Alexandria Health Centre

28-32 Bourke Road, Alexandria, Sydney

Stage 2 SSDA Acoustic and Vibration Assessment Report

Prepared for: Centuria Healthcare Pty. Ltd.

Document no: NA230327

Issue no: 3

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REVISIONS

Revision	Date	Purpose	Prepared By	Approved By
1	30/10/2023	SSDA Acoustic Assessment Report	Mahbub Sheikh / Pablo Reboredo Gasalla	M. Sheikh
2	30/10/2023	SSDA Acoustic Assessment Report	Mahbub Sheikh / Pablo Reboredo Gasalla	M. Sheikh
3	23/11/2023	SSDA Acoustic Assessment Report	Mahbub Sheikh / Pablo Reboredo Gasalla	M. Sheikh

Review Panel	
Division/Office	**Name**
Acoustics/Melbourne	Pablo Reboredo Gasalla
Acoustics/Sydney	Mahbub Sheikh

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Executive Summary

ACOR Consultants Pty Ltd (ACOR) have been engaged by Centuria Healthcare Pty Ltd to provide acoustic and vibration consulting services for the proposed development of Alexandria Health Centre, to be located at 28-32 Bourke Road, Alexandria, NSW.

- The purpose of this report is to provide an acoustic and vibration assessment for the Stage 2 State Significant Development Application (SSDA) and it has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-59006709) dated 8 June 2023. Specifically, this report has been prepared to respond to the SEARs requirement issued in the table below.

SEAR	Expected Deliverables
12. Noise and Vibration Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protect Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented	Noise and Vibration Impact Assessment

- Report presents key design acoustic considerations and provide preliminary design recommendations to achieve design indoor sound levels as required by the AS 2107:2016, NSW Health Guide 2022, State Environmental Planning Policy (Transport and Infrastructure) 2021 and Development Near Rail Corridor and Busy Roads Guideline 2008.
- The current noise and vibration environment at the project site were measured by ACOR at several locations around the site to assess potential external noise and vibration impacts on Alexandria's operation. The noise environment is dominated by road traffic along Bourke Road (North) and O'Riordan Street (South), commercial buildings, light industrial activities and mechanical plant/equipment from surrounding buildings.
- Based on the measured noise levels on site and our 3D acoustic model for the proposed development; the minimum requirement for the north façade glazing would be R_w/R_{w+Ctr} 37/34. The remainder of the glazing should be R_w/R_{w+Ctr} 36/32. Solid façade walls are recommended to provide a minimum sound insulation of R_w50.
- The vibration monitoring indicated that the dominant external sources were passenger trains movements from adjacent infrastructure; Airport and South Rail Line T8 underground tunnel. The assessment indicates that external vibration complies with established vibration criteria and the risk of vibration impact to the proposed facility from external sources is low. Therefore, no additional structural isolation or vibration attenuation measures are considered necessary to mitigate external vibration ingress.
- Noise and vibration generated by the proposed development, including construction, is addressed in this report as a preliminary assessment in accordance with relevant guidelines and standards.
- Noise emissions via mechanical services from the proposed development are required to comply with the Noise Policy for Industry (NPfI) criteria at all nearest sensitive receivers, including premises within the development. Mechanical plant and equipment were not finalised at the time of this assessment. This is typical for DA stage of a development and the mechanical design will be further reviewed when project stages further progress. To comply with the NPfI noise requirements, acoustic criteria provided in Table 8-1 should be satisfied for this project. Details of the operational noise and vibration assessment and management plan is provided in Section 8.
- Based on the preliminary construction noise assessment, predicted construction noise levels would satisfy the ICNG recommended Noise Management Level (Noise Affected) at the residential receivers.

However, noise levels at the nearby commercial premises would be exceeding the recommended levels. Details on the construction noise and vibration assessment and management plan is provided in Section 9.

- As part of the vibration control measures, vibration monitoring is recommended during construction phase at strategic locations, mainly during rock breaking activities, excavation, and drilling of the ground, piling process, construction of the basement and ground levels or other related construction activity that may affect adjacent structures.
- This report and recommendations should be further developed in consultation with the client and relevant engineering disciplines in further stages of the project. It is predicted that the proposed development would achieve the relevant noise criteria, provided the design recommendations are implemented.

1 Introduction

ACOR Consultants Pty Ltd (ACOR) have been engaged by Centuria Healthcare Pty Ltd (C/- Johnstaff Projects) to provide acoustic and vibration consulting services for the proposed development of Alexandria Health Centre, to be located at 28-32 Bourke Road, Alexandria, NSW.

The site currently accommodates a single storey warehouse building used for the purposes of vehicle repairs, which is proposed to be demolished for the redevelopment of Alexandria Health Centre.

The project comprises a multi-purpose health facility anchored by a mental health hospital with medical centre space located on lower levels to be occupied by allied health providers. The facility will provide services targeted at privately insured patients aged 18+ with mood disorders, anxiety disorders, and those with comorbid drug and alcohol disorders. The facility will provide both inpatient and outpatient services to suit the specific needs of the patients.

Location of the project site is shown in Figure 1-1.

Figure 1-1 Location of the project site (Source: Six Maps NSW)

The purpose of this report is to provide an acoustic assessment required for the Stage 2 State Significant Development Application (SSDA) for the project, including the NSW Department of Planning and Environment's Secretary's Environmental Assessment Requirements (SEAR) and Concept Conditions of Consent as presented in Table 1-1 Secretary's Environmental Assessment Requirements (SEAR)

SEAR	Expected Deliverables
12. Noise and Vibration Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protect Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented	Noise and Vibration Impact Assessment

Table 1-2 Concept Conditions of Consent

Concept Conditions of Consent	Expected Deliverables
B26. Future development application(s) must be accompanied by a Noise and Vibration Impact Assessment (NVIA), prepared by a suitably qualified professional, including (but not limited to): (a) quantitative assessment of the main noise generating sources and activities during operation; and (b) any management and mitigating measures necessary to ensure the amenity of future sensitive land uses on the site and neighbouring sites is protected during the operation of the development	Noise and Vibration Impact Assessment
B44(b) Construction Noise and Vibration Impact Assessments (CNVMP) providing a quantitative assessment of the main noise generating sources and activities during construction, impacts of construction noise/vibration on surrounding sensitive receivers and relevant management and mitigation measures to reduce adverse impacts due to construction noise and vibration	Construction Noise and Vibration Impact Assessments

and Table 1-2.

The design will be reviewed, and recommendations updated as the project progresses.

Table 1-1 Secretary's Environmental Assessment Requirements (SEAR)

SEAR	Expected Deliverables
12. Noise and Vibration Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protect Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented	Noise and Vibration Impact Assessment

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B44(b) Construction Noise and Vibration Impact Assessments (CNVMP) providing a quantitative assessment of the main noise generating sources and activities during construction, impacts of construction noise/vibration on surrounding sensitive receivers and relevant management and mitigation measures to reduce adverse impacts due to construction noise and vibration	Construction Noise and Vibration Impact Assessments

2 Site Analysis and Project Description

The proposed development would be located at 28-32 Bourke Road, Alexandria. Buildings surrounding the proposed development are typically commercial and light industrial in nature. The surrounding land uses include:

- North: Various light industrial and retail uses, including an NSW Fire and Rescue facility.
- East: Directly adjoining the site is 26 Bourke Road which comprises a single storey warehouse building (currently a café). Further east of the site is the Green Square Town Centre. The Town Centre contains critical infrastructure such as the Green Square Railway Station and various other commercial/retail uses.
- South: 13 Cabs Alexandria is located on the immediate southern boundary of the site.
- West: 34-42 Bourke Road comprises a two-storey warehouse building that is owned and operated by the City of Sydney Council. West of the site is a mix of industrial and warehouse development.

A zoning map around the proposed development site is shown in Figure 2-1 below.

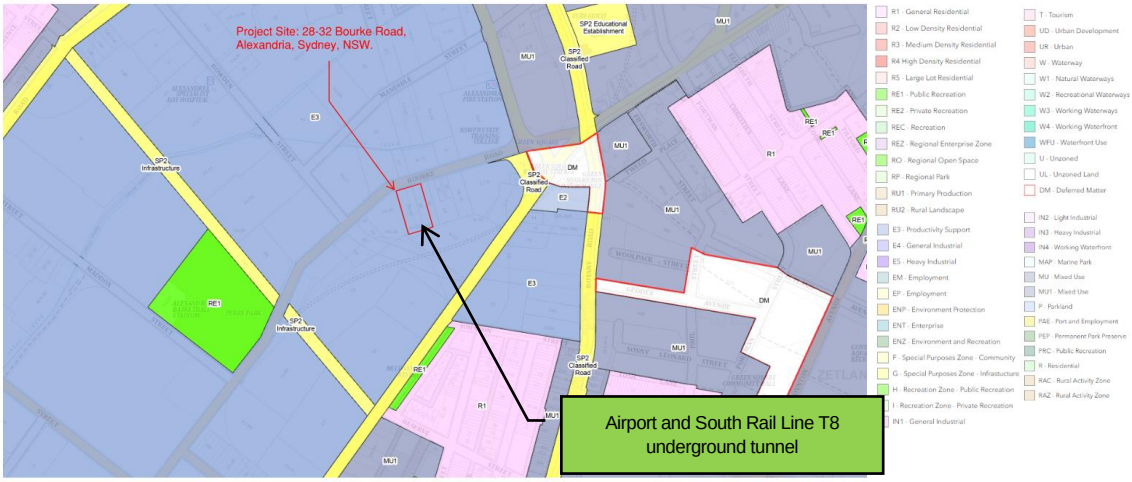


Figure 2-1: Zoning map (Source NSW Planning Portal)

Based on the preliminary information provided by the client, it is understood that the project would comprise of the following:

- Basement: Carparking bays and fire pump room.
- Ground Level: Parking, ambulance bay, admin offices, reception, hospital lobby, loading bay, plant room, and Pharmacy/Medical Tenancy.
- Level 1 to Level 3: Medical centre (Warm Shell – No fit-out).
- Level 4: A day hospital facility comprising of Consultation Rooms, Clinical rooms, Offices, Group Therapy Rooms, Exercise Room, Dining Area, Executive Offices or similar.
- Level 5 to Level 6: Mental Health Hospital including beds and ensuite for accommodations, staff stations and amenities.
- Level 7: Rooftop plant.

The proposed development site is located along Bourke Road, which is a busy road. Therefore, noise from Bourke Road would be a key consideration for the design of the proposed development. Also, the southern boundary of the proposed development is in close to Airport and South Rail Line T8 underground tunnel. Therefore, ground-borne vibration impact from the underground tunnel into the building would be an important consideration to investigate. The project site is located outside ANEF 20-25 noise contour of Sydney Airport, therefore aircraft noise on project site would not require an assessment and design for aircraft noise intrusion into the building.

3 Regulations, Standards and Guidelines

The following regulations, standards, and guidelines have been referred to in relation to the noise and vibration impact assessment performed for this project:

- NSW EPA Noise Policy for Industry 2017 (NPI).
- NSW State Environmental Planning Policy (Transport and Infrastructure) 2021.
- NSW EPA Noise Guide for Local Government (NGLG).
- NSW EPA Approved Methods for the Measurement and Analysis of Environmental Noise in NSW.
- AS 1055:2018 – Acoustics – Description and measurement of environmental noise (AS 1055).
- NSW Health – Engineering Services Guide 2022.
- NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006).
- Green Star Buildings v1-Revision B.
- Australian/New Zealand Standard AS/NZS 2107: 2016 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors (AS 2107).
- Protection of the Environmental Operations (Noise Control) Regulations 2017 (POEO).
- NSW RMS Construction Noise and Vibration Guideline – August 2016.
- EPA NSW Interim Construction Noise Guidelines (ICNG) 2009.
- Association of Australasian Acoustical Consultants (AAAC) Guideline for Healthcare Facilities Version 2.0.
- BS ISO 14837-1:2005 Mechanical vibration – Ground-borne noise and vibration arising from rail systems – Part 1: General guidance.
- BS ISO 2631-1:1997 Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration Part 1: General Requirements.
- ISO 2631-2:2003(E) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 2: Vibration in buildings (1 Hz to 80 Hz).
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE Applications Handbook – Chapter 49 Noise & Vibration control).
- Australian Standard AS 2670.2:1990 Evaluation of human exposure to whole-body vibration, Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz). N.B. – Please note that this standard was superseded by Australian Standard ISO 2631.2:2014 Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration, Part 2: Vibration in buildings (1 to 80 Hz); however, it is accepted practice within the Australian market to adopt the multiplying factors (R) as presented in Table 2 Appendix A (AS 2670.2:1990) for building vibration from human comfort.
- DIN Standard 4150-3 2016-12 – Vibration in Buildings – Part 3: Effects on Structures.
- British Standard BS 7385-2:1993 “Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration”.
- BS 6472-1:2008 – Guide to evaluation of human exposure to vibration in buildings - Vibration sources other than blasting.
- BS ISO 148371-1 Mechanical Vibration - Ground-borne Noise and Vibration arising from Rail Systems - Part 1: General Guidance.

4 Reference Documents

Table 4-1 below shows the documents referred to during the assessment.

Table 4-1 Reference documents

Document Name	Drawing/Doc No.	Revision	Discipline	Prepared By	Date
DA-A05.001[A]_AREA PLANS - GFA	DA-A05.001	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A05.002[A]_AREA PLANS - NUA	DA-A05.002	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.102[A]_LEVEL 02 GENERAL ARRANGEMENT PLAN	DA-A10.102	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.107[A]_LEVEL 07 GENERAL ARRANGEMENT PLAN	DA-A10.107	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A01.002[A]_PROPOSED SITE PLAN	DA-A01.002	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.101[A]_LEVEL 01 GENERAL ARRANGEMENT PLAN	DA-A10.101	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.103[A]_LEVEL 03 GENERAL ARRANGEMENT PLAN	DA-A10.103	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A11.108[A]_ROOF GENERAL ARRANGEMENT PLAN	DA-A11.108	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A30.001[A]_EAST - WEST SECTION	DA-A30.001	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A02.001[A]_EXISTING SITE PLAN	DA-A02.001	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.100M[A]_GROUND FLOOR MEZZANINE GENERAL ARRANGEMENT PLAN	DA-A10.100	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A30.002[A]_NORTH - SOUTH SECTION	DA-A30.002	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.100[A]_GROUND FLOOR GENERAL ARRANGEMENT PLAN	DA-A10.100	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.104[A]_LEVEL 04 GENERAL ARRANGEMENT PLAN	DA-A10.104	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.106[A]_LEVEL 06 GENERAL ARRANGEMENT PLAN.pdf	DA-A10.106	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A10.105[A]_LEVEL 05 GENERAL ARRANGEMENT PLAN	DA-A10.105	-	Architectural	Warren and Mahoney	19/10/2023

Document Name	Drawing/Doc No.	Revision	Discipline	Prepared By	Date
				Architects	
DA-A10.B01[A]_BASEMENT GENERAL ARRANGEMENT PLAN	DA-A10.B01	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A20.002[A]_EAST ELEVATION	DA-A20.002	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A01.001[A]_LOCATION PLAN	DA-A01.001	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A20.004[A]_WEST ELEVATION	DA-A20.004	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A20.001[A]_NORTH ELEVATION.pdf	DA-A20.001	-	Architectural	Warren and Mahoney Architects	19/10/2023
DA-A20.003[A]_SOUTH ELEVATION	DA-A20.003	-	Architectural	Warren and Mahoney Architects	19/10/2023

5 Current Noise and Vibration Environment

5.1 Current Noise Environment

The current noise environment at the project site is dominated by noise from road traffic along Bourke Road (North) and O'Riordan Street (South), commercial and light industrial activities at the surroundings and mechanical plant/equipment noise from all surrounding buildings.

5.1.1 On Site Noise Measurements

Attended measurements were conducted on 3rd October 2023 at various locations around the project site to determine the ambient noise profile and impacts to the development via airborne & vibration sources.

Attended noise measurements were conducted over short durations recording in continuous with a logging interval of 1 second to capture passenger and traffic noise over different time intervals. Noise levels were measured in terms of L_{Amax}, L_{A10}, L_{A90}, L_{Aeq} and L_{Amin} sound pressure levels during peak hour in order to obtain a sample of the highest-noise exposure levels on the project site.

The noise monitoring equipment was calibrated prior to commencement of the measuring period and at the completion of the monitoring. Photographs illustrating environmental noise measurement locations are presented in Figure 5-1.

Figure 5-1 : Noise measurement locations

5.1.2 Methodology

The noise logger was configured to record continuous sound pressure levels over a recurring period of 15 minutes during the measurement period. Measured data was stored for the measurement parameters L_{A10}, L_{A90}, L_{Aeq}, and L_{Amax} during each 15-minute period. Logging was done in A-weighted fast response mode.

The instruments used for attended and unattended measurements are listed in Table 5-1. The equipment was field-calibrated before and after all measurements, with no significant drift (± 0.5 dB(A)) in calibration level. All instruments have been internally calibrated in NATA certified laboratories and hold current and traceable calibration certificates.

Table 5-1 Instrument details

Instrument Name	Make/Model	Serial No.	Equipment Use
Sound Level Meter (Type 1)	NTi XL2	A2A-18927-E0	Attended measurements ambient noise and traffic noise measurement
Noise Logger (Type 1)	NTi XL2	A2A-18956-E0	Noise logging for background and traffic noise measurements
Acoustic Calibrator	Larson Davis Cal 200	18644	Field calibration of equipment

Measurements were undertaken in general accordance with AS 1055 and NSW EPA Approved Methods for the Measurement and Analysis of Environmental Noise in NSW.

Meteorological data from during the measurement period was collected from the Bureau of Meteorology (BOM) website for Sydney Airport weather station and can be seen in Appendix B . NPfI states that noise data affected by adverse meteorological conditions (wind speed >5m/s or rain) should be excluded from calculations. During the measurement period there were instances of rain according to the BOM, however there was no significant wind on the subject site during the measurement period. Rain affected noise data was removed from the assessment, this occurred on 5th October.

The meteorological parameters measured during the noise measurement period on site were as follows:

- Temperature: 35.2 ^{O}C.
- Wind Speed: 0.8m/s.
- Humidity: R.H. 16%.

5.1.3 Attended Noise Measurement Results

The results for the short-term noise measurements are shown in Table 5-2. Locations of short-term (15 minutes) attended noise measurements are provided in Figure 5-1.

Table 5-2 Short term noise measurement results summary

Location	Description	Time (Hr:Min)	L_{eq}, dBA	L_{AFmax}, dBA	L_{90}, dBA	Comments and Observations
L1	Attended 15-minute traffic noise measurement at the northern boundary at the road kerb (along Bourke Road).	08:00 to 08:15	70	89	58	Morning peak period traffic noise. Measured traffic noise level is dominated by road traffic along Bourke Road, some car parking noise at nearby places, people walking past and talking.
L2	Attended 15-minute traffic noise measurement at the road kerb near northern boundary of the site (along Bourke Road).	08:16 to 08:31	69	87	57	
L3	Attended 15-minute traffic noise measurement at the northern boundary of the site (at road kerb along Bourke Road).	08:36 to 08:51	71	88	60	Morning peak period traffic noise. Measured traffic noise level is dominated by road traffic along Bourke Road
		15:05 to 15:20	69	87	56	Afternoon peak period traffic noise. Measured traffic noise level is dominated by road traffic along Bourke Road.
L4	Attended 15-minute ambient noise measurement at the	09:02 to 09:17	61	86	55	Noise level at the measurement location is dominated by road traffic along

Location	Description	Time (Hr:Min)	L_{eq}, dBA	L_{AFmax}, dBA	L_{90}, dBA	Comments and Observations
	eastern boundary of the site (alleyway).					Bourke Road and mechanical equipment noise at nearby areas.
L5	Attended 15-minute traffic noise measurement at the southern boundary of the site (at the road kerb along O'Riordan Street).	09:35 to 09:50	70	96	57	Morning peak period traffic noise. Measured traffic noise level is dominated by road traffic along O'Riordan Street.
		15:33 to 15:48	71	92	59	Afternoon peak period traffic noise. Measured traffic noise level is dominated by road traffic along O'Riordan Street.

5.1.4 Measured Background and Ambient Noise Levels

A noise logger was installed at Location 6 (refer to Figure 5-1) to establish current background, ambient noise levels. This is considered a representative location for background noise for the nearby noise sensitive receiver. Acoustic Assessment for Stage 1 Development (by Acoustic Studio Report) has also adopted the same location for background noise assessment and justified the suitability of this location for representing background noise level.

Measured noise data was processed in accordance with the Noise Policy for Industry 2017 to establish the Rating Background Level (RBL). Table 5-3 provides the measured background noise levels (L_{A90}) and the ambient noise levels (L_{Aeq}) at the noise monitoring locations. Refer to Figure 5-1 for location of the unattended noise monitoring (noise logger location).

Table 5-3 Measured background noise levels at unattended noise monitoring Location 6

Date	Day of the Week	Background Noise Level, L_{A90} dB(A)			Ambient Noise Level, L_{Aeq} dB(A)		
		Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)	Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
03/10/23	Tuesday	53	48	42	69	64	62
04/10/23	Wednesday	54	51	42	67	67	63
05/10/23	Thursday	53	48	41	67	65	683
06/10/23	Friday	54	48	41	68	67	61
Rating Background Level (RBL)		**52**	**46**	**40**			
Average Ambient Noise Level					**64**	**64**	**58**

The measured RBLs are very similar to the RBLs established in the Acoustic Assessment for Stage 1 Development (by Acoustic Studio Report). Hence, these levels will be used for establishing environmental noise performance criteria in accordance with Noise Policy for Industry 2017.

However, the measured ambient noise levels during our measurement period are found to be 2 to 4 dB lower than the levels reported by Acoustic Studio Report for the Acoustic Assessment for Stage 1 Development. Noted that, as the noise logger was located at the opening of the building façade, it includes the façade reflection. Therefore, a 2.5 dB(A) façade correction was adopted in ACOR's report to determine the ambient levels.

Detailed noise monitoring results are graphically presented in Appendix C .

5.1.5 Measured Traffic Noise Levels (Unattended Measurements)

Noise logger installed at Location 6 (refer to Figure 5-1) was also used to determine the road traffic noise levels along Bourke Road. The measured traffic noise levels are at the building façade (at the window opening), which includes façade reflections. Noise data affected by rain and nearby temporary ai pump has been removed for the calculation of the road traffic noise levels.

Table 5-4 Measured Road Traffic Noise Levels at noise monitoring Location 6 (inclusive of façade reflection)

Date	Day of the Week	Traffic Noise Levels, dB(A)							
		$L_{A10(18h)}$ (6am to 12am)	$L_{Aeq(15h)}$ (7am to 10pm)	$L_{Aeq(9h)}$ (10pm to 7am)	$L_{Aeq(day)}$ (7am to 6pm)	$L_{Aeq(eve)}$ (6pm to 10pm)	$L_{Aeq((night)}$ (10pm to 7am)	$L_{Aeq(1h)\ Day}$ (7am to 10pm)	$L_{Aeq(1h)\ Night}$ (10pm to 7am)
03/10/23	Tuesday	67	63	62	63	64	62	67	67
04/10/23	Wednesday	70	67	57	67	67	57	68	64
05/10/23	Thursday	Data excluded due to rain							
06/10/23	Friday	70	68	61	68	67	68	70	64
Overall Traffic Noise Level		**69**	**66**	**60**	**66**	**66**	**60**	**70**	**66**

Detailed noise monitoring results are graphically presented in Appendix C .

Measured traffic noise spectrum is provided in Table 5-5.

