ALDINGTON AND ABBOTTS ROAD UPGRADE

Construction Noise and Vibration Impact Assessment

Prepared for:

LOG-E c/o AT&L
Level 7, 153 Walker Street
North Sydney NSW 2060

SLR Ref: 610.31166.00000-R01
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with LOG-E c/o AT&L (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.31166.00000-R01-v1.0	30 March 2023	Steven Luzuriaga	Aaron Miller	Aaron Miller

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DOCUMENT REFERENCES

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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Land Owners Group – East (LOG-E) to prepare a Construction Noise and Vibration Impact Assessment (CNVIA) for construction work associated with the Aldington and Abbotts Road Upgrade (the Project), located in Kemps Creek, NSW.

This CNVIA addresses the potential noise and vibration impacts associated with the Project. Specific acoustic terminology is used in this report; an explanation of common acoustic terms is provided in **Appendix A**.

SLR is suitably qualified to produce this CNVIA and SLR staff are members of the Australian Acoustical Society (AAS). SLR is also a member firm of the Association of Australasian Acoustical Consultants (AAAC).

2 Project Description

2.1 Aldington and Abbotts Road Upgrade

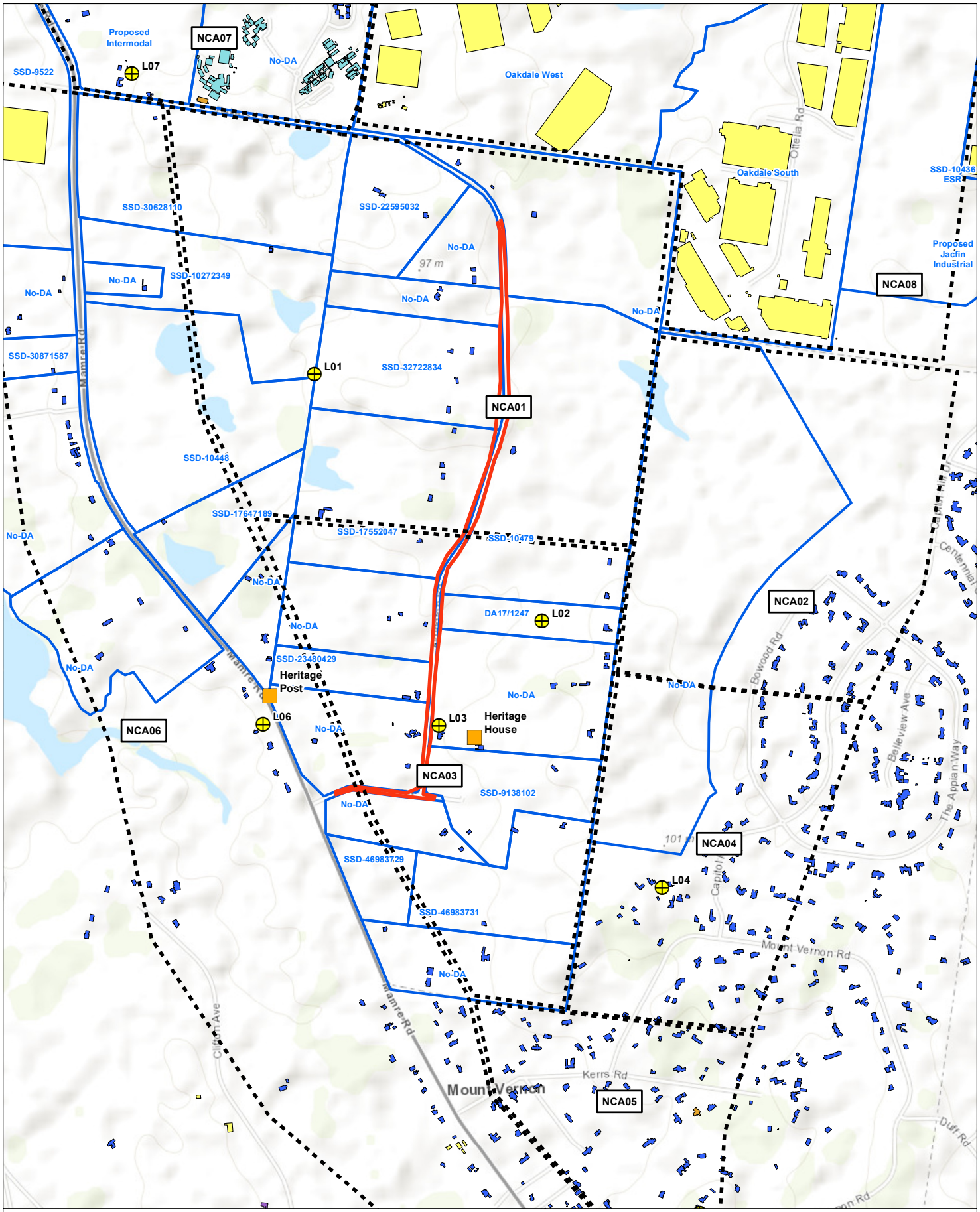
The Project involves the upgrade and widening of Aldington and Abbotts Roads to provide for the development of land within the Mamre Road Precinct. The upgrade is being progressed by the developer group known as the Land Owners Group – East (LOG-E) and is linked to their proposed developments which are accessed via Abbotts and Aldington Roads.

Aldington and Abbotts Roads are controlled by Penrith City Council. The dimensions of the Aldington and Abbotts Road upgrades are established in the Mamre Road Precinct DCP.

The proposed construction project is currently at concept design stage and includes:

- widening the road beyond the existing road reserve (5-10m either side on Aldington Road),
- signalised intersections
- earthworks including raising and lowering road,
- stormwater (new and larger culverts under and adjacent to road),
- relocation of services (above and underground),
- new services (incl water, power, comms).
- site sheds, material storage as required for road construction project.
- temporary works as necessary to facilitate construction.

The location of the Project and surrounding receivers are shown in **Figure 1**.



0 250 500 m

Coordinate System:	GDA2020 MGA Zone 56
Scale:	1:20,000 at A4
Project Number:	610.31166
Date:	29-Mar-2023
Drawn by:	PW

LEGEND

- Heritage Items
- Noise Logging Locations
- NCAs
- Aldington Rd Work Area
- Know Development Applications

Receiver Type

- Residential
- Commerical
- Childcare Centre
- Educational
- Place of Worship

ALDINGTON AND ABBOTTS ROAD UPGRADE

SITE LOCATION

FIGURE 1

H:\Projects-SLR\610-Srv\SYD\610.31166.00000 Aldington Road Upgrade CNV Assessment fol\06 SLR Data\01 CAD\GIS\GIS\SLR61031166_F01_Aldington_Site_Location_03.mxd

2.2 Nearest Sensitive Receivers

Sensitive receivers in the area surrounding the Project have been identified and Noise Catchment Areas (NCAs) have been defined. The NCAs reflect the existing ambient noise environment of that area, as well as the noise sensitivity of the surrounding land uses.

Receivers potentially sensitive to noise and vibration have been categorised as residential buildings, commercial/industrial buildings, or 'other sensitive' land uses which includes educational institutions, childcare centres, medical facilities, places of worship, outdoor recreation areas, etc. Receiver types, locations and NCAs are shown in **Figure 1**.

The area is changing rapidly with numerous Development Applications submitted in the surrounding area. This suggests that the status of the residential receivers, particularly within the Mamre Road precinct, could be subject to change at short notice: these could be acquired by neighbouring developers, or demolished, or both during the construction works. The areas that are subject to Development Applications are also shown in **Figure 1**.

3 Existing Environment

The existing noise environment in the area is typically dominated by road traffic noise from Mamre Road, with rural ambient noise becoming dominant at distances further back from existing roads. Industrial noise from existing premises also influences the noise environment at receivers close to those premises.

Previously measured existing noise levels from nearby noise assessments have been used for this Project. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the Project. The noise monitoring locations are shown in **Figure 1** and the measured levels are summarised in **Table 1**.

