission, where possible, whilst maintaining efficiency of function. Residential grade silencers will be fitted, and all noise control equipment will be maintained in good order.
Reversing Alarms	Mobile plant and trucks operating on site for a significant portion of the asset will have reversing alarm noise emissions minimised, where possible, recognising the need to maintain occupational safety standards. An example of this is to use 'quacker' alarm rather than 'beeper' style alarms.
Trucks	All trucks regularly used for the asset are to have mufflers and all noise control equipment related to trucks will be maintained in good working order. Truck drivers are required minimise the use of engine brakes and avoid extended periods of engine idling.
Tonal/Impulsive Equipment	When using tonal or impulsive equipment, ensure to provide respite. An example of this could be use of tonal/impulsive equipment for three hours followed by at least one hours' respite.
Site Personnel	Site personnel are required to adhere to the following: • Avoid the use of radios or stereos outdoors. • Avoid shouting and minimise talking loudly and slamming vehicle doors. • Avoid using vehicle horns when possible
Vibration Buffer Zones	General safe working distances for vibration intensive activities are described in **Table** 5-7. Monitoring is recommended to confirm these buffer zones at locations where buildings are closest. Identify nearby sensitive structures of heritage value and establish working limits accordingly prior to any vibration works.

Item	Description
Community Liaison	A programme of community liaison and complaint response will be implemented.
Training	Site induction training will include a noise awareness component, community consultation and response to complaints as provided in the 'Community Consultation' and 'Response to Complaints' Sections outlined below.
Site-Specific Noise/Vibration Control Measures	Site-specific noise/vibration found within future noise and vibration construction impact assessment are also to be implemented on site.

5.6.3 Community Consultation

Consultation with and the provision of information to the surrounding community is regarded as a major factor in controlling the negative reaction to the inevitable impacts associated with construction works.

In order for any construction noise management programme to work effectively, continuous communication is required between all parties, which may be potentially impacted upon including the builder, neighbours and apartment building residents. This establishes a dynamic response process which allows for the adjustment of control methods and criteria for the benefit of all parties.

The objective in undertaking a consultation process is to:

- Inform and educate the groups about the project and the noise controls being implemented;
- Increase understanding of all acoustic issues related to the project and options available;
- Identify group concerns generated by the project, so that they can be addressed; and
- Ensure that concerned individuals or groups are aware of and have access to the Complaints Register which will be used to address any construction noise related problems should they arise.

To ensure that this process is effective, regular information regarding the proposed works and period when they will be required to be conducted will be provided to neighbouring receivers.

Further consultation details are provided in the Community Communication Strategy. The Strategy provides mechanisms to facilitate communication between the proponent, the environmental representative, the relevant council and community stakeholder.

5.6.4 Response to Complaints

Should ongoing complaints of excessive noise and vibration impacts occur measures shall be undertaken to investigate the complaint, the cause of the complaint identified and changes to work practices implemented. In the case of exceedances of the vibration limits, all work potentially producing vibration shall cease until the exceedance is investigated.

The effectiveness of any changes shall be verified before continuing. Documentation and training of site staff shall occur to ensure the practices that produced the exceedances are not repeated.

If a noise and vibration complaint is received the complaint is to be recorded. The complaint form is required to list:

- The name and location of the complainant (if provided);
- The time and date the complaint was received;
- The nature of the complaint and the time and date it occurred;
- The name of the employee who received the complaint;
- Actions taken to investigate the complaint, and a summary of the results of the investigation;
- Required remedial action, if required;
- Validation of the remedial action as detailed in this report; and
- Summary of feedback to the complainant.

A permanent register of complaints is to be held. All complaints received is to be fully investigated and reported to management. The complainant is to be notified of the results and actions arising from the investigation.

The investigation of a complaint shall involve where applicable:

- measurements at the affected receiver;
- an investigation of the activities occurring at the time of the incident;
- inspection of the activity; and
- whether work practices were being carried out either within established guidelines or outside these guidelines.

5.6.5 Vibration Safe Working Distances

Table 5-7 sets out the typical ground vibration levels at various distances for safe working distances (Extracted from the *Construction Noise Strategy* (*CNS*, Transport for NSW, 2013).

Table 5-7 Recommended Safe Working Distances for Vibration Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Vibratory Rollers	<50 kN (Typically 1-2 tonnes)	5m	15-20m
	<100 kN (Typically 2-4 tonnes)	6m	20m
	<200 kN (Typically 4-6 tonnes)	12m	40m
	<300 kN (Typically 7-13 tonnes)	15m	100m
	300 kN (Typically 13-18 tonnes)	20m	100m
	300 kN (>-18 tonnes)	25m	100m

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Small Hydraulic Hammer	(300 kg – 5-12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12-18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18-34t excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Bored Piling	≤ 800mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

5.7 Non-Routine (Incident/Emergency) Works

This section sets out the controls that is required to be considered to manage noise and potential vibration impacts from non-routine (incident/emergency) works. Incident Management Training programs are required to include aspects relating to noise and vibration emissions, as presented in Table 5-8.

Table 5-8 Incident Management Training Noise & Vibration Requirements

Incident Management Training Noise & Vibration Requirements
Undertake incident management training as part of the compliance, training and awareness measures. This will include measures to: • Identify potential incidents and emergencies that would involve the use of noise-generating equipment. • Assess the likelihood of the incident or emergency occurring to determine the potential need to use noise and vibration generating equipment. • Eliminate any risk for noise and vibration complaints during an incident and emergency by maintaining fixed and mobile equipment. • Train staff in the correct use of noise and vibration generating equipment in an incident and emergency situation.

The noise control plan for non-routine work is presented in

Table 5-9. The control will be followed as part of the incident and emergency response activities. The following control steps will only be introduced where it is safe to do so. This will also only be introduced where there is time to respond to the incident or emergency.

In an event where the response is immediate to avoid any risk human life, property and the environment, then it may not be feasible or reasonable to undertake the following control steps.

Table 5-9 Non-Routine (Incident/Emergency) Work – Noise Control Plan

Step	Requirement
1	If possible, set up mobile acoustic screens or equipment shields around equipment used in an incident and emergency.
2	If noise and vibration generating equipment is used for more than 24-hours then, when possible, update the mobile road signage and website to notify the community of the expected higher levels of noise and vibration and the length of time it is likely to last.
3	Advise the person/people manning the 24-hour telephone number and email address of the incident and emergency so that they can respond to any complaints quickly. Consider using automated messaging or providing a mail shot to the community to communicate the incident and emergency where the use of noise-generating response equipment is expected to last longer than 72-hours.
4	Review the effectiveness of **Steps 1** to **4** as part of the incident and emergency response process review. This will include a review of the: • Deployment of noise and vibration controls. • Nature and extent of noise and vibration queries and complaints. • Effectiveness of the communication and consultation responsiveness during the incident and emergency.
5	Review this management sub-plan, the OEMP, community communications strategy and O&M contractor's EMP based on the review undertaken in **Step 5.**

6 NOISE & VIBRATION MONITORING

6.1 Monitoring Programs

The proposed monitoring program prepared in this section is to ensure future noise compliance measurements satisfy the MCoA E24 (f), E25 and E26. Additional monitoring programs for maintenance/ operational works and compliance noise measurement of upgraded/repair noise mitigation infrastructures and/or mechanical plant at ventilation facilities is also provided to address the noise management requirement outlined in MCoA E24 (e).

Table 6-1 Conditions of Monitoring

Conditions of Monitoring	Section
Mechanical Noise Compliance Assessment (Commissioning) – MCoA E25 (refer to Table 4-2)	Section 6.2
Post Road Traffic Noise Compliance Assessment – MCoA E26 (refer to Table 4-2)	Section 6.3
Pre and Post Operation Road Traffic Noise Assessment of Surrounding Roads – MCoA E24 (f) (refer to Table 4-1)	Section 6.4
Noise compliance post maintenance/repair/upgrade works of: • Mechanical plant at the ventilation facilities • Noise wall, fencing and mounds and road surface	Section 6.5
Noise/vibration monitoring of site maintenance/repair works	Section 6.7

Noise compliance post maintenance/repair/upgrade works, and monitoring of site maintenance/repair works is consistent with the managerial measures for controlling noise requirement outlined in MCoA E24 (e).

6.2 Post-Construction Mechanical Noise Assessment (Commissioning)

The following post noise monitoring requirement addresses the MCoA condition E25 and E26.

The noise compliance assessment is to be conducted during commissioning, within one year of the construction of the NorthConnex ventilation facilities. This includes noise measurement of the Coral Tree Drive Substation, VSO1, VSO2, VSO3 and VSO4 ventilation facilities.

The measurement must be taken at the most affected point in or within the site boundary at the most sensitive receiver locations. The monitoring assessment must be undertaken under the following conditions:

- 15-minute attended noise measurement of each ventilation facility/compound must be undertaken at the receiver locations outlined in Table 6-2. Any additional measurement locations at noise complainant's location needs to be undertaken. In addition to this, background noise measurement of the site immediately after the impact measurement needs to be undertaken to minimise the ambient noise contribution of the recorded operational noise measurement.
- Noise measurement must be free field, at least three metres from any vertical reflecting surface in line with the worst-affected dwelling facade to determine compliance with

Industrial Noise Policy.Sound level meter configured for "Fast" time weighting and "A" frequency weighting. At a minimum L_{eq}, L_{max}, L_{10} and L_{90} levels will be measured and reported.

- Noise measurement is required to exclude extraneous noise and is not be undertaken during adverse weather conditions likely to significantly impact noise levels.
- Conditions such as wind velocity and direction, temperature, relative humidity and cloud cover will be recorded from the nearest Bureau of Meteorology station or on-site weather station/observations.
- Modification factors provided in Section 4 of the NSW *Industrial Noise Policy* (EPA 2000) needs to be applied to noise levels when necessary.
- The observations of the person undertaking the measurements will be reported including audibility of any discernible mechanical noise.
- Any mechanical units causing noise exceedance on site shall be recorded.

If for any reason direct measurement of mechanical noise from the fixed facilities is impractical, the Proponent may employ an alternative noise assessment method deemed acceptable by the EPA [refer to Section 11 of the NSW *Industrial Noise Policy* (EPA 2000)]. Details of such an alternative noise assessment method accepted by the EPA shall be submitted to the Secretary prior to the implementation of the assessment.

Post-Construction Mechanical Noise Assessment report is required to be prepared and include the following items:

- Details of the noise monitoring locations and reasons for any additional monitoring locations.
- A summary of the relevant noise criteria and goals
- The measured operational noise of the ventilation facilities. Impact on sleep disturbance also needs to be addressed.
- Discussion of the operational noise measurement and outline relevant findings on site.

If operational noise does not comply with relevant noise standards, a discussion of the mechanical noise causing the exceedance is required. In addition to this, noise control options are to be prepared to ensure the ventilation facilities comply with relevant noise standards.

Table 6-2 provides a list of proposed noise measurement locations for this assessment. The locations have been selected in response to the receivers' sensitivity and predicted levels. The table also includes the predicted noise impact at each noise receiver location as per the NorthConnex: M&E Acoustic Services – FDD Airborne Noise Assessment report prepared by Air Noise Environment.

Table 6-2 Operational Noise monitoring locations

Compound	WM ID	NCA	Address	PSNL L_{Aeq}			Sleep Disturbance L_{Amax}	Predicted Noise Level
				Day	Eve	Night	Night	
VSO1/MCC	2108	10A	20 Gum Pl, West Pennant Hills	48	47	40	60	32
	2051	10A	20 Hillside Pl, Pennant Hills	48	47	40	60	31
	2044	10A	2B Eaton Rd, West Pennant Hills	48	47	40	60	29
VSO2	1413	7A	442A Pennant Hills Rd, Pennant Hills	55	51	48	58	33
	1431	7A	430 Pennant Hills Rd, Pennant Hills	55	51	48	58	34
	3844	7B	3 Killaloe Ave, Pennant Hills	50	45	40	52	28
VSO3	1261	6A	4A Trelawney St, Thornleigh	52	45	40	54	27
	1220	6B	5 Loch Maree Ave, Thornleigh	52	45	40	54	21
VSO4	360	1A	25 Woonona Ave, Wahroonga	55	50	43	53	28
	367	1A	52 Woonona Ave, Wahroonga	55	50	43	53	30
	374	1A	42 Woonona Ave, Wahroonga	55	50	43	53	31
Coral Tree Drive Substation	2188	10C	39 Coral Tree Dr, Carlingford	48	48	40	55	33
	2172	10C	50A Coral Tree Dr, Carlingford	48	48	40	55	35

The noise monitoring program should also include the locations of noise complaints. Noise criteria for additional monitoring locations can be found in Appendix B.

6.3 Post Construction Road Traffic Noise Assessment

The following post noise monitoring requirement addresses the MCoA conditions E25 and E26.

Between six months and one year after the opening of the Road NorthConnex project a road traffic noise monitoring assessment is to be undertaken. The monitoring results are to be compared against the predicted noise results outlined in Appendix F of the Wilkinson Murray NorthConnex & M2 Integration Project – Operational Noise Management Report (reference: 13245-O Ver J). The purpose of this assessment is to determine whether operational noise levels are consistent with relevant noise design limits and to evaluate the implemented noise mitigation treatment on site. The monitoring assessment must be undertaken under the following conditions:

- Operational noise monitoring procedures must be conducted in accordance with Practice VIII of the Roads and Maritime's Environmental Noise Management Manual.
- Continuous noise monitoring must be undertaken using noise logging instrumentation which samples continuously over each 24-day period and must record 15-minute time intervals. The L_{A10}, L_{A90}, L_{Aeq} and L_{Amax} noise parameters are to be recorded.
- Noise monitoring needs to be undertaken at the residential receiver locations outlined in Table 6-3. Additional monitoring may be required at locations based on any complaints that may be received from residents near the NorthConnex.
- 15-minute Attended noise measurement must also be undertaken at the locations listed in Table 6-3 during the day and night period as identified in the NSW Road Noise Policy. The purpose of this measurement is to assist in characterising the ambient noise environment in each location. Field notes are to be made on acoustically significant issues.
- Noise monitoring is to be undertaken alongside traffic volume monitors. The monitors must be installed for a minimum of 10 days to ensure the likelihood of acquiring full seven days of valid data.
- Noise monitoring is to be conducted 1m from the residential building façade that is most exposed to traffic noise and at a height of 1.5m above the floor level. If monitoring in the free-field, a 2.5dB(A) façade reflection correction is to be added to the measured L_{Aeq} noise levels. In case of multi-level residential buildings, noise monitoring be undertaken at the two floors of the buildings most exposed to traffic noise.
- Extraneous noise and adverse weather conditions likely to significantly impact noise data are to be excluded from the computation of the noise parameters.

A Post-Construction Noise Monitoring report needs to be prepared and include the following items:

- Details of the noise monitoring locations and reasons for any additional monitoring locations.
- A summary of the relevant noise criteria and goals
- The context, conditions, locations and frequency where the monitoring was undertaken.
- Any required recalibrations of the noise model taking into consideration factors including actual traffic volume data, change in road pavement surfaces etc.
- The measured road traffic noise level and traffic volume results.
- Validation of the noise model used during design phase shall be completed. Comparison of the modelled values of traffic noise using existing traffic flows with measures values from noise monitoring is to be made, as per the requirement within the RMS Model Validation Guideline (2018). Where differences of more than 2dBA occur, discuss the reason for the differences and if applicable adjust the model accordingly.
- Complaints and enquiries received from the date of opening of the asset. Details such as the nature of the complaint, the actions taken and the residual outcome.
- An assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of all feasible and reasonable mitigation measures. Identification of any additional feasible and reasonable measures to those identified in the review of noise mitigation measures.

The report will be issued to the NSW EPA 60 days of undertaking the monitoring. In the event the noise measurements do not meet noise predictions from the NorthConnex ONAR, the following steps need to be undertaken:

1. Contact TfNSW (Environment Branch) and discuss the need to revise or update the NorthConnex strategic traffic model and noise model to respond to revised or higher than expected growth in the area than modelled originally.
2. Review the need for supplementary or additional noise mitigation controls consistent with the NMG (Roads and Maritime, 2015) in the event that the noise monitoring confirms an exceedance of the predicted modelling prepared during the detailed design. Prepare (if needed) and submit a supplementary noise mitigation strategy to NSW EPA.
3. Implement the confirmed and agreed supplementary noise mitigation strategy.
4. Undertake noise monitoring during typical operational conditions at representative locations to monitor the effectiveness of any additional noise mitigation.
5. If the monitoring shows the controls to be effective, seek clarification in writing from an acoustician (and the regulator if required).
6. If the monitoring shows the plan to be ineffective, this procedure must begin at item 1 to revise and/or supplement the management controls.
7. Additional monitoring would be undertaken after changes to infrastructure have occurred or significant changes to operations. If the noise management levels are not met at any time, then this procedure is to be repeated from Item 1.

Table 6-3 provides a list of proposed road traffic noise measurement locations for this compliance assessment. The locations have been selected based on previous road traffic noise measurement conducted in 2015. Comparison of the previous and the new road traffic noise level can be made.