Table 5-5 Measured traffic noise spectrum (inclusive of façade reflection)

Parameter	Octave – Band Centre Frequencies (Hz) Sound Pressure Level, dB									Total, dB(A)
	31.5	63	125	250	500	1000	2000	4000	8000	
$L_{A10(18h)}$ (6am to 12am)	70	71	69	66	65	65	62	54	46	69
$L_{Aeq(15h)}$ (7am to 10pm)	67	70	67	64	62	62	59	51	44	66
$L_{Aeq(9h)}$ (10pm to 7am)	61	64	61	58	56	56	53	45	38	60
$L_{Aeq(day)}$ (7am to 6pm)	67	70	67	64	62	62	59	51	44	66
$L_{Aeq(eve)}$ (6pm to 10pm)	67	70	67	64	62	62	59	51	44	66
$L_{Aeq((night)}$ (10pm to 7am)	61	64	61	58	56	56	53	45	38	60
$L_{Aeq(1h)}$ (7am to 10pm) Day	71	74	71	68	66	66	63	55	48	70
$L_{Aeq(1h)}$ (10pm to 7am) Night	67	70	67	64	62	62	59	51	44	66

5.2 Current Vibration Environment

5.2.1 Ground and Structural Vibration Assessment

External vibration levels were measured by ACOR at several locations around the site to assess potential external vibration impacts on the proposed development's operation. The vibration measurements indicated that the dominant external sources were passenger trains movements from adjacent underground tunnel infrastructure as shown in Figure 1-1. Spectral data were analysed, and the measured data was compared with the established criteria.

The assessment indicates that external vibration complies with established vibration criteria, and the risk of vibration impact to the proposed facility from external sources is low. Therefore, no additional structural isolation or vibration attenuation measures are considered necessary to mitigate external vibration ingress. Refer to Section 8.2 and Appendix D for vibration data and analysis.

5.2.2 Vibration Sensor Locations – 3 October 2023

Attended structural and ground vibration measurements were performed for the purpose of assessing the existing vibration environment at the proposed site, and to develop an understanding of the external vibration sources such as passenger trains and road traffic. This information is fundamental to understanding the potential impacts that these external vibration sources will have on the design and operation of the building.

Vibration measurements were taken with a 6-channel analyzer data acquisition system using three seismic accelerometers fixed to the ground floor via adjacent structures (concrete floor) at Alexandria (current operating as Sydney City Tyres) to confirm vibration levels in the vertical direction.

Raw acceleration and velocity vibration data were recorded over a representative time interval of passenger train duration and traffic. The seismic accelerometers were fixed to the existing concrete floor.

Photographs illustrating structural and ground sensor locations are presented in Table 5-6.

The summary results of vibration monitoring are presented in Appendix D .

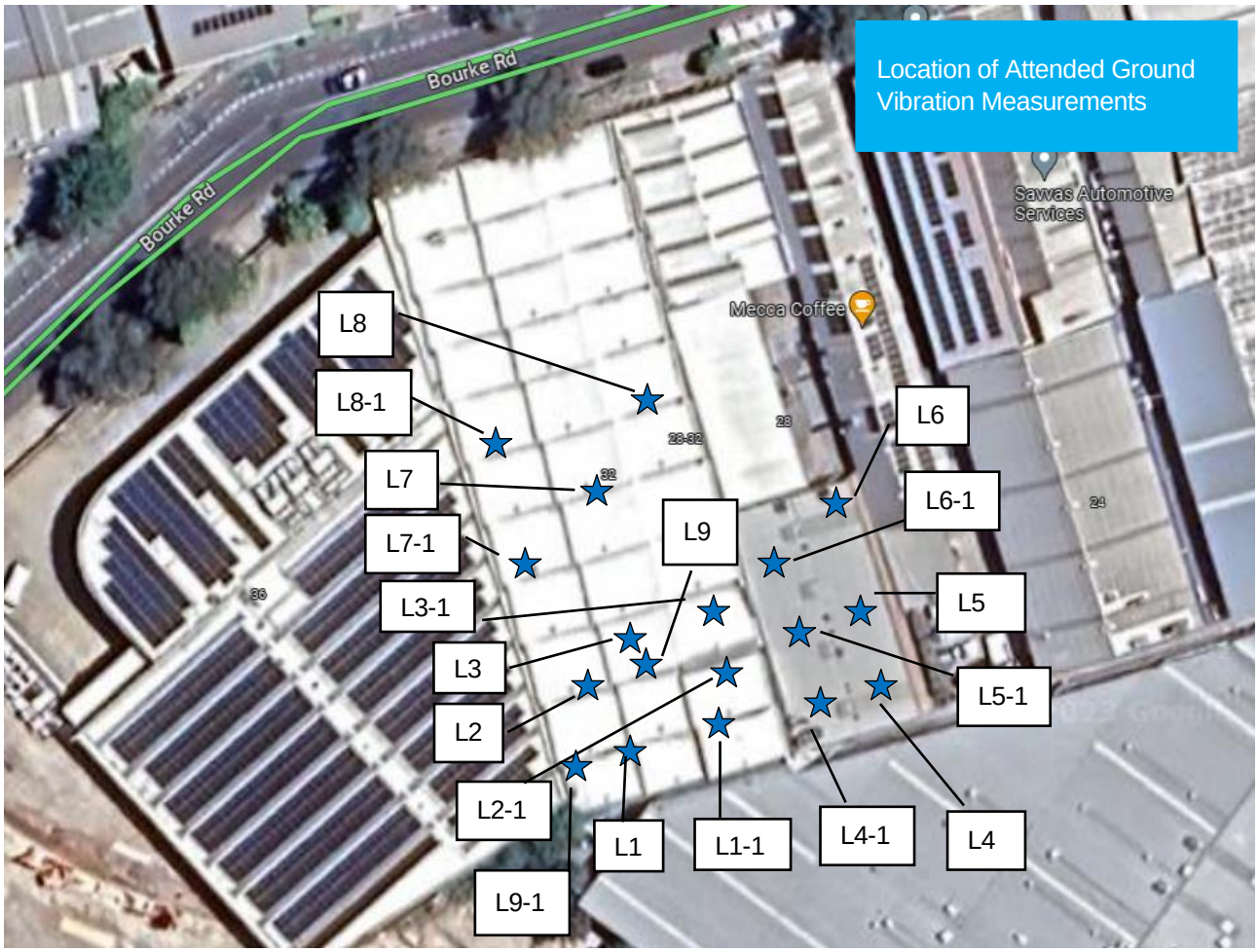
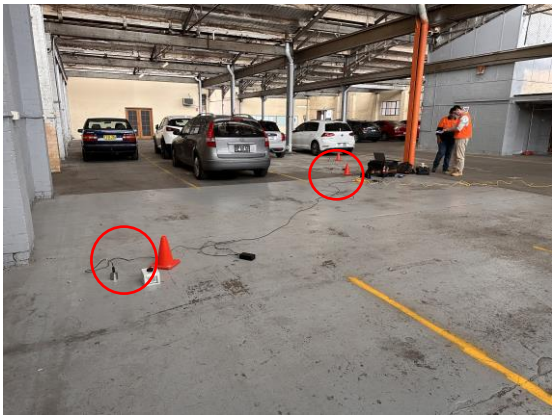


Figure 5-2 Locality plan of ground measurement locations

Table 5-6 Sensors Locations

Sensor Locations	
 Location 1 and 1-1	 Location 2 and 2-1
 Location 3 and 3-1	 Location 4 and 4-1
 Location 4 and 4-1	 Location 5 and 5-1

Sensor Locations	
 Location 6 and 6-1	 Location 7 and 7-1
 Location 8 and 8-1	 Location 9 and 9-1

5.2.3 Vibration Instrumentation

Table 5-7 list the equipment details used during the monitoring on 3 October 2023. All instrumentation has been laboratory calibrated and was checked for calibration during the on-site measurements.

Table 5-7 Equipment details

Instrument	Make	Model	Serial no.
DAQ System	Brüel & Kjaer	3050-A-060	3050-113130
Calibrator	Brüel & Kjaer	4294	3281878
Seismic Accelerometer, Sensitivity 10 V/g	Wilcoxon	731A + P31 amplifier	12628
Seismic Accelerometer, Sensitivity 10 V/g	Wilcoxon	731A + P31 amplifier	12626

6 Acoustic and Building Vibration Criteria

6.1 NSW EPA Noise Policy for Industry 2017 – Noise Emission Criteria

Industrial noise can have a significant effect on noise-sensitive receivers (see below). Both the increase in noise level above background levels, as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources. The project "noise trigger level" established in the NPI addresses each of these components of noise impact. The following subsections show the process of determining the project noise trigger level in accordance with the NPI.

6.1.1 Noise Sensitive Receivers

The proposed development would be located at 28-32 Bourke Road, Alexandria. Buildings surrounding the proposed development are typically commercial and light industrial in nature.

The nearest residential noise sensitive receivers would be multi-storey Hotel Building at 16 O'Riordan St (Receiver R1) which is to the south-east of the proposed development and row of single/double storey residential units located at 5-19 Reserve St (Receiver R2) which is to the south of the proposed development. The immediate adjacent premises to the proposed development are commercial developments (Receivers R3 to R6). The noise sensitive receivers are shown in Figure 6-1.

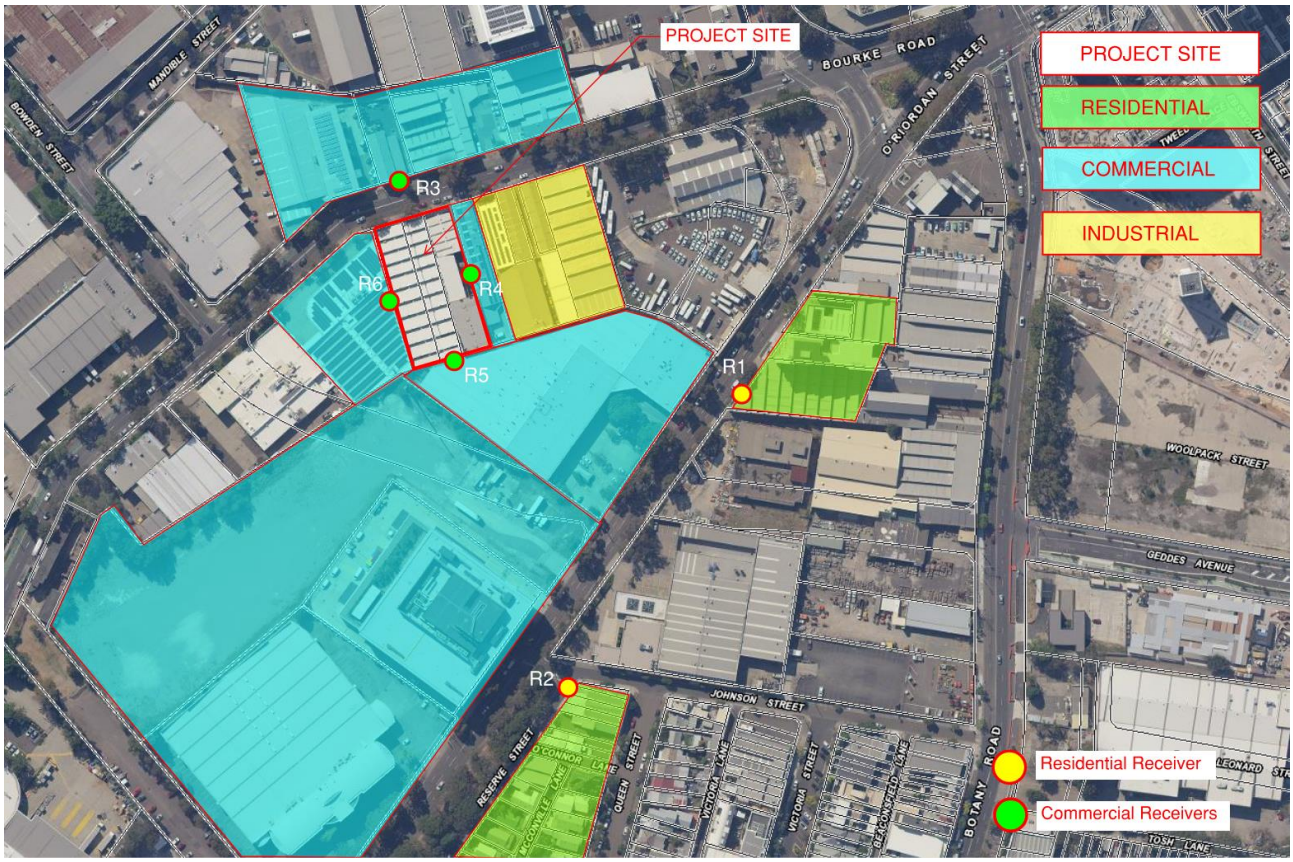


Figure 6-1 Satellite image showing project site and noise sensitive receivers (Source: Six Maps NSW)

Noise sensitive receivers are listed below in Table 6-1.

Table 6-1 Noise sensitive receivers

Receiver #	Noise Sensitive Receiver Address	Direction from Project Site
R1	16 O'Riordan St (Residential)	South-east
R2	5-19 Reserve St (Residential)	South
R3	15 Bourke Rd (Commercial)	North
R4	26 Bourke Rd (Commercial)	East
R5	9-13 O'Riordan St (Commercial)	South
R6	36 Bourke Rd (Commercial)	West

6.1.2 Project Intrusiveness Noise Level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source ($L_{Aeq,15min}$) does not exceed the RBL by more than 5 dB, when beyond a minimum threshold (35 dB(A) for the day, 30 dB(A) for the evening and night). This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. The outcome of this approach aims to ensure that the intrusiveness noise level is being met for at least 90% of the time-periods over which annoyance reactions can occur (taken to be periods of 15 minutes). Project intrusiveness noise level is defined as follows:

- Project intrusiveness noise level ($L_{Aeq,15min}$) = RBL + 5 dB

Based on the measured RBL presented in Section 5.1.4 and the NPI, the project intrusiveness noise levels are established in Table 6-2.

Table 6-2 Project intrusiveness noise levels

Noise Sensitive Receivers	Rating Background Level RBL, dB(A)			Project Intrusiveness Noise Levels, $L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night	Day	Evening	Night
R1 (Residential)	52	46	40	57	51	45
R2 (Residential)	52	46	40	57	51	45
R3 (Commercial)	52	46	40	-	-	-
R4 (Commercial)	52	46	40	-	-	-
R5 (Commercial)	52	46	40	-	-	-
R6 (Commercial)	52	46	40	-	-	-
*This is based on NPI recommended assumed RBLs, the measured levels are affected by operation of mechanical plant equipment and fans.						

6.1.3 Project Amenity Noise Level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the NPI, where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended amenity noise levels (Table 2.2 of the NPI) represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows:

- Project amenity noise level $L_{Aeq,15min}$ = Recommended amenity noise level – 5 dB(A) + 3 dB(A)

The recommended amenity noise level should be established from Table 2.2 of the NPI based on the noise sensitive receivers' category, determined based on Table 2.3 of the NPI.

As the NPI states, the approach of deriving the project amenity noise level from the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources. To standardise the time periods for the intrusiveness and amenity noise levels, NPI assumes that the Amenity $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Considering that the residential noise sensitive receivers are located in a R1 General Residential Zone (Urban Residential), the NPI recommended Amenity Noise Level and Project Amenity Noise Level for this project are presented in Table 6-3 below.

Table 6-3 Project amenity noise levels

Noise Sensitive Receiver	**Recommended Amenity Noise Level, LAeq dB(A)**			**Project Amenity Noise Levels, LAeq,15min dB(A)**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**
R1 (Residential)	60	50	45	58	48	43
R2 (Residential)	60	50	45	58	48	43
R3 (Commercial)	65 (when in use)			63 (when in use)		
R4 (Commercial)						
R5 (Commercial)						
R6 (Commercial)						

6.1.4 Project Noise Trigger Level

The project noise trigger level is the lower (that is, the more stringent) value of the project intrusiveness noise level and the project amenity noise level determined in accordance with the NPI. The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Applying the most stringent requirement as the project noise trigger level ensures that both intrusive noise is limited, and amenity is protected and that no single industry can unacceptably change the noise level of an area. It is noted that Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2 of the NPI, only the amenity levels apply. The project noise trigger levels for this project are established in accordance with the NPI and are shown below in Table 6-4.

Table 6-4 Project noise trigger levels

Noise Sensitive Receiver	**Project Intrusiveness Noise Level, $L_{Aeq,15min}$ dB(A)**			**Project Amenity Noise Level, $L_{Aeq,15min}$ dB(A)**			**Project Noise Trigger Level, $L_{Aeq,15min}$ dB(A)**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
R1 (Residential)	57	51	45	58	48	43	**57**	**48**	**43**
R2 (Residential)	57	51	45	58	48	43	**57**	**48**	**43**
R3 (Commercial)	n/a	n/a	n/a	63 (when in use)			**63 (when in use)**		
R4 (Commercial)	n/a	n/a	n/a						
R5 (Commercial)	n/a	n/a	n/a						
R6 (Commercial)	n/a	n/a	n/a						

6.1.5 Correction for Modifying Factors

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, a correction should be applied as per the NPI, to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. The maximum correction of 10 dB(A) to be applied to the predicted or the measured level where two or more modifying factors are present. NPI recommended correction factors (Table C1 of the NPI) are shown in Table 6-5.

Table 6-5 Modifying factor corrections for noise characteristics.

Factors	Corrections[1]	Notes
Tonal Noise	5 dB[2,3]	[1.] Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion. [2.] Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz. [3.] Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard
Low-Frequency Noise	2 or 5 dB[2]	
Intermittent Noise	5 dB	
Duration	0 to 20 dB(A)	
Maximum Adjustment	Maximum correction of 10 dB(A)[2] (excluding duration correction).	

As per the NPI, correction for duration is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the $L_{Aeq,15min}$ equivalent noise criterion is provided in Table C3 of the NPI for the duration of the event. This adjustment is designed to account for unusual and one-off events and does not apply to regular and/or routine high-noise level events. The adjustments for duration are to be applied to the criterion.

6.1.6 Sleep Disturbance Criteria

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. NPI recommends, where the subject development/premises night-time noise levels at a residential location exceed:

- LAeq,15min 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- LAFmax 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

that a detailed maximum noise level event assessment should be undertaken. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Based on the NPI, the sleep disturbance criteria for the proposed development are determined as shown in Table 6-6.

Table 6-6 Sleep disturbance criteria.

Noise Sensitive Receiver	Rating Background Level (RBL) at Night, L_{A90} dB(A)	NPI Recommended Sleep Disturbance Criteria, dB(A)	
		$L_{Aeq,15min}$ (40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater)	L_{AFmax} (52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater)
R1 (Residential)	40	45	55
R2 (Residential)	40	45	55
R3 (Commercial)	40	Sleep disturbance criteria is not applicable for commercial premises.	
R4 (Commercial)	40		
R5 (Commercial)	40		
R6 (Commercial)	40		

In addition to the above, NSW Road Noise Policy (RNP) noted that the research on sleep disturbance to date concluded that:

- Maximum internal noise levels below 50–55 dB(A) is unlikely to awaken people from sleep.
- One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

6.2 Protection of the Environment Operations (POEO) Act 1997 – Noise Emission Criteria

The POEO Act 1997 aims to protect, restore and enhance the quality of the noise environment in New South Wales. 'Offensive noise' in the Act is defined as noise:

> *(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances—*
>
> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
>
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
>
> *(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.*

For control of noise from Air Conditioners, Pumps and Heat Pump Water Heaters, the Act defines the following in regard to its use on residential premises:

> *A person is guilty of an offence if -*
>
> *(a) the person causes or permits an air conditioner / pump to be used on residential premises in such a manner that it emits noise that can be heard within any room in any other residential premises (that is not a garage, storage area, bathroom, laundry, toilet or pantry) whether or not any door or window to that room is open -*
>
> *(i) before 8 am or after 10 pm on any Saturday, Sunday or public holiday, or*
>
> *(ii) before 7 am or after 10 pm on any other day,*

However, there is no quantitative criteria to define the "offensive noise" in the POEO. Generally speaking, the recommended noise criteria defined in the Noise Policy for Industry (NPfI) 2017 should be adopted for acceptable noise level at different noise sensitive receivers.

6.3 Secretary's Environmental Assessment Requirements (SEAR)

NSW Department of Planning and Environment's Secretary's Environmental Assessment Requirements (SEAR) would be relevant to the project. Based on the current information available for this project (SEARs matrix for the Stage 2 Detailed SSDA), the following noise and vibration assessment would be required:

Table 6-7 Secretary's Environmental Assessment Requirements (SEAR)

SEAR	Expected Deliverables
12. Noise and Vibration Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protect Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented	Noise and Vibration Impact Assessment

Table 6-8 Concept Conditions of Consent

Concept Conditions of Consent	Expected Deliverables
B26. Future development application(s) must be accompanied by a Noise and Vibration Impact Assessment (NVIA), prepared by a suitably qualified professional, including (but not limited to): (a) quantitative assessment of the main noise generating sources and activities during operation; and (b) any management and mitigating measures necessary to ensure the amenity of future sensitive land uses on the site and neighbouring sites is protected during the operation of the development	Noise and Vibration Impact Assessment
B44(b) Construction Noise and Vibration Impact Assessments (CNVMP) providing a quantitative assessment of the main noise generating sources and activities during construction, impacts of construction noise/vibration on surrounding sensitive receivers and relevant management and mitigation measures to reduce adverse impacts due to construction noise and vibration	Construction Noise and Vibration Impact Assessments

6.4 Construction Noise Criteria - DECC Interim Construction Noise Guideline (ICNG) 2009

6.4.1 Airborne Noise Criteria

The Interim Construction Noise Guideline (ICNG) (DECC, 2009) guideline recommends standard hours for construction activities as Monday to Friday: 7am to 6pm, Saturday: 8am to 1pm and no work on Sundays or public holidays. These hours are not mandatory and the ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads.
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.
- works which maintain noise levels at sensitive receivers to below the noise management levels outside of the recommended standard construction hours.

Construction noise management levels at sensitive residential receivers are provided in Table 6-9. The construction noise management levels during recommended standard hours represent a noise level that, if exceeded, would require management measures including:

- reasonable and feasible work practices.
- contact with the residences to inform them of the nature or works to be carried out, the expected noise levels and durations and contact details.

The management measures are aimed at reducing noise impacts at the residential receivers. However, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level. The noise affected construction noise management levels during recommended standard hours is not intended as a noise limit but rather a level where noise management is required and as such should not be included as a noise limit in the environmental protection license.

Table 6-9 Residential construction noise management levels, dBA

Time of day	Noise Management level, $L_{Aeq\ (15\ min)}$	Application Notes
Recommended standard hours	Noise affected: RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. ▪ where the predicted or measured LAeq(15 min) 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 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 restricting 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, 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 recommended standard hours	Noise affected: RBL + 5 dBA	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 measures have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Noise management levels for other sensitive land uses are provided in Table 6-10 and only apply when the properties are in use.

Table 6-10: Noise management levels for other sensitive land uses

Land Use	Noise management, $L_{Aeq\ (15\ minutes)}$
Commercial premises	70 dBA (external)
Industrial Premises	75 dBA (external)

A summary of the construction noise management levels is provided in Table 6-11.

