138 Maroubra Road, Maroubra

Noise and Vibration Impact Assessment

Lindsay Bennelong Developments

Ground Floor 21 Solent Circuit Baulkham Hills
NSW 2153

Prepared by:

SLR Consulting Australia

SLR Project No.: 610.31029.00006

13 March 2026

Revision: 1.1

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0.1	13 June 2025	Brandon Nguyen Khuong	Mark Irish	Mark Irish
1.0	2 July 2025	Brandon Nguyen Khuong	Mark Irish	Mark Irish
1.1	13 March 2026	Brandon Nguyen Khuong	Mark Irish	Mark Irish

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Lindsay Bennelong Developments (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Tables

Figures

Appendices

1.0 Introduction

This report is submitted to the Department of Planning, Housing and Infrastructure on behalf of Lindsay Bennelong Developments in support of a State Significant Development Application (SSDA) (SSD-814266710) for a mixed-use development with in-fill affordable housing at 138 Maroubra Road, Maroubra (the site)

SLR is suitably qualified and endorsed by the Planning Secretary to produce this noise impact assessment. SLR is a member firm of the Association of Australasian Acoustical Consultants (AAAC).

The acoustic report is reviewed and certified by a suitably qualified acoustic consultant who is a member of the Australian Acoustical Society.

This report summarises the assessment of the potential construction and operational noise impacts associated with the mixed use apartment building. The following report uses specialist acoustic terminology, with an explanation of common acoustic terms is provided in **Appendix A**.

1.1 Relevant Documents

The following standards, guidelines and drawings have been used to establish the project specific acoustic design requirements for the development.

- Architectural drawings, prepared by DJRD Architects dated 27 June 2025 (Architectural Drawings).
- Secretary's Environmental Assessment Requirements (SEARs) for SSD-81426710 (SEARs) issued 31 March 2025.
- State Environmental Planning Policy (Transport and Infrastructure) 2021 (SEPP)
- NSW EPA's Noise Policy for Industry, dated October 2017 (NPfI).
- NSW EPA's Road Noise Policy, dated March 2011 (RNP).
- Australian / New Zealand Standard AS/NZS 2107:2016 'Acoustics – Recommended design sound levels and reverberation times for building interiors' (AS/NZS 2107).
- NSW EPA's Interim Construction Noise Guideline, dated July 2009 (ICNG).
- Transport for NSW's Construction Noise and Vibration Guideline, dated September 2023 (CNVG).
- Association of Australasian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment Version 3.0, dated September 2020 (AAAC Guideline)
- BS 7385.2:1993 Evaluation and Measurement for Vibration in Buildings Part 2: Guide to Damage Levels from Ground-borne Vibration (BS 7385.2).
- NSW Department of Environment and Conservation – Assessing Vibration: A Technical Guideline, dated February 2006 (AVTG).
- Transport for NSW Guide to Transport Impact Assessment
- Department of Planning, Housing and Infrastructure's Development Near Rail Corridors and Busy Roads – Interim Guideline (DoP Guideline).
- Randwick City Council's Development Control Plan 2013 (DCP).

1.2 The Site

The proposed development is located at 138 Maroubra Road, Maroubra (henceforth the Proposal Site). The proposal site is located in what is primarily an urban residential area with frontage to Maroubra Road to the south and Piccadilly Place to the north, a Police Station (open 24hours) adjacent to the western boundary and a child care centre adjacent to the eastern boundary.

The site comprises two allotments, which are legally described as Lot 1 and Lot 2 in DP506844 within Randwick City.

The site currently comprises an existing vacant commercial building. The site location and surrounding land uses are shown in **Figure 1.**