Table 6-3 Road Traffic Noise Monitoring Locations

WM ID	NCA	Address
-	1A	45 Bareena Avenue, Wahroonga
395	2A	118A Coonanbarra Road, Wahroonga
195	2A	22 Woonona Avenue South, Wahroonga
3028	3	10 Pennant Hills Road, Wahroonga
2159	10B	3 Mundon Place, West Pennant Hills
NR-119	10D	58 Oakes Road, North Rocks
2534	11B	66 Carmen Drive, North Rocks
2863	13	122 Barclay Road, North Rocks
2880	14	25 Williams Road, North Rocks

Additional noise monitoring locations should be considered to address noise complaint areas.

6.4 Pre- & Post-Operation Road Traffic Noise Assessment of Surrounding Roads

The following noise monitoring requirement addresses the MCoA condition E24 (f). This condition refers to noise monitoring assessment of the surrounding roads which are likely to experience significant increase in traffic volumes as a result of the project. The pre road traffic noise assessment to address this condition is to be undertaken prior to the opening of the NorthConnex project. The post road traffic noise assessment to address this condition is to be undertaken within 12 months of the project opening.

A review of the road traffic volume data and the predicted future traffic volume of roads surrounding the project was undertaken. The purpose of the Traffic volume data and prediction review will provide indication of the relevant noise monitoring locations to assess potential increase in noise from surrounding roads.

The proposed noise monitoring locations of the surrounding roads, presented in Table 6-4 , are based on roads where the traffic increase forecast is predicted to have an increase of 25% overall vehicles during the day or night or when there is a 33% increase in heavy vehicles. The outlined percentage increases in the traffic volumes are near the threshold of when noticeable change in traffic noise level is likely to occur.

The monitoring assessment would consist of the following procedures:

- Pre-operation noise monitoring must be conducted at various locations in order to establish existing road traffic noise impact. The noise monitoring must be conducted prior to the opening of the NorthConnex project.
- Post-Operation noise monitoring procedures must be conducted in accordance with Practice VIII of the Roads and Maritime's Environmental Noise Management Manual. The noise monitoring must be conducted within 12 months of the opening of the project.

Pre & Post Noise Monitoring Assessment of Surrounding Roads would adhere to the following monitoring conditions:

- Continuous noise monitoring must be undertaken using noise-logging instrumentation which samples continuously over each 24-day period and must record 15-minute time intervals. The L_{A10}, L_{A90}, L_{Aeq} and L_{Amax} noise parameters are to be recorded.
- Noise monitoring is to be undertaken at the residential receiver locations to be affected by significant road traffic increase. In the post noise monitoring assessment, monitoring locations must match the pre noise monitoring locations.
- 15-minute Attended noise measurement must also be undertaken at the assigned locations during the day and night period as identified in the NSW Road Noise Policy. The purpose of this measurement is to assist in characterising the ambient noise environment in each location. Field notes are to be made on acoustically significant issues.
- Noise monitoring is to be undertaken alongside traffic volume monitors. The monitors must be installed for a minimum of 10 days to ensure the likelihood of acquiring full seven days of valid data.
- Noise monitoring is to be conducted 1m from the residential building façade that is most exposed to traffic noise and at a height of 1.5m above the floor level. If monitoring in the free-field, a 2.5dB(A) façade reflection correction is to be added to the measured L_{Aeq} noise levels. In case of multi-level residential buildings, noise monitoring be undertaken at the two floors of the buildings most exposed to traffic noise.

- Extraneous noise and adverse weather conditions likely to significantly impact noise data are to be excluded from the computation of the noise parameters.

A separate Pre and Post-Operation Noise Monitoring report would be prepared, and each report will include the following items:

- Details of the noise monitoring locations and reasons for any additional or reduction of monitoring locations.
- A summary of the relevant noise criteria and goals
- The context, conditions, locations and frequency where the monitoring was undertaken.
- The measured road traffic noise level and traffic volume results.
- Complaints and enquiries received from the date of opening of the asset. Details such as the nature of the complaint, the actions taken and the residual outcome.

If surrounding road traffic noise do not comply with relevant noise standards, a review of the road traffic volume number and other potential causes of increase in noise is to be undertaken. In addition to this, proposed noise control options are to be prepared to minimise noise impact on nearby receivers.

The Environmental Impact Statement provides a comparison of the 2029 traffic volume predictions for scenarios 'without project' and 'with project' NorthConnex operating. Multiple roads with over 33% increase in heavy vehicles were identified and noise monitoring assessment of these roads is required.

Appendix C provides reference for the 2029 surrounding road traffic volume predictions. The Appendix consists of Table 8-31 Comparison of 2019 and 2029 'without project' and 'with project' light vehicle volumes on the surrounding road network. And Table 8-32 Comparison of 2019 and 2029 'without project' and 'with project' heavy vehicle volumes on the surrounding road network.

Table 6-4 presents roads that are required for the surrounding road noise monitoring assessment. The table outlines the traffic direction with the highest increase in heavy vehicles.

Table 6-5 below present the EPA's Road Noise Policy target abatement levels for existing roads not subject to redevelopment.

Table 6-4 Proposed Surrounding Road Traffic Noise Monitoring Areas

Road	Location	Direction	AWDT Heavy Vehicle		Heavy Vehicle Increase %
			2029 without	2029 with	
North Rocks Road	West of Pennant Hills Road	Eastbound	1200	1250	4%
		Westbound	700	1150	**64%**
Abbott Road	West of Old Windsor Road	Eastbound	1600	2850	**78%**
		Westbound	1500	2100	40%
Abbott Road	East of Old Windsor Road	Eastbound	1500	2950	**97%**
		Westbound	1100	2050	86%
Hume Highway	South of Elizabeth Drive	Northbound	2,950	4,550	54%
		Southbound	1800	3000	**67%**
Cowpasture Road	Westlink M7 Motorway Interchange to Green Valley Road	Northbound	1100	1850	**68%**
		Southbound	1700	2550	50%

Table 6-5 Road Noise Policy Target Noise Levels for Existing Roads

Existing Road Category	Target Noise Level, dB(A)	
	Day: 7:00 – 22:00, $L_{Aeq(15hr)}$	Night-time: 22:00 - 07:00, $L_{Aeq(9hr)}$
Freeway/arterial/sub-arterial road	60 dB(A)	55 dB(A)

6.5 Post Upgrade Noise Compliance Assessment

After the completion of major upgrade works of a mechanical plant a noise compliance assessment is to be undertaken. Table 6- presents the procedure of the noise compliance assessment for major maintenance/repair works on mechanical equipment at the ventilation facilities, such as, a major upgrade or repair of mechanical plant (e.g. fan).

The noise measurements of the mechanical units are to be compared against the performance rating limits (sound power levels), or previous measuring data, to ensure the equipment is functioning properly and within manufacturer specifications. The monitoring will take place during a typical operating cycle.

Table 6-6 Post Mechanical Upgrade – Noise Compliance Assessment Procedure

Step	Requirement
1	Prepare a schedule of all noise generating plant and equipment at each ventilation facilities and determine the sound power levels of each item. Review the schedule annually or following a change in operations, equipment, or legislation.
2	**Noise monitoring of the mechanical plant** after a change in operations/equipment is to be undertaken. Measurement shall be undertaken at either the nearest sensitive receiver, the complainant's property or a representative location(s). Noise measurement is required to meet the criteria of the *INP* (NSW EPA, 2000).
3a	If the monitoring shows compliance, prepare a letter or memo confirming this.
Non-compliance	
3b	The following steps are to be undertaken when noise measurement is non-compliant: Prepare a letter, report or email detailing noise measurement showing non-compliance with the *INP* (NSW EPA, 2000) criteria. The report is to also detail the current noise emissions compared with the initially measured sound power levels and the reason for the non-compliance. The letter/report/email needs to also detail the conditions when the monitoring was undertaken, including operating configuration and meteorological conditions and confirm the reason(s) for any departure between the previous compliant monitoring results or the sound power/pressure levels presented in Section 1 of this sub-plan.
4	Prepare an **equipment noise Standard Operating Procedure (SOP)** describing what is required to improve the noise performance of the equipment ranging from (a) maintenance, (b) equipment replacement, and/or (c) the introduction of additional noise controls.
5	In preparing the procedure, review the OEMP and this sub-plan.
6	Submit the procedure to the O&M Stakeholders outlining the relevant issues. Given that the procedure is a summary of the requirements, and the urgency of the situation, it should take no longer than two working days to prepare and submit.
Regulatory notification	
7	Review the procedure to ensure all requirements can be reasonably implemented. Additional advice will be sought if required.
8	Review the procedure to confirm if regulatory notification is required.
9	If regulatory notification is required, complete a standard notification letter.
10	Forward the draft notification letter, procedure and preliminary report for review, and consider any amendments.
11	Forward the signed notification letter to the relevant regulator.
12	Keep the notification letter, procedure and preliminary assessment in the TRANSURBAN IMS.
Implementing the equipment noise standard operating procedure	
13	Modify the procedure to take into account any additional regulatory advice and comments.
14	Implement the procedure.
15	Undertake short-term noise measurement of mechanical equipment during a typical operational cycle at the source and at adjacent noise-sensitive receivers (if required) to monitor the effectiveness of the noise control recommendation.
16	If the monitoring shows the procedure to be effective, seek clarification in writing that its environmental provisions are effective and is to be adopted under the OEMP and this management sub-plan.
17	If the monitoring shows the procedure to be ineffective, the above steps must be followed again from **Control 3b** and the provisions of the procedure must be revised or supplemented.
18	Maintain monitoring after the provisions of the procedure are implemented to determine compliance with the *INP* (NSW EPA, 2000) criteria. If there is any change in the monitoring levels, consider revising or relaxing the management plan controls. Conversely, if the noise management levels are not met at any time then the above steps must be followed again from **Control 3b**.

Table 6-7 Operational Noise monitoring locations

Compound	WM ID	NCA	Address	PSNL L_{Aeq}			Sleep Disturbance L_{Amax}
				Day	Eve	Night	Night
VSO1/MCC	2108	10A	20 Gum Pl, West Pennant Hills	48	47	40	60
	2051	10A	20 Hillside Pl, Pennant Hills	48	47	40	60
	2044	10A	2B Eaton Rd, West Pennant Hills	48	47	40	60
VSO2	1413	7A	442A Pennant Hills Rd, Pennant Hills	55	51	48	58
	1431	7A	430 Pennant Hills Rd, Pennant Hills	55	51	48	58
	3844	7B	3 Killaloe Ave, Pennant Hills	50	45	40	52
VSO3	1261	6A	4A Trelawney St, Thornleigh	52	45	40	54
	1220	6B	5 Loch Maree Ave, Thornleigh	52	45	40	54
VSO4	360	1A	25 Woonona Ave, Wahroonga	55	50	43	53
	367	1A	52 Woonona Ave, Wahroonga	55	50	43	53
	374	1A	42 Woonona Ave, Wahroonga	55	50	43	53
Coral Tree Drive Substation	2188	10C	39 Coral Tree Dr, Carlingford	48	48	40	55
	2172	10C	50A Coral Tree Dr, Carlingford	48	48	40	55

6.6 Noise & Vibration Monitoring Program

Table 6- presents the annual noise monitoring program to ensure noise emissions from the ventilation facility comply with the relevant noise goals. In addition to this, the table also outlines noise and vibration monitoring procedures to be undertaken for site/maintenance works.

Table 6-8 Noise/Vibration Monitoring during Site Maintenance/Repair Works

Monitoring Details	Test Procedures
Annual Noise Monitoring Assessment of all ventilation facilities	The noise monitoring procedure outlined in Section 6.2 of this ONMP is to be considered.
Where a complaint is received, and monitoring is considered an appropriate response to determine if noise levels exceed predicted operational noise levels. Where noise intensive maintenance/site work may occur, especially at night time. Spot checks for worst-case noise impact scenarios or when new predicted high noise impact activities commence. Where required for the purposes of refining methods or techniques to reduce noise levels.	The testing method includes: • Determine whether short-term (15-minute) or long-term noise measurement is required for the proposed activities and determine the noise monitoring locations. Any additional locations due to noise complaint are to be considered. • Noise measurement must be free field, at least 3 to 5 metres from any vertical reflecting surface in line with the worst-affected dwelling façade. • Sound level meter configured for "Fast" time weighting and "A" frequency weighting. At a minimum L_{eq}, $L_{max,}$ L_{10} and L_{90} levels will be measured and reported. • Noise measurement need to exclude extraneous noise and is not to be undertaken during adverse weather conditions likely to significantly impact noise levels. • Conditions such as wind velocity and direction, temperature, relative humidity and cloud cover will be recorded from the nearest Bureau of Meteorology station or on-site weather station/observations. • Modification factors provided in Section 4 of the NSW *Industrial Noise Policy* (EPA 2000) is to be applied to noise levels when necessary. • Recording any noise source causing exceedance on site. • Prepare a noise monitoring report. The report must include the purpose of the monitoring, activities undertaken on site, relevant noise criteria, measured noise level and, if necessary, noise control recommendations.
Where vibration intense maintenance/site work may occur within safe working distances for cosmetic damage.	Continuous vibration monitoring will be undertaken where vibration from a construction activity may exceed cosmetic damage criteria at a sensitive structure, where activities may occur within safe working distances for cosmetic damage. The testing method includes: • Vibration logger to continuously measure vibration while relevant works are occurring within the safe working distance for cosmetic damage • Measurement to be conducted as close as possible to the sensitive structure

Monitoring Details	Test Procedures
	• A warning system will be implemented including one or both of an audible and/or visual warning alarm, and/or SMS and/or email alerts to O&M Contractor personnel. • Prepare a vibration monitoring report and must include the activities undertaken, relevant criteria, vibration impact and mitigation control, if necessary.

6.7 Monitoring & Auditing the Plan

The ONMP is to be assessed and reviewed on an ongoing basis to ensure continual improvement to the document is made. Specifically, it will be reviewed:

In preparing for a change in:

- Legislation or regulation
- Licencing or approval conditions
- Operations.

Following:

- Routine inspections, monitoring and audits where there is an associated observation, corrective action, and/or environmental improvement notice issued.
- An incident or emergency.
- A recorded noise/vibration exceedance
- Persistent noise/vibration complaints

Otherwise the plan will be audited, reviewed and modified annually.

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

Reviews will comprise:

- O&M contractor documentation
- Observing procedure and protocol onsite
- Issuing corrective actions or environmental improvement notices
- Re-auditing performance once the corrective actions/improvement notices have been implemented.

APPENDIX A

SUMMARISED INFRASTRUCTURE & MECHANICAL NOISE MITIGATION MEASURES

Condition E25 of the MCoA requires that:

(d) location, type and timing of erection of permanent noise barriers and/or other noise mitigation measures demonstrating best practice including silencers and building treatments for associated plant rooms and enclosures for exposed plant;

(e) specific physical and managerial measures for controlling noise;

Condition (d) has been addressed in ONAR prepared by Wilkinson Murray (reference: 13245-O ver J). A list of future noisy activities outlined in Section 5 of this report suggests maintenance and repair works of mechanical and barrier could potentially occur during the operations of the road. Therefore, a summary of the barrier and mechanical noise control measures presented in the ONAR are provided in this Section. Other noise control measures such as specific Architectural Treatment of affected residential structures and building treatment of the Ventilation Facilities/compounds are recommended in the Appendices. Condition (e) is addressed in Section 5 of this report.

A - 1 Noise mitigation infrastructure

Section 6.7 of the Operational Noise Assessment Report (ONAR) for NorthConnex & M2 Integration Projects prepared by Wilkinson Murray provides road traffic noise mitigation controls to reduce noise levels at affected receivers. Locations where noise mitigation would be required, guidance is taken from the ENMM which was published to assist in interpretation of the *Environmental Criteria for Road Traffic Noise* (ECRTN) and in particular, provides guidance on the selection of appropriate mitigation measures.

This guideline was still in place at the time of the approval, although has since been partially replaced. It should be noted that the *ENMM* states that community views should be fully considered in following the processes for evaluating and selecting noise treatments.

In the *ECRTN* the EPA recommends the priority for treatment as follows:

- Road design and traffic management;
- Quiet pavement surface;
- In corridor noise barriers / mounds; and
- At property treatments or localised barriers/ mounds.

Road design and traffic management has already been considered in previous stages of the project. In considering road pavement, the M1 and M2 currently has low noise pavement (OGA). In particular, the southbound carriageway along the M1 was resurfaced with OGA due to its deteriorated condition. Portal ramps were built with stone mastic asphalt (SMA). As a result of this, noise barriers and property treatments were considered to minimise the noise impact at relevant sensitive receivers.

A summary of the ONAR's recommendations for road traffic noise mitigation control to be implemented is outlined in Sections A - 2 and A - 3. Full details of the road traffic noise control can be found in the ONAR for NorthConnex & M2 Integration Projects (reference: 13245-O ver J). Noise control attributed to the NorthConnex compound/facilities (i.e. mechanical noise) is outlined in Section A - 4.

A - 2 At-Property Treatment

Section 6.7 of the ONAR provides a list of structures near the NorthConnex road that are eligible for Architectural Treatment (AT). Lend Lease Bouygues Joint Venture have confirmed that 151 AT have been completed, 27 tenants have declined the AT, 6 due diligence and 2 receiver buildings required no treatment because their properties had acoustic treatment already.

A - 3 Noise Barrier

A summary of the constructed barrier heights along the M1 is shown in Table A – 1. And a summary of the recommended barrier heights along the M2 is shown Table A - 2.