Table 1 Summary of Unattended Noise Monitoring Results

ID	NCA	Address	Measured Noise Levels (dBA)[1]					
			Background Noise (RBL)			Average Noise (L_{Aeq})		
			Day	Evening	Night	Day	Evening	Night
L01[2]	NCA01	141-153 Aldington Road, Kemps Creek	34	33	29	44	41	41
L02[3]	NCA02	230-242 Aldington Road, Kemps Creek	32	31	30	50	35	35
L03[4]	NCA03	286 Aldington Road, Kemps Creek	34	34	33	47	48	46
L04[5]	NCA04	62 Mount Vernon Road, Mount Vernon	36	36	33	50	44	43
L05[5]	NCA05	26 Cressy Road, Mount Vernon	42	40	35	53	48	47
L06[5]	NCA06	981 Mamre Road, Kemps Creek	48	46	34	61	59	57
L07[6]	NCA07	Bakers Lane, Kemps Creek	44	43	37	-	-	-
L08[7]	NCA08	Western boundary of Oakdale West	39	38	36	47	46	45

Note 1: The assessment periods are the daytime which is 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sundays and public holidays, the evening which is 6 pm to 10 pm, and the night-time which is 10 pm to 7 am on Monday to Saturday and 10 pm to 8 am on Sunday and public holidays. See the NSW EPA *Noise Policy for Industry*.

Note 2: Measured data at L01 from SSD-10448 noise assessment (SLR report 610.19127-R02-v1.3, dated October 2020).

Note 3: Measured data at L02 from SSD-10479 noise assessment (White Noise Acoustics report 20141_200819, dated 26 August 2022). SLR deployed a logger within this catchment area as part of this assessment which was considerably affected by extraneous noise (insects). Consequently SLR has conservatively adopted the noise levels from L02 for this assessment.

Note 4: Measured data at L03 from SSD-9138102 noise assessment (RWDI report 2101343 Version B, dated February 2021).

Note 5: Measured data at L04, L05 and L06 from SSD-46983729 noise assessment (SLR Report 610.30893.00100-R02-v1.0, dated October 2022).

Note 6: Measured data at L07 from SSD-9522 noise assessment (AcousticWorks report 1018022 R01P, dated May 2019).

Note 7: Measured data at L08 from SSD-7348 noise assessment (SLR report 610.15617-R2 Revision 4, dated June 2017).

4 Assessment Criteria

4.1 Construction Noise and Vibration Guidelines

The standards and guidelines relevant to the development are listed in **Table 2**. These guidelines aim to protect the community and environment from excessive noise and vibration impacts during construction of projects.

Table 2 Construction Noise and Vibration Standards and Guidelines

Guideline/Policy Name	Where Guideline Used
Interim Construction Noise Guideline (ICNG) (DECC, 2009)	Assessment of airborne noise impacts on sensitive receivers
Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime Services, 2016)	Assessment and management protocols for noise and vibration impacts
Road Noise Policy (RNP) (DECCW, 2011)	Assessment of construction traffic impacts
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993	Assessment of vibration impacts (structural damage) to non-heritage sensitive structures
DIN 4150:Part 3-2016 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 2016	Screening assessment of vibration impacts (structural damage) to heritage sensitive structures, where the structure is found to be unsound
Assessing Vibration: a technical guideline (DEC, 2006)	Assessment of vibration impacts on sensitive receivers

4.2 Interim Construction Noise Guideline

The NSW *Interim Construction Noise Guideline* (ICNG) is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers based on the existing background noise in the area. The 'worst-case' noise levels from construction of a project are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact of the project.

The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

Residential Receivers

The ICNG approach for determining NMLs at residential receivers is shown in **Table 3**.

Table 3 ICNG NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard Construction Hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL[1] + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly Noise Affected
	75 dBA
		• The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise
		• Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account:
		  • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences
		  • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside Standard Construction Hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours • The proponent should apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practises have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1: The RBL is the Rating Background Level and the ICNG refers to the calculation procedures in the NSW *Industrial Noise Policy* (INP). The INP has been superseded by the NSW EPA *Noise Policy for Industry* (NPfI).

'Other Sensitive' Land Uses and Commercial Receivers

The NMLs for 'other sensitive' non-residential land uses are shown in **Table 4**.

Table 4 NMLs for 'Other Sensitive' Receivers

Land Use	Noise Management Level $L_{Aeq(15minute)}$ (dBA) (Applied when the property is in use)	
	Internal	External
ICNG 'Other Sensitive' Receivers		
Classrooms at schools and other educational institutions	45	55[1]
Hospital wards and operating theatres	45	65[2]
Places of worship	45	55[1]
Active recreation areas (characterised by sporting activities and activities which generate noise)	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	-	60
Commercial	-	70
Industrial	-	75
ICNG 'Other Sensitive' Receivers		
Childcare Centres	40	50[1]

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Sleep Disturbance

A method for assessing sleep disturbance is contained in the NPfI. Although the NPfI sleep disturbance criteria relates to industrial noise, it is also considered relevant for reviewing potential impacts from construction noise as a screening criterion to identify the need for further assessment. The NPfI notes that a detailed maximum noise level assessment should be undertaken where a project results in night-time noise levels which exceed 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is the greater.

Work will generally be limited to the standard daytime construction hours, in accordance with ICNG. Some work may be required during out-of-hours periods, such as culvert road crossings and asphalt paving. Where out-of-hours work does occur, the sleep disturbance screening level will be applied.

NML Summary

The construction NMLs are summarised in **Table 5**. Out of hours NMLs would be applicable to works undertaken outside the ICNG standard construction hours.

Table 5 Construction Noise Management Levels

NCA	Receiver Type	Monitoring Location	Measured RBL[1] – dBA			NML ($L_{Aeq(15minute)}$ – dBA)				Sleep Disturbance Screening Level[2] (L_{max} dBA)
						Standard Construction Hours (RBL+10dB)	Out of Hours (RBL+5dB)			
			Day	Eve.	Night	Day	Day	Eve.	Night	Night
NCA01	Residential	L01	35[5]	33	30[5]	45	40	38	35	52
NCA02	Residential	L02	35[5]	31	30	45	40	36	35	52
NCA03	Residential	L03	35[5]	34	33	45	40	39	38	52
NCA04	Residential	L04	36	36	33	46	41	41	38	52
NCA05	Residential	L05	42	40	35	52	47	45	40	52
NCA06	Residential	L06	48	46	34	58	53	51	39	52
NCA07	Residential	L07	44	43	37	54	49	48	42	52
NCA08	Residential[4]	L08	39	38	36	49	44	43	41	52
All	Place of Worship	n/a				External noise level 55 dBA when in use[3]				n/a
	Commercial	n/a				External noise level 70 dBA when in use[3]				n/a
	Educational	n/a				External noise level 55 dBA when in use[3]				n/a
	Childcare Centres	n/a				External noise level 50 dBA when in use[3]				n/a

Note 1: RBL = Rating Background Level.

Note 2: Sleep disturbance screening level is RBL+15 dB or 52 dBA, whichever is higher.

Note 3: The criterion is specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that these receiver types have openable windows and external noise levels are therefore 10 dB higher than the corresponding internal level, which is generally considered representative of windows being partially open for ventilation.

Note 4: No residential receivers have been identified in NCA08

Note 5: The NPfI minimum RBL value has been used due to the measured RBL being below the NPfI minimum value.

4.3 Construction Road Traffic Noise Guidelines

The potential impacts from construction traffic on public roads are assessed under the NSW EPA *Road Noise Policy* (RNP) and Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (CNVG).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2.0 dB as a result of construction traffic; differences in noise levels of less than approximately 2 dBA (whether an increase or a decrease) is generally considered to be imperceptible in practice. Where this is considered likely, further assessment is required using the RNP base criteria shown in **Table 6**.

Traffic noise in the project area is generally dominated by Mamre Road. For construction traffic using Mamre Road and Abbotts Road, additional construction traffic is not anticipated to increase road traffic noise on Mamre Road during operation of the project by more than 2 dBA.

For construction traffic using Bakers Lane (entering the project from the north), road traffic noise outside of peak school pickup/drop-off times is likely to increase by more than 2 dBA: however predicted $L_{Aeq\ (1\ hour)}$ noise levels are well below the RNP criteria in **Table 6**, assuming up to 32 construction vehicle pass-bys per hour. Therefore, cumulative road traffic noise on Bakers Lane is not expected to exceed the RNP criteria.