Table 6-11: Proposal construction noise management levels, dBA

Receiver type	Construction noise management levels, $L_{Aeq(15\ min)}$				
	Standard construction hours		Outside standard construction hours		
	Noise affected	Highly noise affected	Day	Evening	Night
R1 (Residential)	62	75	57	51	45
R2 (Residential)	62	75	57	51	45
R3 (Commercial)	70 (when in use)		70 (when in use)		

Receiver type	Construction noise management levels, $L_{Aeq(15\ min)}$	
R4 (Commercial)		
R5 (Commercial)		
R6 (Commercial)		

6.4.2 Ground-borne Noise Criteria

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example, by underground works such as tunnelling can be more noticeable than airborne noise. The following ground-borne noise levels for residences indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening (6 pm to 10 pm): Internal: LAeq (15 min) 40 dB(A)
- Night-time (10 pm to 7 am): Internal: LAeq (15 min) 35 dB(A)

The internal noise levels are to be assessed at the centre of the most affected habitable room. Mitigation options to deal with ground-borne noise may include extensive community consultation to determine the acceptable level of disruption and the provision of respite accommodation in some circumstances, not just restriction of work hours. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction that the relevant authority (consent, determining or regulatory) may impose on the days when construction work is allowed should take into account whether the community:

- has identified times of day when they are more sensitive to noise (for example, Sundays or public holidays)
- is prepared to accept a longer construction duration in exchange for days of respite.

6.5 Building Acoustic Criteria

6.5.1 Green Star – Acoustic Comfort Credits

The Green Star Buildings v1-Revision B provides acoustic performance criteria to encourage the design of buildings to achieve acoustic environments that are comfortable for occupants to work and reside in.

The Acoustic Comfort section provides three credits with respect to acoustic performance, with each credit having 1 point available.

Table 6-12 presents a summary of the Acoustic Comfort points that would be applicable for the building to pursue the Acoustic Comfort points for a Green Star rating. The three points are being target for acoustics.

Table 6-12 Summary of Green Star Acoustic Credits

Credit	Acoustic Criterion	Compliance requirement
10.1	Internal Noise Levels	1 point is awarded where the internal ambient noise level in the nominated area is no more than 5 dB(A) above the “lower figure” sound levels provided in Table 1 of AS/NZS 2107:2016 This includes all sound generated by the building systems and any external noise ingress
10.2	Reverberation	1 point is awarded where the reverberation time in the nominated area is below the maximum stated in the ‘Recommended Reverberation Time’ provided in Table 1 of AS/NZ 2107:2016
10.3	Acoustic Separation	1 point is awarded where the project addresses noise transmission in enclosed spaces using either of the following methods: — The partition (fixed without a door and glazed partitions without a door) between

Credit	Acoustic Criterion	Compliance requirement
		the spaces should be constructed to achieve a weighted sound reduction index (Rw) of at least 45. — At least Rw 35 for all partition types that contain a door. Or — The sound insulation between enclosed spaces complies with Dw + LAeqT > 75

6.5.2 Australian Standard AS/NZS 2107:2016 for Indoor Design Sound Levels and Reverberations

AS/NZS 2107:2106 recommends design sound level and reverberation criteria for conditions affecting the acoustic environment within building interiors to ensure a healthy, comfortable and productive environment for the occupant and the users. The recommended background sound levels (L_{Aeq}) consider the function of the space and apply to the sound level measured within the space unoccupied but ready for occupancy. The standard is applicable to steady-state or quasi-steady-state sounds. The reverberation times recommended are for the occupied state of the space.

It should be noted that the recommended sound level range provides a recommended minimum sound level to provide acoustic masking that will help to improve speech privacy. When designing building services systems, it is highly unlikely to be possible to design to such a tight tolerance. This is primarily because of the variable nature of modern air handling systems. Therefore, it is likely that there will be some areas within the building that will have internal noise levels below the minimum values recommended in Table 6-13, especially when building services are running at low speed and/or are in night mode and/or when supplementary systems are not operating.

The design internal sound level criteria (L_{Aeq}) for the building services have been determined for each type of room in the building in accordance with the AS/NZS 2107:2016. The recommended goals for this building are based upon equivalent spaces within appropriate buildings, presented in Table 6-13.

Table 6-13 AS/NZS 2107:2016 Recommended Design Sound Level Levels

Item	Recommended Design Sound Level Range $L_{Aeq,T}$ dB(A)	Design Reverberations Time (RT) ranges, s
HEALTH BUILDINGS		
Emergency areas	40 to 45	< 0.6
Control rooms	40 to 50	0.4 to 0.6
Corridors and lobby spaces	< 50	See Note 1
Consulting rooms	40 to 45	0.4 to 0.6
Dining areas	40 to 45	See Note 1
Kitchens, sterilizing and service areas	< 55	< 0.8 (see Note 8)
Laboratories	40 to 50	0.4 to 0.7
Maintenance workshops	< 60	See Note 1
Nurses' stations	40 to 45	0.4 to 0.7
Office areas	35 to 45	0.4 to 0.7
Patient lounge	40 to 45	0.4 to 0.6
Pharmacies	45 to 50	0.4 to 0.6
Staff rooms	40 to 45	0.4 to 0.6
Surgeries/treatment/procedure rooms	40 to 45	0.4 to 0.7

Item	Recommended Design Sound Level Range $L_{Aeq,T}$ dB(A)	Design Reverberations Time (RT) ranges, s
Utility rooms	50 to 60	—
Ward bedrooms		
Single bed	35 to 40	0.4 to 0.7
Multiple beds	35 to 40	0.4 to 0.7 (see Note 8)
Waiting rooms, reception areas	40 to 50	< 0.7

6.5.3 NSW Health Engineering Service Guide 2022

Acoustic design is fundamental to the quality of healthcare buildings. There is a growing body of clinical research that shows that better acoustics leads to improved health outcomes. Well-designed, high-quality spaces have been shown to facilitate a reduction in the use of analgesics, improved patient recovery times, increased staff efficiency and reduced staff turnover. Further, poor acoustic design of clinical, procedural and consultation areas can negatively impact the performance, communication and concentration levels of staff.

NSW Health – Engineering Services Guidelines 2022 recommends design sound level and reverberation criteria for conditions affecting the acoustic environment within building interiors to ensure a healthy, comfortable and productive environment for the occupant and the users. The recommended background sound levels (L_{Aeq}) consider the function of the space and apply to the sound level measured within the space unoccupied but ready for occupancy. The standard is applicable to steady-state or quasi-steady-state sounds. The reverberation times recommended are for the occupied state of the space.

It should be noted that the recommended sound level range provides a recommended minimum sound level to provide acoustic masking that will help to improve speech privacy. When designing building services systems, it is highly unlikely to be possible to design to such a tight tolerance. This is primarily because of the variable nature of modern air handling systems. Therefore, it is likely that there will be some areas within the building that will have internal noise levels below the minimum values recommended in Table 6-14, especially when building services are running at low speed and/or are in night mode and/or when supplementary systems are not operating.

Table 6-14 NSW Health 2022 Recommended internal sound levels and reverberation times.

Room Type	NSW Health Criteria	
	Internal Noise Level, L_{eq} dB(A)	Reverberation Time (Sec)
Single Patient Bedroom	35 to 40	0.4 to 0.7 (Note 13)
Multi Bedroom	35 to 40	0.4 to 0.7 (Note 13)
Patient Corridor	40 to 50	Note 8
Counselling / Bereavement / Interview Room	40 to 45	0.4 to 0.6
Consultation Room	40 to 45	0.4 to 0.6
Speech Therapy	35 to 40	0.4 to 0.6
Treatment/ Medication/ Examination Rooms	40 to 50	0.4 to 0.6
Public Corridor and Lobby	40 to 50	Note 8
Cafeteria / Dining	45 to 50	Note 8
Waiting Rooms/ Reception Area	40 to 50	0.4 to 0.6
Meeting Room / Private Office	35 to 40	0.6 to 0.8
Board / Conference Room (large)	30 to 35	0.6 to 0.8
Open Plan Office	40 to 45	0.4 to 0.6

Room Type	NSW Health Criteria	
Single Person Office	35 to 40	0.6 to 0.8
Multiple Person Office	40 to 45	0.4 to 0.6
Change/Locker Room	50 to 55	-
Staff Room	40 to 45	Note 8
Rest room – break-out spaces	40 to 45	0.4 – 0.6
Toilets / Ensuite	50 to 55	N/A
Note 8: Reverberation time should be minimized as much as practicable for noise control. Acoustic treatment should have a minimum acoustic performance equivalent to NRC 0.7 covering at least 80% of the area of the ceiling. If acoustic materials with a higher NRC performance are proposed, the coverage area can be reduced proportionally.		
Note 13: For mental health units, while good room acoustic design is desired, achieving the reverberation time targets will be challenging given conflicting requirements (e.g., anti-ligature, security, tamper proof, etc.). The design team should justify. any instances where sound absorptive finishes may not be possible.		

6.5.4 State Environmental Planning Policy

NSW State Environmental Planning Policy (Transport and Infrastructure) 2021 Clause 2.120 Impact of road noise or vibration on non-road development states that:

(1) This section applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration—

(a) residential accommodation,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or centre-based childcare facility.

(2) Before determining a development application for development to which this section applies, the consent authority must take into consideration any guidelines that are issued by the Planning Secretary for the purposes of this section and published in the Gazette.

(3) If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded—

- in any bedroom in the residential accommodation—35 dB(A) at any time between 10 pm and 7 am,
- anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.

Based on the traffic impact assessment provided in the Positive Traffic's Report v2, dated in October 2023, the traffic volume is below 20,000 vehicles, therefore Clause 2.120 of the NSW State Environmental Planning Policy (Transport and Infrastructure) 2021 is not applicable for this project site. However, considering that this is a Health building, the following noise criteria is adopted for this project as presented in Table 6-15 below.

Table 6-15 SEPP 2021 – Road Noise Criteria

RESIDENTIAL BUILDINGS		
Type of Occupancy	**Noise Level, dB(A)**	**Applicable Time Period**
Sleeping Areas	35	Night 10 pm to 7 am

RESIDENTIAL BUILDINGS		
Anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)	40	At any time

6.5.5 Development Near Rail Corridors and Busy Roads Interim Guideline 2008

The Interim Guideline for Development near Rail Corridors and Busy Roads also refers to the Infrastructure SEPP noise requirements for different noise sensitive receivers where the development is adjacent to a traffic corridor with an annual average daily traffic volume of more than 40,000 vehicles.

The interim guideline for Development Near Rail Corridor and Busy Roads 2008 specifies the following noise criteria for road noise for different types of sensitive receivers.

Table 6-16 Development near rail corridor and busy roads – Road Noise Criteria

RESIDENTIAL BUILDINGS	
NON-RESIDENTIAL BUILDINGS	
Hospitals	Recommended maximum level for: Wards: 35 dB(A) Other noise sensitive areas: 45 dB(A)

6.6 Emergency Noise Levels - Fire and Smoke Control Equipment

Fire and smoke control equipment must meet the noise provisions of AS 1668.3 for plant operating in an emergency operation mode including (but not limited to).

- The noise level during operation of the smoke control systems (including smoke-spill fans and air pressurization fans) shall not exceed 65 dB(A) in occupied spaces or 5dB above ambient noise levels to a maximum level of 80 dB(A).
- Noise levels in fire-isolated exits shall not exceed 80 dB(A).

6.7 Fire control room

NCC Section Specification E1.8 requires the ambient sound level within the Fire Control Rooms (FCRs) as measured when all fire safety equipment is operating in the way it operates in an emergency, to not exceed 65 dBA Leq;1 minute.

6.8 Emergency back-up generators

There is no guidance in Australian Standards for prescribing set limits or recommendations in relation to internal noise from emergency generators.

The AAAC Guideline recommends that internal noise levels during emergency and testing operation should be limited to no more than 5dB above the maximum recommended internal noise criteria, which are outlined in Table 6-13.

6.9 NSW Road Noise Policy

The NSW Road Noise Policy (RNP) states that for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2dB above the existing noise levels. The policy noted that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

6.10 Building Vibration Criteria

The transmission of vibration has the potential to adversely affect occupants within the building. The building structure will need to be designed to achieve appropriate levels of vibration to minimise any adverse effects. The following section outlines commonly used vibration criteria that for assessing human comfort and response to building vibration.

Perception thresholds for continuous whole-body vibration vary widely among individuals. Approximately half the people in a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015 m/s^2. A quarter of the people would perceive a vibration of 0.01 m/s^2 peak, but the least sensitive quarter would only be able to detect a vibration of 0.02 m/s^2 peak or more. Perception thresholds are slightly higher for vibration duration of less than about 1 sec.

6.10.1 Human Comfort

Human response to floor motion is a complex phenomenon. There are wide variations in vibration tolerance of humans and accordingly the acceptance criteria for human comfort are difficult to define and quantify.

Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g., office, meeting rooms, residential, theatres etc.) and the character of vibration (e.g., continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perceptibility.

Vibration transfer within a building has the potential to adversely affect the occupants. The building structure must be designed to achieve appropriate levels of vibration to minimise such adverse effects.

The concept of using base curves to assess human comfort has been adopted from Australian Standard 2670.2:1990. NB - Please note that this standard was superseded by AS ISO 2631.2:2014, however, it is accepted practice within the Australian market to adopt the multiplying factors as presented in Table 2 Appendix A (2670.2:1990) for building vibration from human comfort.

A base curve marks the threshold of human perception and is defined in one-third octave bands from 1 Hz to 80 Hz. Vibration levels below the base curves typically do not result in adverse comments or complaints from occupants. The vibration criteria for different occupancy types are obtained by multiplying the base curve by a factor. Multiplying factors for different occupation types on the recommendations in AS 2670.2:1990 are listed in Table 6-17.

Table 6-17 Multiplying factors for satisfactory magnitudes of building vibration.

Room Type	**Multiplying Factor**	
	Continuous or Intermittent Vibration	**Transient Vibration excitation with several occurrences per day**
Critical working areas (for example some hospital operating-theatres, some precision laboratories)	1.0	1.0
Boardroom/conference, open plan and private offices	4.0	60 to 128
Engineering, Workshop, co-working and collaborative spaces, Plant rooms	8.0	90 to 128

The ASHRAE curves include workshop, office, residential, operating room and VC curves for sensitive equipment. Velocity vibration criteria curves (RMS) defined in one-third octave frequency bands (CPB) range 1 to 80 Hz are shown in Table 6-18.

Table 6-18 Human Comfort and Equipment Vibration Criteria from Continuous Vibration

Location	Assessment Period	1 to 80Hz Curve mm/s
Workshops	Day – or Night-time	0.813
Office Areas, Consulting, examination, treatment, procedures, interview, counselling	Day – or Night-time	0.406
Hospital operating theatres rooms and critical work areas	Day – or Night-time	0.102
Single bed ward (including Mental Health, Parent Accommodation), Multiple bed ward, General intensive care wards, Neonatal or paediatric ICUs, and the like	Day – or Night-time	0.140

Guidelines for human comfort with respect to vibration within a building are also provided by NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006). This technical guideline provides acceptable RMS acceleration and velocity for continuous, impulsive and intermittent vibration. Velocity and acceleration limits are presented in Table 6-19.

Table 6-19 Velocity and acceleration criteria for exposure to continuous and impulsive vibration

Location	Assessment Period	RMS velocity (mm/s)		RMS acceleration (m/s^2)		Peak velocity (mm/s)	
Continuous Vibration							
	Preferred		Maximum	Preferred	Maximum	Preferred	Maximum
Offices	Day – or Night-time	0.40	0.80	0.020	0.040	0.56	1.1
Critical Areas, include hospital operating theatres and precision laboratories where sensitive operations are occurring	Day – or Night-time	0.10	0.20	0.0050	0.010	0.14	0.28
Workshops	Day – or Night-time	0.80	1.6	0.040	0.080	1.1	2.2
Impulsive Vibration							
Offices	Day – or Night-time	13	26	0.64	1.28	18.0	36.0
Critical Areas, include hospital operating theatres and precision laboratories where sensitive operations are occurring	Day – or Night-time	0.10	0.2	0.0050	0.010	0.14	0.28
Workshops	Day – or Night-time	13.0	26.0	0.64	1.28	18.0	36.0

6.10.2 Vibration Dose Values (VDV)

The vibration dose value (VDV) is fully described in British Standard BS 6472:2008 Guide to Evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting.

Table 6-20 below presents the vibration criteria for human comfort, in terms of preferred and maximum vibration dose values as described in BS 6472 and also provided by NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006). The VDV level can be directly related to vibration discomfort experienced by a person. VDV accumulates the vibration energy received over the daytime and night-time periods.

Table 6-20 Maximum vibration dose values for intermittent vibration

Place	Vibration Dose Values (m/s$^{1.75}$)			
	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Critical Areas, hospital operating theatres and precision laboratories where operations are occurring	0.10 Curve 0.10 (Velocity ASHRAE, refer to Figure 6-2)	0.20	0.10	0.20
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Place	Vibration Dose Values (m/s$^{1.75}$)			
▪ AAAC Guideline for Healthcare Facilities: Single bed ward (including Mental Health, Parent Accommodation), Multiple bed ward, General intensive care wards, Neonatal or paediatric ICUs, and the like	-	0.20 Curve 0.14 (Velocity ASHRAE, refer to Figure 6-2)	-	0.10
▪ AAAC Guideline for Healthcare Facilities: Consulting, examination, treatment, procedures, interview, counselling etc.	-	0.40 Curve 0.4 (Velocity ASHRAE, refer to Figure 6-2)	-	0.40
▪ AAAC Guideline for Healthcare Facilities: Boardroom/conference, open plan and private offices, etc.	-	0.80 Curve 4 (Velocity ASHRAE, refer to Figure 6-2)	-	0.80

6.10.3 Vibration Criteria for Sensitive Equipment

Vibration Criteria (VC) curves are used extensively in scientific and research environments. The VC curves were introduced by Gordon in 1991 in his publication by SPIE in 1991 and by IEST in 1993 and adopted in ASHRAE as widely accepted criteria for design of facilities accommodating vibration sensitive equipment.

The ASHRAE curves include workshop, office, residential, operating room and VC curves for sensitive equipment.

Table 6-21 present recommended acceptable criteria for vibration in a building structure to assess vibration impacts. Velocity vibration criteria curves (RMS) defined in one-third octave frequency bands range 1 to 80 Hz are shown in Figure 6-2.

Table 6-21 Building Vibration Criteria

Criterion Curve	Maximum RMS Velocity Level [µm/sec]	Detail Size (1) Microns	Description of Use
Workshop (ISO)	800	N/A	Distinctly perceptible vibration. Appropriate to workshops and non-sensitive areas
Office (ISO)	400	N/A	Perceptible vibration. Appropriate to offices and non sensitive areas
Residential Day (ISO)	200	75	Barely perceptible vibration. Appropriate to sleep areas in most instances. Probably adequate for computer equipment, probe test equipment and low-power (to 20X) microscopes
Operating Theatre (ISO)	100	25	Vibration not perception. Suitable for sensitive sleep areas. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity
VC-A	50 (0.05mm/s)	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3-micron line widths
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1-micron detail size
VC-D	6.25	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability
VC-E	3.12	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability

Note:

(1) The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given take into account the observation that the vibration requirements of many items depend upon the detail size of the process.

(2) Floor structure is expected to be dictated by vibration requirements for sensitive equipment required and operational/functional brief.

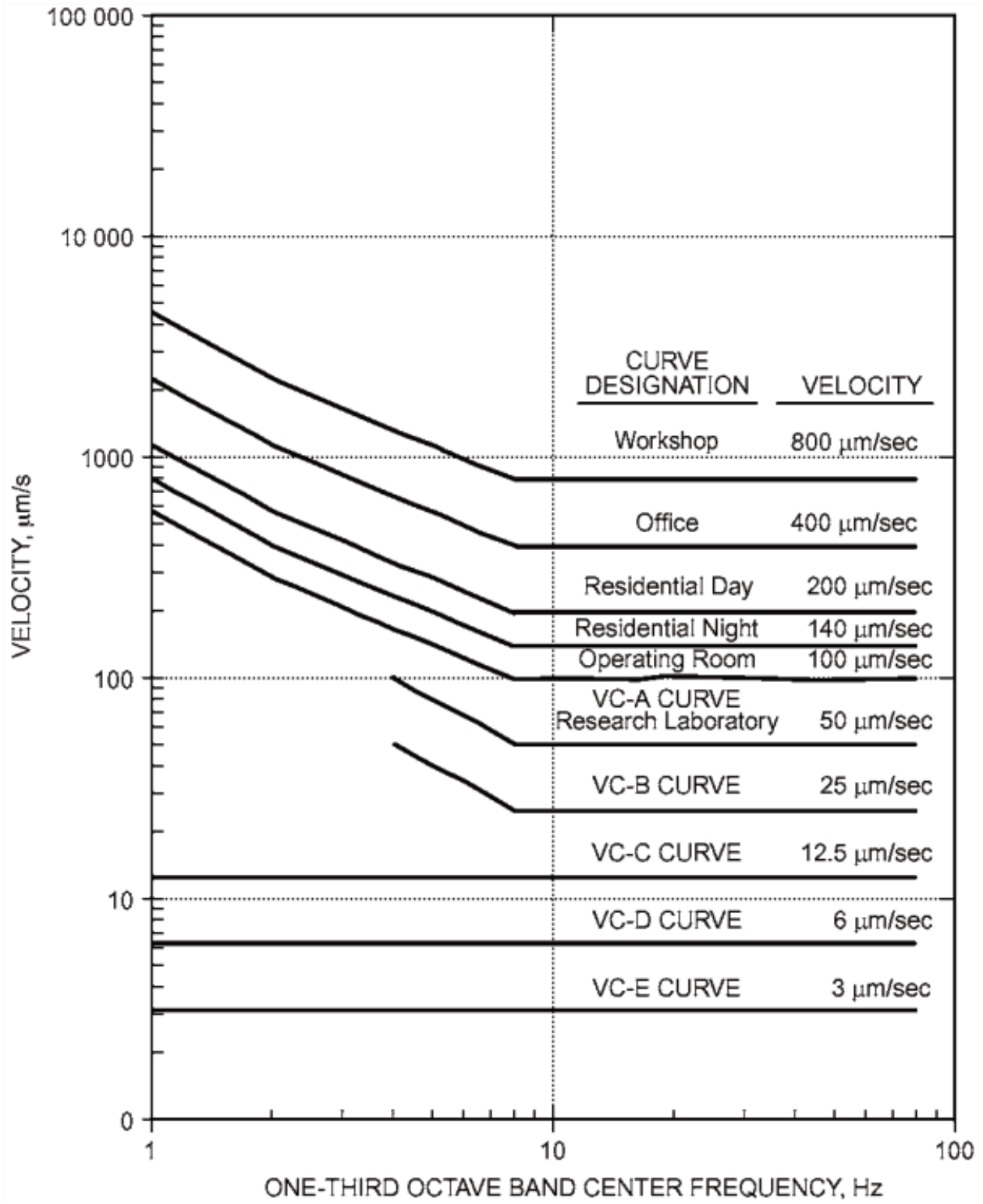


Figure 6-2 Building vibration criteria for vibration measured on building structure (ASHRAE, 2019)

6.10.4 Ground-borne Noise from Rail pass-by

Table 6-22 presents the ground-borne noise criteria for noise sensitive receivers. These criteria should only be applied where the level of ground-borne noise from rail pass-by is higher than the level of air-borne noise from the pass-by. Refer to the Rail Noise and Vibration Guidelines for further information.

Table 6-22 Ground-borne Noise Criteria for Sensitive Receivers

Type of occupancy	Time Period	AAAC Ground-borne noise criteria, dB
Wards and sleeping areas	Day, 7am to 10pm	40 $L_{Amax,s}$
	Night, 10pm to 7am	35 $L_{Amax,s}$
Other sensitive hospital areas	When in use	40 - 45 $L_{Amax,s}$

The L_{Asmax} criteria outlined in this table refer to the maximum noise level not exceeded for 95% of rail pass-by events, measured using the 'slow' response setting on the sound level meter.