Table A - 1 Summary of Barrier Heights for NorthConnex Northern

Wall	Barrier Height (m)	Timing of Completion
NW-N-1M0-01	4.8	Q2 2018
NW-N-1R0-02	3.6	Q3 2017
NW-N-110-06	6.0	Q1 2020
NW-N-110-07	4.2	Q1 2020
NW-N-110-01	4.2	Q2 2018
NW-N-110-02	4.2	Q3 2017
NW-N-120-04	northern end RL 160.5m; southern end RL 163m	Q1 2020
NW-N-120-02	4.2	Q3 2019
REB-1a	Existing noise barrier	-
REB-1b	Existing noise barrier	-

Table A - 2 Summary of Barrier Heights for NorthConnex Southern & M2 Integration

Wall	Barrier Height (m)	Timing of Erection
NW-S-110-04	5.4	Q4 2018
NW-S-110-03	4.8	Q4 2019
NW-S-110-07	4.8	Q1 2020
NW-S-120-01	4.8	Q3 2018
NW-S-120-02	4.8	Q1 2019
NW-S-120-03	7.8	Q4 2019
NW-S-120-05-01A	4.8 to 6.0	Q2 2019
NW-S-120-05-01B	3.6 above MV120	Q4 2019
NW-S-120-05-02	No barrier required	-
NW-S-120-06	7.8	Q4 2019
NW-S-120-07	4.8	Q1 2020
NW-S-110-01	4.2	Q2 2018
NW-S-110-02	4.2	Q2 2018
M2-DW6	6	Q2 2018
M2-DW7	7.2 to 7.8	Q1 2018
M2-DW8	7.8	Q4 2017
M2-DW9	5.4 to 6.0	Q4 2017
M2-DW10	2.4 to 6.6	Q4 2017
M2-DW11	4.8	Q1 2018
M2-EW1	Existing noise barrier	-
M2-EW2	Existing noise barrier	-

Receivers eligible for architectural treatment and the layout of the noise barriers for this road project are presented in ONAR for NorthConnex & M2 Integration Projects (reference: 13245-O ver J).

A - 4 Mechanical Noise

The following mechanical noise control recommendations for the NorthConnex ventilation facilities were provided within the ONAR. A summary of the attenuators, recommended Sound Power/Pressure Level of the mechanical units and other noise control measures are outlined in this section. The attenuators outlined in this section have been installed at all ventilation facilities.

Sound Power/Pressure Level of mechanical units should be referenced when assessing noise compliance of the ventilation facilities.

VSO1 Southern Ventilation Facility

Table A - 3 below presents the test sound power level data for the axial fans operating at VSO1 from the supplier Witt & Sohn. Table A - 4 present the attenuators (Inlet & Outlet) performance.

Table A - 3 Axial Fans Sound Power Level for VSO1 - South (Linear dB) – per fan

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Witt & Sohn – Axial Fans									
4 off fans at 100% Inlet / Outlet	116[a]	116	126	123	123	120	116	111	107
5 off fans at 80% Inlet / Outlet	115[a]	115	124	121	120	117	113	108	104
5 off fans at 72% Inlet / Outlet	114[a]	114	123	119	118	115	110	106	101

Table A - 4 Attenuator Transmission Loss (Linear dB) Inlet & Outlet VSO1

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Attenuator (Inlet / Outlet)									
ATT011 (Inlet)	2[a]	12	31	44	49	53	51	34	21
ATT012 (Outlet)	8[a]	18	36	45	51	52	49	40	29

[a] Extrapolated, with conservative assumption of -10 dB relative to 63 Hz octave data

Table A - 5 presents the FDD test data for regenerated noise data from the attenuators.

Table A - 5 VSO1 Regenerated Noise Data for In-Flow & Attenuator Tender Design (Linear dB)

	Octave Band Centre Frequency (Hz) dB								Total (Lin)
	63	125	250	500	1k	2k	4k	8k	
Regenerated Noise from Attenuator (based on supplier test data: Regenerated face value (0.72 m^2)									
ATT011 (Inlet Attenuator)	55	53	50	51	50	48	45	43	60
ATT012 (Outlet Attenuator)	61	59	56	57	56	54	51	49	66
Regenerated Noise through System									
In-Flow Regenerated (80%)[a]	71	69	62	60	48	51	54	57	76
In-Flow Regenerated (72%)	68	66	59	57	45	48	51	54	74

[a] Modelling of 100 % operation results in the same air-flow speeds as the 80 % scenario

In addition to the axial fans, various ancillary mechanical plant and equipment will operate on site. Table A - 6 presents a summary of the additional noise sources on site.

Table A - 6 VSO1 Ancillary Noise Sources FDD (Linear dB) (SWL)

Source	Supplier / Item Number	Total	Operating	Octave Band Frequency (Hz) Linear dB									dBA
				31.5	63	125	250	500	1K	2K	4K	8K	
Transformers													
4.5 MVA Transformer	TRX112 / TRX212	2	2	96	84	86	78	73	63	57	52	47	75
2.5 MVA Transformer	TRX113 / TRX213	2	2	92	80	83	74	69	60	54	49	44	72
CTD Transformer Room A/B	TRX101 / 201	2	2	96	82	101	70	56	55	48	48	52	85
Ventilation													
HVA Room FCU	FCU0101-FCU0102	2	1	70	70	70	67	71	68	65	64	64	74
HVB Room FCU	FCU0103-FCU0104	2	1	70	70	70	67	71	68	65	64	64	74
LVA Room FCU	FCU0105-FCU0107	3	2	86	86	86	79	79	74	69	66	66	80
LVB Room FCU	FCU0108-FCU0110	3	2	86	86	86	79	79	74	69	66	66	80
Air Conditioning Condensers	ACU0101_104	4	2	76	76	76	73	68	66	61	54	54	71
Air Conditioning Condensers	ACU0105_110	6	4	84	84	84	83	78	75	67	61	61	80
Western Corridor Supply Air	SAF0104	1	1	63	63	73	75	67	67	63	56	43	72
Eastern Corridor Supply Air	SAF0105	1	1	69	69	79	84	85	83	76	69	58	87
Battery Exhaust, Supply Air	SAF0111	1	1	81	81	79	75	72	63	65	64	54	74
LV Room Battery Exhaust Fans	EAF0111_0114_Inlet	4	2	64	64	75	76	74	72	69	63	49	77
LV Room Battery Exhaust Fans	EAF0111_0114_Outlet	4	2	73	73	73	77	72	70	68	64	52	76

Source	Supplier / Item Number	Total	Operating	Octave Band Frequency (Hz) Linear dB									dBA
				31.5	63	125	250	500	1K	2K	4K	8K	
Maintenance Yard													
Toilet Exhaust Fan	RC_01	1	1	60	60	60	64	73	66	67	62	55	74
Toilet Exhaust Fan	RC_02	2	2	72	72	82	73	70	69	66	64	62	75
Condenser Unit	CU_G01	1	1	88	88	88	88	87	83	78	74	74	88
Condenser Unit	CU_G02	1	1	73	73	79	71	64	63	61	59	54	69
Condenser Unit	CU_G03	1	1	70	70	72	70	68	63	58	50	42	68
Outlet Exhaust Fan	OAF_GO1	1	1	75	75	68	67	64	61	58	56	47	67
MCC Building													
Condenser Unit	CU_R07_R10	4	4	81	81	81	74	73	67	61	57	57	74
Condenser Unit	CU_R01,R03,R04	3	3	76	76	76	73	68	66	61	54	54	71
Computer Room A/C	CU_R11_R14	4	4	60	60	60	63	69	74	74	69	60	79
Condenser Unit	CU_R02	1	1	84	84	84	83	78	75	67	61	61	80
Condenser Unit	CU_R05_R06	1	1	80	80	80	79	74	71	63	57	57	76
Air Handling Unit	AHU_R01_R02	2	2	81	81	81	67	68	67	61	51	51	72
Air Handling Unit	AHU_R03	1	1	85	85	85	77	75	74	68	60	60	78
Air Handling Unit	AHU_R04	1	1	80	80	80	73	68	68	62	60	60	73
Toilet Exhaust Fan	TEF_R01	1	1	66	66	76	79	72	72	67	61	54	76
General Extract Fan	GEF_R01	1	1	65	65	72	75	67	68	63	54	42	72
Return/Relief Air Fan	RAF_R01	1	1	73	73	73	68	69	70	69	66	60	75
Return/Relief Air Fan	RAF_R02	1	1	78	78	74	72	71	71	68	65	59	75
Outside Air Fan, Intake	OAF_B01	1	1	52	52	50	57	57	56	52	44	37	60
Outside Air Fan, Fresh Air	OAF_B02	1	1	60	60	55	68	64	63	62	58	48	69
Outside Air Fan, Relief Air	OAF_B03	1	1	54	54	57	50	47	43	45	44	38	52
Exhaust Air Fan	EAF_G01_04	4	4	66	66	72	70	63	57	54	57	38	66
Electric Hydrant Pump	EHP_0701_0702	2	2	80	81	82	84	84	87	84	80	74	91
CTD & Egress Passage													
CTD_Battery Exhaust Fans	EAF1001_1004_Inlet	4	2	61	61	63	69	64	61	58	51	41	67
CTD_Battery Exhaust Fans	EAF1001_1004_Outlet	4	2	66	66	65	69	61	59	58	54	49	66
CTD_ACU Condensers	ACU1001_1004	4	2	76	76	76	73	68	66	61	54	54	71
CTD_ACU Condensers	ACU1005_1008	4	2	76	76	76	73	68	66	61	54	54	71
CTD_LV Room FCU	FCU1001_1004	4	2	70	70	70	67	71	68	65	64	64	74
CTD_Switchroom FCU	FCU1005_1008	4	2	70	70	70	67	71	68	65	64	64	74
Egress Passage_Inlet	EPF2011_2012 Inlet	2	1	94	94	90	92	98	98	94	87	80	101
Egress Passage_Outlet	EPF2011_2012 Outlet	2	1	96	96	91	91	97	97	93	87	80	100

Source	Supplier / Item Number	Total	Operating	Octave Band Frequency (Hz) Linear dB									dBA
				31.5	63	125	250	500	1K	2K	4K	8K	
WTP													
Flocculation Feed Pumps	2	2	2	107	95	86	81	75	75	71	67	63	81
DAF Filtrate Pumps	11	2	1	97	85	76	71	65	65	61	57	53	71
DAF Recycle Pumps	14	2	1	97	85	76	71	65	65	61	57	53	71
DAF Sludge Pumps	15	2	1	97	85	76	71	65	65	61	57	53	71
UF Train A	17	1	1	111	98	90	83	78	72	68	62	55	81
UF Train B	17	1	1	111	98	90	83	78	72	68	62	55	81
RO Train A	23	1	1	111	98	90	83	78	72	68	62	55	81
RO Train B	24	1	1	111	98	90	83	78	72	68	62	55	81
Centrifuge Feed Pump	25	1	1	97	85	76	71	65	65	61	57	53	71

Table A - 7 presents a summary of the adopted attenuators to the auxiliary mechanical plant sources and their acoustic performances.

Table A - 7 VSO1 Ancillary Noise Sources Attenuators FDD (dB)

Details	Octave Band Centre Frequency (Hz) dB									R_w
	31.5	63	125	250	500	1k	2k	4k	8k	
ATT0101 - 0104	0[a]	8	16	30	47	50	50	47	39	39
ATT0105 - 0106	0[a]	6	11	16	28	34	31	28	20	28
CTD Roof Ridge Ventilation (Airocle 3sv.1500 EAV1001 - 1004)	5	8	8	11	16	20	21	20	19	19
Egress Passage ATT2011	0[a]	4	10	20	33	36	27	17	12	28
Egress Passage ATT2012	0[a]	4	11	23	34	38	26	16	10	29
Type 1 Louvre	0[a]	5	4	5	6	9	13	14	13	10
Acoustic Louvre[b]	0[a]	5	13	13	15	20	23	23	23	20

[a] Extrapolated, with conservative assumption relative to 63Hz octave data.
[b] Based on Acran A100 Acraflow.

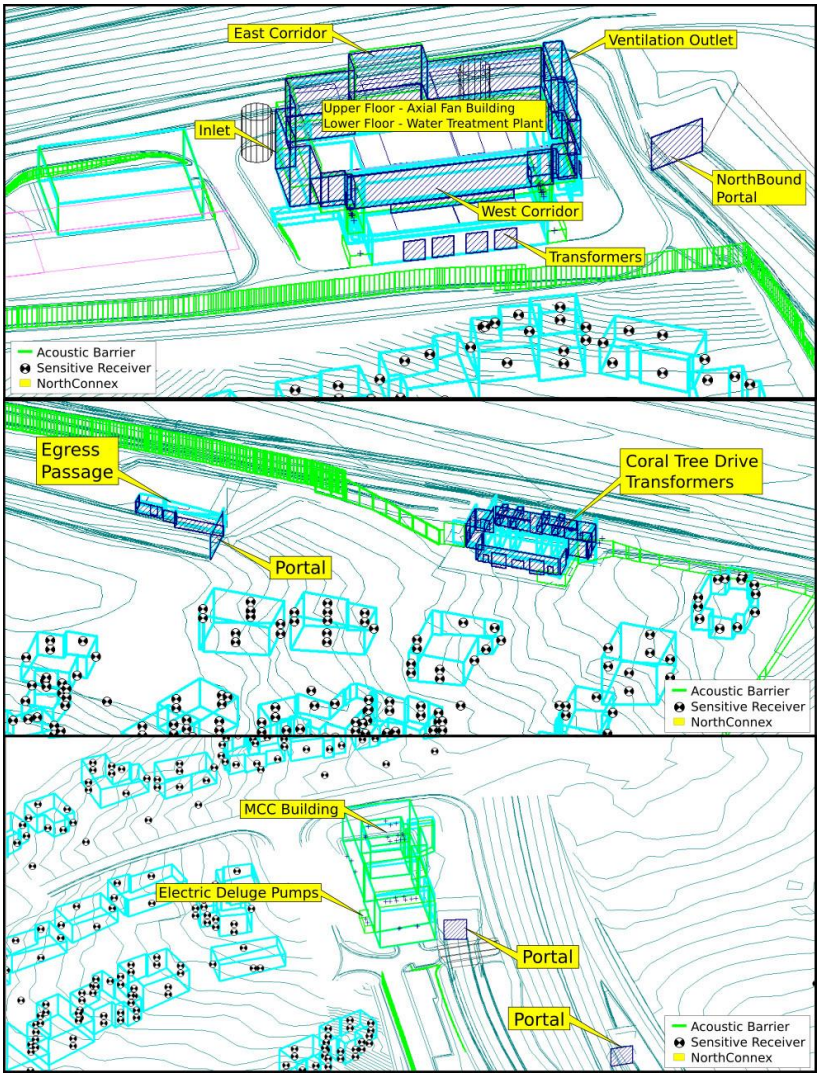
Various aspects of the project such as road traffic noise, visual amenity etc, have resulted in the provision of acoustic barriers to various areas surrounding the facilities and sensitive receiver areas. The VSO1 facility will consist of both proposed and existing barriers as per the drawing packages below:

- Southern Facilities Zone – Civil Works
  - **GEN-LLB-10079-03-1270-06_Combined.pdf**

- Structural Noise Walls – Eastbound
  - **GEN-LLB-10079-02-1240-07_Combined.pdf**
- Structural Noise Walls – Westbound
  - **GEN-LLB-10079-02-1241-06_Combined.pdf**

Figure A - 1 presents a 3-D wire-model prepared using the acoustic model to illustrate the relevant areas of the VSO1 building and nearest sensitive receivers.

Figure A - 1 VSO1 3-D Model & Location of Nearest Sensitive Receptors



VSO2 Wilson VSO Compound

Table A - 8 below presents the test sound power level data for the axial fans operating at VSO2 from the supplier Witt & Sohn. It is noted that the modelling considers operation of 2-3 fans operating simultaneously. Table A - 9 presents the implemented attenuators (Inlet & Outlet) on site.

Table A - 8 Axial Fans Sound Power Level for VSO2 - Wilson (Linear dB) – per fan

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Witt & Sohn – Axial Fans									
3 off fans at 100% Forward (Smoke Extraction) Inlet / Outlet	116[a]	116	122	131	127	126	122	118	113
2 off fans at 76% Reverse (Fresh Air Supply) Inlet / Outlet	112[a]	112	116	124	119	116	112	108	103

[a] Extrapolated, with conservative assumption of 0dB correction relative to 63Hz octave data.

Table A - 9 Attenuator Transmission Loss (Linear dB) Inlet and Outlet VSO2

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Attenuator (Inlet / Outlet)									
ATT031_032 (Inlet)	18[a]	28	40	50	54	62	65	61	40
ATT033_034 (Outlet)	14[a]	24	40	47	51	58	57	46	31

Table A - 10 presents the FDD test data provided by the supplier (Sound Control) for regenerated noise from the attenuators.

Table A - 10 VSO2 Regenerated Noise Data for In-Flow and Attenuator Tender Design (Linear dB)

	Octave Band Centre Frequency (Hz) dB								
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**Total (Linear)**
Regenerated Noise from Attenuator (based on supplier test data: Regenerated face value (0.72m²)									
ATT031_032 (Inlet Attenuator)	69	67	64	65	64	62	59	57	75
ATT033_034 (Outlet Attenuator)	69	67	64	65	64	62	59	57	75
Regenerated Noise through System									
In-Flow Regenerated (76%)[a]	21	19	12	10	0	1	4	7	25
In-Flow Regenerated (100%)	36	34	27	25	13	16	19	22	40

[a] Modelling of 100% operation results in the same air-flow speeds as the 80% scenario.