As such, no recommendations for road traffic noise mitigation and management measures are considered necessary in this assessment.

Table 6 RNP Criteria for Assessing Construction Vehicles on Public Roads

Road Category	Type of Project/Land Use	Assessment Criteria (dBA)	
		Daytime (7 am – 10 pm)	Night-time (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

4.4 Vibration Guidelines

The effects of vibration from construction work can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where building contents may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

4.4.1 Human Comfort Vibration

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings.

Vibration from construction works tends to be intermittent in nature and the EPA's *Assessing Vibration: a technical guideline* (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in **Table 7**.

Table 7 Vibration Dose Values for Intermittent Vibration

Building Type	Assessment Period	Vibration Dose Value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

4.4.2 Effects on Building Contents

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes, are located in buildings near to construction works. No such items of equipment have been identified in the project area.

4.4.3 Structural and Cosmetic Damage Vibration

The Roads and Maritime Services (RMS, now TfNSW) *Construction Noise and Vibration Guideline* (CNVG) provides guidance regarding cosmetic damage criteria for buildings to be applied on road construction projects in NSW, and refers to:

- Australian Standard AS 2187: Part 2-2006 "*Explosives - Storage and Use - Part 2: Use of Explosives*"
- BS 7385 Part 2-1993 "*Evaluation and measurement for vibration in buildings Part 2*"
- DIN 4150 (of particular reference for heritage structures)

4.4.3.1 British Standard 7385: Part 2 - 1993

In terms of the most recent relevant vibration damage criteria, 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".

The 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.

Sources of vibration that are considered in the Standard include demolition, piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 8** and graphically in **Figure 2**.

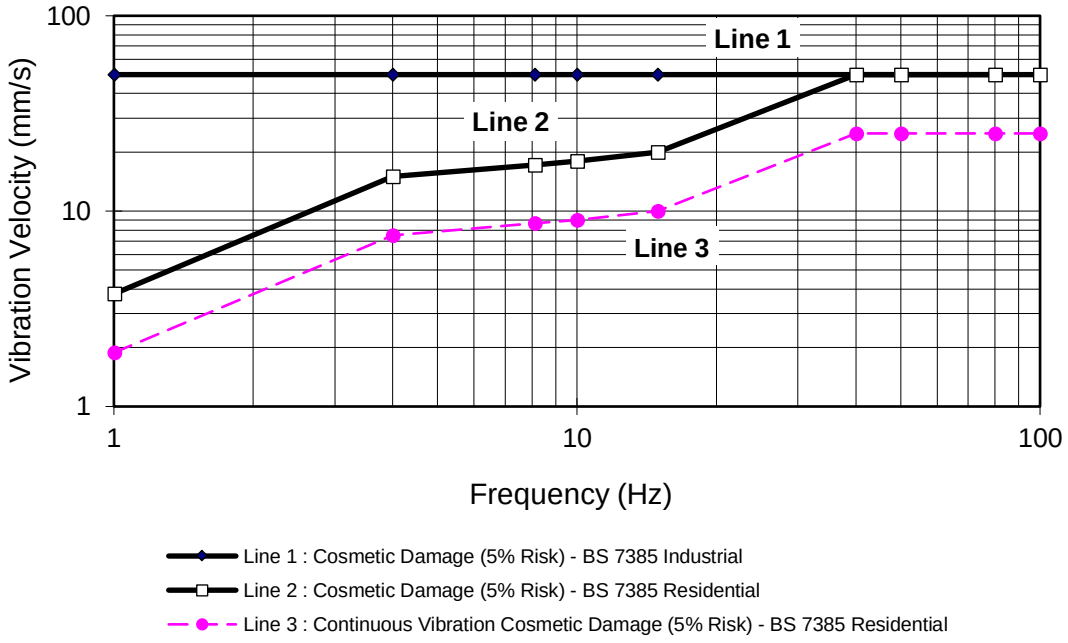
Table 8 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard states that the guide values in **Table 8** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 8** may need to be reduced by up to 50%.

Figure 2 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 8**, and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 8** should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measured should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in **Table 8**.

It is noteworthy that extra to the guide values nominated in **Table 8**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

4.4.4 Heritage Buildings or Structures

For continuous long-term vibration or repetitive vibration with the potential to cause fatigue effects, DIN 4150 provides a Peak Component Particle Velocity value of 2.5 mm/s for buildings of great intrinsic value (e.g. heritage listed buildings) as a safe limit, below which even superficial cosmetic damage is not to be expected.

Heritage listed buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound. Where a heritage building is deemed to be "structurally unsound" following an assessment from a structural engineer (or other suitably qualified person), the more stringent DIN 4150 limits can be considered.

Two heritage structures have been identified nearby the Project site:

- Heritage listed house at 282 Aldington Rd, Kemps Creek NSW (approximately 150 m from the Project)
- Heritage listed post at 269 Aldington Rd, Kemps Creek NSW (approximately 300 m from the Project)

It is noted that the heritage building at 282 Aldington Rd burnt down and was reconstructed in 1999 and is currently deemed structurally sound.

Both heritage structures are well beyond the minimum working distances identified in **Section 4.4.6** below, therefore impacts are not expected. As such, no further recommendations for heritage mitigation and management measures are considered necessary.

4.4.5 General Vibration Screening Criteria

The TfNSW *Construction Noise and Vibration Strategy* (CNVS) elaborates on the criteria provided within the CNVG. It notes that for most construction activities involving intermittent vibration such as rock breakers, piling rigs, vibratory rollers, excavators and the like, vibration predominantly occurs at frequencies greater than 4 Hz and therefore specifies the following conservative vibration damage screening levels:

- Reinforced or heavy frame structures: 25 mm/s
- Unreinforced or light frame structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequency and dynamic characteristics of the structure would be required to determine the applicable safe vibration levels.

4.4.6 Minimum Working Distances for Vibration Intensive Works

Minimum working distances for typical vibration intensive construction equipment are provided in the RMS (now Transport for NSW) CNVG and are shown in **Table 9**. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA *Assessing Vibration: a technical guideline*). They are calculated from empirical data which suggests that where work is further from receivers than the quoted minimum distances then impacts are not considered likely.

Table 9 Recommended Minimum Working Distances from Vibration Intensive Equipment

Plant Item	Rating/Description	Minimum Distance		
		Cosmetic Damage		Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1–2 tonne)	5 m	11 m	15 m to 20 m
	<100 kN (2–4 tonne)	6 m	13 m	20 m
	<200 kN (4–6 tonne)	12 m	25 m	40 m
	<300 kN (7–13 tonne)	15 m	31 m	100 m
	>300 kN (13–18 tonne)	20 m	40 m	100 m
	>300 kN (>18 tonne)	25 m	50 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12 t excavator)	2 m	5 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18 t excavator)	7 m	15 m	23 m
Large Hydraulic Hammer	1,600 kg (18 to 34 t excavator)	22 m	44 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	5 m to 40 m	20 m
Piling Rig – Bored	≤ 800 mm	2 m (nominal)	5 m	4 m
Jackhammer	Hand held	1 m (nominal)	3 m	2 m

The minimum working distances are indicative and will vary depending on the particular item of equipment and local geotechnical conditions. The distances apply to cosmetic damage of typical buildings under typical geotechnical conditions.

5 Construction Noise and Vibration Assessment

A noise model of the study area has been used to predict noise levels from the proposed construction work to all surrounding receivers. The model uses ISO 9613 algorithms in SoundPLAN V8.2 software.

Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding areas.

5.1 Construction Activities

The construction activities required for the Project are shown in **Table 10**. Sound power levels for individual items of equipment and the overall activity are also shown in **Table 10**.

The assessment uses 'realistic worst-case' scenarios to determine the impacts from the noisiest 15-minute period that are likely to occur for each work scenario, as required by the ICNG.

5.2 Hours of Construction

Project construction hours will generally be limited to the ICNG Standard Construction Hours of:

- Monday to Friday 7:00am to 6:00pm; and
- Saturday 7:00am to 1:00pm

Due to the nature of the work, 10 out-of-hours work (OOHW) shifts (eg weekend or nights) will also be required for the culvert road crossings and asphalt paving scenarios (W.005 and W.008 in **Table 10**).