The criteria are intended for the assessment of ground-borne noise from railway traffic only (generally the third octave bands with centre frequencies 8 to 315 Hz) and measurement should exclude contributions from other noise sources. Ground-borne noise levels should be assessed near, but not at, the centre of the most exposed sensitive room to avoid any undue influence from standing waves. Note that within dedicated quiet areas where listening is important, the lower criterion of 40 L_{Asmax} would be more applicable.

6.10.5 Structural Damage

Currently there are no Australian Standards specifying the acceptable level of vibration limits for structural integrity due to ground vibration.

6.10.5.1 Cosmetic Damage

Recommended vibration criteria for cosmetic damage are based on the British Standard BS 7385-2:1993 "Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration" BS 7385-2:1993 recommends the lower value of vibration limits, above which cosmetic damage could occur, presented in Table 6-23.

Table 6-23 Recommended transient vibration values for cosmetic damage.

Type of Building	Peak component particle velocity (PPV) in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial	50mm/s at 4 Hz and above	50mm/s at 4 Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/sec at 15 Hz	20mm/s at 15 Hz increasing to 50mm/sec at 40 Hz and above.

The recommended values relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to 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 recommended values in Table 6-23 may need to be reduced by up to 50 %.

6.10.5.2 Structural Damage

Vibration criteria for structural damage, as recommended in German Standard DIN 4150-Part 3 (2016-12) Effects on Structures, is adopted and recommended for vibration assessment for structural integrity. The DIN 4150 Part 3 prescribes maximum allowable vibration velocities measured at the foundation of the buildings, which do not affect the structural integrity of the buildings. Based on the Standard, the maximum allowable ground vibration velocity deemed acceptable for different types of buildings is shown in Table 6-24.

Table 6-24 Guideline for vibration velocity for evaluating the effects of short-term vibration on structures (DIN 4150 -2016)

Type of Structure	**Guideline values for $v_{i,max}$ in mm/s**				
	Foundation, all directions (i=x,y,z) at a frequency of			**Topmost floor, horizontal direction (i=x,y)**	**Floor Slabs, vertical direction (i=z)**
	1 Hz to 10 Hz	**10 to 50Hz**	**50 to 100Hz**	**All frequencies**	**All frequencies**
Buildings used for commercial purposes, industrial buildings and buildings of similar design (Industrial)	20	20 to 40	40 to 50	40	20
Residential buildings and buildings of similar design and/or occupancy (Residential)	5	5 to 15	15 to 20	15	20
Structures that, because of their particular sensitivity to vibration, cannot be classified under the above two classifications and are of great intrinsic value (e.g., listed buildings under preservation order). (Heritage)	3	3 to 8	8 to 10	8	20

6.10.6 Construction Vibration Criteria

The latest release of BS 6472-1:2008 includes information on the evaluation of intermittent vibration by introducing a ‘vibration dose’ concept. This approach can be used for the evaluation and assessment of vibration from trains, heavy road vehicles, construction activity and other vibration sources which are not continuous.

The DECC “Assessing Vibration: A Technical Guideline” is based on the guidelines contained in BS 6472.1:2008, Guide to evaluation of human exposure to vibration in buildings - Vibration sources other than blasting.

Vibration criteria for continuous and impulsive vibration are presented in Table 6-25 and Table 6-26 below.

Table 6-25 Vibration acceleration and velocity criteria for exposure to continuous and impulsive vibration

Place	Time	Weighted RMS acceleration (m/s^2);Vibration acceleration value (dB re 10^{-6} m/s^2)		Weighted RMS velocity (mm/s). Vibration velocity value (dB re 10^{-6} mm/s)	
		Preferred	**Maximum**	**Preferred**	**Maximum**
Continuous vibration					
Critical working areas (e.g., hospital operating theatres, precision laboratories)	Day-or night-time	0.0050 (74dB)	0.010 (80dB)	0.10 (100dB)	0.20 (106dB)
Residences	Day time	0.010 (80dB)	0.020 (86dB)	0.20 (106dB)	0.40 (112dB)
	Night-time	0.0070 (77dB)	0.014 (83dB)	0.14 (103dB)	0.28 (109dB)
Offices	Day-or night-time	0.020 (86 dB)	0.040 (92 dB)	0.40 (112 dB)	0.80 (118 dB)
Workshops	Day-or night-time	0.040 (92 dB)	0.080 (98 dB)	0.80 (118 dB)	1.6 (124 dB)
Impulsive vibration					
Critical working areas (e.g., hospital operating theatres, precision laboratories)	Day-or night-time	0.0050 (74 dB)	0.010 (80 dB)	0.10 (100 dB)	0.20 (106 dB)
Residences	Day time	0.30 (110dB)	0.60 (113dB)	6.0 (136dB)	12.0 (142dB)
	Night-time	0.10 (100dB)	0.20 (106dB)	2.0 (126dB)	4.0 (132dB)
Offices	Day-or night-time	0.64 (116 dB)	1.28 (122 dB)	13.0 (142 dB)	26.0 (148 dB)
Workshops	Day-or night-time	0.64 (116 dB)	1.28 (122 dB)	13.0 (142 dB)	26.0 (148 dB)

Table 6-26 Peak velocity criteria for exposure to continuous and impulsive vibration

Place	Time	Peak velocity (mm/s)	
		Preferred	**Maximum**
Continuous vibration			
Critical working areas (e.g., hospital operating theatres, precision laboratories)	Day-or night-time	0.14	0.28
Residences	Day time	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
Impulsive vibration			
Critical working areas (e.g., hospital operating theatres, precision laboratories)	Day-or night-time	0.14	0.28
Residences	Day time	8.6	17.0
	Night-time	2.8	5.6
Offices	Day-or night-time	18.0	36.0
Workshops	Day-or night-time	18.0	36.0

7 Assessment of External Noise Intrusion and Façade Design

The noise impact at the proposed development façade would be dominated by road traffic noise from Bourke Road and O'Riordan Street and noise from mechanical plant equipment from nearby commercial/industrial premises. The following sections assess these noises and provide design recommendations to achieve design indoor sound levels as required by the AS2107:2016, NSW Health Guide 2022, State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP,2007) and Development Near Rail Corridor and Busy Roads Guideline 2008.

7.1 Road Traffic Noise Assessment

7.1.1 Prediction of Façade Noise Levels

As discussed in Section 5.1.3 and Section 5.1.5, attended and unattended noise measurements were performed on site to establish current ambient and traffic noise levels at the proposed development site. Based on these measured noise data, a high-level road traffic noise model was developed for the proposed development in SoundPLAN using the Calculation of Road Traffic Noise (CoRTN) algorithm. The model was calibrated using the measured unattended noise level at the site (Location 6) and attended measured noise levels along O'Riordan Street (Location 5) as shown in Figure 5-1. The measured and predicted noise levels at the noise measurement locations (calibration points) are shown in Table 7-1.

Table 7-1 Validation of the Acoustic Model

Acoustic Indices/Parameters	**Predicted and Measured Noise Levels at the Calibration Points, dB(A)**					
	Location 6 (Bourke Road)			Location 5 (O'Riordan Street)		
	Predicted	Measured	Difference	Predicted	Measured	Difference
$L_{A10,18hr\ 6am-12am}$	69.6	69	0.6	-	-	
$L_{Aday,15hr\ 7am-10pm}$	66.6	66	0.6	-	-	
$L_{Anight,9hr\ 10pm-7am}$	60.4	60	0.4	-	-	
$L_{Aday,11hr\ 7am-6pm}$	66.6	66	0.6	71	$L_{Aeq,15min}$ 71	0

Predicted road traffic noise levels were found to be within ±2 dB of the measured noise level, therefore the road traffic noise model is considered to be acceptable and valid.

Based on the traffic impact assessment provided in the Positive Traffic's Report v2, dated in October 2023, we understand that future traffic growth is expected to be no more than 6%. Considering that there is potential for further growth at the subject site area, we consider an addition of 2 dB to account for future traffic growth. Predicted façade noise levels are provided in Table 7-2.

Table 7-2 Predicted façade noise levels (inclusive of +2.5 dB for façade reflection)

Parameter	**Predicted Façade Noise Level, dB(A)**			
	North Facade	South Facade	East Facade	West Facade
$L_{Aeq,15hr}$ - Day	66 dB(A)	61 dB(A)	61 dB(A)	62 dB(A)
$L_{Aeq,9hr}$ - Night	60 dB(A)	60 dB(A)	61 dB(A)	59 dB(A)

Snapshots of façade noise maps are provided in Figure 7-1 and Figure 7-2.

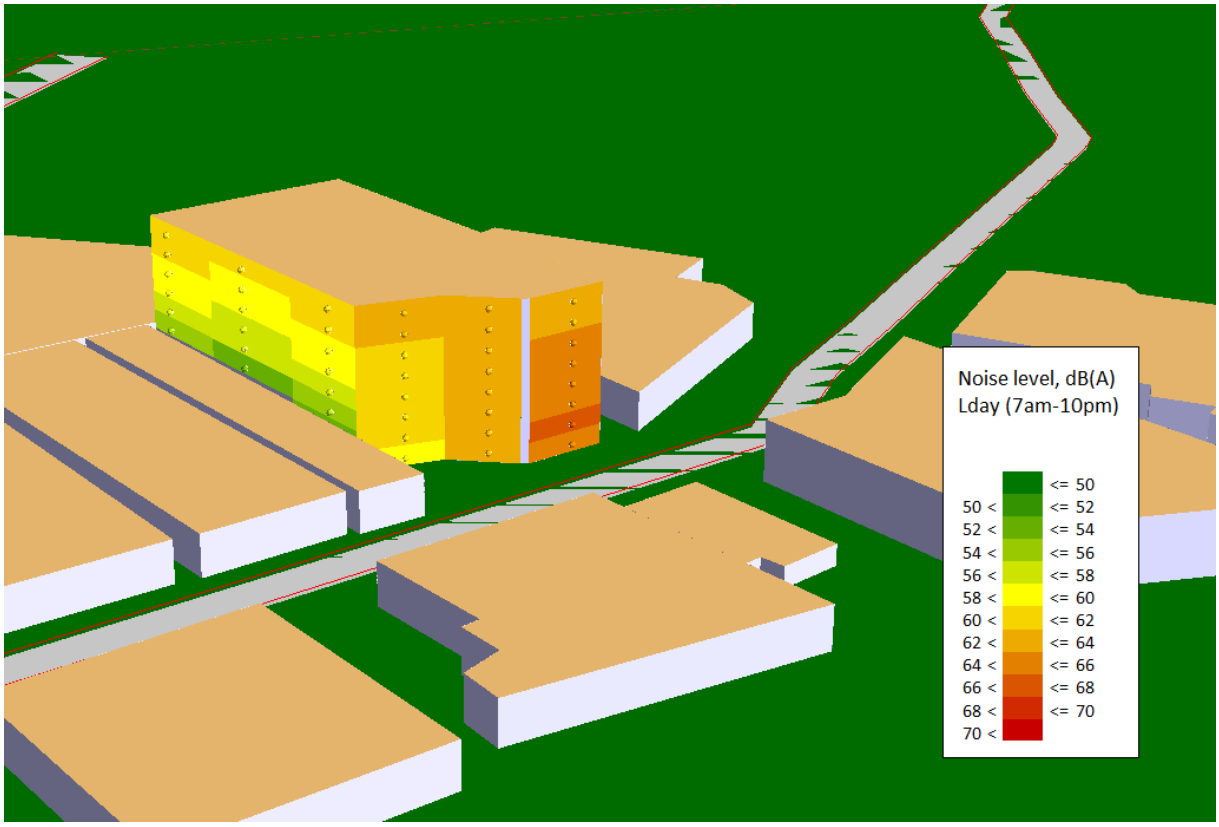


Figure 7-1 Façade noise map – North and East Façade facing Bourke Road

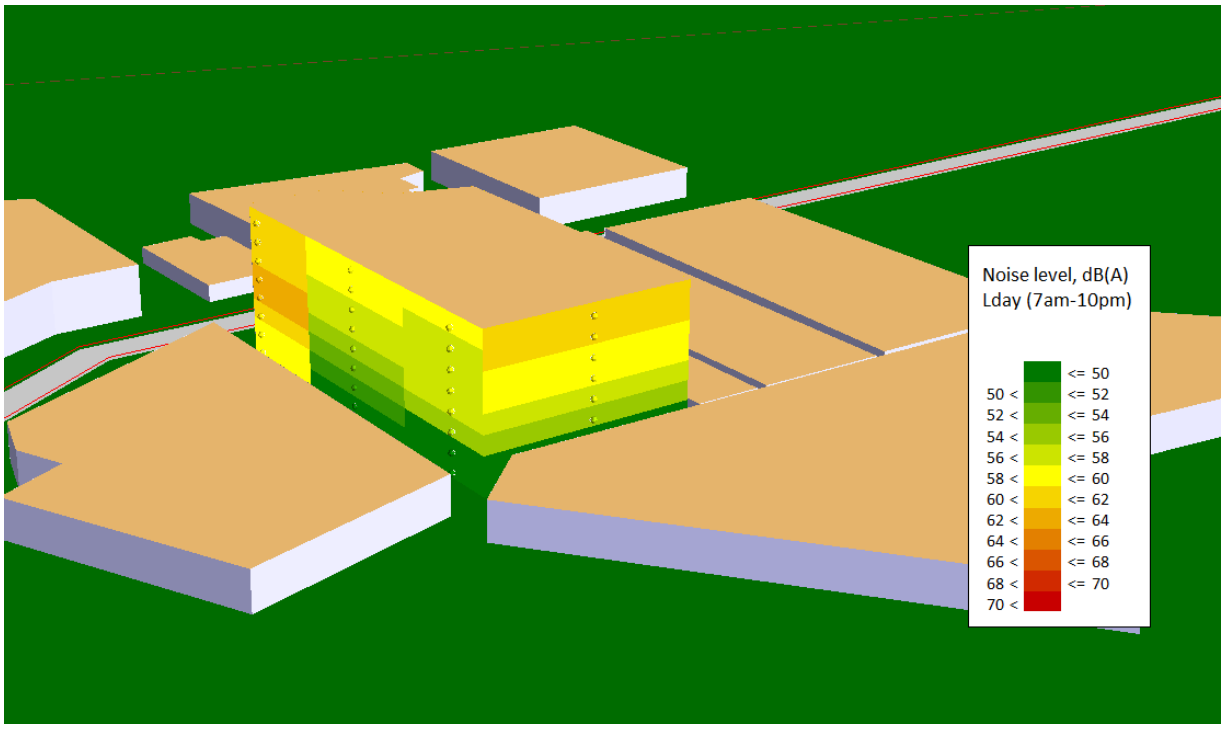


Figure 7-2 Façade noise map – South and West Façade facing O'Riordan Street

7.1.2 Sound Insulation Requirement for Building Envelope

7.1.2.1 External Glazed Door and Windows

Based on the predicted façade noise levels for the proposed building, the minimum glazing requirement is provided in Table 7-3. Noted that this is a preliminary glazing recommendation, which would be finalised during detail design stage once the architectural layout and room functions are determined.

Table 7-3 Minimum façade glazing requirements.

Façade Orientation	Minimum Façade Glazing Requirements, dB		Example of Suitable Glazing Construction
	Rw	Rw+Ctr	
North	37	34	▪ Option 1: Single Glazing: 8.5mm Viridian Laminated Hush Glass ▪ Option 2: Double Glazing Unit: 4mm VFloat/16mm Gap/8.5mm Viridian Hush
South	36	32	▪ Option 1: Single Glazing: 6.5mm Viridian Laminated Hush Glass ▪ Option 2: Double Glazing Unit: 6mm VFloat/12mm Gap/6.5mm Viridian Hush
East Facade			
West Facade			

All glazing should be installed with appropriate acoustic seals. Mohair Seals are not considered suitable where acoustic glazing is recommended. Recommended acoustic seals are as follows:

- Schlegel Q-Lon
- Raven

It is important that the glazed door and window frames also match the acoustic rating of the recommended façade glazing. This should be confirmed by the supplier/manufacturer of the façade glazing (i.e. acoustic test results of the system).

Small gaps around the door or window frames or perimeter can significantly compromise the acoustic rating of the façade glazing system. It is important to understand that workmanship must be excellent. All gaps must be sealed with a resilient, non-hardening mastic that can withstand any movement likely throughout the life of the rooms. Generally, a polyurethane mastic or fire mastic that allows for minimum 15% joint movement will be acceptable. All penetrations must be fully mastic sealed and inspected, prior to any finishing detailing (skirting, architraves and the like) being provided.

The junctions between the façade systems and internal walls and floors need to be appropriately detailed to minimise flanking noise and to maintain the acoustic performance of the internal walls and floors. Details will be reviewed as the project design progresses.

For the acoustic integrity of building elements to be maintained, all gaps and interfaces along the junctions and joints of linings must be sealed with an appropriate acoustic grade sealant. Penetrations for mechanical or electrical services must be properly blocked and sealed around the ductwork/cabling to ensure the intended acoustic rating of the partition is retained. Appropriate acoustic caulking products include:

- Bostik Firemastic
- Bostik Seal-n-flex 1
- Pyropanel Multiflex

- Boral Fyreflex
- Dow-Corning 790 Silicone
- Dow-Corning 795 Silicone
- Sika Sikaflex-11 FC
- Fosroc Flamex 3

7.1.3 Exterior Walls

The preliminary recommended external wall constructions to achieve the nominated internal noise criteria are provided below. The walls construction will be further reviewed when design progress.

Table 7-4 Recommended exterior wall construction.

Wall Type	Minimum Acoustic Rating, R_w dB	Example of suitable Wall Construction
Masonry	50	▪ 150mm Concrete Wall (density 2,340 kg/m^3)
Stud Wall	50	▪ Side 1: 1x 12mm CFC Wallboard (Surface mass18kg/m^2) ▪ Frame: 92mm Steel Stud with 75mm, 14kg/m^3 Glasswool or Fibreglass acoustic insulation. ▪ Side 2: 1x 13mm Standard Plasterboard (Surface mass 8.4 kg/m^2 per layer)

7.1.4 Roof

The roof construction detail is not known at this stage. The design would also depend on the noise from roof-mounted mechanical plant. At this stage, the following preliminary roof construction is recommended to control noise intrusion from the road traffic and plant room serving the building. The roof construction will be further reviewed when design progress.

Table 7-5 Roof and ceiling construction

Roof Type	Minimum Acoustic Rating, R_w dB	Example of suitable Wall Construction
Concrete Roof	54	▪ 200mm Concrete Slab (density 2,340 kg/m^3) with a suspended ceiling. ▪ Ceiling cavity should be minimum 150mm. ▪ Insulation in the cavity should be filled with 75mm, 14kg/m^3 Glasswool or Fibreglass acoustic insulation. ▪ One layer of 13mm standard plasterboard (surface mass 8.4kg/m^2) installed on furring channel.
Light-weight Roof	54	▪ Profiled steel sheet (0.6mm) roofing ▪ 150mm Steel Purlin or Timber Joist ▪ 145mm R3.6 Bradford Anticon insulation in the cavity. ▪ 2 x 13mm Acoustic Rated Plasterboard (surface mass 13kg/m^2 per layer) fixed to the purlin using resilient rail (e.g. Rondo 581 pr equivalent)

7.1.5 Acoustic Treatment of the Ventilation Ducts

The project site is located next to busy roads, it is therefore considered that the ventilation openings at the building façade should be acoustically treated to minimise the traffic noise intrusion into the sleeping and consultation area. Ventilation ducts connected to toilet or kitchen exhaust fans that opens at the Bourke Road and O'Riordan Street should be acoustically treated. This should be further reviewed when design progress.

7.2 Mechanical Plant Noise Intrusion to the Proposed Building

Based on the site observations, road traffic noise levels are dominant on façade as compared to mechanical plant and equipment at nearby premises. Based on the measured noise level on site and surrounds, the recommended minimum acoustic rating of the building façade should be sufficient in achieving the recommended design indoor noise level. However, it is noted that mechanical plant design is not available at this early stage of the development, therefore this should be further considered during detail design stage to ensure that noise from mechanical plant within the proposed development achieves the design indoor sound level requirements.

Relevant recommendations should be developed when mechanical plant design is made available. Preliminary recommendations are provided in Section 8.1.

8 Operational Noise and Vibration Assessment

8.1 Operational Noise Assessment

8.1.1 Noise Emission from Mechanical Plant and Equipment to Environment

Noise emissions via the mechanical services from the proposed development are required to comply with the Noise Policy for Industry (NPfI) criteria at all nearest sensitive receivers, including premises within the development. Mechanical plant and equipment were not finalised at the time of this assessment. This is typical for DA stage of a development as the mechanical design will be further developed when project design stages further progress.

It is understood that most of the mechanical plant and equipment would be located on the rooftop level. Currently there is no information available about the plant and equipment for the proposed development. However, following mechanical plant and equipment are typical for similar project:

- Air Handling Units (AHU)
- Air cooled Chillers
- Central VRV System
- Roof Mounted Condenser Units
- Kitchen Exhausts
- Carpark Supply Air Fan
- Carpark Return Air Fan

Appropriate noise control measures should be adopted if any of the above mechanical plant and equipment are proposed for the project. Examples of suitable noise control mitigation measures may include the following:

- Selection of quieter mechanical plant and equipment.
- Installing the plant and equipment on appropriate vibration isolation to achieve 95% to 98% Isolation efficiency, depending on the sensitive location to the floor level below.
- Installing acoustic screen or noise barrier. The height of the barrier should typically be 1m above the height of the tallest equipment.
- Installation of acoustic louvre, where ventilation would be required for the equipment.
- Acoustic attenuators or silencers for supply or return air fans.
- Acoustic lining of the HVAC ducts/risers for control of airborne noise.

Noise from mechanical plant and equipment should be reviewed once mechanical design is available for this project. Noise emission from the proposed plant and equipment should comply with the NPfI noise requirements at the nearby noise sensitive receivers (shown in Figure 8-1) as provided in Table 8-1.

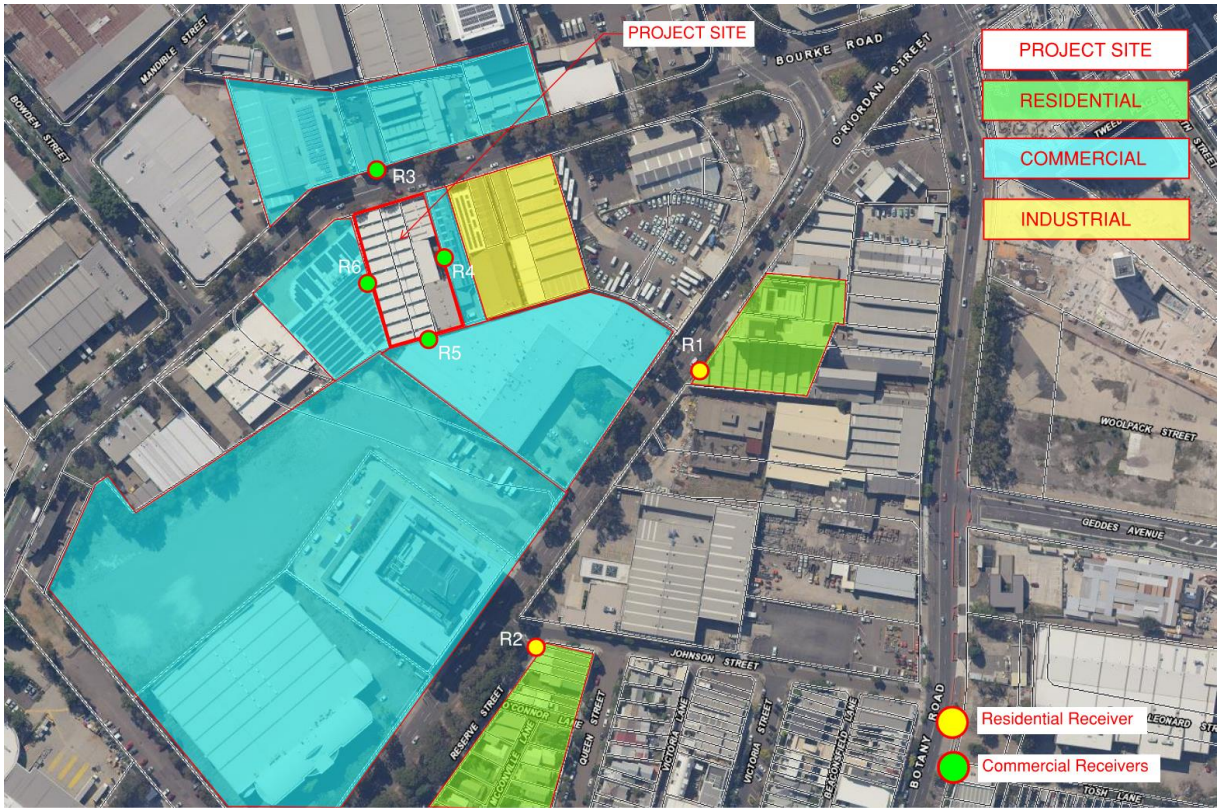


Figure 8-1 Noise sensitive receivers surrounding the proposed development (Source: Six Maps NSW)

Noise sensitive receivers and relevant acoustic requirements as per NPfI are listed below in Table 8-1.