In addition to the axial fans, there are various ancillary mechanical plant and equipment likely to contribute to the noise impacts on the area surrounding the VSO2 facility. Table A - 11 presents a summary of the ancillary noise sources on site

Table A - 11 VSO2 Ancillary Noise Sources FDD (Linear dBA) (SWL)

Source	Supplier / Item Number	Total	Operating	Octave Band Frequency (Hz) dB									
				31.5	**63**	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**	**dBA**
DRS Building													
DRS FCU ISD	FCU0311_0312	2	1	70	70	70	69	69	69	67	64	64	74
DRS FCU CRAC	FCU0313_0315	3	2	71	71	78	81	79	79	80	78	70	85
ACU Temperzone OSD194	ACU0311_0312	2	1	79	79	79	70	67	65	60	55	55	71
ACU Stulz RC54C-EC-R410A	ACU0313_0315	3	2	72	76	77	76	78	80	75	68	57	83
Toilet Exhaust Fan	EAF0302	1	1	60	60	60	64	73	66	67	62	55	74

Table A - 12 presents the installed product data specification for regenerated noise from a representative acoustic louvre with performance R_W 21. Results are presented for face velocities of 1m/s and 2m/s, as expected for the fresh air, and smoke extraction modes respectively.

Table A - 12 VSO2 Regenerated Noise Data for Louvres of Head-House (dB)

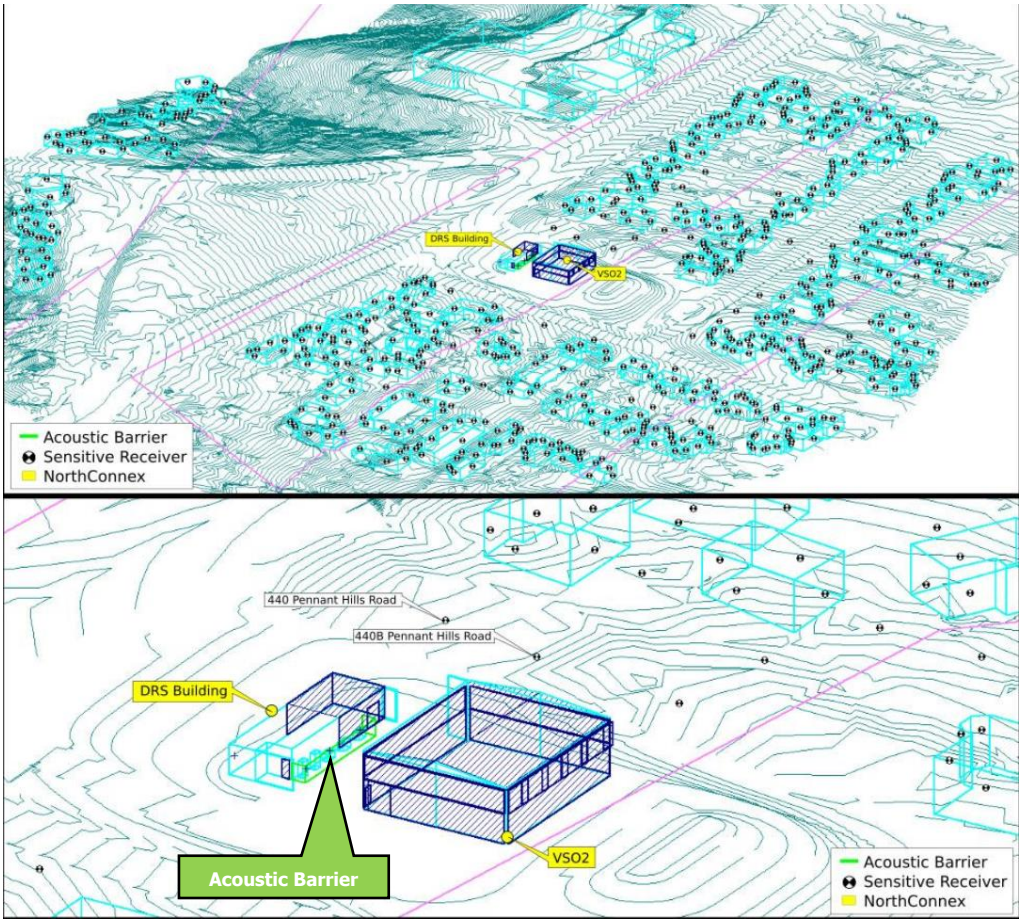
	Octave Band Centre Frequency (Hz) dB								
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**Total (Linear)**
Regenerated Noise from Louvres (based on supplier test data)									
Regenerated SWL @ 1m/s	50	44	39	34	30	26	17	12	54
Regenerated SWL @ 2m/s	70	60	55	52	49	49	43	35	73

During the design phase it was identified that the external plant items required mitigation to achieve predicted compliance to the nearest sensitive receivers. As such, the following mitigation solution was implemented:

- 2.2 m acoustic barrier around the external plant on the northern side of the facility
    - the acoustic barrier have a minimum mass density of 12kg/m^2, be continuous and relatively gap free along the length and at the base.

Figure A - 2 presents a 3-D wire-model prepared using the acoustic model to illustrate the relevant areas of the VSO2 building and nearest sensitive receivers.

Figure A - 2 VSO2 3-D Model & Location of Nearest Sensitive Receptors



VSO3 Trelawny VSO Compound

Table A - 13 presents the test sound power level data for the axial fans operating at VSO3 from the supplier Witt & Sohn. Table A - 14 presents the installed attenuator (Inlet & Outlet) performance.

Table A - 13 Axial Fans Sound Power Level for VSO3 – Trelawney (Linear dB) – per fan

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Witt & Sohn – Axial Fans									
3 off fans at 100% Forward (Smoke Extraction) Inlet / Outlet	116[a]	116	122	131	127	126	122	118	113
2 off fans at 76% Reverse (Fresh Air Supply) Inlet / Outlet	112[a]	112	116	124	119	116	112	108	103

Table A - 14 Attenuator Transmission Loss (Linear dB) Inlet and Outlet VSO3

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Attenuator (Inlet / Outlet)									
ATT051_052 (Inlet)	18[a]	28	40	50	54	62	65	61	40
ATT053_054 (Outlet)	14[a]	24	40	47	51	58	57	46	31

[a] Extrapolated, with conservative assumption of -10dB relative to 63Hz octave data.

Table A - 15 presents the FDD test data provided by the supplier (Sound Control) for regenerated noise from the attenuators.

Table A - 15 VSO3 Regenerated Noise Data for In-Flow and Attenuator Tender Design (Linear dB)

	Octave Band Centre Frequency (Hz) dB								
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**Total (Linear)**
Regenerated Noise from Attenuator (based on supplier test data: Regenerated face value (0.72m²)									
ATT031_032 (Inlet Attenuator)	69	67	64	65	64	62	59	57	75
ATT033_034 (Outlet Attenuator)	69	67	64	65	64	62	59	57	75
Regenerated Noise through System									
In-Flow Regenerated (76%)[a]	21	19	12	10	0	1	4	7	25
In-Flow Regenerated (100%)	36	34	27	25	13	16	19	22	40

[a] Modelling of 100% operation results in the same air-flow speeds as the 80% scenario.

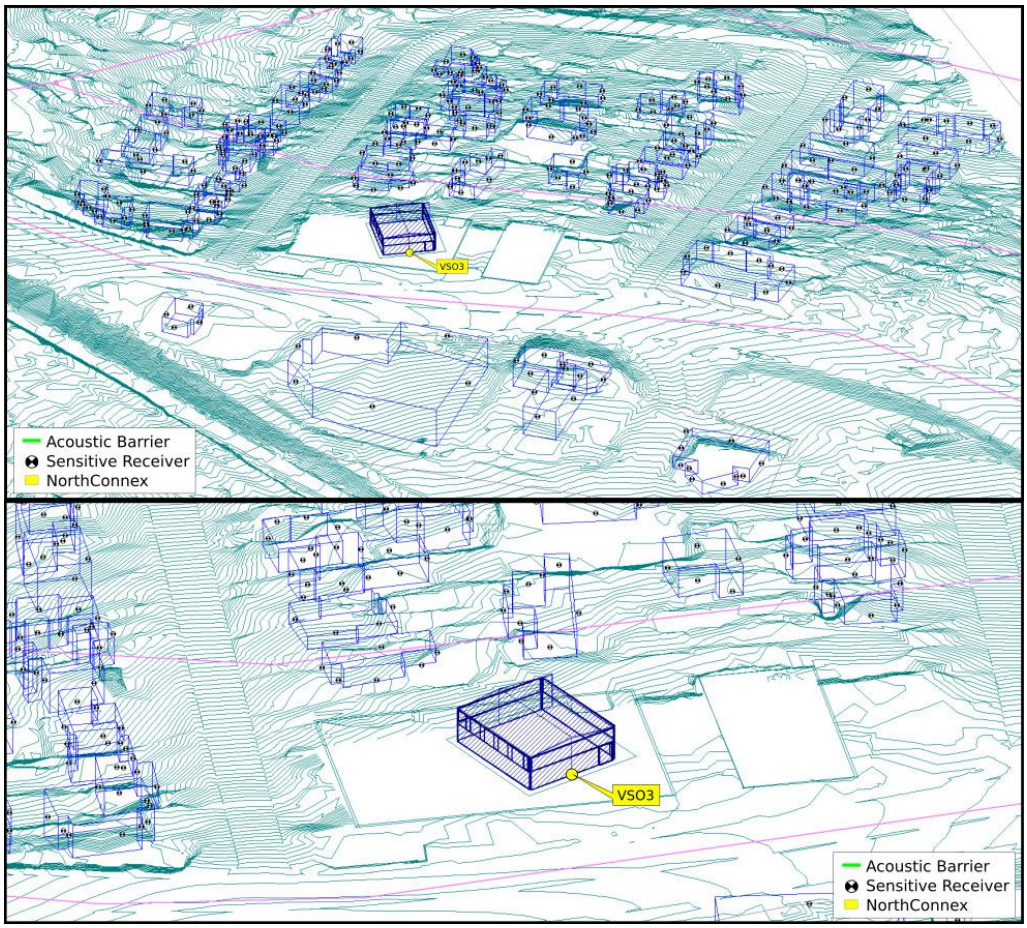
Table A - 16 presents the product data specification for regenerated noise from a representative acoustic louvre with performance R_W 21. Results are presented for face velocities of 1m/s and 2m/s, as expected for the fresh air, and smoke extraction modes respectively.

Table A - 16 VSO3 Regenerated Noise Data for Louvres of Head-House (dB)

	Octave Band Centre Frequency (Hz) dB								
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**Total (Linear)**
Regenerated Noise from Louvres (based on supplier test data)									
Regenerated SWL @ 1m/s	50	44	39	34	30	26	17	12	54
Regenerated SWL @ 2m/s	70	60	55	52	49	49	43	35	73

Figure A - 3 presents a 3-D wire-model prepared using the acoustic model to illustrate the relevant areas of the VSO3 building and nearest sensitive receptors.

Figure A - 3 VSO3 3-D Model & Location of Nearest Sensitive Receptors



VSO4 Northern Compound

Table A - 17 presents the test sound power level data for the axial fan operating in VSO4 from the supplier Witt & Sohn. Table A - 18 presents the installed attenuator inlet and outlet performance.

Table A - 17 Axial Fans Sound Power Level for VSO4 – North (Linear dB) – per fan

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
4 off fans at 100% Inlet / Outlet	115[a]	115	125	122	121	118	114	109	105
5 off fans at 80% Inlet / Outlet	113[a]	113	122	119	118	114	110	105	101
5 off fans at 72% Inlet / Outlet	112[a]	112	121	117	115	112	107	103	98

[a] Extrapolated, with conservative assumption of 0dB correction relative to 63Hz octave data.

Table A - 18 Attenuator Transmission Loss (Linear dB) Inlet & Outlet VSO4

Details	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
Modelled: Attenuator (Inlet / Outlet)									
ATT071 (Inlet)	2[a]	12	31	44	49	53	51	34	21
ATT072 (Outlet)	8[a]	18	36	45	51	52	49	40	29
ATT073 (Inlet)	2[a]	12	31	44	49	53	51	34	21
ATT074 (Outlet)	8[a]	18	36	45	51	52	49	40	24

[a] Extrapolated, with conservative assumption of -10dB relative to 63Hz octave data.

Table A - 19 presents the FDD test data provided by the supplier (Sound Control) for regenerated noise from the attenuators.

Table A - 19 VSO4 Regenerated Noise Data for – In-Flow and Attenuator Tender Design (Linear dB)

	Octave Band Centre Frequency (Hz) dB								Total (Linear)
	63	125	250	500	1k	2k	4k	8k	
Regenerated Noise from Attenuator (based on supplier test data: Regenerated face value (0.72m^2)									
ATT071 (Inlet Upper)	59	57	54	55	54	52	49	47	64
ATT072 (Outlet Upper)	62	60	57	58	57	55	52	50	67
ATT073 (Inlet Lower)	56	54	51	52	51	49	46	44	61
ATT074 (Outlet Lower)	58	56	53	54	53	51	48	46	63
Regenerated Noise through System									
In-Flow Regenerated (80%)[a]	71	69	62	60	48	51	54	57	75
In-Flow Regenerated (72%)	69	67	60	58	46	49	52	55	73

[a] Modelling of 100 % operation results in the same air-flow speeds as the 80% scenario.

Table A - 20 presents a summary of the noise levels for the additional ancillary noise sources at the VS04 Northern Compound.

Table A - 20 VSO4 Ancillary Noise Sources FDD (Linear dB) (SWL)

Sources	Supplier / Item Number	Total	Operating	Octave Band Frequency (Hz)									dBA
				31.5	63	125	250	500	1K	2K	4K	8K	
Transformers													
4.5 MVA Transformer	TRX172 / TRX272	2	2	96	84	86	78	73	63	57	52	47	75
1 MVA Transformer	TRX173 / TRX273	2	2	87	75	77	69	64	54	48	43	38	66
Fire Pump Room													
Diesel Deluge Pump	DDP0701	1	1	107	97	96	98	101	103	106	103	99	110
Diesel Deluge Pump Exhaust	DDP0701_Exhaust	1	1	140	130	124	112	108	105	106	104	96	114
Electric Deluge Pump	EDP0701 / EDP0702	2	1	83	84	85	87	87	90	87	83	77	96
Electric Hydrant Pump	EHP0701 / EHP0702	2	1	80	81	82	84	84	87	84	80	74	93
Deluge Pressure Maintenance Pump	FMP0701 / FMP0702	2	1	67	68	69	71	71	74	71	67	61	78
Hydrant Pressure Maintenance Pump	FMP0703 / FMP0704	2	1	67	68	69	71	71	74	71	67	61	78
Ventilation													
Fire Pump Room Exhaust Fans	EAF0701_03	3	3	82	82	88	84	85	85	83	80	74	90
ER75 Supply Fan Air	SAF1751	1	1	87	87	84	91	95	94	92	86	79	98
Unallocated Space Supply Air Fan	SAF0704	1	1	80	80	90	90	88	83	79	76	73	86
LV Room Condenser	ACU0705_0710	6	4	70	70	70	67	71	68	65	64	64	74
HV Room Condenser	ACU0701_0704	4	2	76	76	76	73	68	66	61	54	54	71
Outlet Air Monitoring Room	ACU0711_0712	2	1	70	70	70	56	55	53	48	41	41	77
Outlet Air Monitoring Room	FCU0711_0712	2	1	44	44	41	45	42	39	38	38	78	67
ER75 Condenser	ECU1751_1752	2	1	83	83	83	76	76	71	66	63	63	77
Upper Level Access Corridor Supply Air Fan	SAF0705	1	1	69	69	79	84	85	83	76	69	58	87
Stair Pressurisation Fan Inlet	EPF1751_1752_IN	2	1	87	87	84	91	95	94	92	86	79	98
Stair Pressurisation Fan Outlet	EPF1751_1752_OUT	2	1	89	89	85	90	94	94	92	86	78	98
Transformer Bay A	FCU0701_02	2	1	70	70	70	67	71	68	65	64	64	73
Transformer Bay B	FCU0703_04	2	1	70	70	70	67	71	68	65	64	64	73
LVA Room SU1	FCU0705_07	3	2	86	86	86	79	79	74	69	66	66	80
LVB Room SU2	FCU0708_10	3	2	86	86	86	79	79	74	69	66	66	80
ER_75_Conc	EFU1751_52	2	1	70	70	70	69	69	69	67	64	64	74
Battery Exhaust Supply	SAF0711_0712	2	2	81	81	79	75	72	63	65	64	54	74
Battery Exhaust Inlet Side	EAF0711_0714_IN	4	2	64	64	75	76	74	72	69	63	49	77
Battery Exhaust Outlet Side	EAF0711_0714_OUT	4	2	73	73	73	77	72	70	68	64	52	76

Table A - 21 presents a summary of the noise reductions properties of the attenuators for the auxiliary mechanical plant.