Table 10 Construction Activities

			Total Lw (dBA)	Compactor	Crane Franna (20t)	Dozer (CAT D9)	Elevated Work Platform - Scissor Lift	Excavator (35t) + Hammer[2]	Excavator - Tracked (20t)	Excavator - Tracked (30t)	Grader	Generator - attenuated	Line Marking Truck	Pavement Laying Machine	Roller - smooth drum	Roller - large pad foot	Roller - Vibratory[2]	Saw - Concrete[2]	Scraper	Truck - Medium Rigid (20t)	Truck - road truck (30t)	Tub Grinder/Mulcher (40-50hp)	Water Cart	Concrete agitator truck	Dump Truck (23t)	Chainsaw[2]
Sound Power Level (Lw)[1]				106	98	116	98	118	105	110	113	92	108	114	107	109	109	118	113	103	108	116	107	109	106	105
Estimated utilisation per period (%)				50%	30%	100%	30%	30%	100%	100%	100%	100%	100%	100%	100%	100%	100%	30%	100%	25%	25%	30%	50%	100%	25%	100%
ID	**Construction Scenario**	**Assessment Period**																								
W.001	Mobilisation and site establishment	Standard Hours	**104**		1														1	1						
W.002	Utility relocations	Standard Hours	**119**		1					1		1						1						1	1	
W.003	Corridor clearing	Standard Hours	**120**			1				1									1			1			1	2
W.004	Bulk earthworks	Standard Hours	**124**	1		1		1			1					1			1				1		1	
W.005	Drainage infrastructure	Standard Hours / OOHW	**117**		1					1							1				1			1		
W.006	Kerb and footpath	Standard Hours	**112**						1						1									1		
W.007	Subbase and base	Standard Hours	**115**								1				1						1		1			
W.008	Asphalting	Standard Hours / OOHW	**120**											1	1			1			1					
W.009	Road furniture installation	Standard Hours	**109**		1		1						1								1					

Note 1: Individual Sound Power Levels (Lw) for key activities have been adopted from the DEFRA Noise Database, AS2436, TfNSW *Construction Noise and Vibration Strategy*.

Note 2: The ICNG requires 'annoying' activities (eg saw operations) to have a 5 dB 'penalty' applied to the source sound power level.

5.3 Construction Noise

The following overview is based on the predicted impacts at the most affected receivers and is representative of the worst-case noise levels that are likely to occur during Project work.

The assessment shows the predicted impacts based on the exceedance of the management levels, as per the categories in **Table 11**.

Table 11 Exceedance Bands and Impact Colouring

Exceedance of RBL	Exceedance of Standard Hours NML	Exceedance of OOHW NML	Subjective Classification	Impact Colouring
1 to 10 dB	No exceedance	Up to 5 dB	Noticeable	
11 dB to 20 dB	1 to 10 dB	6 dB to 15 dB	Clearly Audible	
21 dB to 30 dB	11 dB to 20 dB	16 dB to 25 dB	Moderately intrusive	
>30 dB	>20 dB	>25 dB	Highly Intrusive	

Note 1: This subjective classification is indicative and follows the approach outlined in the CNVG.

A summary of the number of buildings where NML exceedances were predicted for the various work activities is shown in **Table 12** for standard construction hours, and **Table 13** for OOHW (which, as a worst-case scenario, is assumed to occur during the night-time). **Table 12** and **Table 13** also include a summary of the buildings that are not on lots that are subject to existing development applications and are therefore more likely to be occupied. Noise contour maps of the worst-case construction scenarios are presented in **Appendix C**.

The assessment is generally considered conservative as the calculations assume all items of construction equipment are in use at the same time within individual scenarios at the nearest location to each receiver. In reality, there would frequently be periods when construction noise levels are much lower than the worst-case levels predicted as well as times when no equipment is in use and no noise impacts occur.

Table 12 Overview of NML Exceedances – All Receiver Types (Standard Construction Hours)

Receiver Category	NCA	Number of Receivers (Number of Receivers not Subject to Development Applications)									
		Total	Exceedance Category[1]	With NML Exceedance[2]							
				Aldington and Abbotts Road Upgrades							
				W.001	W.002	W.003	W.004	W.005	W.006	W.007	W.008	W.009
Residential	NCA01	535 (161)	1-10 dB	12 (5)	3 (0)	5 (0)	3 (0)	3 (1)	8 (4)	3 (1)	3 (0)	14 (6)
			11-20 dB	1 (0)	14 (6)	11 (4)	7 (3)	16 (7)	10 (4)	16 (7)	14 (6)	3 (2)
			>20 dB	-	4 (2)	7 (4)	13 (5)	1 (0)	1 (0)	1 (0)	4 (2)	1 (0)
			HNA	-	**1 (0)**	**1 (0)**	**1 (0)**	-	-	-	**1 (0)**	-
	NCA02	51 (46)	1-10 dB	-	-	1 (1)	29 (29)	-	-	-	-	-
			11-20 dB	-	-	-	-	-	-	-	-	-
			>20 dB	-	-	-	-	-	-	-	-	-
			HNA	-	-	-	-	-	-	-	-	-
	NCA03	517 (431)	1-10 dB	11 (11)	13 (13)	13 (13)	1 (1)	14 (14)	11 (11)	14 (14)	13 (13)	11 (11)
			11-20 dB	2 (2)	11 (11)	10 (10)	14 (14)	10 (10)	8 (8)	11 (11)	11 (11)	2 (2)
			>20 dB	3 (3)	7 (7)	8 (8)	16 (16)	7 (7)	5 (5)	6 (6)	7 (7)	5 (5)
			HNA	-	**5 (5)**	**5 (5)**	**5 (5)**	**4 (4)**	**3 (3)**	**4 (4)**	**5 (5)**	**1 (1)**
	NCA04	115 (115)	1-10 dB	-	3 (3)	9 (9)	76 (76)	-	-	-	3 (3)	-
			11-20 dB	-	-	-	-	-	-	-	-	-
			>20 dB	-	-	-	-	-	-	-	-	-
			HNA	-	-	-	-	-	-	-	-	-
	NCA05	1 (1)	1-10 dB	-	-	-	1 (1)	-	-	-	-	-
			11-20 dB	-	-	-	-	-	-	-	-	-
			>20 dB	-	-	-	-	-	-	-	-	-
			HNA	-	-	-	-	-	-	-	-	-
	NCA06	34 (34)	1-10 dB	-	3 (3)	3 (3)	6 (6)	2 (2)	-	-	3 (3)	-
			11-20 dB	-	-	-	-	-	-	-	-	-
			>20 dB	-	-	-	-	-	-	-	-	-
			HNA	-	-	-	-	-	-	-	-	-
	NCA07	-	1-10 dB	-	-	-	-	-	-	-	-	-
			11-20 dB	-	-	-	-	-	-	-	-	-
			>20 dB	-	-	-	-	-	-	-	-	-
			HNA	-	-	-	-	-	-	-	-	-
Other Sensitive	All NCAs	-	1-10 dB	-	-	-	-	-	-	-	-	-
			11-20 dB	-	-	-	-	-	-	-	-	-
			>20 dB	-	-	-	-	-	-	-	-	-

Note 1: HNA = Highly Noise Affected, based on ICNG definition (ie predicted $L_{Aeq(15minute)}$ noise at residential receiver is 75 dBA or greater).

Note 2: Based on worst-case predicted noise levels.