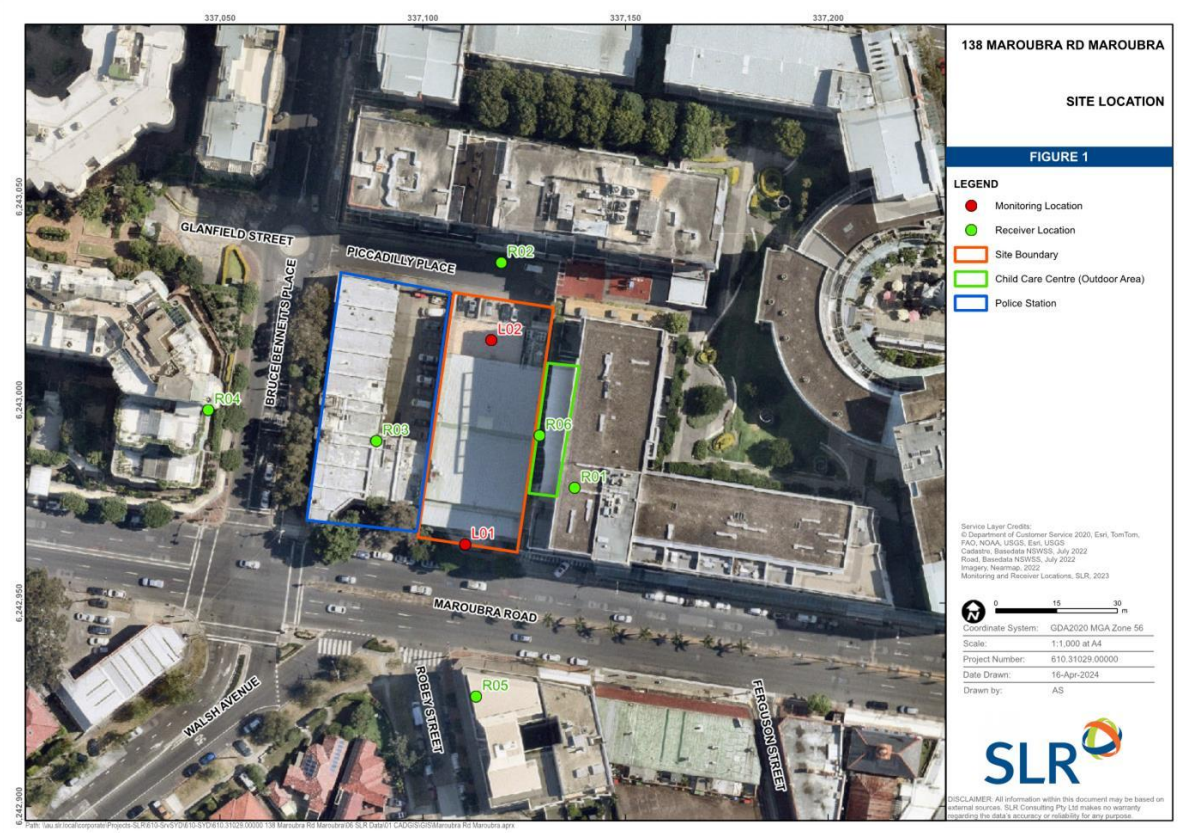
1.3 The Proposed Development

This SSDA seeks approval for a new multi-residential apartment complex. Specifically, the proposed development will comprise the following scope of works:

- Site preparation and excavation works, including demolition of all structures on the site.
- Construction of a new mixed-use 8 storey building, comprising the following:
    - One level of basement carparking with ingress via Piccadilly Place and egress via Maroubra Road.
    - Ground floor retail adjacent to Maroubra Road. The loading dock access is via Piccadilly Place.
    - Parking and residential apartments in Level 1.
    - Residential apartments, and a communal open space on Level 2.
    - Residential apartments from Level 3 to Level 8.
    - Rooftop communal terrace area.
    - Roof level mechanical plant.

Figure 1 shows the location of the proposed development, noise monitoring locations, and the surrounding noise-sensitive receivers.

Figure 1 Site Location, Noise Monitoring Locations and Surrounding Receivers



1.4 Assessment Requirements

This Noise and Vibration Impact Assessment addresses the relevant Secretary's Environmental Assessment Requirements (SEARs) as set out in the SEARs Declaration shown in **Table 1**.

Table 1 SEARs Compliance Table

Declaration		
Name	Mark Irish	
Qualifications	B.Eng (Elec), M.DesSc (Acoustics), Member of Australian Acoustical Society, Member of Institute Of Acoustics	
	The undersigned declares that this operational noise and vibration impact assessment has been prepared in response to the following SEARs requirements issued for the Project on 31/03/2025 for SSD-81426710:	
SEARs item no.	**SEARs Requirement**	**Relevant Section of this Report**
10.	Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection 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.	**Sections 3.0, 4.0, 5.0, 6.0, 6.4.1 and 8.0**

Declaration	
Signed	
Dated	2/07/2025

This assessment has been prepared in accordance with the above requirement and is deemed suitable for submission in support of the State Significant Development Application.

2.0 Existing Noise Environment

2.1 Nearest Receivers

The closest existing receivers to the site immediately north, south, east and west of the site and are summarised in **Table 2**. Additionally, the site boundary, receiver locations and unattended noise monitoring locations are depicted in **Figure 1**.

As part of this assessment, we will consider the existing receivers for construction and for the operation of the future development.

Table 2 Surrounding Sensitive Receivers

ID	Receiver Type	Address	Approximate distance (m)
R01	Residential	140 Maroubra Road Maroubra NSW 2035	< 5
R02	Residential	1 Bruce Bennetts Place Maroubra NSW 2035	25
R03	Commercial (Police Station)	136 Maroubra Road Maroubra NSW 2035	< 5
R04	Residential	116-132 Maroubra Road Maroubra NSW 2035	50
R05	Residential	165-167 Maroubra Road Maroubra NSW 2035	35
R06	Commercial (Child care centre)	140 Maroubra Road Maroubra NSW 2035	< 5

2.2 Unattended Noise Monitoring

Unattended noise monitoring was conducted at the site during November 2022. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts on nearby noise sensitive receivers.