Table A - 21 VSO4 Ancillary Noise Sources – Attenuators FDD (dB)

Details	Octave Band Centre Frequency (Hz) dB									R_w
	31.5	63	125	250	500	1k	2k	4k	8k	
ATT0703	0[a]	8	16	30	47	50	50	47	39	39
ATT0706/10/11/12	0[a]	5	10	19	33	39	34	27	22	30
ATT0707/08/09	0[a]	5	10	19	31	39	35	27	21	31
ATT1751/52	0[a]	8	11	18	27	28	27	23	19	27
ATT1753	0[a]	3	7	13	19	25	17	10	7	20
Type 1 Louvre	0[a]	5	4	5	6	9	13	14	13	10
Acoustic Louvre	0[a]	5	13	13	15	20	23	23	23	20

[a] Extrapolated, with conservative assumption relative to 63Hz octave data.

Maintenance & Emergency Operations – VSO4 North

The Diesel Deluge Pump Exhaust operating during maintenance and emergency operations is found to exceed relevant noise criteria. An industrial attenuator is fitted on the Diesel Deluge pump exhaust, as identified in Table A - 22.

Table A - 22 Diesel Deluge Pump Exhaust Attenuator Minimum Required Transmission Loss (dB)

Attenuation (dB)	Octave Band Centre Frequency (Hz) dB								
	31.5	63	125	250	500	1k	2k	4k	8k
FDD Selection (Industrial Silencer) *Predicted to achieve daytime compliance only*	5	15	20	18	16	15	14	13	13

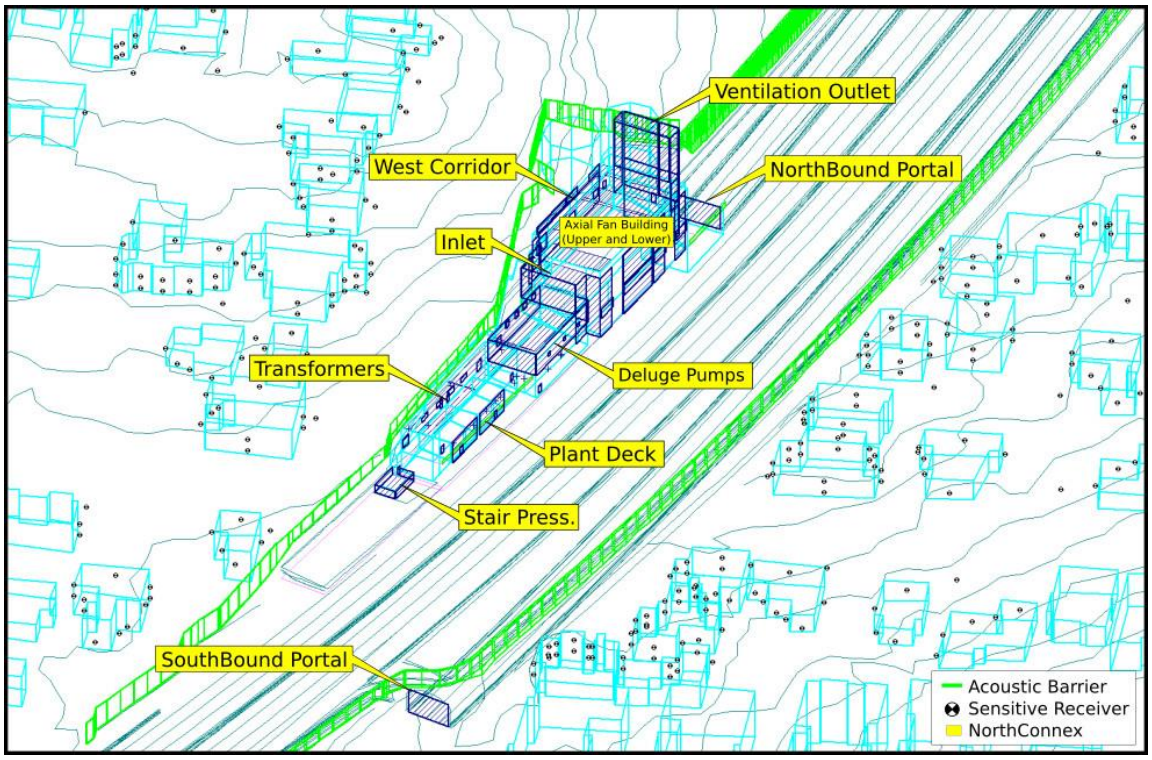
Operation of the diesel deluge pump for maintenance purposes is to be limited to the daytime only. Review of contributions from other maintenance activity sources, including the electric deluge pumps indicate compliance with the daytime and evening criteria. Where the electric deluge pumps are operated, compliance is predicted with the night time criteria.

Various aspects of the project such as road traffic noise, visual amenity etc, have resulted in the provision of acoustic barriers to various areas surrounding the facilities and sensitive receiver areas. The VSO4 facility will consist of both proposed and existing barriers as per the drawing packages below:

- Structural Noise Walls – Northbound (M1 Intersection)
    - **GEN-LLB-10079-07-1490-08_Combined.pdf**
- Structural Noise Walls – Northbound (Facility)
    - **GEN-LLB-10079-07-1491-05_Combined.pdf**

Figure A - 1 presents a 3-D wire-model prepared using the acoustic model to illustrate the relevant areas of the VSO4 building and nearest sensitive receptors.

Figure A - 4 VSO4 3-D Model & Location of Nearest Sensitive Receptors



A - 5 Building Treatment

The following building treatment for the ventilation facilities outlined in Table A – 23 to Table A - 26, as outlined in Appendix K of the ONAR, have been constructed.

VSO1 Southern Ventilation Facility

Table A - 23 Construction Material VS01 Southern Ventilation

ID	Description
W1.1	Structure: PCC1 180 mm thick supported off structural steel framing
W1.5	Internal: CMP2 – Ribs in horizontal alignment + 76 mm MSF + 2 x 13 mm PBD2 + 75 mm Sound insulation Structure: PCC1 180 mm thick supported off structural steel framing
W1.9 (CTD)	PCC1 200 mm thick – reinforced precast concrete panel (RW 50)(COF2)
W3.1	PCC2 MIN. 180 mm thick moulded decorative 3D finish supported off structural steel framing
W5.3 (CTD)	Structure: 250 mm reinforced concrete wall (COF1)
W9.1	Internal: 78 mm IWP2 vertical panel with manufacturer's angle fixing galvanised steel sheet finishes
W10.3	Internal: 13 mm PBD2 (direct stick) structure: 190 mm blockwork
W10.6	Internal:100 mm IWP1
W10.7	External: CMC 30 mm + 35 mm TH + VPB + 6mm FCS Structure:200 mm steel GIRT
W12.1 (CTD)	External: 9 mm FCC + 35 mm top hat + vapour barrier + 2 X 16 mm.PBD3 (RW 50) Structure: GIRT system /truss internal: 2 x 16 mm PBD3 + 75 mm insulation
W20.1	Structure: 190 mm CBP
W38.0	External: steel mesh wall - MSS3
W40.2 (CTD)	Structure : 220 mm concrete retaining wall
W50.1	Internal: 100 mm IWP1 structure: supported off structural steel column internal: 100 mm IWP1
W52.4	Internal : CMP2- ribs in horizontal alignment + 2 x 13 mm PBD2 Structure: 75 mm MSF
W55.1 (CTD)	150 mm auto claved aerated concrete panel
Floor Slab, Corridor Roof	MFD1 Bondek (152 mm)
VSO1 Roof	152 mm Bondeck slab, composite with a Z purlin and cleat system with isolation mount, 75 mm Fibreglass (22kg/m^3). 60 mm insulated roof sheet system.
Transformer Room Roof	190 mm Blockwork – Hollow Blockwork (760 kg/m3) or Minimum 200 mm Light Weight Concrete
CTD Main Roof	1 x 13mm fire rated plasterboard + 1 x 16 mm fire rated plasterboard + 120 mm acoustic insulation R3.0 + 60 mm MetecnoSpan insulated roof
CTD Other Roof	60 mm Metecnospan insulated roof (Rw 24)
CTD Roof Ridge Ventilator	LRVA HC 1000 (Rw19)
Egress Passage Roof	Structure: 250 mm reinforced concrete wall (COF1)
Egress Passage Walls	190 mm Blockwork – Hollow Blockwork (760 kg/m3)

ID	Description
Rw/STC 50 Doors	Axial Fan room and Transformer room doors, Rw / STC 50 dBA
Solid Core Doors	Solid Hardwood 35 – 40 mm, General doors, Rw / STC 30 dBA
Roller Doors	0.55 Galvanised Steel Sheet
Acoustic Caulk	Fire rated caulking, Rw 45
Laminated Glass	10.38 mm Laminated Glazing

VSO2 Wilson VSO Compound

Table A - 24 Construction Material VS02 Wilson Compound

ID	Description
W60.1	Internal: 6mm FCS Structure: LLBF 138mm External: 6mm FCS
W12.1	Internal: 13mm Plasterboard (PBD1) Structure: 150mm MSG + R2.7 90mm Insulation External: 9mm FCC OFF 35mm TH + Vapour Barrier
Roof Head-House	Colorbond, Trapezoid profiled sheet (0.6mm) 7800kg/m^3
DRS Building Roof	Colorbond, Trapezoid profiled sheet (0.6mm) 7800kg/m^3
Slab between Axial Fan Room Levels	W1.1 180mm Precast Concrete (R_W 57). *Note – architectural drawings identify R_W 59, value above provided based on INSUL software*
Wall Panels to Fan Levels (inlet and outlet)	24mm CFC Panel
Louvres	Head-House facility louvred facades, R_W 20 or better
R_W / STC 50 Doors	Axial Fan room and Transformer room doors, R_W / STC 50dBA
Solid Core Doors	Solid Hardwood 35 – 40mm, General doors, R_W / STC 30dBA

VSO3 Trelawny VSO Compound

Table A - 25 Construction Material VS02 Wilson Compound

ID	Description
W60.1	Internal: 6mm FCS Structure: LLBF 138mm External: 6mm FCS
W12.1	Internal: 13mm Plasterboard (PBD1) Structure: 150mm MSG + R2.7 90mm Insulation External: 9mm FCC OFF 35mm TH + Vapour Barrier
Roof Head-House	Colorbond, Trapezoid profiled sheet (0.6mm) 7800kg/m^3

ID	Description
Slab between Axial Fan Room Levels	W1.1 180mm Precast Concrete (R_W 57). *Note – architectural drawings identify R_W 59, value above provided based on INSUL software*
Wall Panels to Fan Levels (inlet and outlet)	24mm CFC Panel
Louvres	Head-House facility louvred facades, R_W 20 or better
R_W / STC 50 Doors	Axial Fan room and Transformer room doors, R_W / STC 50 dBA

VSO4 Northern Compound

Table A - 26 Construction Material VS04 North

ID	Description
W1.1	Structure: PCC1 180mm thick supported off structural steel framing
W1.5	Internal: CMP2 – ribs in horizontal alignment + 76mm MSF + 2 x 13mm PBD2 + 75mm sound insulation Structure: PCC1 180mm thick supported off structural steel framing
W3.1	PCC2 MIN. 180mm thick moulded decorative 3D finish supported off structural steel framing
W5.1	Structure: 200mm thick reinforced concrete wall (COF1)
W9.1	Internal: 78mm IWP2 vertical panel with manufacturer's angle fixing galvanised steel sheet finishes
W10.3	Internal: 13mm PBD2 (direct stick) structure: 190 mm blockwork
W10.6	Internal:100mm IWP1
W10.7	External: CMC 30mm + 35mm TH + VPB + 6mm FCS structure: 200mm Steel GIRT
W10.8	External: 6mm FCS Structure: 150mm MSF external: 6mm FCS + 13mm PBD + 35mm TH + CMC on 30mm
W11.10	External: 9mm FCC supported off 35mm FRC Structure: structural steel framing external: CMP2 – RIBS IN VERTICAL ALIGNMENT
W20.1	Structure: 190mm CBP
W38.0	External: steel mesh wall – MSS3
W40.1	Structure: concrete retaining wall (refer to ENG'S details)
W50.1	Internal: 100mm IWP1 structure: supported off structural steel column internal: 100mm IWP1
W52.4	Internal: CMP2 – ribs in horizontal alignment + 2 x 13mm PBD2 structure: 75mm MSF
W52.5	Internal: CMP2 – ribs in vertical alignment Substructure: 200mm GIRT system
Floor Slab, Corridor Roof	MFD1 Bondek (152mm)
VSO4 Roof	152mm Bondeck slab, composite with a Z purlin and cleat system with isolation mount, 75mm Fibreglass (22 kg/m^3). 60mm insulated roof sheet system.

ID	Description
Transformer Room Roof Slab	152mm Bondeck slab or Minimum 200mm Light Weight Concrete
Pump Room Roof	60mm Metecnospan insulated roof (R_W 24), with 13mm Plasterboard
Stair Pressurisation Room Roof	60mm Metecnospan insulated roof (R_W 24)
R_W / STC 55 Doors	Axial Fan room and Transformer room doors, R_W / STC 55dBA
R_W / STC 50 Doors	Axial Fan room and Transformer room doors, R_W / STC 50dBA
Solid Core Doors	Solid Hardwood 35 – 40mm, General doors, R_W / STC 30dBA
Access Hatch	0.55 Galvanised Steel Sheet
Acoustic Caulk	Fire rated caulking, R_W 45
Laminated Glass	10.38mm Laminated Glazing

APPENDIX B

NOISE & VIBRATION CRITERIA

Noise from construction/routine maintenance work of the ventilation facilities, roads and barriers are assessed against the *Interim Construction Noise Guideline* (ICNG). It should be noted, this guideline does not address noise from the operations of the roads and ventilation facilities. A summary of the ICNG is presented in Section B - 1.

The operational noise from the NorthConnex road is assessed in two different ways in accordance with the MCoA. The road traffic noise is assessed against the Road Noise Policy NSW. Maintenance of the asset is required to ensure these criteria are not exceeded. The operations of the Ventilation facilities and compounds are assessed against the *Industrial Noise Policy* (INP). A summary of these noise standards and the relevant criteria are presented in this Appendix.

B - 1 Construction/Routine Maintenance Work Noise & Vibration Criteria

Noise Criteria

The *ICNG* provides noise goals that assist in assessing the impact of construction/routine maintenance work related to the asset.

For residences, the basic daytime construction noise goal is that the noise should not exceed the noise affected Rating Background Level (RBL) by more than 10dBA. This is for construction during standard hours: Monday to Friday 7.00am – 18.00pm, and Saturday 8.00am – 13.00pm. Outside the standard hours, the criterion would be RBL + 5dBA.

Based on the *ICNG* requirements, the applicable site-specific noise management levels for construction activities for areas near the assets are presented in Table B - 2. Table B - 1 presents construction noise management levels $L_{Aeq,15min}$ for other receivers and areas.

Table B - 1 Other Land Use Construction Noise Management Levels

Land Use	Management Level $L_{Aeq(15min)}$
Industrial premises	External 75 dBA
Offices, retail outlets	External 70 dBA
Classrooms at schools and other educational institutions	Internal 45 dBA External 55dBA
Places of worship	Internal 45 dBA External 55dBA

Table B - 2 Site-Specific Construction Noise Management Levels

NCA	Logger ID	Address	Monitor Period	Noise Management Level (dBA)							
				Day	Eve	Night	4-5am	5-6am	6-7am	10-11pm	11pm-12am
NCA 1A	NCA-1A-B1	45 Bareema Ave, Wahroonga	Mar 2015	65	53	43	51	57	59	51	49
NCA 1A	NCA-1A-B4	3B Benson Cl, Wahroonga	Feb 2015	65	52	41	50	57	59	51	47
NCA 1B	NCA-1B-B21	56 Bundarra Ave North, Wahroonga	May 2015	53	48	42	45	49	52	47	45
NCA 1D	NCA-1D-B7	28 Isis St, Wahroonga	Mar 2015	59	52	45	48	54	56	50	49
NCA 2A	NCA-2A-T2	118A Coonanbarra Rd, Wahroonga	Feb 2015	61	51	43	47	53	56	51	50
NCA 2B	NCA-2B-B22	35 Lochville St, Wahroonga	May 2015	59	52	45	48	52	54	50	48
NCA 2C	NCA-2C-B3	4-12 Neringah Ave South, Wahroonga	Mar 2015	65	60	56	56	56	58	58	57
NCA 2D	NCA-2D-B2	22 Woonona Ave South, Wahroonga	Feb 2015	69	57	51	54	58	62	55	55
NCA 3	NCA-3-T4	10 Pennant Hills Rd, Wahroonga	Mar 2015	61	51	43	49	52	56	49	48
NCA 4A	NCA-4A-B5	2/1 Aaron Pl, Wahroonga	Feb 2015	61	51	46	48	54	56	49	48
NCA 4B	NCA-4B-B6	23/1740 Pacific Hwy, Wahroonga	Feb 2015	57	50	45	48	50	53	49	48
NCA 5A	NCA-5A-B8	9 Kingsley Cl, Wahroonga	Feb 2015	58	50	44	49	52	54	52	50
NCA 5B	NCA-5B-B20	35 Lucinda Ave, Wahroonga	Nov 2014	54	49	47	48	51	53	49	47

NCA	Logger ID	Address	Monitor Period	Noise Management Level (dBA)							
				Day	Eve	Night	4-5am	5-6am	6-7am	10-11pm	11pm-12am
NCA 6A	NCA-6A-B9	223 Pennant Hills Rd, Thornleigh	Mar 2015	56	51	46	49	51	52	49	48
NCA 6B	NCA-6B-B10	12 Trelawney St, Thornleigh	May 2015	55	48	43	47	50	53	47	45
NCA 6C	NCA-6C-B11	6 Duffy Ave, Thornleigh	Mar 2015	60	53	49	54	56	57	51	49
NCA 7A	NCA-7A-B19	440 Pennant Hills Rd, Pennant Hills	Nov 2014	67	57	48	61	64	63	53	51
NCA 7B	NCA-7B-B18	1A Killaloe Ave, Pennant Hills	Nov 2014	55	47	42	51	53	52	43	42
NCA 7C	NCA-7C-B12	449C Pennant Hills Rd, Pennant Hills	Feb 2015	68	59	47	52	60	62	58	56
NCA 8B	NCA-8B-B13	606 Pennant Hills Rd, West Pennant Hills	May 2015	62	56	49	54	57	58	55	54
NCA 9A	NL15	28 Maher Cl, Beecroft[1]	Dec 2013	58	53	49	51	55	57	53	52
NCA 10A	NL13	7 Eaton Rd, West Pennant Hills[1]	Dec 2013	54	49	44	46	50	51	49	48
NCA 10B	NCA-10B-B15	3 Mundon Pl, West Pennant Hills	Mar 2015	65	59	56	56	56	58	58	57
NCA 10C	NCA-10C-B16	35 Coral Tree Dr, Carlingford	Mar 2015	52	48	45	48	50	50	49	49
NCA 10D	NCA-10D-B17	58 Oakes Rd, Carlingford	Mar 2015	61	52	43	45	50	57	49	46
NCA 11A	NL18B	46 Westmore Drive, West Pennant Hills[1]	Dec 2013	62	54	46	55	59	60	54	53
NCA 11B	NL19	361-365 North Rocks Rd, North Rocks	May 2015	61	54	45	50	55	58	52	50
NCA 11B	NCA-11B-T11	66 Carmen Dr, Carlingford	Apr 2015	59	51	43	48	54	57	50	48

NCA	Logger ID	Address	Monitor Period	Noise Management Level (dBA)							
				Day	Eve	Night	4-5am	5-6am	6-7am	10-11pm	11pm-12am
NCA 12	NL21	30 Carlton Rd, North Rocks	May 2015	60	49	40	44	50	56	48	44
NCA 13	NCA-13-T12	122 Barclay Rd, North Rocks	Feb 2015	61	51	38	42	51	59	48	43
NCA 14	NCA-14-T13	25 Williams Rd, North Rocks	Feb 2015	65	56	50	47	55	63	52	48
NCA 15A	NCA-15A-T14	e	Feb 2015	57	50	39	44	48	54	47	44

Note: 1. Values from EIS tables.