Table 13 Overview of NML Exceedances – All Receiver Types (Out-of-Hours Work)

Receiver Category	NCA	Number of Receivers (Number of Receivers not Subject to Development Application)		
		Exceedance Category[1]	With NML Exceedance[2]	
			Aldington and Abbotts Road Upgrades	
			W.005	W.008
Residential	NCA01	1-5 dB	-	-
		6-15 dB	4 (0)	3 (0)
		16-25 dB	8 (4)	7 (3)
		> 25 dB	11 (4)	13 (5)
		SD	**19 (8)**	**23 (8)**
	NCA02	1-5 dB	28 (28)	11 (11)
		6-15 dB	14 (14)	32 (32)
		16-25 dB	-	-
		> 25 dB	-	-
		SD	-	-
	NCA03	1-5 dB	-	-
		6-15 dB	13 (7)	10 (5)
		16-25 dB	11 (9)	11 (8)
		> 25 dB	7 (4)	10 (7)
		SD	**23 (16)**	**31 (20)**
	NCA04	1-5 dB	87 (87)	98 (98)
		6-15 dB	9 (9)	32 (32)
		16-25 dB	-	-
		> 25 dB	-	-
		SD	-	**14 (14)**
	NCA05	1-5 dB	18 (18)	38 (38)
		6-15 dB	1 (1)	3 (3)
		16-25 dB	-	-
		> 25 dB	-	-
		SD	-	**4 (4)**
	NCA06	1-5 dB	35 (34)	46 (44)
		6-15 dB	29 (28)	42 (41)
		16-25 dB	3 (3)	4 (4)
		> 25 dB	-	-
		SD	**9 (9)**	**43 (42)**

Receiver Category	NCA	Number of Receivers (Number of Receivers not Subject to Development Application)		
		Exceedance Category[1]	With NML Exceedance[2]	
			Aldington and Abbotts Road Upgrades	
			W.005	W.008
	NCA07	1-5 dB	-	-
		6-15 dB	-	-
		16-25 dB	-	-
		> 25 dB	-	-
		SD	-	-
Other Sensitive	All NCAs	1-5 dB	-	-
		6-15 dB	-	-
		16-25 dB	-	-
		> 25 dB	-	-

Note 1: SD = Sleep Disturbance Screening Level, refer **Section 4.2** (ie predicted L_{Amax} noise at residential receiver is 52 dBA or greater).

Note 2: Based on worst-case predicted noise levels.

The assessment of the predicted worst-case noise levels in **Table 12** and **Table 13** shows:

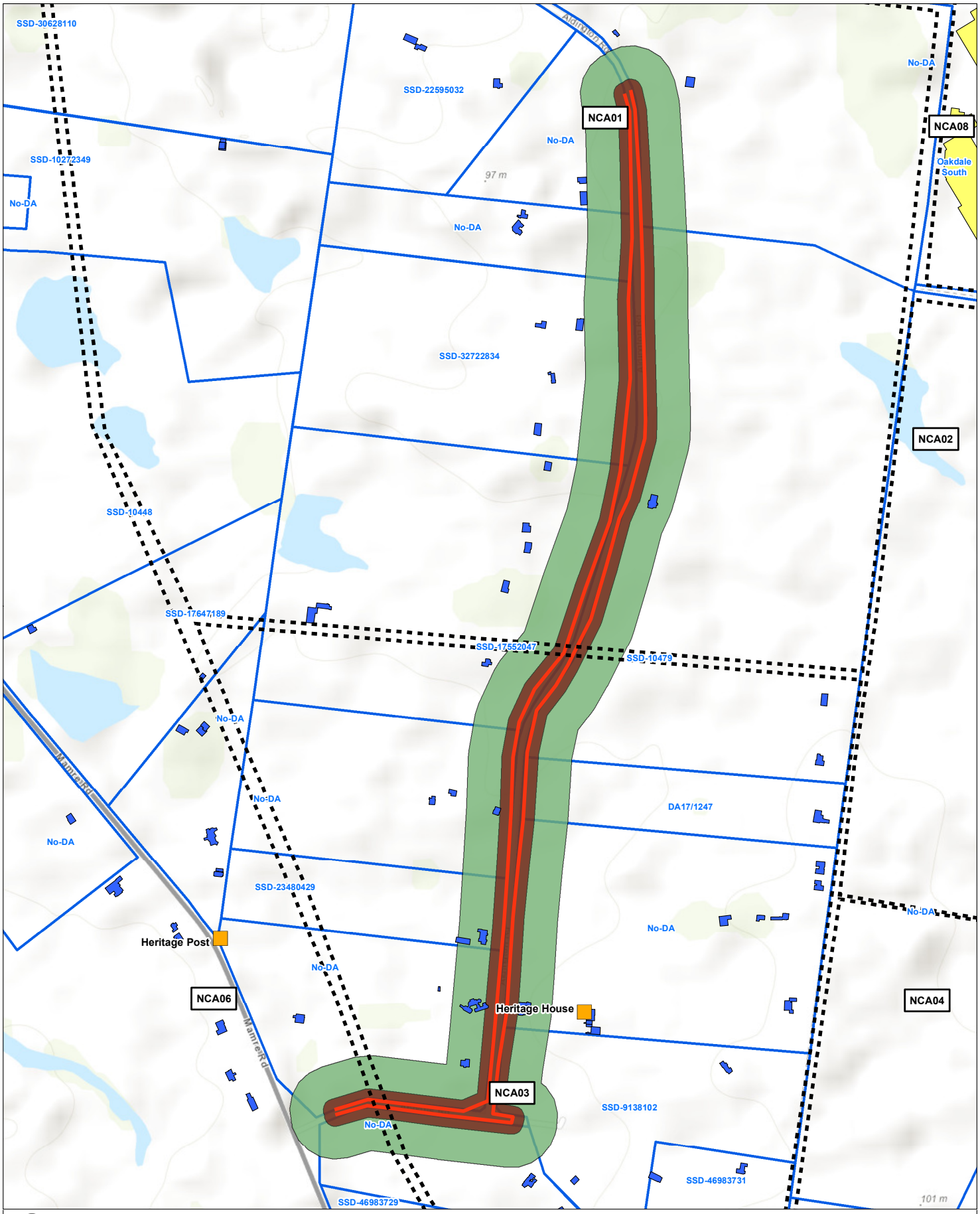
- The highest impacts are expected to occur where highly noise intensive activities are being undertaken (ie concrete sawing, hydraulic hammering and vibratory rolling). Where reasonable and feasible, these activities should be limited to the standard hours to avoid noise impacts during more sensitive out-of-hours periods (refer **Section 6**).
- Highly intrusive noise levels are predicted in NCA01 and NCA03 during standard construction hours for all scenarios (**Appendix C** shows worst case noise contour maps).
- The Highly Noise Affected (HNA) NML of 75 dBA, is also exceeded in NCA01 and NCA03 during standard construction hours for the majority of the scenarios.
- The majority of work scenarios will occur during the approved project hours. Two work scenarios are anticipated to occur during out-of-hours periods. These scenarios are W.005 and W.008.
- Highly intrusive noise levels are predicted in NCA01 and NCA03 during OOHW for W.005 and W.008 (**Appendix C** shows worst case noise contour maps).
- L_{AFmax} noise levels have the potential to exceed the sleep disturbance screening level at the closest residential receivers in NCA01, NCA03, NCA04, NCA05 and NCA06. L_{AFmax} noise levels are generally associated with highly noise intensive activities (ie concrete sawing, hydraulic hammering and vibratory rolling). Where reasonable and feasible, these activities should be limited to the less sensitive periods to avoid noise impacts during more sensitive out-of-hours periods (refer **Section 6**).

Recommended noise mitigation and management measures are discussed in **Section 6**.

5.4 Construction Vibration

Vibration intensive equipment required during construction include vibratory rollers and hydraulic hammers. Vibratory rollers will be used during *W.005 – Drainage Infrastructure*, and the hydraulic hammers will be used during *W.004 – Bulk Earthworks.*

Offset distances for the vibration intensive equipment have been determined from the CNVG minimum working distances for cosmetic damage and human response (see **Table 9**). Buildings within the minimum working distances are shown in **Figure 3** below. **Figure 3** has assumed the worst-case and considered the use of large hydraulic hammers and large vibratory rollers (ie >18 tonne).