The monitoring equipment was positioned on-site to measure the existing noise levels, representing the nearest receivers most likely to be affected by the noise emissions from both the potential construction and operational impacts associated with the proposed mixed use apartment building.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. All equipment carried current *National Association of Testing Authorities (NATA*), or manufacturer calibration certificates and equipment calibration was confirmed before and after each measurement with the drift in calibration not exceeding ±0.5 dB (as required by *AS 1055*).

The measured data has been processed in accordance with the *NSW Environment Protection Authority's (EPA's) Noise Policy for Industry (NPfI)* and the *NSW Road Noise Policy (RNP)* to exclude noise from extraneous events and periods affected by adverse weather conditions, such as strong wind or rain measured at the Bureau of Meteorology Little Bay weather station, to establish representative existing noise levels.

The noise monitoring locations are shown in **Figure 1** and the results are summarised in **Table 3**. Details of the unattended monitoring together with graphs of the measured daily noise levels are provided in **Appendix B**.

Table 3: Summary of Unattended Noise Logging Results

ID[3]	Measured Noise Levels (dBA)					
	Background Noise (RBL)[1]			Average Noise ($L_{Aeq,\ 15\ minutes}$)[2]		
	Day	Evening	Night-time	Day	Evening	Night-time
L01	57	54	43	69	68	64
L02	63	64	61	67	67	66

Note 1: The RBL noise level is representative of the 'average minimum background sound level', or simply the background level.

Note 2: The LAeq is essentially the 'average sound level'. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Note 3: Noise logger locations are as follows: L01 (On-site 138 Maroubra Road Front Balcony), L02 (On-site 138 Maroubra Road Rear Balcony).

2.3 Attended Noise Monitoring

Additionally, attended noise monitoring measurements were conducted at each monitoring location. The attended measurement was performed on-site within close-proximity to the noise logger to supplement and confirm the unattended noise monitoring data as representative of the area and its surrounds. These measurements where then used to qualify and quantify the noise levels in the area and hence justify the chosen noise logger locations. A summary of the attended measurements is provided in **Table 4**.

Table 4 Operator Attended Ambient Noise Survey

Location	Date/ Time	Measured Noise Levels	
		L_{A90}	L_{Aeq}
L01 On-site 138 Maroubra Road, Front	3 November 2022 @ 10:47 am	59	67
L02 On-site 138 Maroubra Road, Rear	3 November 2022 @ 11:48 am	66	68

3.0 Existing Vibration Environment

3.1 Existing Vibration Environment

There are currently no major existing vibration sources in the project area.

3.2 Future Vibration Environment

The future vibration environment is not anticipated to significantly change from that of the existing environment.

4.0 Noise and Vibration Criteria

4.1 Construction Noise Management Levels

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

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

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

4.1.1 Residential Receivers

The *ICNG* approach for determining NMLs at residential receivers is shown in **Table 5**.

Table 5 ICNG NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard Construction Hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL[1] + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	• The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: o Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences o If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Standard Construction Hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours • The proponent should apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practises have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

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

4.1.2 Other Sensitive Land Uses and Industrial receivers

Non-residential land uses have been identified in the study area. The NMLs for 'other sensitive' receivers are shown in **Table 6**.

Table 6 Construction NMLs for *ICNG* 'Other Sensitive' Receivers

Land Use	Noise Management Level $L_{Aeq(15minute)}$ (dBA) (applied when the property is in use)	
	Internal	External
Commercial	-	70
Child care centres – sleeping areas[2]	40	60[1]

Note 1: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Note 2: Taken from Association of Australian Acoustical Consultants *Guideline for Child Care Centre Acoustic Assessment*.

4.1.3 NML for Residential receivers

The construction NMLs for residential receivers have been determined using the results from the unattended noise monitoring and are shown in **Table 7.**

Out of hours NMLs would be applicable should works be required to be undertaken outside *ICNG* standard construction hours. As this development is likely to be constructed during Standard Construction Hours, approval should be sought as such, with out of hours construction works to be part of a separate approval.

Table 7 Project Specific NML for Residential Receivers

Monitoring Location	Noise Management Level ($L_{Aeq(15minute)}$ – dBA)
	Standard Construction (RBL +10 dB)[1]
	Daytime
L01	67
L02	73

Note 1: RBL = Rating Background Level.

Note 2: Daytime out of hours is 7 am to 8 am and 1 pm to 6 pm on Saturday, and 8 am to 6 pm on Sunday and public holidays.

4.2 Construction Vibration Criteria

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

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

4.2.1 Human Comfort Criteria

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

Vibration from construction works tends to be intermittent in nature and the EPA's *Assessing Vibration: a technical guideline* (2006) provides criteria for intermittent vibration based on the

Vibration Dose Value (VDV). The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in **Table 8**.