Table 8-1 Noise sensitive receivers and noise emission criteria

Receiver #	Noise Sensitive Receiver Address	Noise Criteria, $L_{Aeq,15min}$ dB(A)		
		Day	Evening	Night
R1	16 O'Riordan St (Residential)	57	48	43
R2	5-19 Reserve St (Residential)	57	48	43
R3	15 Bourke Rd (Commercial)	63 (when in use)		
R4	26 Bourke Rd (Commercial)			
R5	9-13 O'Riordan St (Commercial)			
R6	36 Bourke Rd (Commercial)			
	Hospital Wards within the proposed Hospital Building	▪ External Areas: 48 dB(A), during noisiest 1-hour period. ▪ Internal Areas: 35 dB(A)		

For a residence, the project noise trigger level and maximum noise levels are to be assessed at the reasonably most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence, but not closer than 3 metres to a reflective surface and at a height of between 1.2–1.5 metres above ground level.

For multi-storey residential buildings (greater than two storeys) where a ground floor assessment location is deemed to be unrepresentative of the exposure of upper stories, the assessment may be undertaken at a representative elevation and closer than 3 metres to a reflective surface, as agreed with the regulator. However, the assessed/measured noise level is to be suitably adjusted to reflect a 'free field' (that is, nominally no reflective signals) assessment/measurement location.

8.1.2 Noise from Emergency Fire Pumps - Pumproom

Hydraulic pumproom is currently proposed at the basement level, on the eastern side of the building. It is understood that the fire hydrant pumps will only be operated in a fire emergency. However, there would be some scheduled maintenance/testing of the pumps time to time (probably on quarterly basis) when the pumps may be operated for an hour period. Noise from all these pumps should comply with NSW EPA NPfI at all noise sensitive receivers during the maintenance period.

This should be further assessed and relevant noise control measures such as internal duct lining, acoustic attenuator, acoustic screen etc should be considered to achieve noise compliance. It is recommended that the maintenance of the pumps is operated during the day period between 7am and 5pm. As the pumps are located with the basement level, noise impact at nearby noise sensitive receivers is considered to be minimal.

8.1.3 Control of Building Services Noise (Indoor Noise)

ACOR Acoustics will review and provide comprehensive recommendations for the building services to achieve the requirements through the design phases when Mechanical documentation will be provided.

8.1.4 Vibration Isolation

All mechanical services plant, equipment and associated ancillaries, and hydraulic services, should be mounted or supported using vibration isolating elements to minimise the transmission of structure-borne noise throughout the building. This includes all building services, such as ductwork and pipework.

It is recommended that all plant, including but not limited to, outdoor condenser units, outdoor fans and pumps be mounted on vibration mounts that achieve an isolation efficiency of at least 95/98%. Similarly, all in-ceiling fans and fan coil units will need to be supported using isolated hangers.

There should be a flexible coupling or connection installed between each item of plant, such as a fan, air handling unit or pump, and the associated ductwork and pipework.

Rigid contact between ductwork or pipework and the building structure should be avoided by mounting the duct or pipe such that contact does not occur, or by installing a 6mm thick neoprene strip between the duct or pipe and the building structure for cases where space constraints are an issue.

All pipework should be isolated at support points. Main riser and dropper pipes should be supported from the floor slabs only, and mounting points on lightweight walls between the slabs should not be used. All branch and main riser pipes must be supported by rubber lined clips or vibration-isolated hangers.

Pipework should only be located in dividing walls if the dividing walls are of a discontinuous construction. Pipes in dividing walls should be supported by resilient clamps and only be mounted to the wall leaf adjacent to the room served by the pipe, or the wall leaf adjacent to the least noise sensitive space in the case of common pipework. If a pipe is required to be installed in single framed stud wall, the pipe should be connected to the stud frame using vibration isolating elements, for e.g., rubber lined clips or resilient mounts.

8.1.5 Noise from Additional Road Traffic Growth

The NSW Road Noise Policy (RNP) states that for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2dB above the existing noise levels. The policy noted that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

Based on the traffic impact assessment provided in the Positive Traffic's Report v2, dated in October 2023, we understand that future traffic growth is expected to be no more than 6%. On this basis, it is considered that traffic noise generation from the development is unlikely to increase the existing noise levels considerably and will be less than 2 dB(A). Therefore, the proposed development is likely to meet the NSW Road Noise Policy (RNP) criteria of a development not increasing existing traffic noise levels by more than 2 dB(A).

8.1.6 Noise from the Underground Carpark

Noise emissions from cars on the internal road, and the underground carpark will include vehicles starting, car doors and boots closing, people talking and cars travelling through the carpark. Most noise from modern cars is from road-tyre contact noise, with very little exhaust or engine noise. The road-tyre contact noise increases with increasing vehicle speed. Generally speaking, the low vehicle speeds, expected to be less than 30 km/hr, will result in very low car travel noise levels, as long as some important factors are taken into account. ACOR recommends the following be considered to minimise noise from vehicle travel:

- Do not use a smooth surface that results in tyre squeal. Use a brushed or textured surface that does not result in tyre squeal.
- Avoid sharp transitions in angle. Instead, use smooth transitions between flat surfaces and ramps. A resilient element between the ramp and main structure of the building may be considered to avoid any structure-borne vibration associated with vehicle movement.
- Do not use loud speed humps, such as metal speed humps. If concrete or rubber speed humps are necessary, use a smooth transition on either side to minimise vehicle clunking etc.
- Minimise vehicle speed through the internal road by using appropriate traffic calming devices.
- The ramp to the basement should not include any irregular surfaces including any speed bumps that may generate noise due to the vehicle movement.
- The use of acoustically absorptive materials on concrete soffits can help to reduce noise from the carpark. Where thermal insulation is required, insulation with acoustically absorptive properties to absorb some of the sound generated within the carparks should be used.
- Appropriate elastomeric material should be used for the metal grille if installed over the linear drainage in the carpark or on the ramps. This should reduce the noise impact when the car drives over the metal grill.
- Automated garage door (if any) should be installed with appropriate vibration isolation system. Motors should be vibration isolated and selected to have quiet operation.

8.1.7 Noise from Ambulance Bay

Noise from emergency vehicle, such as ambulances, are excluded from meeting the noise requirements of the NPfI. The current ambulance bay is currently proposed on the ground level, on the western boundary. The neighbouring premises adjacent to the proposed development are all commercial nature and the nearest residential premises is located 130m to the south-east corner of the proposed development. Therefore, it is unlikely that the noise from Ambulance would be source of annoyance to the neighbouring premises. It is understood that the sirens in the ambulance would not be typically used within the hospital premises, with the exception of short burst to alert people in the surroundings.

8.2 Operational Vibration Assessment

8.2.1 Rail ground-borne noise and vibration

RMS spectral data were analysed for each train movement recorded, and the measured data were used to predict vibration levels on the floors and compare against established criteria.

The vibration assessment has been undertaken in general accordance with the prediction model is a single-site empirical model, as defined in BS ISO 148371-1 Mechanical Vibration - Ground-borne Noise and Vibration arising from Rail Systems - Part 1: General Guidance.

The calculation of attenuation during propagation through the soil (i.e., from geometric divergence and soil damping mechanisms) is based on that presented by Amick: A Frequency Dependent Soil Propagation Model,

PROC SPIE conference on current developments in vibration control for optomechanical systems (1999). The method also appears in documents from other authors, so Amick may not be the original source. Data for the material properties of different soils is taken from Amick, who lists the original sources.

Transfer functions for the propagation of vibration from the soil into the building foundations and then through the building to the internal floors are taken from Nelson and Saurenman: A Prediction Procedure for Rail Transportation Ground borne Noise and Vibration, Transportation Research Record 1143, US Dept of Transport, and Villot et al: Procedures to Predict Exposure in Buildings and Estimate Annoyance, a report from the Railway Induced Vibration Abatement Solutions (RIVAS) Collaborative Project (2012).

To predict the floor vibration levels inside the building, the measured vibration levels are corrected for:

- Distance correction
- Transfer function soil to foundations
- Transfer function foundations floor
- Amplification on suspended floors

The theoretical/empirical assessment indicates that external vibration ingress is predicted to be complaint with established floor vibration criteria and the risk of vibration impact to the proposed facility from external sources is low.

A conservative assumption has been applied for floor amplification to represent the vibration levels mid-grid. However, for a >200mm concrete slab, with internal partitions, furnishing, and equipment, the amplifications are expected to be low. Floor structure is to be designed to ensure vibration requirements for human comfort and sensitive equipment as presented in Section 6.10.

The theoretical/empirical assessment indicates that rail ground-borne noise levels are predicted to be complaint with established LAmax,s criteria and the risk of ground-borne noise is low.

Building foundations and piles should be located a safe distance from adjacent tunnel infrastructure to prevent structural damage and vibration transfer into the building.

9 Construction Noise and Vibration Assessment and Management Plan

9.1 Construction Noise

9.1.1 Construction Noise Assessment

It is understood that the project is currently at the concept/feasibility design stage and there is no contractor engaged or any construction plan developed, therefore assessment of construction noise and vibration would be very preliminary at this stage.

The noise emissions from construction have been assessed at the surrounding potentially affected receivers during the standard construction hours. As shown in Figure 6-1, the noise sensitive receivers in the vicinity of the proposed development are typically commercial in nature, with residential premises located about 130m south-east and west of the proposed development. A quantitative assessment has been undertaken with consideration to the Interim Construction Noise Guideline (ICNG).

The Interim Construction Noise Guideline (ICNG) (DECC, 2009) guideline recommends standard hours for construction activities as:

- Monday to Friday: 7am to 6pm,
- Saturday: 8am to 1pm, and
- no work on Sundays or public holidays.

These hours are not mandatory and the ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads.
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.
- works which maintain noise levels at sensitive receivers to below the noise management levels outside of the recommended standard construction hours.

Construction activities would generally be carried out during the recommended standard construction working hours. Early morning oversized deliveries may be required on occasion for some of the construction works and may occur outside the recommended construction hours. No work would be intended on Sundays or public holidays.

Construction traffic movements would primarily be associated with the transportation of construction machinery and equipment to the proposal site and the transportation of material.

Plant and equipment needed for the proposal would be determined during the construction planning phase. Other equipment may be used however it is anticipated that they would produce similar noise emissions.

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- The intensity and location of construction activities.
- The type of equipment used.
- Existing background noise levels.

- Intervening terrain and structures.
- The prevailing weather conditions.

Construction machinery would likely move about the study area altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time and certain types of construction machinery would be present in the study area for only brief periods during construction. Therefore, noise predictions are considered conservative.

As noted earlier, the project is currently at the concept/feasibility design stage and there is no contractor engaged or any construction plan developed. Therefore, construction equipment required for this project is not known at this stage. Table 9-1 below provides typical construction equipment associated with different stages of construction, some of which may be relevant to this project. The table also includes the equipment Sound Power Levels (SWL) and sound pressure level at 7m distance.

Table 9-1: Highest allowable noise levels for construction equipment (Source: NSW RMS Construction Noise and Vibration Guideline)

Activity	**Description of Activity**	**Plant/Equipment**	**L_{Aeq} SWL**	**L_{Aeq} at 7m**
Mobilisation & Site Establishment	Installing construction boundary hoardings/ fences and traffic barriers	Truck (medium rigid)	103	78
		Road truck	108	83
		Scissor Lift	98	73
		Franna crane	98	73
Utility, property, service	Utility, property, service	Excavator (tracked) 35t	110	85
		Dump truck	110	85
		Franna crane 20t	98	73
		Pneumatic hammer	113	88
		Concrete saw	118	93
		Vacuum truck	109	84
		Backhoe	111	86
		Power generator	103	78
Corridor Cleaning	General land clearing, tree and stump removal, topsoil stripping, loading	Bulldozer D9	116	91
		Excavator (tracked) 35t	110	85
		Chainsaw 4-5hp	114	89
		Tub grinder/ mulcher 40-50hp	116	91
		Dump truck	110	85
		Excavator (tracked) 35t	110	85
	House/ building demolition	Hydraulic hammer	122	97
		Front end loader 23t	112	87
		Dump truck	108	83

Activity	Description of Activity	Plant/Equipment	L_{Aeq} SWL	L_{Aeq} at 7m
Bulk earthworks	Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage, compaction of fill areas, grading	Bulldozer D9	116	91
		Scraper 651	110	85
		Excavator (tracked) 35t	110	85
		As above + hydraulic hammer	122	97
		Grader	113	88
		Dump truck	110	85
		Compactor	106	81
		Roller (large pad foot)	109	84
		Water cart	107	82
Retaining Walls	Construction of Retaining walls	Piling rig - bored	112	87
		Power generator	103	78
		Mobile crane	113	88
		Concrete vibrator	113	88
		Concrete pump	109	84
		Welding equipment	105	80
		Excavator (tracked) 35t	112	87
		Air track drill	124	99
Compounds	Deliveries plant and equipment, maintenance, Office Areas, Storage Areas	Front end loader	91	66
		Excavator (tracked) 35t	110	85
		Road truck	108	83
		Compressor	109	84
		Welding equipment	105	80
		Light vehicles	88	63
		Power generator	103	78
Construction Compound	Site Establishment	Chainsaw 4-5hp	114	89
		Pneumatic hammer	113	88
		Fixed crane	113	88
		Front end loader	112	87
		Excavator (tracked) 35t	110	85
		Grader	113	88
		Vibratory roller	109	84
		Concrete truck	109	84
		Dump truck	110	85
		Water cart	107	82
		Concrete vibrator	113	88

Activity	Description of Activity	Plant/Equipment	L_{Aeq} SWL	L_{Aeq} at 7m
		Concrete pump	109	84
		Power generator	103	78
		Light vehicles (e.g. 4WD)	103	78

Based on the construction equipment and the relevant Sound Power Leves provided in Table 9-1, a high-level noise model was developed in SoundPLAN to predict the construction noise at nearby noise sensitive receivers. The CONCAWE noise propagation algorithm was used to perform the calculations, with the noise-enhancing meteorological conditions specified in Table D1 of the NPfI. The predicted noise levels for different construction stages (assumed) at nearby noise sensitive receivers are provided in Table 9-2.

Note the following in relation to this assessment:

- Receivers R1 and R2 are residential buildings, refer to Figure 6-1.
- Receivers R3 to R6 are commercial buildings, refer to Figure 6-1.
- Noise Management levels for residential building during standard construction period are as follows:
  - Noise Affected: 62 dB(A), $L_{Aeq,15min}$
  - Highly Noise Affected: 75 dB(A), $L_{Aeq,15min}$
- Noise Management levels for commercial building during standard construction period is 70 dB(A), $L_{Aeq,15min}$.
- Locations of the noise sources/construction equipment are adopted randomly, since they would be changing locations time to time depending on the construction.
- Construction equipment that are considered relevant for this project are adopted for this construction noise assessment. However, this is an assumption only and the exact equipment and type would be determined by the construction contractor.
- Predicted maximum noise levels indicated in "**Bold**" indicates that it exceeded the recommended "Highly Noise Affected" Noise Management Level and noise mitigation measures would be required.
- The predicted noise level in Table 9-2 considered a noise barrier of 2.4m high along the perimeter boundary of the project site.
- The plant and equipment used in the acoustic calculations are based on assumptions only and this should be finalised when a contractor is engaged for construction and relevant construction equipment are known. Therefore, the predicted results are an estimate only and is not a true scenario for the project.
- Acoustic calculation assumes that all the plant and equipment are operating at the same time, resulting in worst-case noise. This may not be the case in the reality as all construction equipment are likely not be operated at the same time.

Table 9-2: Predicted Construction Noise (with inclusion of a 2.4m high noise barrier)

Activity	**Plant/Equipment**	**Predicted Noise Levels at Receivers, LAeq,15min**					
		Residential		Commercial			
		R1	R2	R3	R4	R5	R6
Mobilisation & Site Establishment	Truck (medium rigid)	37-55	36	60-69	76	60-69	67-77
	Road truck						
	Scissor Lift						
	Franna crane						
Utility, property, service	Excavator (tracked) 35t	45-64	45	73-76	73-84	70-78	74-84
	Dump truck						
	Pneumatic hammer						
	Backhoe						
	Power generator						
Corridor Cleaning	Excavator (tracked) 35t	55-70	52	75-83	82-92	75-83	79-90
	Dump truck						
	Hydraulic hammer						
	Front end loader 23t						
Bulk earthworks	Excavator (tracked) 35t	54-65	49	74-79	79-88	73-81	76-84
	Hydraulic hammer						
	Dump truck						
	Compactor						
	Roller (large pad foot)						
Retaining Walls	Piling rig - bored	49-67	46	70-78	76-86	74-83	76-87
	Power generator						
	Mobile crane						
	Concrete vibrator						
	Concrete pump						
	Welding equipment						
	Excavator (tracked) 35t						
Compounds	Front end loader	43-63	43	67-74	70-80	68-77	74-85
	Excavator (tracked) 35t						
	Compressor						
	Welding equipment						
	Light vehicles						
	Power generator						
Construction Compound	Pneumatic hammer	49-68	48	72-80	77-88	73-82	79-89
	Fixed crane						
	Front end loader						

Activity	Plant/Equipment	Predicted Noise Levels at Receivers, LAeq,15min					
	Excavator (tracked) 35t						
	Concrete truck						
	Dump truck						
	Concrete vibrator						
	Concrete pump						
	Power generator						
	Light vehicles						

Based on the predicted constructions noise levels provided in Table 9-2, it is observed that the predicted construction noise levels would satisfy he ICNG recommended Noise Management Level (Noise Affected) at the residential receivers. Therefore, it is expected that there would be minimal noise disturbance during the period of construction during standard hours.

In contrary to the residential receivers, commercial receivers are in close proximity to the proposed development and therefore the noise levels at the premises are considered to be higher. As noted from Table 9-2, noise levels would be exceeding the ICNG recommended criteria at commercial premises by 3 to 20 dB(A), although a noise barrier has been used in the acoustic calculations. However, noted that these levels are predicted at the property boundary. With the doors and windows closed in the commercial premise, it is expected that noise impact inside the building would be reduced.

Grid noise maps illustrating the noise contours at different stages of construction (at 1.5m height above ground level) are provided in Figure 9-1 to Figure 9-7. However, this should be noted that currently there is no constructions details available for this project, hence the predicted levels provide an estimation only of the worst-case scenarios for planning purpose. In reality, the construction noise is likely be lower as the number of equipment used on site at a time would differ (maybe less number of noisy equipment and not operating all at the same time) from this wors-cast approximation scenario.

Where the predicted L_{Aeq} (15 minutes) noise level is greater than the noise affected level, all feasible and reasonable work practices should be applied. The magnitudes of construction noise levels are dependent on the duration of construction, the type of equipment, location of activities, the surrounding environment's background noise levels and the weather conditions during construction. The predicted noise levels are generally conservative as the construction noise model predicts the worse-case 15-minute scenario and these levels may not represent the actual noise emission experienced by the community throughout the entire construction period.