0 150 300 m

Coordinate System:	GDA2020 MGA Zone 56
Scale:	1:11,250 at A4
Project Number:	610.31166
Date:	29-Mar-2023
Drawn by:	PW

LEGEND

- Heritage Items
- NCAs
- Aldington Rd Work Area
- Know Development Applications
- Human Comfort - 100m Buffer
- Cosmetic Damage - 25m Buffer

Receiver Type

- Residential
- Commerical
- Childcare Centre
- Educational
- Place of Worship

ALDINGTON AND ABBOTTS ROAD UPGRADE

VIBRATION ASSESSMENT

FIGURE 3

H:\Projects-SLR\610-Srv\SYD\610.31166.00000 Aldington Road Upgrade CNV Assessment fol\06 SLR Data\01 CAD\GIS\GIS\SLR61031166_F02_Aldington_Vibration_Assessment_03.mxd

Cosmetic Damage Assessment

The assessment in **Figure 3** shows that two (2) residential buildings near to the work are likely to be within the minimum working distance for cosmetic damage (25 m) when vibration intensive works are being completed adjacent to these buildings. Construction vibration mitigation measures are discussed in **Section 6**.

Human Comfort Vibration Assessment

The assessment shows that seven (7) additional receivers are also within the human comfort minimum working distances (100 m) and occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Of these seven receivers, three are on lots that are subject to existing development applications and are therefore likely to be unoccupied. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby. Construction vibration mitigation measures are discussed in **Section 6**.

6 Mitigation and Management Measures

The ICNG acknowledges that due to the nature of construction works it is inevitable that there will be impacts where construction is near to sensitive receivers. All appropriate feasible and reasonable mitigation measures must be applied to the work to minimise the potential impacts, as far as practicable.

6.1 Standard Mitigation and Management Measures

The mitigation and management measures that should be applied to the project are detailed in **Table 14**.

Table 14 Environmental Management Controls for Construction Noise and Vibration

Measure	Person Responsible	Timing / Frequency	Reference / Notes
Project Planning			
Use quieter and less vibration emitting construction methods where feasible and reasonable.	Project Manager	Ongoing	Best practice
The majority of work will be completed during standard daytime construction hours outlined in **Section 5.2**. Where OOHW is required, highly noise intensive activities should be scheduled for less sensitive periods.			
Truck routes to site will be limited to Mamre Road. Trucks should access the site from Abbotts Road rather than Bakers Lane.			
Scheduling for High Noise or Vibration Generating Works			
High-noise or vibration generating works will be carried out in continuous blocks no longer than three hours in length, with a minimum respite period of one hour between each block. 'Continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing these works.	Project Manager/ Communications and Community Liaison Representative	Ongoing	Best practice
Site Layout			
Compounds and worksites will be designed to promote one-way traffic and minimise the need for vehicle reversing.	Project Manager	Ongoing	Best practice

Measure	Person Responsible	Timing / Frequency	Reference / Notes
Where practicable, work compounds, parking areas, and equipment and material stockpiles will be positioned away from noise-sensitive locations and take advantage of existing screening from local topography.			
Documentation of how site layout has been considered to reduce noise impacts must be provided to the Contractor's Project Manager. This must occur any time there are significant changes to the site layout.			
Equipment that is noisy will be started away from sensitive receivers			
Training			
Training will be provided to all personnel on noise and vibration requirements for the project. Inductions and toolbox talks to be used to inform personnel of the location and sensitivity of surrounding receivers.	Project Manager	Ongoing	Best practice
Plant and Equipment Source Mitigation			
All plant and equipment must be maintained in a proper and efficient condition, operated in a proper and efficient manner, and feature standard noise amelioration measures where applicable.	Project Manager	Ongoing	Best practice
Where practicable, tonal reversing alarms (beepers) will be replaced with non-tonal alarms (squawkers) on all equipment in use (subject to occupational health and safety requirements).			
Noisy equipment will be sited behind structures that act as barriers, or at the greatest distance from the noise-sensitive area. Equipment will be oriented so that noise emissions are directed away from any sensitive areas, where possible.			
Noise generating equipment will be regularly checked and effectively maintained, including checking of hatches/enclosures regularly to ensure that seals are in good condition and doors close properly against seals.			
Noise monitoring spot checks of equipment will be completed to ensure individual items are operating as expected			
Dropping materials from a height will be avoided.			
Loading and unloading will be carried out away from noise sensitive areas, where practicable.			
Trucks will not queue outside residential properties. Truck drivers will avoid compression braking as far as practicable.			
Truck movements will be kept to a minimum, ie trucks are fully loaded on each trip.			
Screening			
Where possible, install purpose-built screening or enclosures will be used around long-term fixed plant that has the potential to impact nearby receivers	Project Manager	Ongoing	Best practice

Measure	Person Responsible	Timing / Frequency	Reference / Notes
The layout of the site will take advantage of existing screening from local topography, where possible. Site huts, maintenance sheds and/or containers will be positioned between noisy equipment and the affected receivers.			
Complaints Management			
Where complaints are received, work practices will be reviewed and feasible and reasonable practices implemented to minimise any further impacts.	Communications and Community Liaison Representative	Ongoing	Best practice
Monitoring			
Noise and/or vibration monitoring will be conducted (as appropriate) when noise/vibration intensive works are being undertaken in close proximity to sensitive receivers.	Environmental Coordinator	Ongoing	Best practice
Noise and/or vibration monitoring will be conducted (as appropriate) in response to any complaints received to verify that levels are not substantially above the predicted levels.			
Vibration			
If vibration generating works are required within the minimum cosmetic damage working distances and considered likely to exceed the criteria: • Different construction methods with lower source vibration levels will be investigated and implemented, where feasible • Attended vibration measurements will be undertaken at the start of the works to determine actual vibration levels at the item. Works will cease if the monitoring indicates vibration levels are likely to, or do, exceed the relevant criteria.	Environmental Coordinator	Ongoing	Best practice
Where works are required within the cosmetic damage minimum working distances, building condition surveys will be completed before and after the works to ensure no cosmetic damage has occurred.			

6.2 Additional Mitigation Measures

Where the 'mitigated' construction noise levels remain above the noise management levels (NMLs), the Additional Mitigation Measures Matrix (AMMM) identified in the CNVG is to be implemented. The approach, guided by the AMMM, is primarily aimed at pro-active engagement with affected sensitive receptors rather than additional noise reducing mitigation.

The AMMM applies to all receptor types where these receptors are in-use. The types of additional mitigation measures are listed in **Table 15**. The AMMM for construction noise are identified in **Table 16**.

Table 15 Additional Noise Mitigation Measures

Mitigation / Management Measure	Abbreviation
Alternative Accommodation	AA
Respite offers	RO
Respite Period 1	R1
Respite Period 2	R2
Duration Respite	DR
Notification (letterbox drop or equivalent)	N
Specific notifications	SN
Phone calls	PC
Individual briefings	IB
Verification Monitoring	V

Note 1: Refer to the CNVG for further details on additional noise mitigation measures.

Table 16 Additional Mitigation Measures Matrix - Construction Noise

Construction Hours	Receiver Perception	Noise Level above RBL (dBA)	Noise Level above NML (dBA)	Additional Measures
Standard Hours Mon-Fri (7am - 6pm) Saturdays (8am - 1pm)	Noticeable	5 to 10	0	-
	Clearly Audible	>10 to 20	<10	-
	Moderately intrusive	>20 to 30	>10 to 20	N, V
	Highly Intrusive	>30	>20	N, V
	75 dBA or greater[1]	N/A	N/A	N, V, PC, RO
Out-of-Hours Work (OOHW) Period 1 Mon-Fri (6pm - 10pm) Saturdays (7am-8am) and (1pm- 10pm) Sundays/Public Holidays (8am-6pm)	Noticeable	5 to 10	<5	-
	Clearly Audible	>10 to 20	5 to 15	N, R1, DR
	Moderately intrusive	>20 to 30	>15 to 25	V, N, R1, DR
	Highly Intrusive	>30	>25	V, IB, N, R1, DR, PC, SN
Out-of-Hours Work (OOHW) Period 2 Mon-Fri (10pm - 7am) Saturdays (10pm - 8am) Sundays/Public Holidays (6pm - 7am)	Noticeable	0 to 10	<5	N
	Clearly Audible	>10 to 20	5 to 15	V, N, R2, DR
	Moderately intrusive	>20 to 30	>15 to 25	V, IB, N, PC, SN, R2, DR
	Highly Intrusive	>30	>25	AA, V, IB, N, PC, SN, R2, DR

Note 1: Only applies at residential receivers.