Table 8 Vibration Dose Values for Intermittent Vibration

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

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

4.2.2 Effects on Building Contents

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

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

4.2.3 Structural and Cosmetic Damage Vibration

If vibration from construction works is sufficiently high it can cause damage to structural elements of affected buildings. The levels of vibration required to cause cosmetic damage tend to be at least an order of magnitude (10 times) higher than those at which people can perceive vibration.

Examples of damage that can occur includes cracks or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. Structural damage vibration limits are contained in British Standard *BS 7385*.

BS 7385

British Standard *BS 7385* recommends vibration limits for transient vibration judged to give a minimal risk of vibration induced damage to affected buildings. The limits for residential and industrial buildings are shown in **Table 9**.

Table 9 BS 7385 Transient Vibration Values for Minimal Risk of Damage

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

Note 1: Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%.

For heritage buildings, the standard states that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*".

4.2.4 Minimum Woking distances for Vibration

Minimum working distances for typical vibration-intensive construction equipment are provided in the Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (*CNVG*) and are shown in **Table 10**. The minimum working distances are for both cosmetic damage (from *BS 7385*) and human comfort (from the *NSW EPA Vibration Guideline*). They are based on empirical data which suggests that where works are further from receivers than the quoted minimum distances then impacts are not considered likely.

Table 10 Recommended Minimum Working Distances from Vibration-intensive Equipment

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

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

4.3 Operational Noise Emission Criteria

4.3.1 Council Specific Criteria

Section 3.4.2.3 Acoustical Privacy (Noise Nuisance) of the Randwick Development Control Plan (DCP) 2013 states the following with regard to noise and vibration impacts.

> *Consideration must be given to the protection of acoustical privacy in the design and management of development.*
>
> *Proposed development and activities likely to generate noise including certain outdoor living areas like communal areas in Boarding Houses, outdoor open space, driveways, plant equipment including pool pumps and the like should be located in a manner which considers the acoustical privacy of neighbours including neighbouring bedrooms.*
>
> *Council may require a report to be prepared by a Noise Consultant that would assess likely noise and vibration impacts and may include noise and vibration mitigation strategies and measures.*

Consideration will be given to the acoustical amenity of the proposal site as a result of the development being adjacent to a child care centre and a police station.

4.3.2 Noise Policy for Industry 2017

The NSW *Noise Policy for Industry* (*NPfI*) was released in 2017 and sets out the requirements for the assessment and management of operational noise from industry in NSW.

The *NPfI* defines how to determine 'trigger levels' for noise emissions from industrial developments. Where a development is likely to exceed the trigger levels at existing noise-sensitive receivers, feasible and reasonable noise management measures are required to be considered to reduce the impacts.

There are two types of trigger levels – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses:

- The **intrusiveness** of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source, measured over a period of 15-minutes, does not exceed the representative background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended **amenity** levels specified in the NPfI for that particular land use.

Intrusive and amenity noise levels are not used directly as regulatory limits, they are used to assess the potential impact of noise, assess feasible and reasonable mitigation options and subsequently determine achievable noise requirements.

The *NPfI* provides guidance on assigning residential receiver amenity noise categories based on the site-specific features shown in **Table 11**.

Table 11 Residential Receiver Amenity

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Rural	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime <40 dBA Evening <35 dBA Night <30 dBA	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime <45 dBA Evening <40 dBA Night <35dBA	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime >45 dBA Evening >40 dBA Night >35 dBA	Urban – an area with an acoustical environment that: • Is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources • Has through-traffic with characteristically heavy and continuous traffic flows during peak periods • Is near commercial districts or industrial districts • Has any combination of the above.

Amenity noise categories for the surrounding receivers have been determined with reference to the *NPfI* with our recommendations presented in **Table 12**.

Table 12 Residential Receiver Amenity Category Assessment

Receiver Area	Land Use Zoning	Existing Background Noise Levels RBL (dBA)			Resulting Amenity Classification	Discussion
		Day	Eve	Night		
Residential receivers surrounding the site	Mixed Use	57	54	43	Urban	Land use classification is zoned as mixed use to promote future residential and commercial.

4.3.2.1 Project Noise Trigger Levels

The trigger levels for industrial noise from the proposal are summarised in **Table 13.** The Project Noise Trigger Levels (PNTLs) are the most stringent of the intrusiveness and amenity trigger level for each period and are highlighted in bold below.

Table 13 Project Noise Trigger Levels – Industrial Noise

Receiver Area	Logger Location	Period	Recommended Amenity Noise Level $L_{Aeq,\ period}$ (dBA)	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{Aeq,\ 15minute}$ (dBA)	
				RBL[1]	$L_{Aeq,15\ minutes}$	Intrusiveness	Project Amenity[2,3]
Residential	L01	Day	60	57	69 [4]	**62**	**62**
		Evening	50	54	68 [4]	**59**	61
		Night	45	43	64 [4]	**48**	57
	L02	Day	60	63	67 [5]	68	**60**
		Evening	50	63 (64 actual)[6]	67 [5]	68	**60**
		Night	45	61	66 [5]	66	**59**
Commercial	-	When in use	65	-	-	-	**63**
Child care [7]	-	When in use	65	-	-	-	**63**

Note 1: RBL = Rating Background Level.