Figure 9-1 Grid noise map showing predicted construction noise – Mobilisation Stage

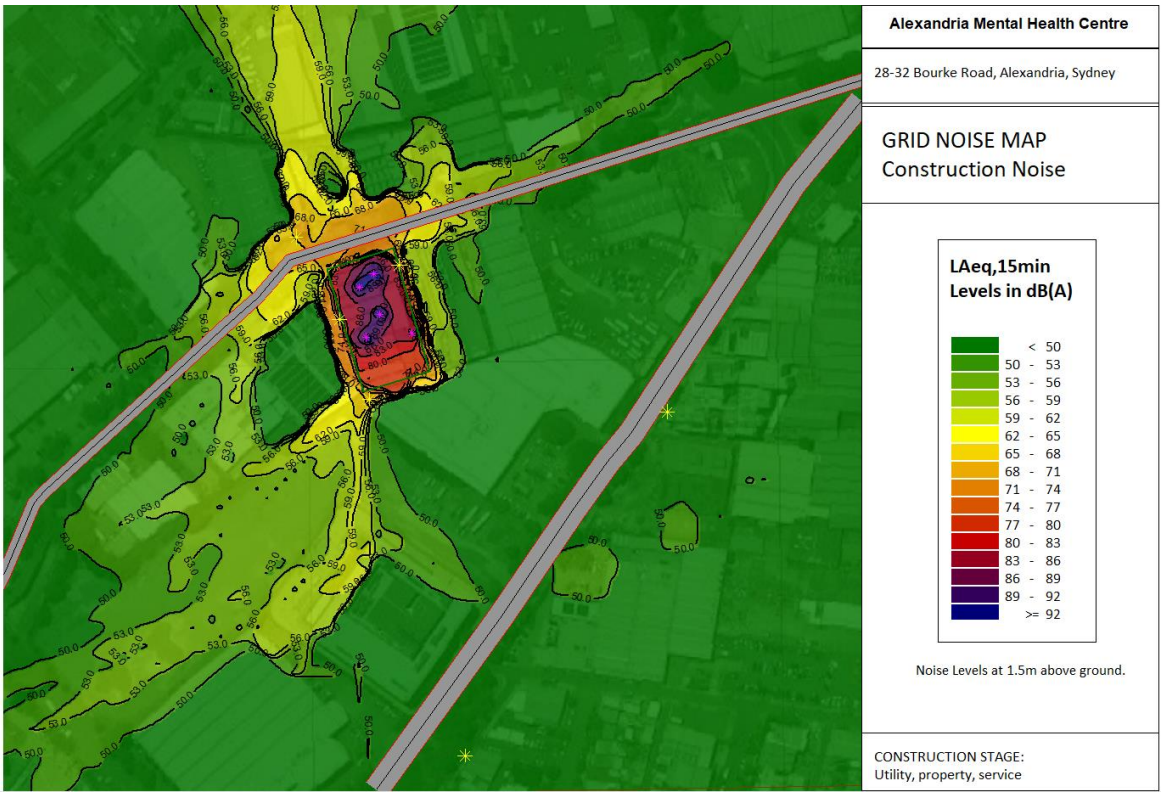


Figure 9-2 Grid noise map showing predicted construction noise – Utility, Property and Service Stage

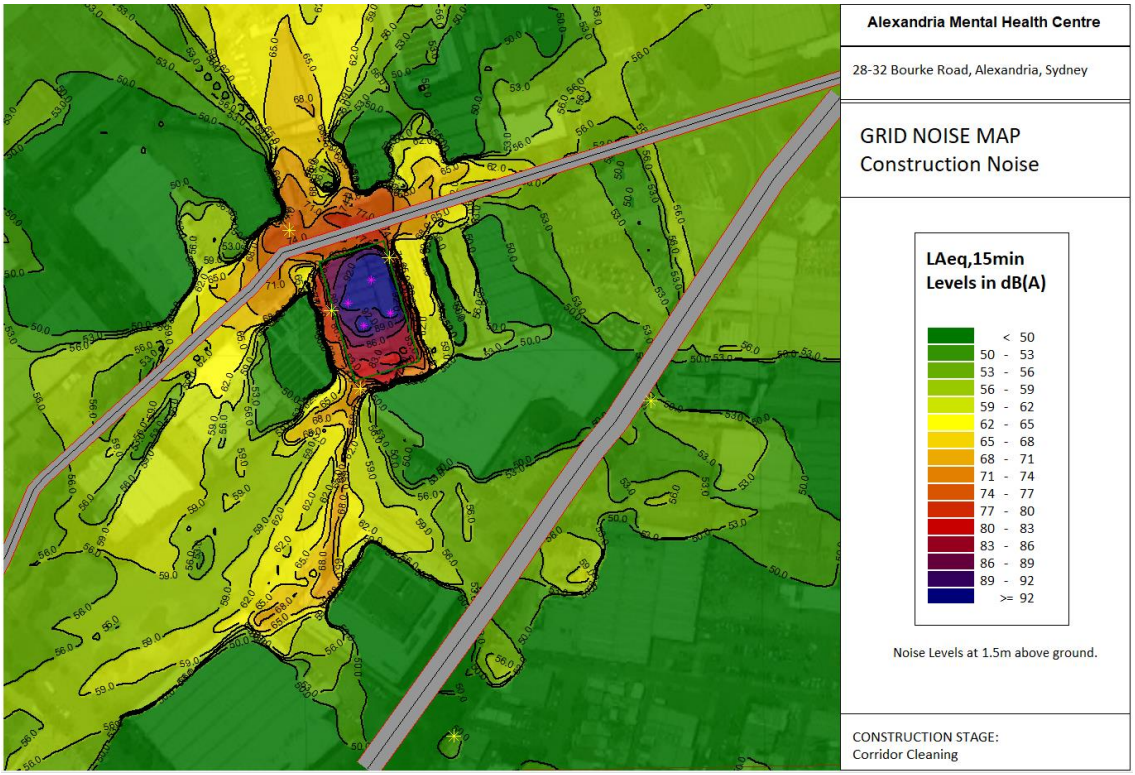


Figure 9-3 Grid noise map showing predicted construction noise – Corridor Cleaning Stage

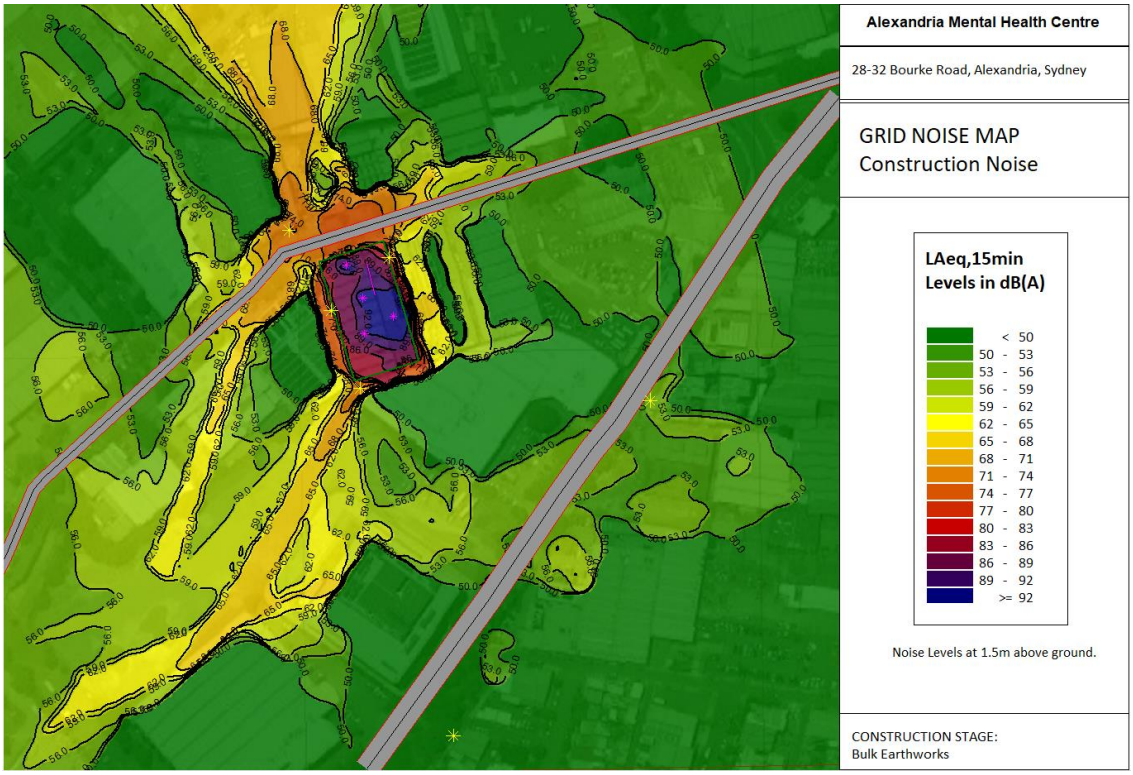


Figure 9-4 Grid noise map showing predicted construction noise – Bulk Earthworks Stage

Figure 9-5 Grid noise map showing predicted construction noise – Retaining Wall Stage

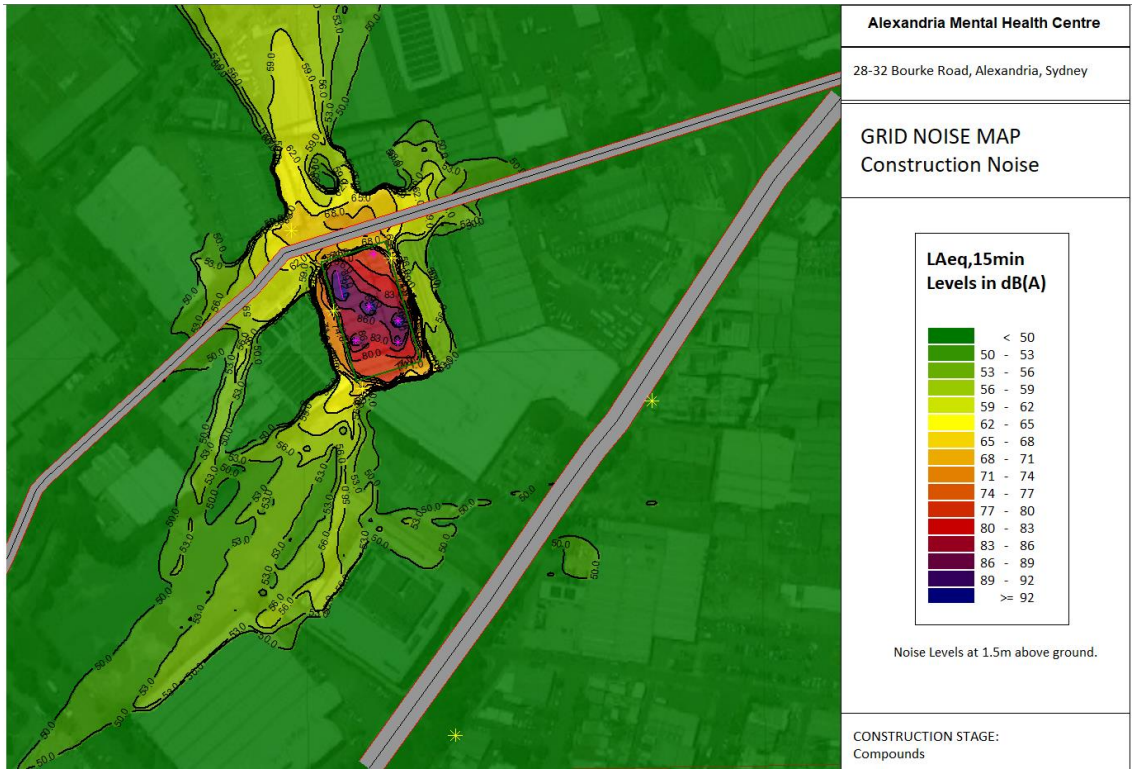


Figure 9-6 Grid noise map showing predicted construction noise – Compounds Stage

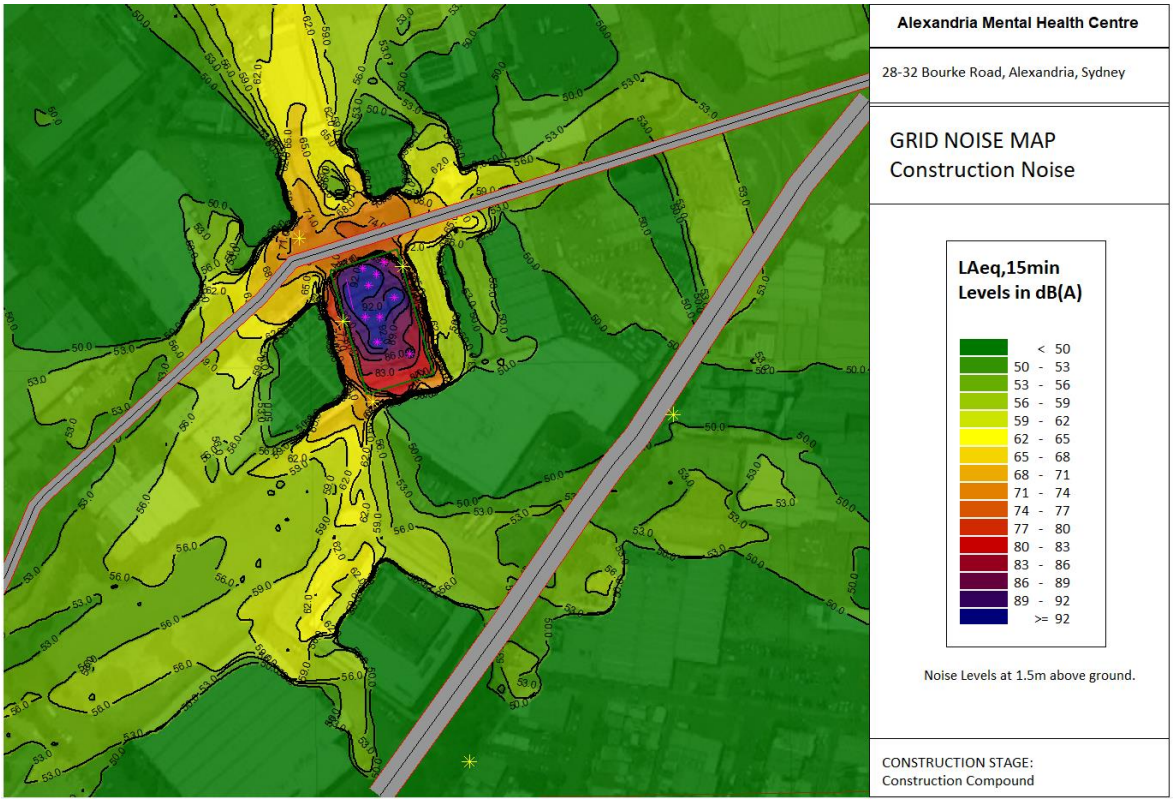


Figure 9-7 Grid noise map showing predicted construction noise – Construction Compound Stage

9.1.2 Sleep Disturbance

All construction activity is expected to occur during recommended standard hours therefore sleep disturbance impacts are not expected.

9.1.3 Construction traffic impacts

The application notes1 for the Road Noise Policy state that "for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion." This is also considered to be applicable for construction noise therefore if road traffic noise increases from construction is within 2 dB(A) of current levels then the objectives on the Road Noise Policy are achieved.

A significant increase in traffic volumes would be needed in order to increase road traffic noise by 2 dB(A) (a doubling in traffic corresponds to an approximate 3 dB(A) increase). Construction work would generate light and heavy vehicle movements associated with employees, deliveries, transportation of machinery, materials and equipment to work sites.

The increase in vehicle movements would be limited to the period of construction. Noise level increases due to construction traffic would not be significant when compared with the existing vehicle numbers in the study area.

9.1.4 Construction Noise Mitigation Measures

For control of construction noise and associated noise annoyance during the period of construction of the proposed development, following preliminary recommendations should be considered.

9.1.4.1 Acoustic Fence / Noise Barrier (Recommended)

It is recommended that a 2.4m high temporary noise barrier / hoarding should be installed on site, along the perimeter, to all sides, as shown in Figure 9-8. There should be no gap between the bottom of the noise barrier and the ground level.

Figure 9-8 Location of recommended temporary noise barrier for control of construction noise

The temporary noise barrier could be construction with any of the following:

- Plywood (minimum 25mm thick).
- Fibre Cement Sheet (minimum 12mm thick).
- Flexible Noise Barrier/ Acoustic Curtains – Example: Flexshield Acoustic Curtains, Echo Barrier (H10),
- Modular Acoustic Wall Panels, such as Dune Wall (Wallmark)
- Any other suitable material with a surface mass of approx. 15 kg/m^2.

In addition to the above recommended noise barrier, the following standard noise mitigation measures should be considered.

9.1.4.2 Standard Mitigation Measures

The following standard actions and mitigation measures should be implemented, where applicable.

Table 9-3 Standard Mitigation Measures (Source NSW RMS Construction Noise and Vibration Guideline)

Action Required	Applies to	Details
Management Control		
Implement community consultation or notification measures	▪ Airborne noise. ▪ Ground-borne noise & vibration.	▪ Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. ▪ Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. ▪ Website (If required) ▪ Contact telephone number for community ▪ Email distribution list (if required) ▪ Community drop-in session (if required by approval conditions).
Site inductions	▪ Airborne noise. ▪ Ground-borne noise & vibration.	▪ All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: ▪ all project specific and relevant standard noise and vibration mitigation measures ▪ relevant licence and approval conditions ▪ permissible hours of work ▪ any limitations on high noise generating activities. ▪ location of nearest sensitive receivers ▪ construction employee parking areas ▪ designated loading/unloading areas and procedures. ▪ site opening/closing times (including deliveries) ▪ environmental incident procedures.
Behavioural practices	▪ Airborne noise	▪ No swearing or unnecessary shouting or loud stereos/radios on site. ▪ No dropping of materials from height, throwing of metal items and slamming of doors.
Attended vibration measurements	▪ Ground-borne vibration	▪ Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Source Control		
Construction hours and scheduling.	▪ Airborne noise. ▪ Ground-borne noise & vibration.	▪ Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled

Action Required	Applies to	Details
		during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	▪ Ground-borne noise & vibration. ▪ Airborne noise.	▪ Respite Offers should be considered made where there are high noise and vibration generating activities near receivers. ▪ 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. ▪ The purpose of such an offer is to provide residents with respite from an ongoing impact. ▪ This measure is evaluated on a project-by-project basis and may not be applicable to all projects.
Equipment selection.	▪ Airborne noise. ▪ Ground-borne noise & vibration	▪ Use quieter and less vibration emitting construction methods where feasible and reasonable. ▪ For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. ▪ Ensure plant including the silencer is well maintained.
Plant noise levels.	▪ Airborne-noise.	▪ The noise levels of plant and equipment must have lower sound power level and should be assessed by the acoustic consultant to ensure that the noise emission levels are within the criteria.
Use and siting of plant.	▪ Airborne-noise.	▪ The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. ▪ Plant used intermittently to be throttled down or shut down. ▪ Noise-emitting plant to be directed away from sensitive receivers. ▪ Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	▪ Airborne noise. ▪ Ground-borne vibration.	▪ Locate compounds away from sensitive receivers and discourage access from local roads. ▪ Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. ▪ Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. ▪ Very noise activities should be scheduled for normal working hours.
Reduced equipment power	▪ Airborne noise. ▪ Ground-borne	▪ Use only the necessary size and power

Action Required	Applies to	Details
	vibration.	
Non-tonal and ambient sensitive reversing alarms	▪ Airborne noise.	▪ Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. ▪ Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	▪ Airborne noise.	▪ Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. ▪ Select site access points and roads as far as possible away from sensitive receivers. ▪ Dedicated loading/unloading areas to be shielded if close to sensitive receivers. ▪ Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. ▪ Avoid or minimise these out of hours movements where possible.
Path Control		
Shield stationary noise sources such as pumps, compressors, fans etc.	▪ Airborne noise.	▪ Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities.	▪ Airborne noise.	▪ Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

The above standard mitigation measures should be considered during the planning stage, which should be further reviewed and updated when the appropriate construction methodology is known.

9.2 Construction Vibration

As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 9-4. The minimum distances are quoted for both “cosmetic” damage (refer BS 7385-2:1993) and human comfort (refer OH&E’s Assessing Vibration - a technical guideline).

The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by Roads and Maritime or under the environmental license as relevant.

DIN 4150 has criteria of particular reference for heritage structures.

Table 9-4 Recommended buffer distance for control of construction vibration

Plant Item	Rating/ /Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5m	15 to 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
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800 mm	2m (nominal)	4m
Jackhammer	Hand held	1m (nominal)	2m

The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.

Operational aspects of some receivers may be highly sensitive to noise and vibration over, and above typical noise and vibration allowances based on annoyance and human comfort. For highly sensitive receivers (i.e., high technology facilities with sensitive equipment, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts.

Some guidance where building contents contain sensitive equipment may be found in these additional references:

- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16
- Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment Proceedings of International Society for Optical Engineering (SPIE), Vol. 1619, San Jose, CA, November 4-6, 1991, pp. 71-85
- ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40
- NSW RMS Construction Noise and Vibration Guideline – August 2016.

In relation to human comfort (response), the minimum working distances in Table 9-4 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see OEH's Assessing Vibration: a technical guideline). Where the predicted vibration levels exceed the human comfort objectives, procedures are to be followed in order to mitigate the potential impacts at sensitive receivers.

If the predicted ground-borne vibration levels exceed the cosmetic damage objectives, a different construction method with lower source vibration levels must be used where feasible and reasonable otherwise construction works should not proceed unless attended vibration measurements are undertaken at the commencement of the works.

If there is any risk of exceedance of the cosmetic damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the cosmetic damage objective.

As part of the vibration control measures, vibration monitoring will be recommended during construction phase at strategic locations, mainly during rock breaking activities, excavation, and drilling of the ground, piling process, construction of the basement and ground levels or other related construction activity that may affect adjacent receivers.

Vibration levels should be continuously monitored throughout the construction activities, so that any exceedance could be swiftly identified, and the construction activities stopped and modified to comply with the relevant criteria. The real time measurements should be set up to provide live alerts via email or SMS to receivers as determined by the client where criterion was exceeded.

During rock breaking activities or similar actions, attended structural vibration measurements at adjacent structures are recommended to confirm vibration levels and prevent damage to adjacent buildings, affecting human comfort or sensitive equipment.

Provision of monthly reports including results of the unattended noise and vibration monitoring undertaken.

Upon receiving the exceedance alert the following actions are required by the head contractor:

- Construction activity is immediately suspended.
- Immediate investigation is carried out by head contractor into what might have caused the exceedance.
- Noise and vibration controls are required to modify equipment or construction approach to ensure ongoing work remains below relevant criteria.
- Provide details of location, type of work, expected duration of work and modifications taken.
- Construction work is resumed.
- Weekly meetings to discuss any alarm events for the week.

Building foundations and piles should be located a safe distance from adjacent tunnel infrastructure to prevent structural damage and vibration transfer into the building. We recommend carrying out vibration measurements on the foundations once the ground has been excavated to verify their impact on the tunnel and the proposed building.

10 Conclusion

ACOR Consultants Pty Ltd (ACOR) has undertaken an acoustic review of the proposed development of Alexandria Health Centre, to be located at 28-32 Bourke Road, Alexandria, NSW.

The purpose of this report is to provide an acoustic assessment required for the Stage 2 State Significant Development Application (SSDA) for the project.

Noted that this is an Acoustic and Vibration Assessment Report for development application, which should be further developed in consultation with the client when design progress. It is predicted that the proposed development would achieve the relevant noise and vibration criteria, provided the design recommendations in this report are implemented.

We trust this information provided in this report meets your requirements. If you have any questions, please do not hesitate to contact ACOR.

Yours sincerely

Mahbub Sheikh (Dr)

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Appendix A Glossary of Acoustic Terms

A-weighting	Frequency weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).
C_{tr}	The spectrum adaptation term C_{tr} adjustment factor takes account of low frequency noise.
CAC	Ceiling Attenuation Class. The CAC determines how much cross-talk will occur between one room and another through the ceiling cavity where both rooms have the tested ceiling tile. This is an ideal situation, with no wall head leaks and no services penetrations in the ceiling. Therefore, it defines the ideal, best possible result as tested in a laboratory
dB	Decibel. This is the unit measurement of sound.
dBA	A weighted decibel is the most commonly used descriptor. The A weighting is an adjustment to the raw sound level to approximate what the average human ear can hear, which is less sensitive at very low and very high frequencies.
D_w	The Weighted Level Difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field with no standardisation or normalisation.
D_nT_w	The Weighted standardised level difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field. The higher the D_nT_w rating, the better is the acoustic performance of the wall or floor.
$D_nT_w + C_{tr}$	$D_nT_w + C_{tr}$ is D_nT_w with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same D_nT_w rating, but have different resistance to low frequency sound, thus a different $D_nT_w + C_{tr}$.
L_w or SWL	Sound power level. This is the total radiated sound energy.
L_p or SPL	Sound pressure level. This is the measurable sound level at a given distance from an item.
L_{max}	The RMS maximum noise level of a measurement
L_{10}	90th percentile sound level of a measurement. Often called the average maximum noise level
L_{eq}	The energy average noise level of a measurement.
L_{90}	10th percentile sound level of a measurement. Often called the average background noise level
L_{min}	The minimum noise level of a measurement
$L_{eq(T)}$	The time (T) equivalent energy noise level. The time interval is often in blocks of 10 or 15 minutes for short term measurements, or hours for long-term measurements. Common increments for long term measurements are 1 hour, day, night, 18 hours and 24 hours.
$L_{eq(8h)}$	The 8 hour equivalent energy noise level. Primarily used for occupational noise assessments
LC_{peak}	The C weighted peak noise level. Primarily used for occupational noise assessments
$L_{n,w}$	The Weighted Normalized Impact Sound Pressure Level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.2. The lower the $L_{n,w}$ rating, the better is the impact sound isolation performance of a floor-ceiling assembly
L'_{nTw}	The weighted standardized impact sound pressure level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a filed. Assessed in accordance with AS/NZS ISO 717.2. The lower the $L'_{nT,w}$ rating, the better is the impact sound isolation performance of a floor-ceiling assembly
NRC	Noise Reduction Coefficient. The NRC defines how much sound is absorbed by a surface. An NRC of 0 means it absorbs no sound while an NRC of 1 means it will absorb most sound.
R_w	The Weighted Sound Reduction Index. This is the single number rating describing the ability of a building element to reduce noise as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.1. The higher the R_w rating, the better is the acoustic performance of the wall or floor.
$R_w + C_{tr}$	$R_w + C_{tr}$ is R_w with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same Rw rating, but have different resistance to low frequency sound, thus a different Rw + Ctr.