What this means in practice is:

- The Notification (N) mitigation measure should be applied to all receivers that have noise impacts greater than 10 dB above the NML during the daytime.

- The Verification (V) mitigation measure should be applied for each of the activities. Measurements of the sound power level of each item shown in **Table 10** should be undertaken upon commencement of the use of that item of equipment. Monitoring should also be undertaken at the nearest sensitive receiver to the work upon the commencement of new activities and the measured levels compared with the predicted impacts in **Table 12** and **Table 13** and **Appendix C**.
- Phone calls (PC) and Respite offers (RO) should be provided for receivers where noise levels are predicted at 75 dBA or greater. As a guide, work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers.
- Where OOHW is required, additional measures would be required as outlined in **Table 16**. For example, highly intrusive noise levels during OOHW period 1 would require the following: V, IB, N, R1, DR, PC, SN. Further detail and guidance on the implementation of these management measures is provided the CNVG, but importantly:
  - Works during the evening periods of OOHW Period 1 can only occur for three consecutive evenings before a four day break is required.
  - Works during OOHW Period 2 can only occur for two consecutive nights before a five day break is required.
  - The receivers that are subjected to at least “moderately intrusive” impacts during the night-time, or “highly intrusive” during the evening period would require specific community consultation measures such as individual briefings, specific notifications and phone calls. The extent of these specific community consultation measures should be detailed as part of the Construction Noise and Vibration Management Plan for the works.
  - The receivers that are subjected to “highly intrusive” impacts during the night-time will require the consideration of Alternative Accommodation. Whether Alternative Accommodation is reasonable and feasible should be determined on a case-by-case basis.
- The receivers that are subjected to at least “moderately intrusive’ noise impacts during the night-time are mostly located within the Mamre Road precinct, with the exception of some receivers on the western side of Mamre Road. Whether community consultation or Alternative Accommodation is required will depend on whether the receiver is occupied at the time of the works. As noted in **Section 2.2**, the status of residential receivers could change at short notice. It is expected that most of the receivers on lots subject to existing Development Applications are unoccupied, and that more receivers in the Mamre Road precinct will become unoccupied in the future due to land acquisitions and subsequent development. Consequently the extent of additional mitigation measures will depend heavily on the timing of the works.

7 Conclusion

SLR has been engaged to assess the potential noise and vibration impact from the Aldington and Abbotts Road Upgrade, located in Kemps Creek, NSW.

Noise emissions from the Project have been predicted to the surrounding receivers and noise levels are expected to exceed noise management levels (NMLs) for the closest receivers throughout all work scenarios. Where highly noise intensive works are scheduled, the closest receivers are predicted to exceed the Highly Noise Affected (HNA) NML (ie >75 dBA).

The majority of Project work will be undertaken during standard construction hours to minimise impacts on nearby receivers. Two work scenarios are anticipated to occur during out-of-hours periods. These scenarios are 'W.005 - Drainage infrastructure' and 'W.008 – Asphalting'. Where out-of-hours are required, noise levels are predicted to exceed NMLs for the closest receivers, with highly intrusive impacts expected in NCA01 and NCA03.

The construction vibration assessment identified that two residential buildings near to the work are likely to be within the minimum working distance for cosmetic damage when vibration intensive works are being completed adjacent to these buildings.

The vibration assessment identified that seven additional receivers are also within the human comfort minimum working distances and occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby.

A number of best-practice mitigation and management measures have been recommended to be applied, where feasible and reasonable, to control and minimise the impacts during construction as far as practicable.

Where the 'mitigated' construction noise levels remain above the noise management levels (NMLs), the Additional Mitigation Measures (AMM) identified in the *Construction Noise and Vibration Guideline* (CNVG) (Roads and Maritime Services, 2016) should be implemented.

Appendix A:

Acoustic Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

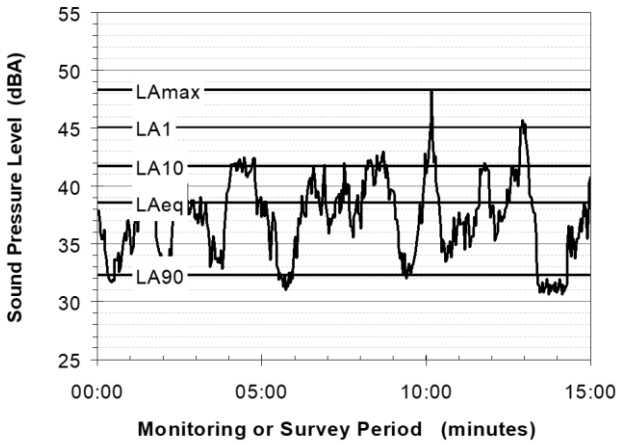
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

LAmax The A-weighted maximum sound pressure level of an event measured with a sound level meter.

5. Frequency Analysis

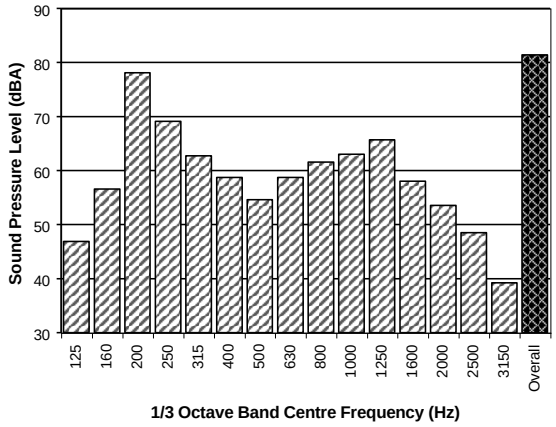
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

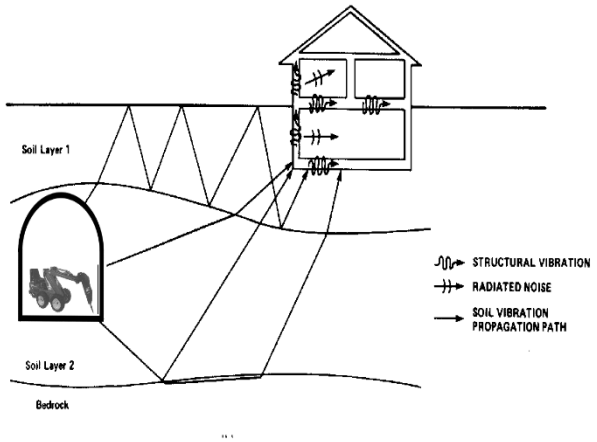
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