B - 2 Human Annoyance Vibration Criteria

Vibration criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document "*Assessing Vibration: A Technical Guideline*" (2006) produced by the NSW DECCW.

Acceptable values of human exposure to continuous vibration are dependent on the time of day and the activity taking place in the occupied space (eg workshop, office, residence or a vibration-critical area). Guidance on preferred values for continuous vibration is set out in Table B - 3.

Table B - 3 Criteria for Exposure to Continuous & Impulsive Vibration

Place	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Critical working areas (eg hospital operating theatres precision laboratories)	Day or Night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices	Day or Night time	0.56	1.1
Workshops	Day or Night time	1.1	2.2

B - 3 Building Damage Vibration Criteria

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187 : Part 2-2006 *"Explosives – Storage and Use – Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"* as they "are applicable to Australian Conditions" BS 7385. In addition to this Standard, the German Standard DIN4150-3 *Part 3 Effects of Vibration on Structures* is used to establish vibration limit for heritage buildings.

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS 7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table B - 4.

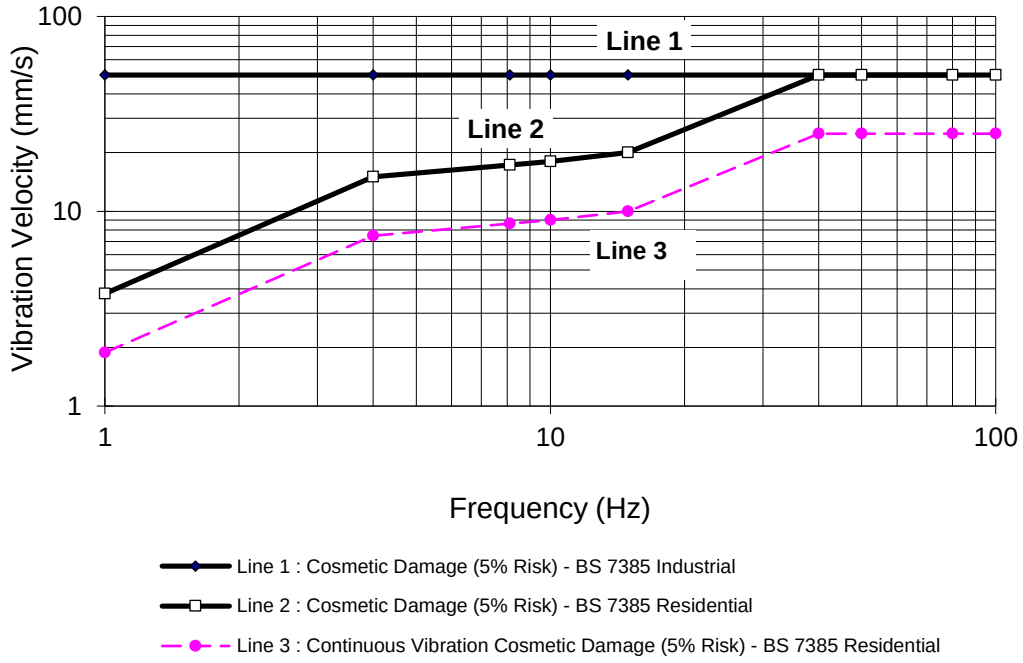
Table B - 4 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

e	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The Standard states that the guide values in Table B - 1 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

Figure B - 1 Graph of Transient Vibration Guide Values for Cosmetic Damage



DIN 4150-3 should be used to assess vibration levels that may cause structural damage to heritage buildings. This Standard specifies methods of measuring and evaluating the effects of vibration on structures designed primarily for static loading.

Short-term vibration is classified as vibrations which do not occur often enough to cause structural fatigue. Table B - 5 below gives a guideline value for short term vibration velocity at the foundation and in the plane of the highest floor of various types of building.

Table B - 5 Structural Damage – Short Term Vibration (mm/s)

Type of Building	Peak component particle velocity in frequency range of predominant pulse			Plane of Floor of uppermost storey
	Less than 10Hz	10-50Hz	50-100Hz	All frequencies
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 (industrial and dwelling buildings) and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

B - 4 Road Noise Policy

The EPA's *Road Noise Policy* (RNP) sets out criteria for assessment of noise from vehicles on public roads. Under the *RNP*, road projects are classified as either "new road" or "redevelopment of an existing road". As discussed in the EIS, the "redeveloped road" criterion has been applied to the project for the following reasons:

- Receivers along the Hills M2 Motorway, M1 Pacific Motorway, Pacific Highway and Pennant Hills Road are subject to existing road traffic noise and works fall within the existing road corridor; and
- While the subterranean tunnel would be considered a 'new road', traffic noise from the tunnel would be effectively attenuated at nearby sensitive receivers with the exception of the areas around the southern and northern portals. However, receivers in the vicinity of the portals have an existing road traffic noise exposure and therefore the redeveloped road criteria will apply in accordance with the *RNP*.

Noise Criteria for Residential Land Use

The applicable criteria for "existent residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads" are given in Table B - 6.

Table B - 6 *RNP* Criteria for Redevelopment of Freeways

Criteria	Time Period	
	Day (7am-10pm)	Night (10pm-7am)
Noise Assessment Criteria	$L_{Aeq,15hr}$, 60dBA (external)	$L_{Aeq,9hr}$ 55dBA (external)

Noise Criteria for Non-Residential Noise-Sensitive Receivers

Several non-residential noise-sensitive receivers were identified within the study area. Section 2.3.2 of the *RNP* defines different criteria for non-residential land uses than those specified for residential land use. The applicable noise criteria are provided in Table B - 7.

Table B - 7 Assessment Criteria for Operational Traffic Noise – Non-Residential Receivers

Existing Sensitive Land Use	Assessment Criteria –dBA		
	Day (7am-10pm)	Night (10pm-7am)	Additional Considerations
1. School classrooms	$L_{Aeq,1hr}$ 40 (internal) * when in use	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000)
2. Hospital wards	$L_{Aeq,1hr}$ 35 (internal) *	$L_{Aeq,1hr}$ 35 (internal) *	
3. Places of worship	$L_{Aeq,1hr}$ 40 (internal) *	$L_{Aeq,1hr}$ 40 (internal) *	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise. For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see row 5 Open space (passive use) of this table) may be applied.
4. Open space (active use)	$L_{Aeq,15hr}$ 60 (external) when in use	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. playing chess, reading. In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, e.g. school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses.
5. Open space (passive use)	$L_{Aeq,15hr}$ 55 (external) when in use	-	
8. Childcare facilities	Sleeping rooms $L_{Aeq,1hr}$ 35 (internal) * Indoor play areas $L_{Aeq,1hr}$ 40 (internal) * Outdoor play areas $L_{Aeq,1hr}$ 55 (external)	-	Multi-purpose spaces, e.g. shared indoor play / sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
9. Aged Care facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities.

Note: * The noise criteria applies for internal noise measurement.

Commercial receivers are not considered noise-sensitive receivers and therefore are not assessed for operational noise impacts.

B - 5 Industrial Noise Policy (INP)

The NSW *Industrial Noise Policy* (INP) recommends two noise criteria, "Intrusiveness" and "Amenity", both of which are relevant for the assessment of noise at residences. In most situations for continuous noise, one of these is more stringent than the other and is the controlling noise criterion for assessment purposes. The noise criteria are based on the L_{Aeq} descriptor, which is explained in the Glossary of Acoustic Terms.

The Project-Specific Noise Levels (PSNL) and the sleep disturbance criteria associated with continuous operational noise are presented in Table B - 8. Both intrusiveness and amenity criterion have been considered to establish the PSNL. The noise criteria are based on the Rating Background Levels (RBLs) from the Wilkinson Murray Report 13245-CD-3 dated May 2015.

Table B - 8 Summary of Operational Noise Criteria – dBA

Compound	NCA	Address of Background Noise Monitoring	PSNL L_{Aeq}			Sleep Disturbance L_{Amax}
			Day	Eve	Night	Night
Northern (VSO4)	NCA 1A	45 Bareena Ave, Wahroonga	55	50	43	53
	NCA 2A	118A Coonanbarra Rd, Wahroonga	55	45	42	53
Northern Portal	NCA 5A	9 Kingsley Cl, Wahroonga	52	45	40	60
Trelawney (VSO3)	NCA 6B	12 Trelawney St, Woollahra	50	45	40	53
	NCA 6A	6 Trelawney St, Woollahra	52	45	40	54
	Commercial Premises	-	65	65	65	-
	Place of worship – external*	-	50	50	50	-
Wilson (VSO2)	NCA 7A	440 Pennant Hills Rd, Pennant Hills	55	51	48	58
	NCA 7B	1A Killaloe Ave, Pennant Hills	50	45	40	52
Southern (VSO1)	NCA 8B	606 Pennant Hills Rd, West Pennant Hills	55	45	40	60
	NCA 9A	28 Maher Cl, Beecroft	53	45	42	60
	NCA 10A	7 Eaton Rd, West Pennant Hills	49	45	40	60
	NCA 10C	35 Coral Tree Dr, Carlingford	48	47	40	60

Notes: - Indicates not applicable.
* Indicates external noise level. It is assumed that the structure offers a conservative transmission loss of 10dB.

APPENDIX C

EIS SURROUNDING ROAD TRAFFIC VOLUME PREDICTIONS

8.5 Surrounding road network: traffic volumes and patterns

Forecast 2019 and 2029 AWDT traffic volumes for the 'with project' scenario have been analysed and compared to the 'without project' scenario volumes at key links in the wider road network. **Table 8-31** and **Table 8-32** show the forecast light and heavy vehicle AWDT volumes.

Table 8-31 Comparison of 2019 and 2029 'without project' and 'with project' light vehicle volumes on the surrounding road network

Road	Location	Direction	AWDT (Light Vehicles)				
			2013	2019 without	2019 with	2029 without	2029 with
Pacific Highway	Pennant Hills Road to Woolcott Avenue	Northbound	14,100	16,650	16,800	21,800	21,350
		Southbound	12,050	20,450	19,400	22,350	18,950
Pacific Highway	M1 Pacific Motorway interchange to Redleaf Avenue	Northbound	26,700	33,550	34,200	37,100	37,900
		Southbound	30,000	34,800	35,300	38,000	38,200
Pacific Highway	North of Bobbin Head Road	Northbound	29,300	33,700	30,950	35,150	33,450
		Southbound	24,650	28,150	25,550	29,950	27,350
Castle Hill Road	New Line Road to Edward Bennett Drive	Eastbound	15,000	18,350	17,250	21,000	20,300
		Westbound	13,050	15,900	14,950	18,250	18,150
Boundary Road	North of Pennant Hills Road	Eastbound	13,500	17,550	15,150	19,400	18,000
		Westbound	10,400	11,100	11,850	11,700	12,650
Beecroft Road	Hills M2 Motorway interchange to Cheltenham Road	Northbound	21,600	24,600	25,550	26,750	28,950
		Southbound	17,250	18,600	19,350	19,750	21,750
Beecroft Road	South of Hills M2 Motorway	Northbound	19,850	22,400	22,600	23,750	24,850
		Southbound	14,300	15,550	15,300	15,700	16,000
North Rocks Road	West of Pennant Hills Road	Eastbound	16,400	16,900	16,850	17,350	17,400
		Westbound	13,200	13,950	13,250	14,250	13,750
Carlingford Road	East of Pennant Hills Road	Eastbound	12,100	14,250	13,950	15,950	16,000
		Westbound	19,100	21,300	20,700	23,150	23,250
Lane Cove Road	South of Hills M2 Motorway	Northbound	22,000	29,700	27,050	33,550	31,700
		Southbound	22,400	25,500	23,650	29,700	28,500

Road	Location	Direction	AWDT (Light Vehicles)				
			2013	2019 without	2019 with	2029 without	2029 with
Epping Road	West of Delhi Road	Northbound	35,950	45,950	43,650	51,300	50,300
		Southbound	28,100	31,450	30,400	34,100	34,050
Pennant Hills Road (Cumberland Highway)	Marsden Road to Carlingford Road	Northbound	24,700	28,250	27,550	30,350	30,450
		Southbound	33,750	37,700	36,000	39,700	38,950
Emert Street (Cumberland Highway)	North of Great Western Highway	Northbound	20,850	24,450	23,000	29,050	28,600
		Southbound	24,700	30,550	28,700	34,350	33,900
Westlink M7 Motorway	Old Windsor Road to Hills M2 Motorway	Eastbound	20,120	28,000	28,400	37,800	38,300
		Westbound	20,630	28,700	29,100	38,700	39,200
Old Windsor Road	Toongabbie Creek crossing	Northbound	17,800	21,300	20,650	24,150	23,850
		Southbound	20,550	24,150	22,650	25,850	24,950
Abbott Road	West of Old Windsor Road	Eastbound	12,700	15,100	14,050	18,750	17,450
		Westbound	14,400	16,450	15,750	20,000	19,700
Abbott Road	East of Old Windsor Road	Eastbound	14,750	16,000	15,100	16,950	15,450
		Westbound	14,750	14,450	14,500	14,050	14,200
Woodville Road	North of Christina Road	Northbound	16,750	19,350	18,550	21,300	21,150
		Southbound	18,000	21,500	20,250	22,950	22,450
Hume Highway	South of Elizabeth Drive	Northbound	28,050	33,450	31,000	37,500	35,400
		Southbound	25,550	29,600	27,300	31,950	30,350
Westlink M7 Motorway	The Horsley Drive to Old Wallgrove Road	Northbound	27,890	38,700	39,200	47,000	47,600
		Southbound	28,370	39,400	39,900	47,900	48,500
Cowpasture Road	Westlink M7 Motorway Interchange to Green Valley Road	Northbound	15,900	19,700	18,500	22,450	21,600
		Southbound	15,900	20,250	18,850	23,600	22,400

(Source: Strategic transport model, 2014)

Table 8-32 Comparison of 2019 and 2029 'without project' and 'with project' heavy vehicle volumes on the surrounding road network

Road	Location	Direction	AWDT (Heavy Vehicles)				
			2013	2019 without	2019 with	2029 without	2029 with
Pacific Highway	Pennant Hills Road to Woolcott Avenue	Northbound	900	1,050	1,150	1,200	1,450
		Southbound	550	550	450	650	550
Pacific Highway	M1 Pacific Motorway interchange to Redleaf Avenue	Northbound	2,450	2,900	2,750	3,600	3,450
		Southbound	4,050	4,550	5,050	5,450	5,900
Pacific Highway	North of Bobbin Head Road	Northbound	2,400	2,850	2,750	3,450	3,350
		Southbound	3,500	3,950	3,700	4,800	4,300
Castle Hill Road	New Line Road to Edward Bennett Drive	Eastbound	550	750	550	950	800
		Westbound	650	750	700	1,050	1,000
Boundary Road	North of Pennant Hills Road	Eastbound	850	1,100	1,050	1,400	1,250
		Westbound	900	1,100	1,200	1,400	1,550
Beecroft Road	Hills M2 Motorway interchange to Cheltenham Road	Northbound	1,000	1,300	1,450	1,850	2,050
		Southbound	750	800	900	1,000	1,150
Beecroft Road	South of Hills M2 Motorway	Northbound	900	1,100	1,250	1,600	1,750
		Southbound	400	450	450	600	600
North Rocks Road	West of Pennant Hills Road	Eastbound	1,250	1,200	1,200	1,200	1,250
		Westbound	600	650	900	700	1,150
Carlingford Road	East of Pennant Hills Road	Eastbound	400	450	450	600	550
		Westbound	800	750	750	900	850
Lane Cove Road	South of Hills M2 Motorway	Northbound	2,150	2,650	2,550	3,250	3,100
		Southbound	2,100	2,450	2,300	3,300	2,900
Epping Road	West of Delhi Road	Northbound	2,800	3,450	3,500	4,150	4,250
		Southbound	1,850	2,300	2,350	2,800	2,800