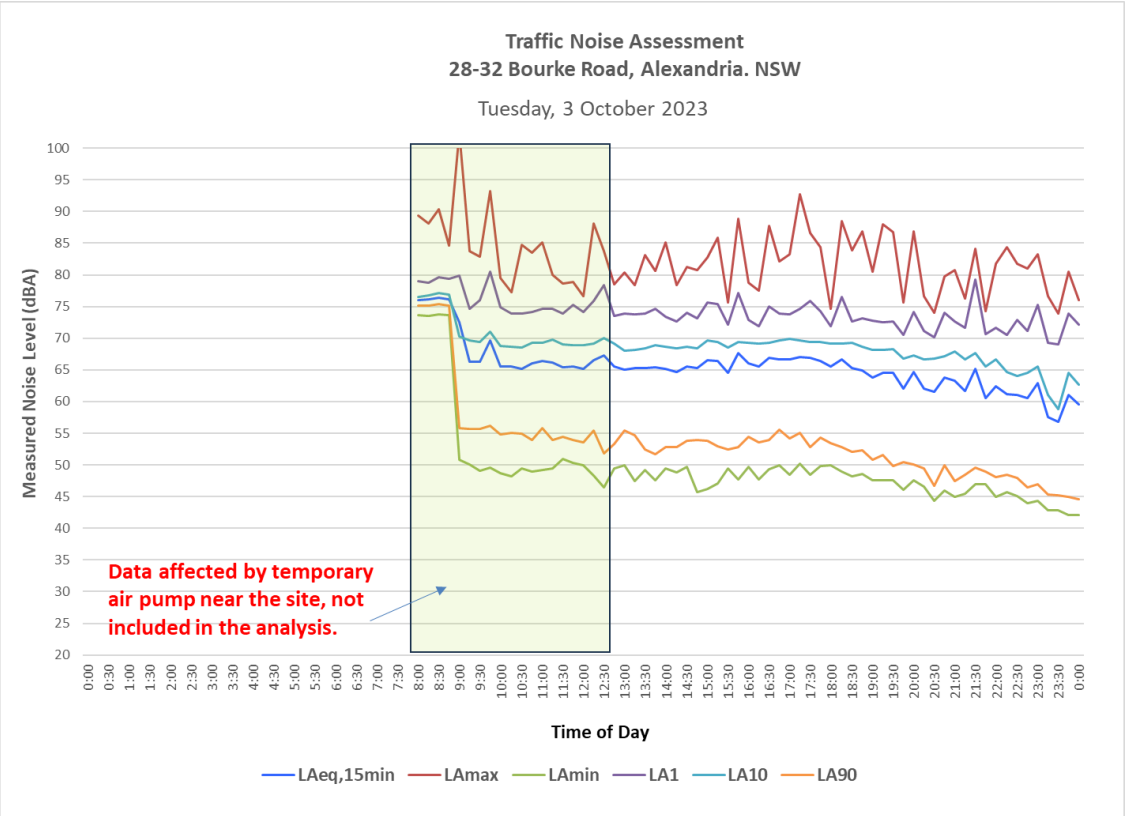
Appendix B Meteorological Conditions

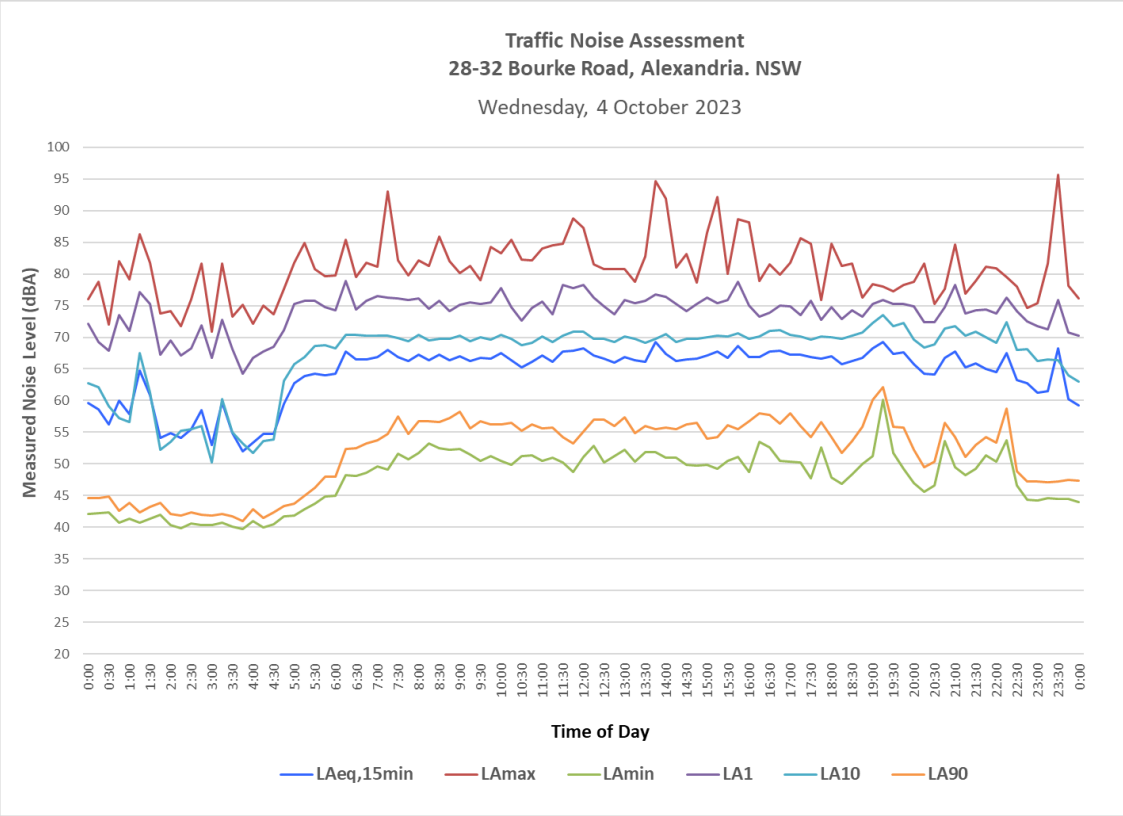
Sydney Airport, New South Wales
October 2023 Daily Weather Observations

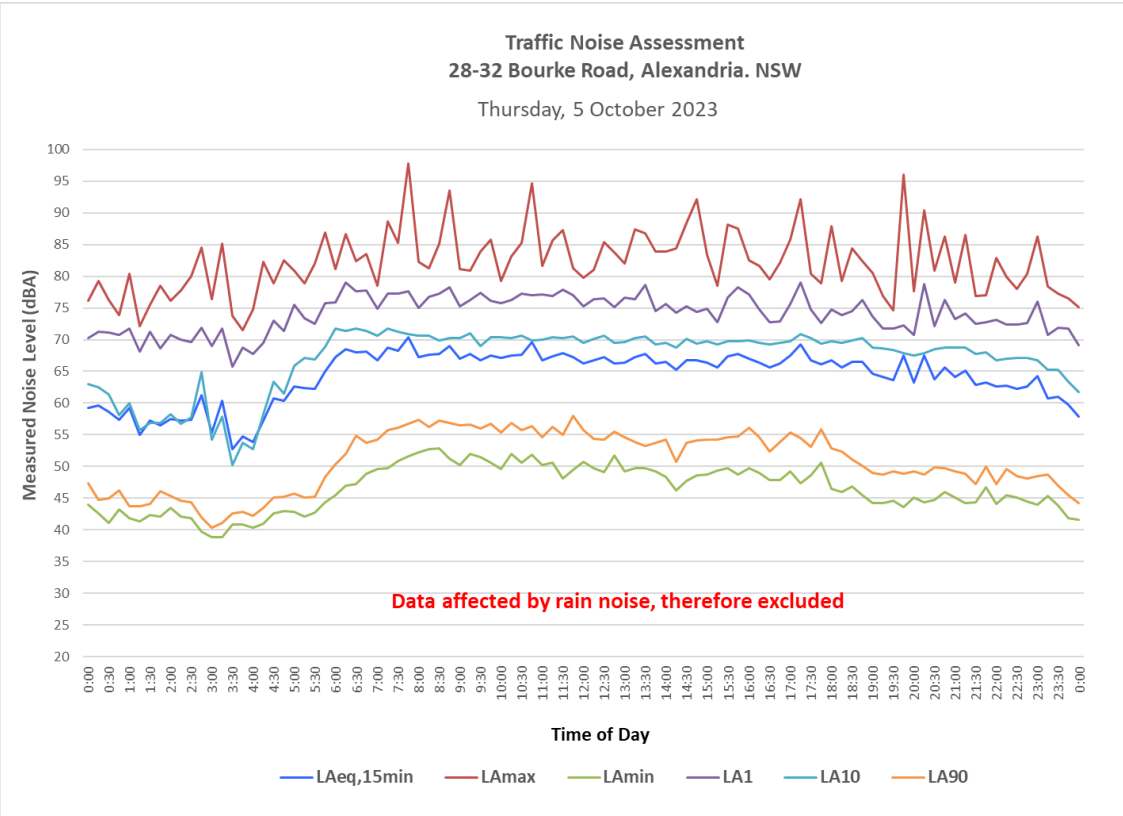
Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9 am						3 pm					
		Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	8th		km/h	hPa	°C	%	8th		km/h	hPa
1	Su	15.9	36.9	0	6.8	9.6	SSW	80	19:57	22.9	48	7	NNW	19	1013.2	35.6	10	2	W	43	1008.0
2	Mo	16.2	23.3	0	12.6	9.8	SSE	50	23:04	19.0	61	5	ESE	15	1023.6	21.4	56	2	ENE	28	1020.3
3	Tu	17.6	37.2	0	5.4	9.2	NNE	56	15:58	22.7	62	3	WNW	11	1016.4	36.1	12	5	NW	35	1011.2
4	We	20.6	28.8	0	14.6	0.9	NW	59	22:48	22.8	57	8	NNE	30	1011.8	27.0	36	8	N	33	1008.4
5	Th	13.2	22.7	9.2	5.4	11.3	W	61	11:02	17.0	36	1	WNW	33	1014.5	21.5	19	1	WSW	39	1015.8
6	Fr	11.7	21.0	0	7.6	7.1	S	57	21:10	16.9	49	2	SW	24	1024.3	16.8	70	7	SSE	31	1025.2
7	Sa	11.7	18.3	2.2	5.6	11.1	SSE	46	23:50	14.0	67	5	SSW	28	1031.8	16.9	66	5	S	28	1030.2
8	Su	12.7	20.9	0	6.6	8.9	ENE	37	16:57	16.4	67	7	WSW	11	1032.8	19.2	54	4	E	19	1029.4
9	Mo	12.1	24.9	0	5.2	11.4	NE	43	14:47	17.7	57	1	WNW	13	1027.1	23.7	37	1	NE	31	1021.8
10	Tu	14.6	22.1	0	6.4	7.6	S	35	01:31	18.2	81	7	SSE	13	1023.5	21.3	61	5	SE	26	1021.4
11	We	16.0	25.6	0	6.2	10.2	NNE	48	16:38	21.1	66	4	N	11	1024.6	24.2	53	1	ENE	31	1021.1
12	Th	15.5	32.8	0	7.4	11.0	WSW	76	19:02	20.6	69	4	NW	13	1017.9	30.0	32	1	NE	22	1009.1
13	Fr	12.4	22.9	2.6	10.4	11.2	WSW	50	01:39	15.9	46	1	W	28	1017.9	21.5	33	1	E	19	1015.3
14	Sa	14.0	30.0	0	6.6	9.8	W	44	14:23	18.8	42	3	WNW	19	1017.9	29.2	21	4	WSW	19	1012.2
15	Su	14.3	24.3	0	8.6	11.7	WSW	52	00:10	19.2	43	2	SW	15	1018.5	23.2	34	2	ENE	28	1012.9
16	Mo	15.0		0	8.0					18.7	53	6	WNW	15	1011.6	23.6	24	7	WSW	44	1009.5
Statistics for the first 16 days of October 2023																					
Mean		14.6	26.1		7.7	9.4				18.9	56	4		18	1020.5	24.4	38	3		29	1017.0
Lowest		11.7	18.3	0	5.2	0.9				14.0	36	1	#	11	1011.6	16.8	10	1	#	19	1008.0
Highest		20.6	37.2	9.2	14.6	11.7	SSW	80		22.9	81	8	WNW	33	1032.8	36.1	70	8	WSW	44	1030.2
Total				14.0	123.4	140.8															

IDCJDW2125 202310 Prepared at 05:36 UTC on Monday 16 October 2023

Appendix C Detailed Noise Monitoring Data




Traffic Noise Assessment
28-32 Bourke Road, Alexandria. NSW
Wednesday, 4 October 2023
Measured Noise Level (dBA)
Time of Day
LAeq,15min
LAmax
LAmin
LA1
LA10
LA90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Data affected by rain noise, therefore excluded
Time of Day
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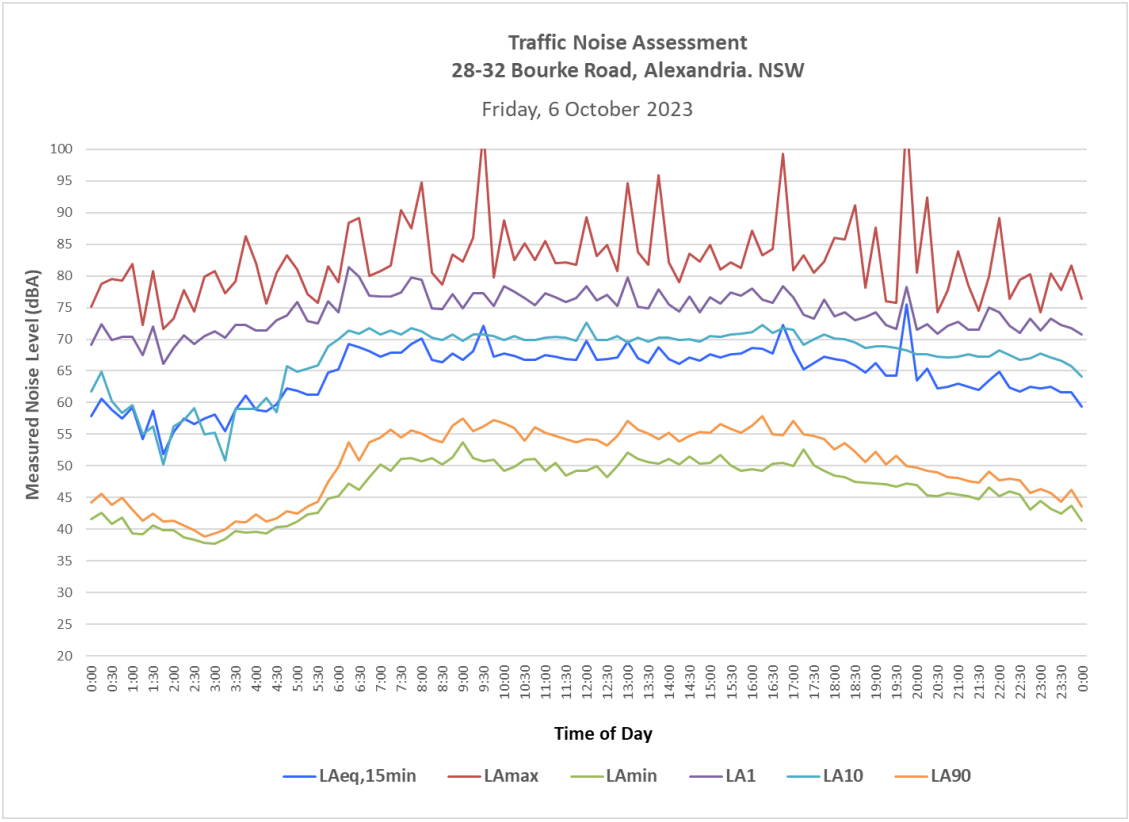
LAmax
LAmin
LA1
LA10
LA90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Time of Day
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LAmax
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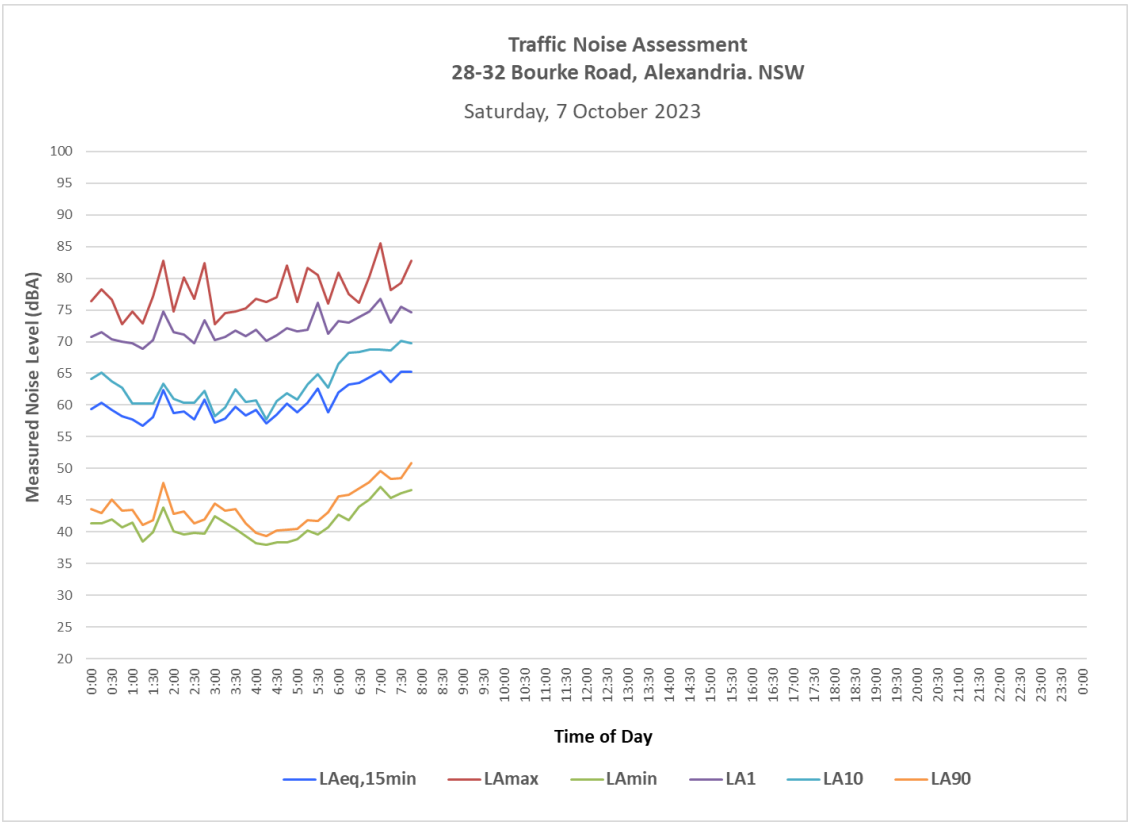
LA10
LA90


Traffic Noise Assessment
28-32 Bourke Road, Alexandria. NSW
Saturday, 7 October 2023
Measured Noise Level (dBA)
Time of Day
LAeq,15min
LAmax
LAmin
LA1
LA10
LA90

Appendix D Measured Vibration Data

A ground vibration survey was undertaken in order to determine the characteristics and levels of vibration at ground level at the building foundations. The assessment of vibration requires the use of an overall frequency-weighted value. This overall value is assessed against the preferred value for the relevant direction. An alternative to using frequency-weighted values is presented as a simplified screening technique in NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006). As a screening method, the overall unweighted rms acceleration could be assessed against the preferred values contained in Section 6.10.

Table 10-1 below summarises the vibration levels in vertical direction (z) measured during day-time period between 8am and 4pm on 3 October 2023 for a range of typical passenger train routes.

The acceleration/velocity levels and spectrum with a frequency bandwidth of 1Hz to 250Hz are presented in figures below.

Table 10-1 Summary of measured vibration levels

Monitoring Location & Orientation		**Overall RMS acceleration levels (m/s^2)**	**Overall RMS velocity levels (mm/s)**	**Overall peak velocity levels (mm/s)**	**VDV ($m/s^{1.75}$)**	**Criterion Achieved**
Location 1	L1 Sensor 12626 Signal 1, z-axis	0.000024	0.00021	0.0019	0.00015	Yes
	L1-1 Sensor 12628 Signal 2, z-axis	0.000073	0.00116	0.0038	0.00020	Yes
Location 2	L2 Sensor 12626 Signal 1, z-axis	0.000030	0.00034	0.0155	0.00018	Yes
	L2-1 Sensor 12628 Signal 2, z-axis	0.000023	0.00022	0.00035	0.00026	Yes
Location 3	L3 Sensor 12626 Signal 1, z-axis	0.000031	0.00055	0.00441	0.00025	Yes
	L3-1 Sensor 12628 Signal 2, z-axis	0.000045	0.00065	0.01142	0.00033	Yes
Location 4	L4 Sensor 12626 Signal 1, z-axis	0.000025	0.00016	0.00366	0.00031	Yes
	L4-1 Sensor 12628 Signal 2, z-axis	0.000030	0.00026	0.00730	0.00030	Yes
Location 5	L5 Sensor 12626 Signal 1, z-axis	0.000031	0.00038	0.0072	0.00039	Yes
	L5-1 Sensor 12628 Signal 2, z-axis	0.000024	0.00022	0.0079	0.00038	Yes
Location 6	L6 Sensor 12626 Signal 1, z-axis	0.000039	0.00045	0.0145	0.00038	Yes
	L6-1 Sensor 12628 Signal 2, z-axis	0.000026	0.00018	0.0036	0.00032	Yes
Location 7	L7 Sensor	0.000029	0.00036	0.0058	0.00052	Yes

Monitoring Location & Orientation		Overall RMS acceleration levels (m/s^2)	Overall RMS velocity levels (mm/s)	Overall peak velocity levels (mm/s)	VDV ($m/s^{1.75}$)	Criterion Achieved
	12626 Signal 1, z-axis					
	L7-1 Sensor 12628 Signal 2, z-axis	0.000015	0.00032	0.0047	0.00041	Yes
Location 8	L8 Sensor 12626 Signal 1, z-axis	0.0000083	0.000065	0.0029	0.00025	Yes
	L8-1 Sensor 12628 Signal 2, z-axis	0.000012	0.00012	0.00244	0.00022	Yes
Location 9	L9 Sensor 12626 Signal 1, z-axis	0.000025	0.00038	0.0037	0.00034	Yes
	L9-1 Sensor 12628 Signal 2, z-axis	0.000019	0.00026	0.0041	0.00034	Yes

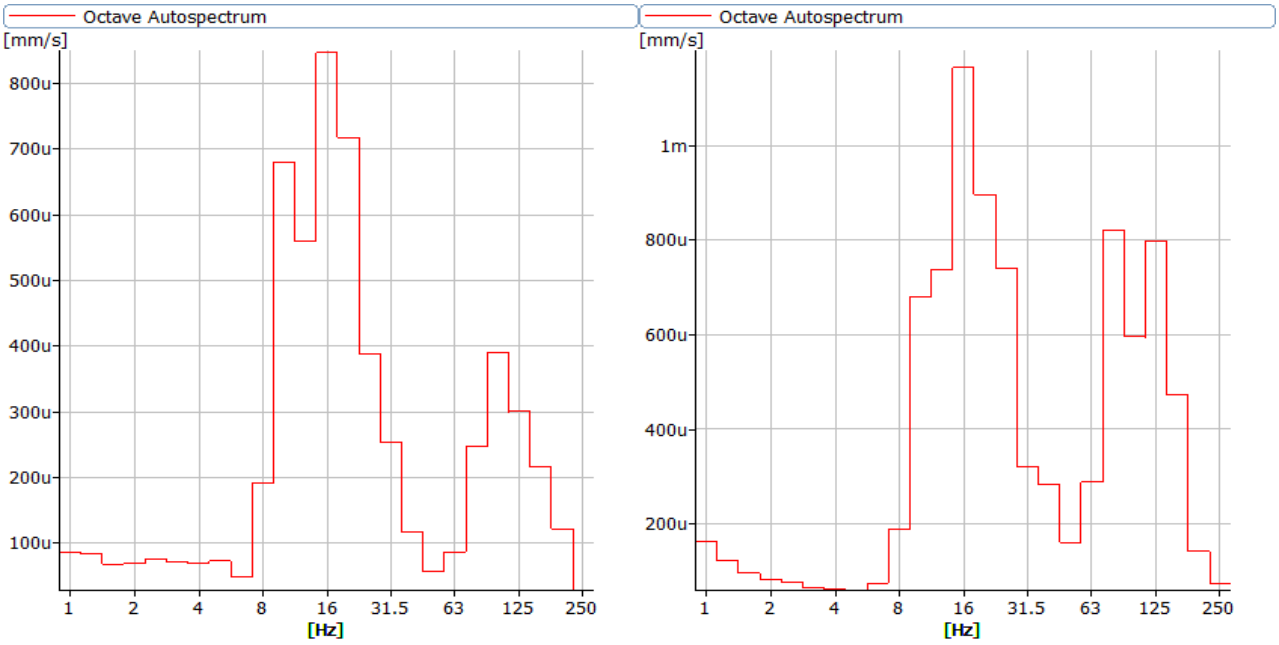


Figure 10-1 One-third octave band velocity spectrum (Maximum) at Location 1 and L1-1