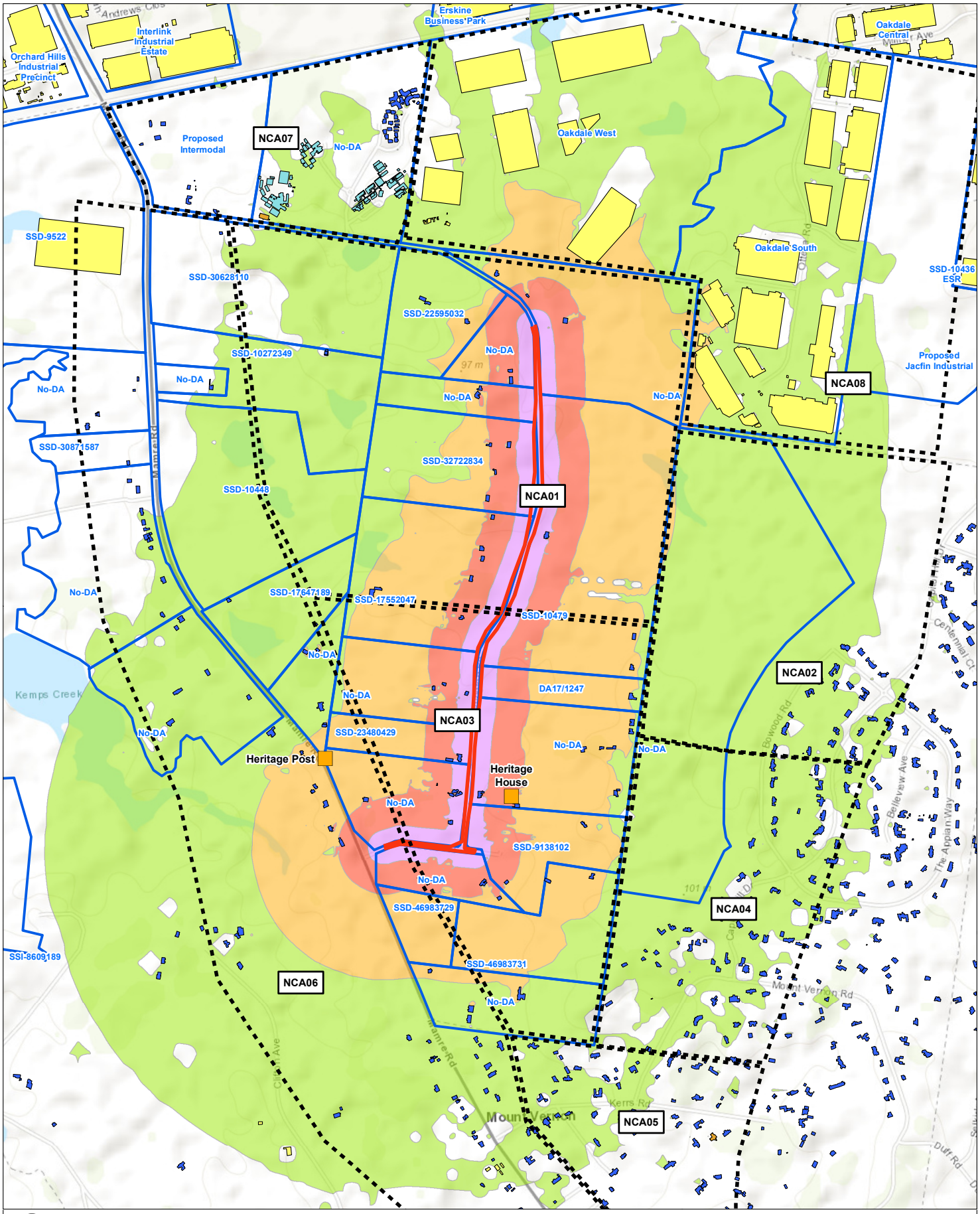
The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

Appendix B:

Noise Contour Maps



0 150 300 m

Coordinate System:	GDA2020 MGA Zone 56
Scale:	1:22,000 at A4
Project Number:	610.31166
Date:	29-Mar-2023
Drawn by:	PW

LEGEND

- Heritage Items
- NCAs
- Know Development Applications
- Aldington Rd Work Area

Receiver Type

- Residential
- Commerical
- Childcare Centre
- Educational
- Place of Worship

Predicted Noise Level (dBA)

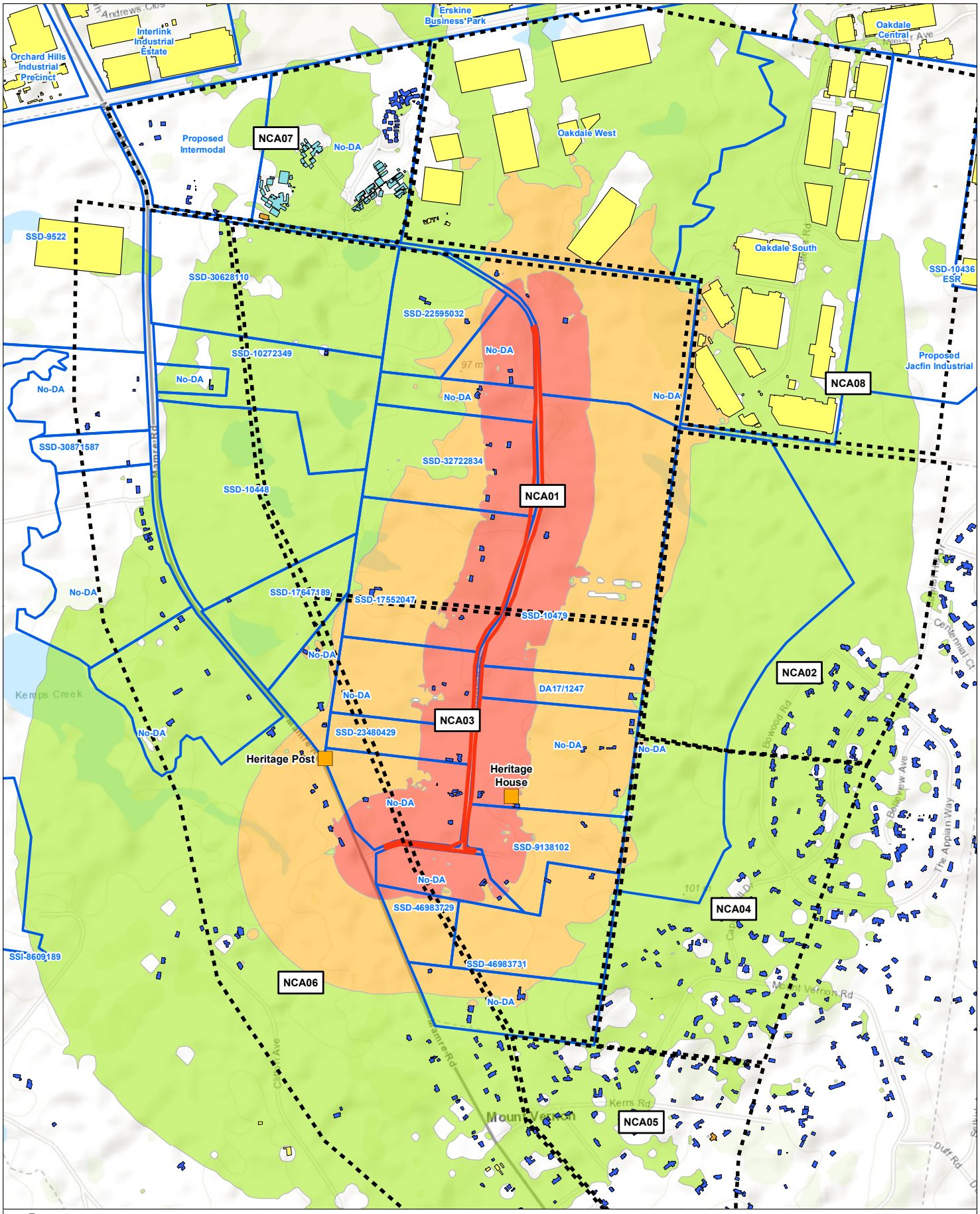
- 45 - 55 dBA (Clearly Audible)
- 55 - 65 dBA (Moderately Intrusive)
- 65 - 75 dBA (Highly Intrusive)
- >75 dBA (Highly Noise Affected)

ALDINGTON AND ABBOTTS ROAD UPGRADE

NOISE CONTOUR WORST CASE (W.004) STANDARD HOURS

APPENDIX B

H:\Projects-SLR\610-Srv\SYD\610.31166.00000 Aldington Road Upgrade CNV Assessment fol\06 SLR Data\01 CAD\GIS\GIS\SLR61031166_APPB_Aldington_Noise_Contour_StandardHours_W004_03.mxd



0 150 300 m

Coordinate System:	GDA2020 MGA Zone 56
Scale:	1:22,000 at A4
Project Number:	610.31166
Date:	29-Mar-2023
Drawn by:	PW

LEGEND

- Heritage Items
- NCAs
- Know Development Applications
- Aldington Rd Work Area

Receiver Type

- Residential
- Commerical
- Childcare Centre
- Educational
- Place of Worship

Predicted Noise Level (dBA)

- 40 - 50 dBA (Clearly Audible)
- 50 - 60 dBA (Moderately Intrusive)
- >60 dBA (Highly Intrusive)

ALDINGTON AND ABBOTTS ROAD UPGRADE

NOISE CONTOUR OUT-OF-HOURS WORK WORST CASE (W.008) OOHW

APPENDIX B

H:\Projects-SLR\610-Srv\SYD\610.31166.00000 Aldington Road Upgrade CNV Assessment fol\06 SLR Data\01 CAD\GIS\GIS\SLR61031166_APPB_Aldington_Noise_Contour_OOHW_W008_03.mxd

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