Road	Location	Direction	AWDT (Heavy Vehicles)				
			2013	2019 without	2019 with	2029 without	2029 with
Pennant Hills Road (Cumberland Highway)	Marsden Road to Carlingford Road	Northbound	3,100	3,250	3,300	3,550	3,650
		Southbound	5,200	5,250	5,700	5,500	6,200
Emert Street (Cumberland Highway)	North of Great Western Highway	Northbound	2,700	2,700	2,900	3,050	3,450
		Southbound	3,000	3,450	3,900	4,000	4,700
Westlink M7 Motorway	Old Windsor Road to Hills M2 Motorway	Eastbound	3,370	4,700	3,300	6,300	4,500
		Westbound	3,380	4,700	3,300	6,300	4,500
Old Windsor Road	Toongabbie Creek crossing	Northbound	1,500	1,650	1,850	2,050	2,400
		Southbound	2,150	2,350	2,700	2,900	3,500
Abbott Road	West of Old Windsor Road	Eastbound	1,200	1,500	2,250	1,600	2,850
		Westbound	900	1,100	1,450	1,500	2,100
Abbott Road	East of Old Windsor Road	Eastbound	1,350	1,500	2,400	1,500	2,950
		Westbound	1,050	1,050	1,600	1,100	2,050
Woodville Road	North of Christina Road	Northbound	2,050	2,050	2,200	2,450	2,650
		Southbound	2,150	1,950	2,450	2,350	2,900
Hume Highway	South of Elizabeth Drive	Northbound	1,850	2,300	3,250	2,950	4,550
		Southbound	1,050	1,250	2,150	1,800	3,000
Westlink M7 Motorway	The Horsley Drive to Old Wallgrove Road	Northbound	7,310	10,200	7,200	12,400	8,800
		Southbound	7,510	10,400	7,400	12,600	8,900
Cowpasture Road	Westlink M7 Motorway Interchange to Green Valley Road	Northbound	1,500	1,000	1,750	1,100	1,850
		Southbound	2,200	1,650	2,350	1,700	2,550

(Source: Strategic transport model, 2014

Generally, daily light vehicle volumes do not change significantly on the wider road network. Light vehicles are unlikely to alter their route to the Pennant Hills Road corridor as a result of the project, because they would still have the choice of using the tunnel or Pennant Hills Road once they got to the corridor. Light vehicles travelling away from the corridor are also unlikely to change their route no matter if they used the tunnel or Pennant Hills Road.

Daily heavy vehicle volumes show a significant decrease on the Westlink M7 Motorway, as a result of the increased toll on the Westlink M7 Motorway, and there are increased heavy vehicle volumes on alternate routes, such as Abbott Road, Cowpasture Road and the Hume Highway.

APPENDIX D

Traffic Volume Extracts from M7 Heavy Vehicle Study

4 Alternative Routes vs M7 routes

The phase 1 report proposed the routes in the table below, all of which were agreed with Roads and Maritime Services.

Table 2 - Primary data collection locations

Road Link	Suburb	Direction	Location
Castle Hill Road	West Pennant Hills	Northbound	Between Church Street and New Line Road
Cowpasture Road	Bonnyrigg	Southbound	Just south of Elizabeth Drive
Elizabeth Drive	Cecil Hills	Eastbound	East of M7
Hume Highway	Liverpool	Northbound	Between Hoxton Park Road and Bourke Street
Knox Road	Doonside	Northbound	Between Cross and Coveny Streets
Pennant Hills Road	Carlingford	Southbound	Between North Rocks Road and M2 Motorway
Wallgrove Road	Horsley Park	Northbound	Between Chandos Road and Austral Bricks

6 Results

6.1 Average Daily trip volumes for Light Vehicles and Heavy Vehicles (with Percent Heavy Vehicles) on the agreed Alternative routes

Automatic Tube Counters have been placed at seven locations as described in Table 2. The tables below summarise by Calendar month, daily average light and heavy vehicle numbers, **in one direction only**.

Table 10 – Average Daily trip volumes on **Castle Hill Road** alternative route

	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV		18112	16754	15533	17748	17726	17228	17204	16576	16441	16942	17013	16635	17716	16410	15283	17155	17228	16397	17076	17027	16757	17218	17091	16943
Average of Daily HV		2099	1794	1505	1807	1831	1792	2006	2002	1948	2100	2133	1946	1985	1864	1719	2014	2069	1907	2102	1997	2008	2128	2110	2046
Percent HV		10.4%	9.7%	8.8%	9.2%	9.4%	9.4%	10.4%	10.8%	10.6%	11.0%	11.1%	10.5%	10.1%	10.2%	10.1%	10.5%	10.7%	10.4%	11.0%	10.5%	10.7%	11.0%	11.0%	10.8%

Table 11 – Average Daily trip volumes on **Cowpasture Road** alternative route

	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV		19703	18515	16072	19782	17446	19536	19837	18949	19050	19706	20051	19673	20029	18892	17313	19727	20032	18603	20356	19612	19728	19956	20028	19284
Average of Daily HV		1212	1006	956	1299	1218	939	1346	1283	1051	1372	1359	1250	1686	1187	1168	1356	1485	1232	1485	1518	1458	1740	1664	1680
Percent HV		5.8%	5.2%	5.6%	6.2%	6.5%	4.6%	6.4%	6.3%	5.2%	6.5%	6.3%	6.0%	7.8%	5.9%	6.3%	6.4%	6.9%	6.2%	6.8%	7.2%	6.9%	8.0%	7.7%	8.0%

Table 12 – Average Daily trip volumes on **Elizabeth Drive** alternative route

	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV		13953	12945	11788	13646	13503	13254	13980	13228	13526	14086	14320	13925	14500	13356	11944	12468	13586	13196	14267	13810	13482	14153	14305	13271
Average of Daily HV		1456	1166	920	1410	1403	1410	1166	990	921	1061	1166	1190	1168	996	892	1241	1378	1073	1296	1286	1192	1234	1212	1397
Percent HV		9.5%	8.3%	7.2%	9.4%	9.4%	9.6%	7.7%	7.0%	6.4%	7.0%	7.5%	7.9%	7.5%	6.9%	7.0%	9.1%	9.2%	7.5%	8.3%	8.5%	8.1%	8.0%	7.8%	9.5%

Table 13 – Average Daily trip volumes on **Hume Highway** alternative route

FROM	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV		24196	22895	21454	23833	22059	23546	23866	23325	23509	23428	23817	23323	23787	22508	20746	23112	22512	21952	23328	22977	24112	23055	23575	20633
Average of Daily HV		2843	2508	2226	2604	2500	2695	2561	2767	2617	2674	2621	2575	3028	2671	2817	3061	2971	2784	3137	3055	3348	3275	3059	2638
Percent HV		10.5%	9.9%	9.4%	9.9%	10.2%	10.3%	9.7%	10.6%	10.0%	10.2%	9.9%	9.9%	11.3%	10.6%	12.0%	11.7%	11.7%	11.3%	11.9%	11.7%	12.2%	12.4%	11.5%	11.3%

Table 14 – Average Daily trip volumes on **Knox Road** alternative route

FROM	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV		14253	12799	11890	14270	13849	13878	14583	13853	14151	14694	14477	14187	14789	13280	12060	14282	14412	13431	9121	14032	14239	13974	14737	13216
Average of Daily HV		901	743	591	773	663	644	809	831	743	815	821	794	859	709	606	971	1001	778	650	920	944	1008	1058	929
Percent HV		5.9%	5.5%	4.7%	5.1%	4.6%	4.4%	5.3%	5.7%	5.0%	5.3%	5.4%	5.3%	5.5%	5.1%	4.8%	6.4%	6.5%	5.5%	6.7%	6.2%	6.2%	6.7%	6.7%	6.6%

Table 15 – Average Daily trip volumes on **Pennant Hills Road** alternative route

FROM	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV		18974	17891	16534	17235	16855	15799	17684	16993	17266	17682	17753	17104	18062	17138	15827	17666	17275	16953	18284	17173	17801	17926	17075	16928
Average of Daily HV		2992	2564	2363	3495	4098	4104	3135	2860	2749	2871	2789	2459	2970	2734	2480	2975	2977	2715	3129	2951	3062	3099	3389	3011
Percent HV		13.6%	12.5%	12.5%	16.9%	19.6%	20.6%	15.1%	14.4%	13.7%	14.0%	13.6%	12.6%	14.1%	13.8%	13.5%	14.4%	14.7%	13.8%	14.6%	14.7%	14.7%	14.7%	16.6%	15.1%

Table 16 – Average Daily trip volumes on **Wallgrove Road** alternative route

FROM	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Average of Daily LV	9260	9293	8830	8124	9299	9260	9392	9560	9452	9364	9414	9597	9220	9729	8712	8311	9203	9264	8666	9246	8886	9257	9338	9121	9462
Average of Daily HV	1330	1384	1262	1119	1442	1250	1152	1103	1039	1138	1272	1207	1145	1280	1090	1058	1239	1232	1096	1432	1303	1309	1592	1643	1429
Percent HV	12.6%	13.0%	12.5%	12.1%	13.4%	11.9%	10.9%	10.3%	9.9%	10.8%	11.9%	11.2%	11.0%	11.6%	11.1%	11.3%	11.9%	11.7%	11.2%	13.4%	12.8%	12.4%	14.6%	15.3%	13.1%

6.2 Average Daily trip volumes for heavy vehicles at the equivalent sections on the M7

Table 17 – Average Daily trip volumes (Heavy Vehicles) for equivalent routes on the M7 for the **Castle Hill Road** alternative route

FROM	TO	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
Power St	M2 Motorway	140	143	123	106	164	141	175	176	172	170	180	183	171	198	150	141	190	191	157	197	183	204	205	197	195
Richmond Rd	M2 Motorway	421	435	327	292	541	466	469	419	378	417	447	442	434	522	346	331	493	482	409	552	457	470	515	494	466
Sunnyholt Rd	M2 Motorway	178	182	190	145	191	188	170	179	184	195	179	190	177	199	163	159	199	194	155	211	187	192	199	198	201
Old Windsor Rd	M2 Motorway	320	323	307	223	334	317	360	440	355	320	355	396	380	409	318	293	461	340	382	491	349	342	346	381	385
Total HV trips (both directions)		27,341	27,826	24,802	20,396	27,965	25,576	25,736	26,457	25,382	24,574	26,704	27,155	26,068	29,355	23,944	22,084	27,675	26,521	23,056	29,541	27,061	26,578	28,547	28,190	27,649

Table 18 – Average Daily trip volumes (Heavy Vehicles) for equivalent routes on the M7 for the **Cowpasture Road** alternative route

FROM	TO	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
M5 Motorway	Cowpasture Rd	233	246	223	161	220	195	238	206	186	182	207	215	189	217	186	150	202	176	158	210	183	184	194	209	206
M5 Motorway	Elizabeth Drv	516	500	443	369	525	436	450	466	441	431	482	481	447	546	465	412	487	438	412	480	436	441	475	491	484
M5 Motorway	The Horsley Drv	872	921	841	706	908	842	836	913	871	819	906	868	811	944	792	711	858	871	699	901	866	815	910	882	872
M5 Motorway	Old Wallgrove Rd	956	1012	957	833	979	915	914	919	902	851	932	977	930	1084	907	866	942	950	825	1032	955	929	1018	1006	1041
M5 Motorway	M4 Motorway	1712	1715	1603	1402	1787	1693	1669	1649	1662	1565	1691	1686	1590	1793	1502	1435	1671	1663	1450	1722	1583	1529	1653	1618	1615
M5 Motorway	Woodstock Ave	193	226	189	160	227	200	208	207	200	206	223	222	207	240	185	168	228	226	187	246	234	213	234	225	225
M5 Motorway	Richmond Rd	384	398	345	283	415	376	380	386	391	383	385	404	383	466	363	343	431	425	365	494	430	418	457	482	483
M5 Motorway	Sunnyholt Rd	239	234	215	168	227	221	217	233	221	194	227	239	214	241	193	182	231	216	187	249	219	217	227	220	212
Bemera Rd	M4 Motorway	281	276	264	227	295	284	268	274	265	275	301	303	310	322	265	252	312	277	240	290	260	241	264	274	268
Cowpasture Rd	M4 Motorway	141	143	144	108	144	152	148	127	125	127	144	156	176	180	120	114	155	133	133	192	155	176	183	174	153
Total HV trips (both directions)		27,341	27,826	24,802	20,396	27,965	25,576	25,736	26,457	25,382	24,574	26,704	27,155	26,068	29,355	23,944	22,084	27,675	26,521	23,056	29,541	27,061	26,578	28,547	28,190	27,649

Table 19 – Average Daily trip volumes (Heavy Vehicles) for equivalent routes on the M7 for the **Elizabeth Drive** alternative route

FROM	TO	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
M5 Motorway	Elizabeth Drv	516	500	443	369	525	436	450	466	441	431	482	481	447	546	465	412	487	438	412	480	436	441	475	491	484
M5 Motorway	Old Wallgrove Rd	956	1012	957	833	979	915	914	919	902	851	932	977	930	1084	907	866	942	950	825	1032	955	929	1018	1006	1041
M5 Motorway	M4 Motorway	1712	1715	1603	1402	1787	1693	1669	1649	1662	1565	1691	1686	1590	1793	1502	1435	1671	1663	1450	1722	1583	1529	1653	1618	1615
M5 Motorway	Woodstock Ave	193	226	189	160	227	200	208	207	200	206	223	222	207	240	185	168	228	226	187	246	234	213	234	225	225
Bemera Rd	M4 Motorway	281	276	264	227	295	284	268	274	265	275	301	303	310	322	265	252	312	277	240	290	260	241	264	274	268
Cowpasture Rd	M4 Motorway	141	143	144	108	144	152	148	127	125	127	144	156	176	180	120	114	155	133	133	192	155	176	183	174	153
Villiers Rd	M4 Motorway	212	205	168	151	220	202	199	210	199	198	218	240	200	220	178	167	219	219	170	220	235	285	274	267	220
Total HV trips (both directions)		27,341	27,826	24,802	20,396	27,965	25,576	25,736	26,457	25,382	24,574	26,704	27,155	26,068	29,355	23,944	22,084	27,675	26,521	23,056	29,541	27,061	26,578	28,547	28,190	27,649

Table 20 – Average Daily trip volumes (Heavy Vehicles) for equivalent routes on the M7 for the **Hume Highway** alternative route

FROM	TO	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
M5 Motorway	M2 Motorway	621	632	552	509	665	631	651	652	641	622	677	737	740	732	575	560	673	679	575	730	677	671	732	691	712
Villiers Rd	M4 Motorway	212	205	168	151	220	202	199	210	199	198	218	240	200	220	178	167	219	219	170	220	235	285	274	267	220
Villiers Rd	M2 Motorway	111	109	95	82	126	114	118	127	121	121	129	133	115	138	106	97	118	120	103	148	118	112	123	120	134
Total HV trips (both directions)		27,341	27,826	24,802	20,396	27,965	25,576	25,736	26,457	25,382	24,574	26,704	27,155	26,068	29,355	23,944	22,084	27,675	26,521	23,056	29,541	27,061	26,578	28,547	28,190	27,649

Table 21 – Average Daily trip volumes (Heavy Vehicles) for equivalent routes on the M7 for the **Knox Road** alternative route

FROM	TO	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
M5 Motorway	Woodstock Ave	193	226	189	160	227	200	208	207	200	206	223	222	207	240	185	168	228	226	187	246	234	213	234	225	225
M5 Motorway	Richmond Rd	384	398	345	283	415	376	380	386	391	383	385	404	383	466	363	343	431	425	365	494	430	418	457	482	483
M4 Motorway	Woodstock Ave	297	335	286	220	312	312	322	347	323	317	333	339	325	370	289	266	353	328	280	378	351	363	365	345	333
M4 Motorway	Richmond Rd	688	596	472	367	523	430	437	532	490	457	504	501	541	569	483	396	522	453	384	483	425	439	461	575	525
Total HV trips (both directions)		27,341	27,826	24,802	20,396	27,965	25,576	25,736	26,457	25,382	24,574	26,704	27,155	26,068	29,355	23,944	22,084	27,675	26,521	23,056	29,541	27,061	26,578	28,547	28,190	27,649

7 Analysis

In accordance with the revised methodology, the following tables summarise the analysis for each Alternative Route and their corresponding M7 routes in the following steps:

- Row 1 = Sourced from the Average daily number of light vehicles from the Automatic Tube Counters (one direction only). Based on Calendar month.
- Row 2 = Sourced from the Average daily number of heavy vehicles from the Automatic Tube Counters (one direction only). Based on Calendar month.
- Row 3 = Row 2 / (sum of Row 1 + Row 2)
- Row 4 = Sum of all relevant M7 routes (average daily number of light vehicles) from M7 OD matrices supplied by Roads and Maritime (one direction only).
- Row 5 = Sum of all relevant M7 routes (average daily number of heavy vehicles) from M7 OD matrices supplied by Roads and Maritime (one direction only).
- Row 6 = Row 5 / (sum of Row 4 + Row 5)
- Row 7 = Row 1 + Row 4 (Aggregate of Light Vehicles on both Alternative Route and relevant M7 routes – one direction only)
- Row 8 = Row 2 + Row 5 (Aggregate of Heavy Vehicles on both Alternative Route and relevant M7 routes – one direction only)
- Row 9 = Row 1 / Row 7
- Row 10 = Row 2 / Row 8
- Row 11 = (Row 10 current month – Row 10 previous month) * Row 8.