Note 2: The recommended amenity noise levels have been reduced by 5 dB, where appropriate, to give the project amenity noise levels due to other sources of industrial noise being present in the area, as outlined in the NPfI.

Note 3: The project amenity noise levels have been converted to a 15-minute level by adding 3 dB, as outlined in the NPfI.

Note 4: Area is dominated road traffic noise and the project amenity level was set at 15 dB below the existing road traffic noise level, as outlined in the NPfI.

Note 5: The measured LAeq noise level was dominated by existing industrial noise (which is considered unlikely to decrease in future) and exceeds the project amenity noise level by 10 dB or more, therefore, the amenity noise level is the existing LAeq(industrial) noise level minus 10 dB, as outlined in the NPfI.

Note 6: The evening-time RBL has been reduced to match the daytime RBL due to the measured evening-time RBL being higher than the daytime, as outlined in the NPfI

Note 7: The NPfI does not include a recommended amenity noise level for child care centres, so there are no defined criteria for industrial noise. Given the existing road traffic and industrial noise in the area, it is assumed that the child care tenancies have been designed appropriately (as per the Association of Australian Acoustical Consultants *Guideline for Child Care Centre Acoustic Assessment*) to ensure suitable internal noise levels. Therefore, noise emissions from the proposal are not expected to impact the child care receivers where they are predicted to comply with the recommended commercial amenity noise level

4.3.2.2 Retail and Commercial Spaces

At this stage of the development, the purpose of the retail spaces located on Ground Level in the architectural drawings do not provide the required detail for us to assess for noise emission.

Associated mechanical plant and equipment are assumed to be included within the dedicated rooftop plant area.

Once these tenants are finalised, Council, or the assessing authority, may require that a separate application be submitted for their use.

As part of their operation, more information may be to provide an assessment on and not limited to; times of operation and sources of noise such as music, patron numbers and any additional mechanical plant and equipment requirements.

We have assumed the following for the purpose of this assessment:

- Tenants are not significant noise generators and do not introduce noisy activities such as music and outdoor seating areas

4.3.2.3 Cumulative Noise Impacts

The NSW Government *Cumulative Impact Assessment Guidelines for State Significant Projects* requires that the potential combined effect of cumulative impacts from all nearby industrial developments to be considered when assessing potential noise impacts from state significant projects. The guideline references the *NPfI* when determining the approach to assessing the cumulative industrial noise impacts.

The *NPfI* states that it aims to limit continuing increases in cumulative industrial noise through the application of amenity noise levels, which are applicable to all industrial noise sources in an area.

The *NPfI* requires that the amenity noise levels which are applied to an individual project be reduced by 5 dB to allow for the potential cumulative impact from multiple sources of industrial noise in an area (including existing and new).

By doing this, the policy accounts for potential cumulative impacts by lowering the criteria for each individual development to ensure that the ambient noise level within an area from all industrial noise sources combined remains below the recommended amenity noise levels, where feasible and reasonable. The *NPfI* states that *"where the project amenity noise level applies and it can be met, no additional consideration of cumulative industrial noise is required"*.

The potential cumulative impacts from the proposal and other sources of industrial noise in the area are therefore accounted for in the proposal-specific PNTLs (see **Table 13**) and have not been considered further.

4.3.2.4 Sleep Disturbance

The potential for sleep disturbance from maximum noise level events from the proposal during the night-time period is required to be considered. This is applicable only to residential receivers.

The *NPfI* defines the sleep disturbance screening level as:

- 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is greater
- 40 dBA $L_{Aeq,\ 15\text{-}min}$ or the prevailing background level plus 5 dB, whichever is greater.

Table 14 Sleep Disturbance Screening Levels

Location	Noise Level (dBA)	
	Sleep Disturbance Screening Levels[1]	
	$L_{Aeq,\ 15min}$	L_{AFmax}
Front façade (Logging Location L01)	48	58
Rear façade (Logging Location L02)	66	76

A detailed maximum noise level event assessment should be completed where the sleep disturbance screening level is exceeded. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night-time period.

The *NPfI* in turn refers to the *Road Noise Policy* (RNP) for additional information regarding sleep disturbance.

The *RNP* goes on to conclude that from the research on sleep disturbance to date:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep.

One or two events per night with maximum internal noise levels of 65-70 dBA are not likely to affect health and wellbeing significantly.

4.3.2.5 Correction for Annoying Characteristics

Sources of industrial noise can cause greater annoyance where they contain certain characteristics, such as tonality, intermittency or dominant low-frequency content. The *NPfI* specifies the following modifying factor corrections, shown in **Table 15**, which are to be applied where annoying characteristics are present. The corrections are to be added to the noise level at the receiver before comparison with the Project Noise Trigger Levels.