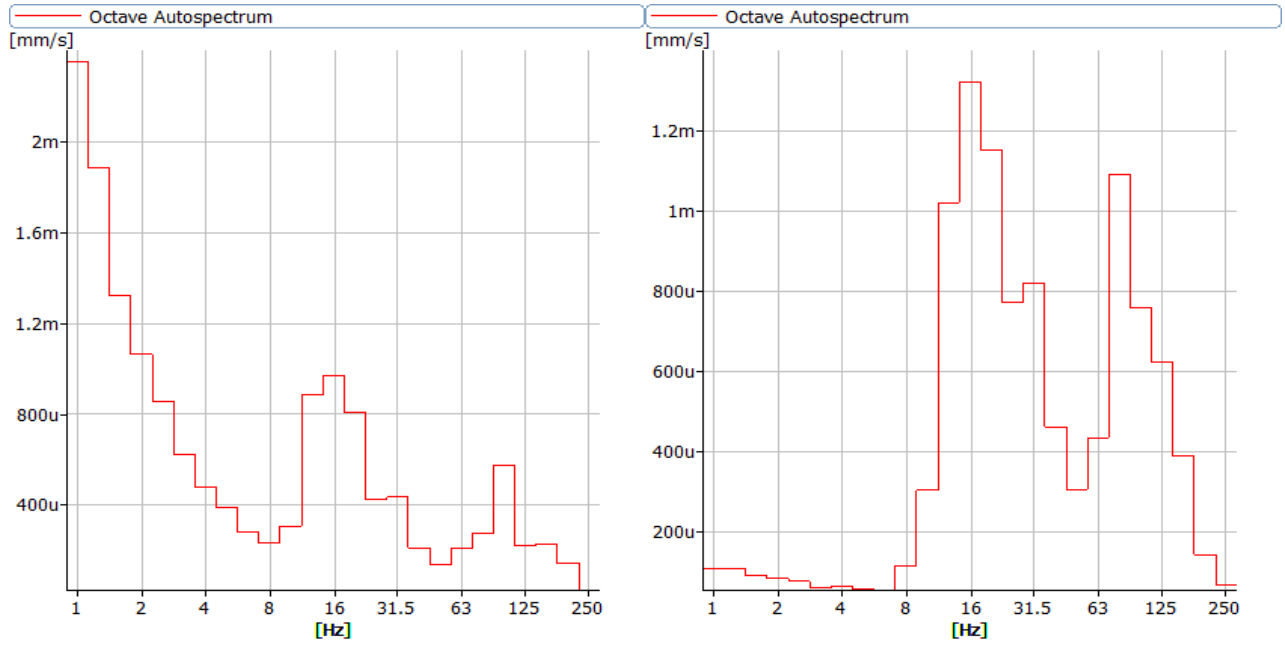


Figure 10-2 One-third octave band velocity spectrum (Maximum) at Location 2 and L2-1

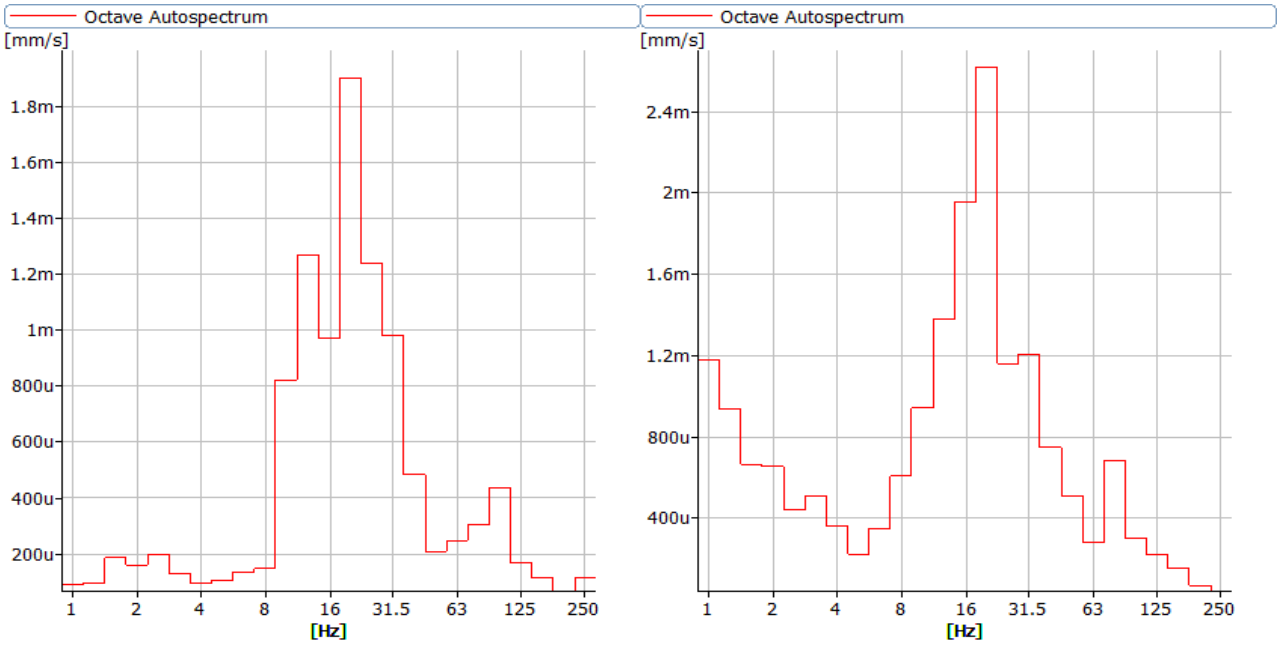


Figure 10-3 One-third octave band velocity spectrum (Maximum) at Location 3 and L3-1

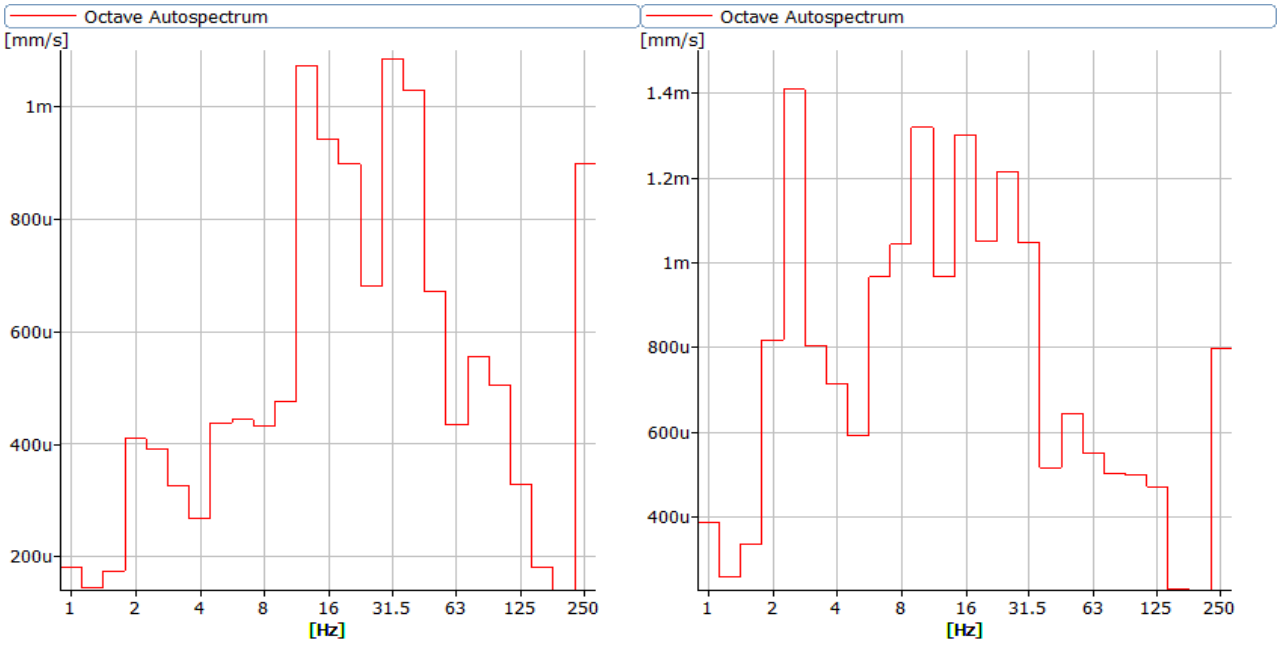


Figure 10-4 One-third octave band velocity spectrum (Maximum) at Location 4 and L4-1

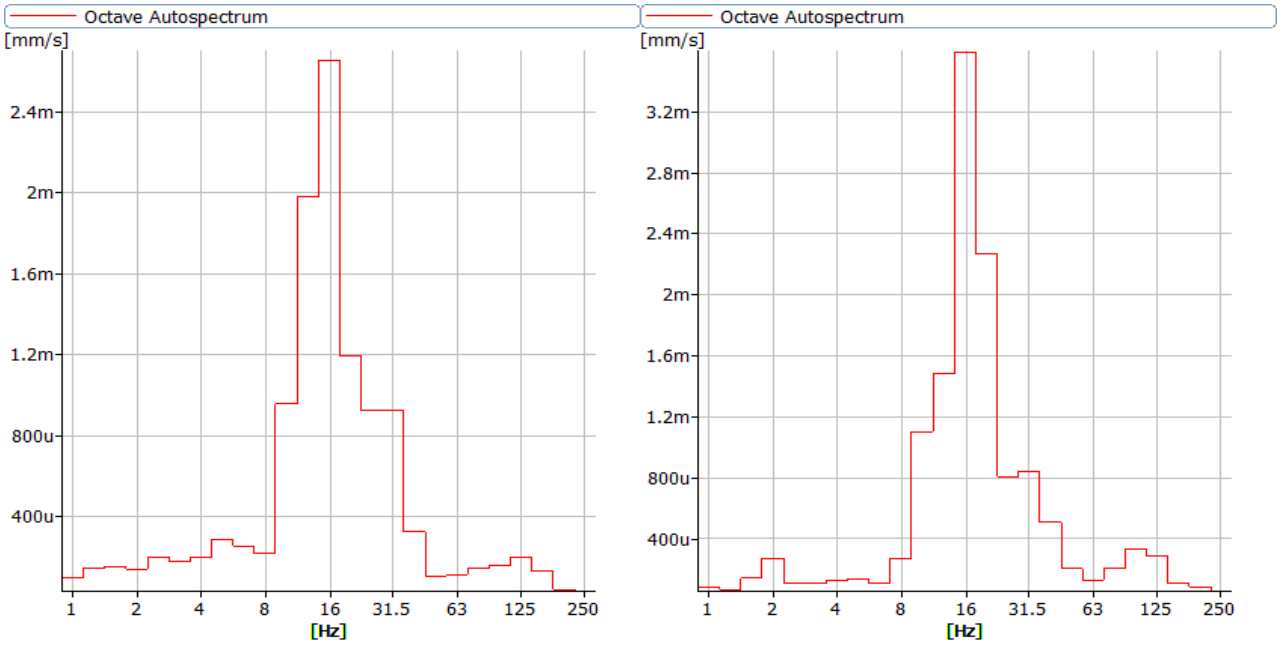


Figure 10-5 One-third octave band velocity spectrum (Maximum) at Location 5 and L5-1

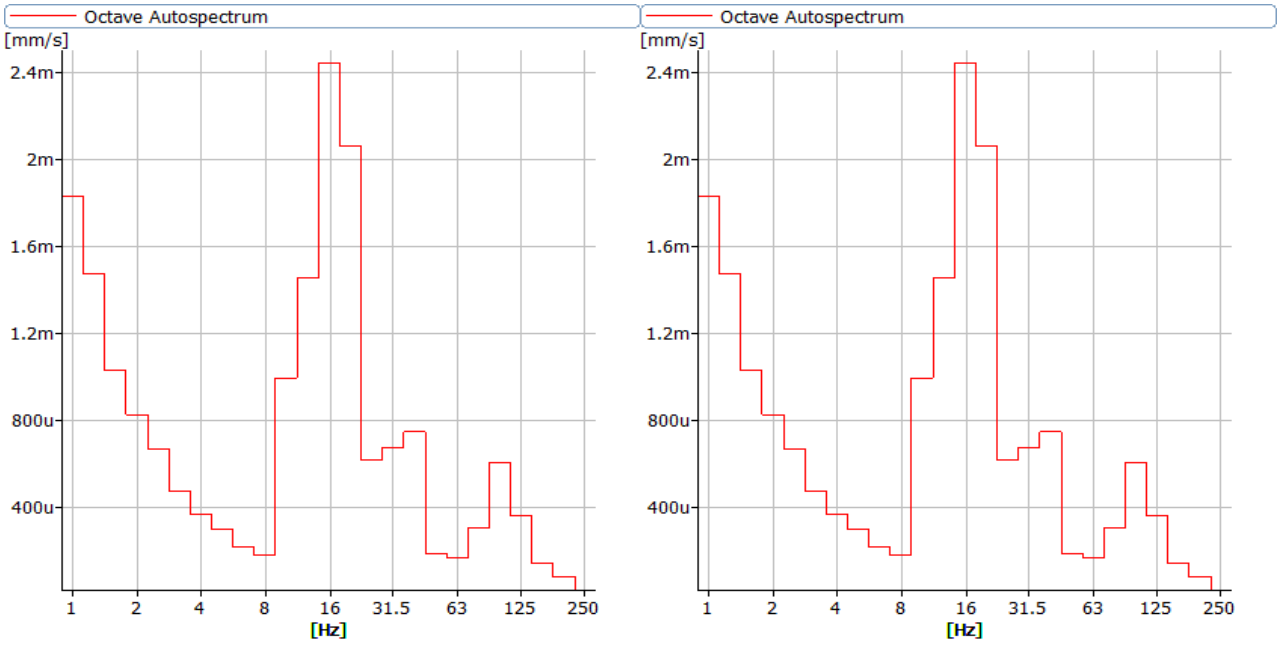


Figure 10-6 One-third octave band velocity spectrum (Maximum) at Location 6 and L6-1

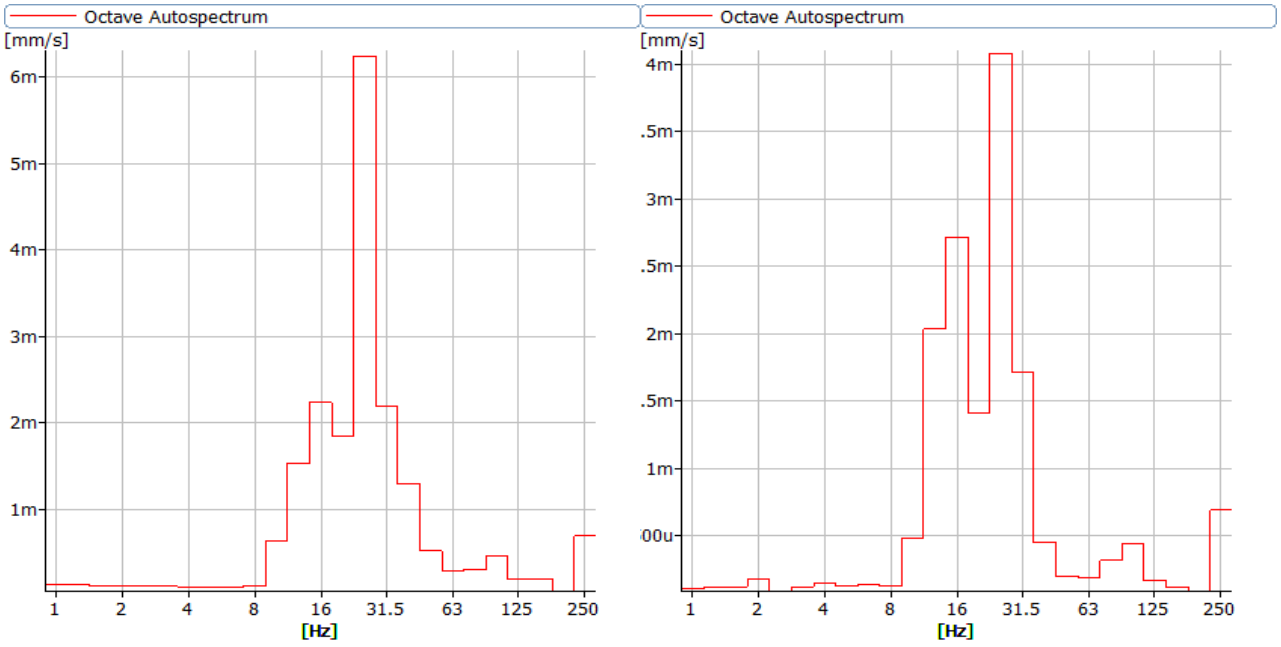


Figure 10-7 One-third octave band velocity spectrum (Maximum) at Location 7 and L7-1

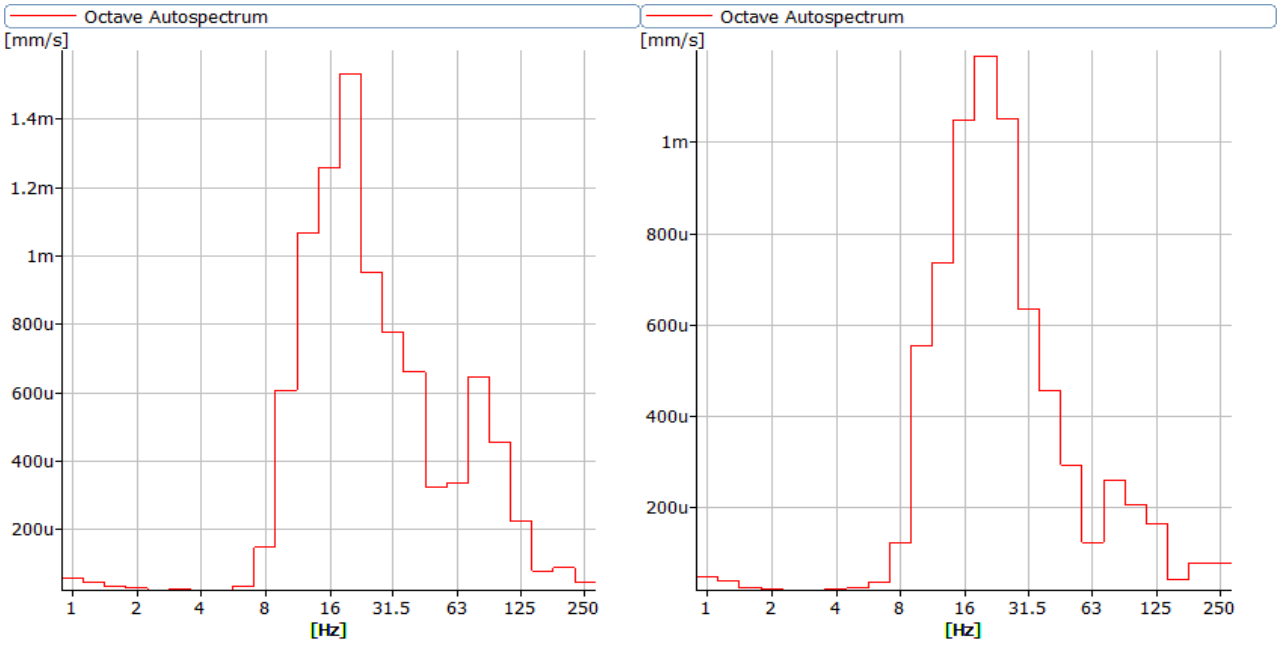


Figure 10-8 One-third octave band velocity spectrum (Maximum) at Location 8 and L8-1

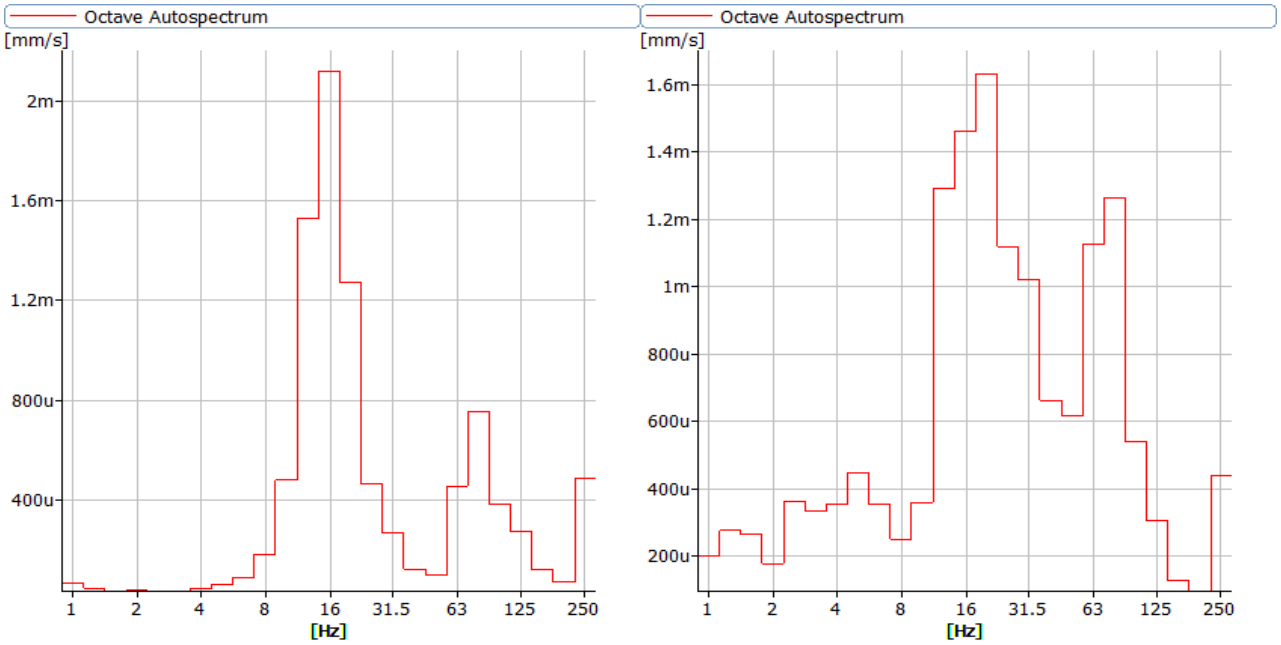


Figure 10-9 One-third octave band velocity spectrum (Maximum) at Location 9 and L9-1