Row 11 provides a net change (month on month) of the number of heavy vehicles in one direction on the alternative route when compared to the relevant M7 routes. A positive number indicates heavy vehicles are attracted to the Alternative Route away from the M7, potentially attempting to avoid the toll increase, and a negative number indicates heavy vehicles are being attracted to the M7 away from the alternative route.

Table 31 –Results of Analysis of Heavy Vehicles avoiding M7 routes. **Castle Hill Road** alternative route.

	Analysis for ONE DIRECTION ONLY Average Daily number of vehicles	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
1	Alternative Route LV		18112	16754	15533	17748	17726	17228	17204	16576	16441	16942	17013	16635	17716	16410	15283	17155	17228	16397	17076	17027	16757	17218	17091	16943
2	Alternative Route HV		2099	1794	1505	1807	1831	1792	2006	2002	1948	2100	2133	1946	1985	1864	1719	2014	2069	1907	2102	1997	2008	2128	2110	2046
3	Alternative Route - Percent HV		10.4%	9.7%	8.8%	9.2%	9.4%	9.4%	10.4%	10.8%	10.6%	11.0%	11.1%	10.5%	10.1%	10.2%	10.1%	10.5%	10.7%	10.4%	11.0%	10.5%	10.7%	11.0%	11.0%	10.8%
4	Relevant M7 Routes LV	13108	13478	12963	11792	13815	13392	13338	13512	13201	13313	13740	13962	13789	14473	13315	12383	14008	14235	13422	14399	13986	13881	14238	14297	14336
5	Relevant M7 Routes HV	1058	1083	947	766	1230	1112	1174	1213	1088	1103	1161	1211	1163	1328	976	923	1343	1208	1103	1449	1177	1208	1264	1270	1247
6	Relevant M7 Routes - Percent HV		7.4%	6.8%	6.1%	8.2%	7.7%	8.1%	8.2%	7.6%	7.7%	7.8%	8.0%	7.8%	8.4%	6.8%	6.9%	8.7%	7.8%	7.6%	9.1%	7.8%	8.0%	8.2%	8.2%	8.0%
7	Aggregate of M7 + ALT routes (LV)		31589	29717	27325	31563	31118	30566	30716	29777	29754	30682	30975	30424	32188	29725	27666	31163	31463	29819	31475	31013	30638	31456	31389	31279
8	Aggregate of M7 + ALT routes (HV)		3182	2741	2271	3037	2943	2967	3219	3091	3050	3262	3345	3109	3313	2840	2642	3357	3277	3010	3551	3174	3216	3392	3380	3293
9	ALT Route PERCENT of Aggregated Routes - LV AVG Daily		57.3%	56.4%	56.8%	56.2%	57.0%	56.4%	56.0%	55.7%	55.3%	55.2%	54.9%	54.7%	55.0%	55.2%	55.2%	55.0%	54.8%	55.0%	54.3%	54.9%	54.7%	54.7%	54.5%	54.2%
10	ALT Route PERCENT of Aggregated Routes - HV AVG Daily		66.0%	65.4%	66.3%	59.5%	62.2%	60.4%	62.3%	64.8%	63.8%	64.4%	63.8%	62.6%	59.9%	65.6%	65.1%	60.0%	63.1%	63.4%	59.2%	62.9%	62.4%	62.7%	62.4%	62.1%
11	Increase ↑ (decrease ↓) in HV usage on Alternative Routes (One Direction - month on month)			-16	23	-154	82	-53	56	80	-29	17	-20	-40	-83	189	-16	-134	106	7	-126	133	-15	9	-10	-10

Table 32 –Results of Analysis of Heavy Vehicles avoiding M7 routes. **Cowpasture Road** alternative route.

	Analysis for ONE DIRECTION ONLY Average Daily number of vehicles	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
1	Alternative Route LV		19703	18515	16072	19782	17446	19536	19837	18949	19050	19706	20051	19673	20029	18892	17313	19727	20032	18603	20356	19612	19728	19956	20028	19284
2	Alternative Route HV		1212	1006	956	1299	1218	939	1346	1283	1051	1372	1359	1250	1686	1187	1168	1356	1485	1232	1485	1518	1458	1740	1664	1680
3	Alternative Route - Percent HV		5.8%	5.2%	5.6%	6.2%	6.5%	4.6%	6.4%	6.3%	5.2%	6.5%	6.3%	6.0%	7.8%	5.9%	6.3%	6.4%	6.9%	6.2%	6.8%	7.2%	6.9%	8.0%	7.7%	8.0%
4	Relevant M7 Routes LV	24230	24384	23473	21371	24822	24668	24604	24716	24010	24413	25213	25232	25092	26086	24315	22853	25457	25531	24525	25909	24725	25034	25451	25610	25035
5	Relevant M7 Routes HV	5528	5669	5223	4417	5727	5315	5328	5381	5265	5034	5499	5552	5255	6033	4979	4634	5515	5375	4656	5813	5320	5163	5614	5583	5562
6	Relevant M7 Routes - Percent HV		18.9%	18.2%	17.1%	18.7%	17.7%	17.8%	17.9%	18.0%	17.1%	17.9%	18.0%	17.3%	18.8%	17.0%	16.9%	17.8%	17.4%	16.0%	18.3%	17.7%	17.1%	18.1%	17.9%	18.2%
7	Aggregate of M7 + ALT routes (LV)		44087	41987	37442	44605	42114	44140	44553	42959	43462	44920	45283	44764	46115	43207	40166	45184	45562	43128	46265	44337	44763	45407	45638	44318
8	Aggregate of M7 + ALT routes (HV)		6882	6230	5373	7026	6534	6267	6727	6548	6085	6871	6911	6505	7719	6166	5802	6871	6860	5888	7298	6839	6621	7354	7247	7242
9	ALT Route PERCENT of Aggregated Routes - LV AVG Daily		44.7%	44.1%	42.9%	44.4%	41.4%	44.3%	44.5%	44.1%	43.8%	43.9%	44.3%	43.9%	43.4%	43.7%	43.1%	43.7%	44.0%	43.1%	44.0%	44.2%	44.1%	43.9%	43.9%	43.5%
10	ALT Route PERCENT of Aggregated Routes - HV AVG Daily		17.6%	16.2%	17.8%	18.5%	18.6%	15.0%	20.0%	19.6%	17.3%	20.0%	19.7%	19.2%	21.8%	19.3%	20.1%	19.7%	21.7%	20.9%	20.3%	22.2%	22.0%	23.7%	23.0%	23.2%
11	Increase ↑ (decrease ↓) in HV usage on Alternative Routes (One Direction - month on month)			-100	102	38	11	-239	315	-27	-152	164	-21	-31	170	-199	54	-23	132	-50	-34	136	-12	108	-51	17

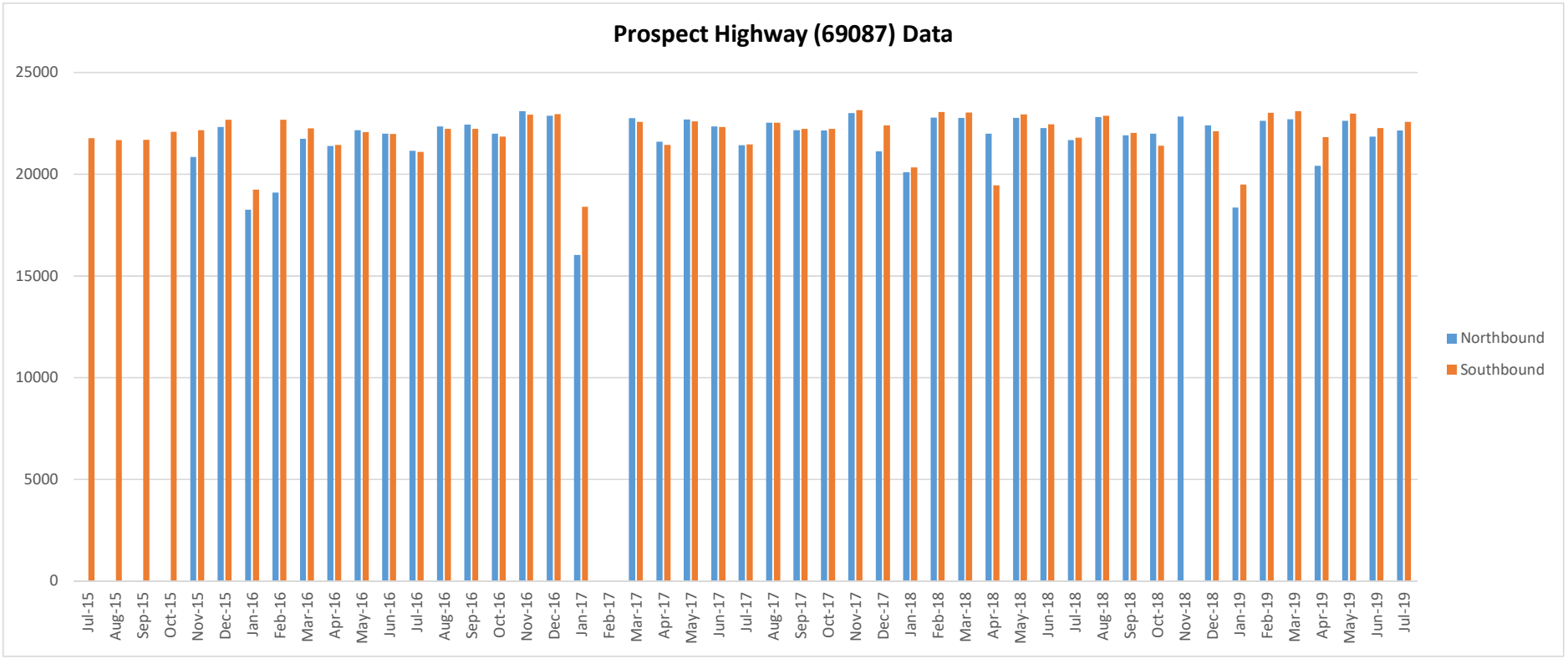
Table 34 –Results of Analysis of Heavy Vehicles avoiding M7 routes. **Hume Highway** alternative route.

	Analysis for ONE DIRECTION ONLY Average Daily number of vehicles	Oct-2015	Nov-2015	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Jul-2016	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017
1	Alternative Route LV		24196	22895	21454	23833	22059	23546	23866	23325	23509	23428	23817	23323	23787	22508	20746	23112	22512	21952	23328	22977	24112	23055	23575	20633
2	Alternative Route HV		2843	2508	2226	2604	2500	2695	2561	2767	2617	2674	2621	2575	3028	2671	2817	3061	2971	2784	3137	3055	3348	3275	3059	2638
3	Alternative Route - Percent HV		10.5%	9.9%	9.4%	9.9%	10.2%	10.3%	9.7%	10.6%	10.0%	10.2%	9.9%	9.9%	11.3%	10.6%	12.0%	11.7%	11.7%	11.3%	11.9%	11.7%	12.2%	12.4%	11.5%	11.3%
4	Relevant M7 Routes LV	5919	5877	6567	5878	5818	6090	6064	5625	5529	6016	5783	6209	6230	6088	6850	6089	5821	5878	6307	5758	5835	6285	6030	6543	6151
5	Relevant M7 Routes HV	945	946	814	742	1011	947	968	988	961	941	1025	1110	1054	1091	860	824	1010	1018	848	1099	1029	1068	1129	1079	1066
6	Relevant M7 Routes - Percent HV		13.9%	11.0%	11.2%	14.8%	13.5%	13.8%	14.9%	14.8%	13.5%	15.1%	15.2%	14.5%	15.2%	11.2%	11.9%	14.8%	14.8%	11.9%	16.0%	15.0%	14.5%	15.8%	14.2%	14.8%
7	Aggregate of M7 + ALT routes (LV)		30073	29462	27332	29651	28149	29610	29492	28854	29525	29211	30026	29553	29875	29358	26834	28934	28390	28259	29086	28811	30397	29086	30117	26784
8	Aggregate of M7 + ALT routes (HV)		3789	3322	2968	3616	3447	3662	3549	3728	3557	3699	3731	3629	4119	3531	3641	4071	3989	3633	4236	4085	4415	4404	4138	3705
9	ALT Route PERCENT of Aggregated Routes - LV AVG Daily		80.5%	77.7%	78.5%	80.4%	78.4%	79.5%	80.9%	80.8%	79.6%	80.2%	79.3%	78.9%	79.6%	76.7%	77.3%	79.9%	79.3%	77.7%	80.2%	79.7%	79.3%	79.3%	78.3%	77.0%
10	ALT Route PERCENT of Aggregated Routes - HV AVG Daily		75.0%	75.5%	75.0%	72.0%	72.5%	73.6%	72.2%	74.2%	73.6%	72.3%	70.2%	70.9%	73.5%	75.7%	77.4%	75.2%	74.5%	76.6%	74.1%	74.8%	75.8%	74.4%	73.9%	71.2%
11	Increase ↑ (decrease ↓) in HV usage on Alternative Routes (One Direction - month on month)			17	-16	-88	18	36	-52	73	-25	-45	-76	26	93	88	61	-80	-29	86	-94	31	42	-64	-19	-112

APPENDIX E

TfNSW Traffic Counts for Abbott Road

Month	Northbound		Southbound	
	Average Daily Vehicles	% increase on previous month	Average Daily Vehicles	% increase on previous month
Jul-15	-	-	21,775	-
Aug-15	-	-	21,679	-0.4%
Sep-15	-	-	21,698	0.1%
Oct-15	-	-	22,095	1.8%
Nov-15	20,854	-	22,174	0.4%
Dec-15	22,327	7.1%	22,681	2.3%
Jan-16	18,257	-18.2%	19,256	-15.1%
Feb-16	19,092	4.6%	22,678	17.8%
Mar-16	21,754	13.9%	22,260	-1.8%
Apr-16	21,397	-1.6%	21,440	-3.7%
May-16	22,167	3.6%	22,072	2.9%
Jun-16	21,994	-0.8%	21,984	-0.4%
Jul-16	21,151	-3.8%	21,098	-4.0%
Aug-16	22,355	5.7%	22,230	5.4%
Sep-16	22,444	0.4%	22,238	0.0%
Oct-16	22,002	-2.0%	21,845	-1.8%
Nov-16	23,096	5.0%	22,931	5.0%
Dec-16	22,872	-1.0%	22,956	0.1%
Jan-17	16,030	-29.9%	18,402	-19.8%
Feb-17	-	-	-	-
Mar-17	22,752	-	22,582	-
Apr-17	21,605	-5.0%	21,455	-5.0%
May-17	22,705	5.1%	22,602	5.3%
Jun-17	22,354	-1.5%	22,321	-1.2%
Jul-17	21,423	-4.2%	21,476	-3.8%
Aug-17	22,537	5.2%	22,539	4.9%
Sep-17	22,166	-1.6%	22,237	-1.3%
Oct-17	22,155	0.0%	22,231	0.0%
Nov-17	23,009	3.9%	23,158	4.2%
Dec-17	21,125	-8.2%	22,398	-3.3%
Jan-18	20,099	-4.9%	20,348	-9.2%
Feb-18	22,791	13.4%	23,068	13.4%
Mar-18	22,778	-0.1%	23,030	-0.2%
Apr-18	21,999	-3.4%	19,459	-15.5%
May-18	22,780	3.6%	22,945	17.9%
Jun-18	22,281	-2.2%	22,458	-2.1%
Jul-18	21,680	-2.7%	21,804	-2.9%
Aug-18	22,807	5.2%	22,874	4.9%
Sep-18	21,916	-3.9%	22,037	-3.7%
Oct-18	22,000	0.4%	21,409	-2.8%
Nov-18	22,847	3.9%	-	-
Dec-18	22,396	-2.0%	22,117	-
Jan-19	18,362	-18.0%	19,498	-11.8%
Feb-19	22,628	23.2%	23,018	18.1%
Mar-19	22,711	0.4%	23,095	0.3%
Apr-19	20,419	-10.1%	21,830	-5.5%
May-19	22,629	10.8%	22,982	5.3%
Jun-19	21,847	-3.5%	22,265	-3.1%
Jul-19	22,155	1.4%	22,579	1.4%


Prospect Highway (69087) Data
25000
20000
15000
10000
5000
0
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Northbound
Southbound

APPENDIX D

Traffic Volume Extracts from M7 Heavy Vehicle Study

APPENDIX E

TfNSW Traffic Counts for Abbott Road