Table 15 *NPfI* Modifying Factor Corrections

Factor	Assessment/ Measurement	When to Apply	Correction[1]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by the levels defined in the NPfI.	5 dB[2]
Low-frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements	Measure/assess source contribution C and A weighted $L_{eq,t}$ levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and the level to which the thresholds defined in the NPfI are exceeded.	2 or 5 dB[2]
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level	The source noise heard at the receiver varies by more than 5 dB and the intermittent nature of the noise is clearly audible. The NPfI further defines intermittent noise as noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB, for example, equipment cycling on and off. The EPA has confirmed[4] that the intermittent correction does not apply to short-term events that emerge above the general industrial noise level and is therefore not applicable to industrial or commercial sites that have vehicle or plant movements at night, including audible reversing alarms. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.	5 dB[3]
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated.	Maximum correction of 10 dB[2] (excluding duration correction)

Note 1: Corrections to be added to the measured or predicted levels.

Note 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.

Note 3: Adjustment to be applied to night-time only.

Note 4: How to Apply the Noise Policy for Industry Intermittent Modifying Factor Corrections, NSW Environment Protection Authority, Acoustics Australia Vol. 50, No. 3, September 2022.

At the time of writing, specific noise sources are yet to be determined. Through the detail design phase of the project, these details will be available, and the necessary corrections will be applied. In our experience, these corrections are capable of being designed out during the detail phases of the project.

4.3.2.6 Residual Impacts

The *NPfI* defines residual noise impacts as exceedances of the Project Noise Trigger Levels which remain after all feasible and reasonable source and pathway mitigation measures have been considered.

The significance of residual noise impacts, as defined in the *NPfI*, is shown in **Table 16.** Examples of receiver-based treatments that can be used to mitigate residual impacts are shown in **Table 17**.

Table 16 *NPfI* Significance of Residual Noise Impacts

If the Predicted Noise Level minus the Project Noise Trigger Level is:	And the Total Cumulative Industrial Noise Levels is:	Then the Significance of the Residual Noise Level is:
≤ 2 dBA	Not applicable	Negligible
≥ 3 but ≤ 5 dBA	< recommended amenity noise level or > recommended amenity noise level, but the increase in total cumulative industrial noise level resulting from the development is less than or equal to 1dB	Marginal
≥ 3 but ≤ 5 dBA	> recommended amenity noise level and the increase in total cumulative industrial noise level resulting from the development is more than 1 dB	Moderate
> 5 dBA	≤ recommended amenity noise level	Moderate
	> recommended amenity noise level	Significant

Table 17 NPfI Examples of Receiver-based Treatments to Mitigate Residual Noise Impacts

Significance of Residual Noise Impact	Example of Potential Treatment
Negligible	The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.
Marginal	Provide mechanical ventilation/comfort condition systems to enable windows to be closed without compromising internal air quality/amenity.
Moderate	As for 'marginal', but also upgraded facade elements, such as windows, doors or roof insulation, to further increase the ability of the building facade to reduce noise levels.

Significance of Residual Noise Impact	Example of Potential Treatment
Significant	May include suitable commercial agreements were considered feasible and reasonable.

4.3.3 External Communal Areas

Noise breakout from communal areas of a residential building is not assessed in accordance with the NPfI criteria and is not assessed cumulatively with other industrial noise sources (eg mechanical plant, on-site vehicle movements).

The NSW EPA *Noise Guide for Local Government* (NGLG) includes the concept of assessing 'intrusive noise' as a screening test for a variety of noise sources that are not assessed under other policies or guidance documents. The definition of intrusive noise is consistent with the methodology used in the NPfI, hence the screening level for the assessment of the communal area noise impacts is based on the NPfI 'intrusiveness' trigger level and is presented in **Table 18** for the nearest receiver R01.

Table 18 Intrusive Noise Screening Levels – Communal Area Noise

Receiver Area	Period	Measured RBL[1] (dBA)	Intrusiveness Screening Level $L_{Aeq(15minute)}$ (dBA)
Pacific Square Residential (R01)	Day	57	62
	Evening	54	59
	Night	43	48

Note 1. RBL = Rating Background Level. Since the facade of Pacific Square runs the full length of the eastern site boundary, in order to be conservative the lower RBL from the two logging locations has been used (Location L01).

4.3.4 Traffic on Surrounding Roads

The potential impacts from proposal-related traffic on the surrounding public roads are assessed using the *NSW EPA Road Noise Policy (RNP)*.

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2.0 dB. Where this is considered likely, further assessment is required using the *RNP* criteria shown in **Table 19**.

Table 19 RNP/NCG Criteria for Assessing Traffic on Public Roads

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

4.4 Noise Intrusion Criteria

4.4.1 State Environmental Planning Policy

In lieu of specific criteria in the Randwick DCP 2013 for internal noise amenity of new residential developments, *Section 2.120 - Impact of Road Noise or Vibration on Non-Road Development* of the State Environmental Planning Policy (Transport & Infrastructure) 2021 (SEPP) has been adopted to determine appropriate internal amenity for the proposal.

It should be noted that the Transport for NSW Guide to Transport Impact Assessment refers to the Development near Rail Corridors and Busy Roads – Interim Guideline to establish the internal noise goals which in turn refers to the aforementioned legislation. Therefore, the requirements from the Transport for NSW Transport Impact Assessment are considered satisfied.

The Transport & Infrastructure SEPP sets out the planning rules and controls for infrastructure in NSW. Section 2.120 is copied below.

> ***2.120 Impact of road noise or vibration on non-road development***
>
> *(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 child care centre.*
>
> *(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 LAeq levels are not exceeded-*
>
> *(a) in any bedroom in the residential accommodation—35 dB(A) at any time between 10 pm and 7 am,*
>
> *(b) anywhere else in the residential building (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.*

Based on information provided by JMT Consulting, typical daily traffic volumes on Maroubra Rd are understood to carry just over 20,000 vehicles per day. Therefore, the internal noise level criteria for habitable rooms outlined in item 3a and 3b of section 2.120 of the SEPP have been adopted for the proposal.

4.4.2 AS/NZS 2107-2016 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors

This standard provides recommended design criteria within building interiors to ensure a healthy, comfortable and productive environment for the occupants and the users. As the site is not within close proximity to any major roads or rail, it is expected that acoustic

amenity of the site will be mostly suburban once developed. Therefore, the design sound level range for relevant occupancies are adopted and summarised in **Table 20**.

Table 20 Recommended Internal Noise Levels – sourced from AS 2107-2016

Type of Occupancy	Design Sound Level Range, dBA L_{Aeq}
Houses and apartments in suburban areas or near minor roads	
Sleeping areas (night-time)	30 – 35
Living areas	30 – 40

The upper limit of the design sound level range for each occupancy has been adopted as the internal noise criteria for the site and is summarised in **Table 21**.

Table 21 Internal Noise Level Criteria - residential

Type of Occupancy	Internal Noise Level, dBA L_{Aeq}
Sleeping areas	35 $L_{Aeq, Night\text{-}time}$
Living areas	40 $L_{Aeq, Day}$

4.4.3 Internal Noise Intrusion – Non-residential uses

All internal non-residential areas should be designed to mitigate external noise intrusion to the recommended internal noise criteria based upon their use in *AS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors* as summarised in **Table 22**.

Table 22 Internal Noise Criteria – Non-residential uses

Type of space	Applicable Time Period	Assessment Noise Metric	Internal Noise Criteria – dB(A)
Restaurants and cafeterias	When in use	$L_{Aeq, Period}$	50
Retail	When in use	$L_{Aeq, Period}$	50

5.0 Methodology

5.1 Construction Noise and Vibration

5.1.1 Construction Activities

The construction activities required for building the development, along with the sound power levels for individual equipment and the overall activity, are presented in **Table 23**.

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

Table 23 Sound Power Levels for Construction Equipment

Construction Activity	Plant Equipment	Utilisation in 15-min period[2]	Sound Power Level L_w (dBA)
Site establishment/hoarding construction	Truck - Medium Rigid (20 tonne)	25%	103
	Light Vehicle	25%	92
	Truck - road truck/ truck & dog (30 tonne)	25%	108
	Crane Franna (20 tonne)	30%	93
	Hand tools (electric)	75%	106
	Elevated Work Platform - Scissor Lift	30%	93
Demolition	Excavator - Tracked (30 tonne)	50%	107
	Excavator 20-30T + hydraulic Hammer	30%	122
	Front End Loader	50%	110
	Truck - Dump	25%	104
Building Construction	Piling Rig - Bored	30%	107
	Excavator - Tracked (30 tonne)	50%	107
	Crane - Fixed	30%	108
	Elevated Work Platform - Scissor Lift	30%	93
	Generator - diesel/ petrol	100%	103
	Hand tools (pneumatic)	75%	120
	Welding equipment	100%	110
	Truck - Concrete	100%	109
	Roller - Vibratory	100%	114
	Concrete saw	30%	117
	Pump - Concrete	100%	109

Construction Activity	Plant Equipment	Utilisation in 15-min period[2]	Sound Power Level L_w (dBA)
	Vibrator - Concrete	100%	113
	Pavement laying machine	50%	111
	Truck - Dump	25%	104
	Asphalt - Truck and Sprayer	100%	106

Note 1: The *ICNG* requires 'annoying' activities (such as jackhammering, rock breaking and power saw operations) to have a 5 dB 'penalty' applied to the source sound power level.

Note 2: This refers to the amount of time in minutes that individual items of equipment would likely be in use for during the worst-case 15-minute assessment period.

5.1.2 Hours of Construction

Based on SLR previous experience and the *ICNG* recommendations, the standard hours of construction is used as follows:

- Monday to Friday 7 am to 6 pm.
- Saturday 8 am to 1 pm.
- No work on Sundays or public holidays.

It is assumed that any work outside of standard hours will be included in a separate submission to the authorities, as required.

5.2 Operational Noise Emissions

Upon reviewing the design documentation prepared for the Development Application, the acoustic elements to consider for the proposed development include operational noise emissions from:

- Mechanical plant
- Loading docks
- Communal areas

5.2.1 Mechanical Plant

At this stage of the development, mechanical plant selections have not been finalised but are expected to be situated in the dedicated rooftop plantroom. Therefore, a preliminary assessment has been undertaken to determine the noise impacts from the operation of a dedicated plant space on the rooftop to surrounding receivers.

Based on this, the maximum allowable cumulative sound power level is determined to ensure compliance with all surrounding receivers and is summarised in **Table 24**.

Table 24 Assumed Mechanical Plant Details

Mechanical Plant	Sound Power Level dB(A)
Rooftop plantroom	85

It should be noted that mechanical plant and equipment selection have not been finalised at this stage and should be continually assessed as the design progresses. The stated cumulative sound power level for the rooftop plant has been conservatively derived to ensure compliance with the PNTL during the onerous night-time period.

Therefore, it is expected that the cumulative rooftop plant noise can be increased during the less stringent day and evening periods assuming appropriate attenuation measures are implemented to ensure compliance with the quieter night-time period.

The following are feasible mitigation measures that should be considered once the design progresses:

- Solid barriers
- Acoustic louvres
- Quieter night-time operating mode
- Attenuators
- Suitable equipment selection

5.2.2 Loading Dock and Carpark entrance

The loading dock and carpark access is via Piccadilly Place and Maroubra Road. Details of the light/heavy vehicle noise sources are shown in **Table 25**. Traffic generated by the proposed development has been modelled representing a worst-case situation impacting all sensitive receivers.

Table 25 Typical Vehicle Noise Sources

Noise Source	Sound Power Level L_{Amax} (dBA)	Source Height (m)	Vehicle movement during Peak hour
Light Vehicle	95	0.5	11
Heavy Vehicle	103	1	3

5.2.3 External Communal Areas

The main noise source from use of the communal outdoor areas would be raised speech. It has been assumed that the outdoor areas are used by building tenants/occupants during daytime and evening periods only (7.00am to 10.00pm) and no music would be played.

The calculated sound power levels for each external area are listed in **Table 26**.

Table 26 Communal External Area Occupancy and Sound Power Levels

Noise Source	Location	Assumed Maximum Occupancy [1]	Sound Power Level (dBA) [2]
Speech (Raised Voice)	Level 2	20	84
Speech (Raised Voice)	Rooftop	50	88

Note 1. As a worst case, 50% of the maximum occupancy is assumed to be talking at the same time in the direction of the nearest receiver.

Note 2. Sound power levels derived from AAAC Licensed Premises Noise Assessment Technical Guideline Version 3.0

5.2.4 Off-Site Road Traffic

The existing and site generated peak AM/PM traffic information have been provided by JMT Consulting and are summarised in **Table 27**.

Table 27 Existing and Site Generated Peak Traffic Data

Scenario	Existing		Development Flows	
	Picadilly Place	Maroubra Road	Picadilly Place	Maroubra Road
AM Peak Hour	115	1730	7	20
PM Peak Hour	119	1850	19	9

The site's AM/PM peak traffic generation, when compared to the existing traffic volume on surrounding roadways, is expected to cause less than a 60% increase in traffic during peak hours. This increase correlates to a relative noise increase of less than 2 dB, which is considered negligible.

As such, no further assessment of off-site traffic noise is required.

5.2.5 Weather Conditions

Fact Sheet D of the *NPfI* requires noise assessments to consider the potential effects of noise-enhancing weather conditions, such as wind from the source to the receiver and/or temperature inversions.

The nearest sensitive receivers are within 50 m of the proposal site and the effects of weather on noise levels are expected to be minimal.

5.3 Noise Intrusion

5.3.1 Traffic Noise Intrusion

A noise monitoring survey was conducted on-site at logger location L01 to establish the existing road traffic noise environment along Maroubra Road.

The measured noise levels were adopted as part of the traffic noise model validation process.

The results from the noise monitoring have been analysed to establish the road traffic noise levels in terms of the daytime $L_{Aeq,15\text{-hour}}$ and night-time $L_{Aeq,9\text{-hour}}$ values as shown in **Table 28**.

Table 28 Measured Day and Night L_{Aeq} Levels

Time Period	Measured Levels
Day (7am – 10pm)	68 dB(A) $L_{Aeq,15\text{-hour}}$
Night (10pm – 7am)	64 dB(A) $L_{Aeq,9\text{-hour}}$

The measured road traffic noise levels are incorporated in the traffic noise assessment detailed in **Section 6.4.1**.

5.3.2 Childcare Noise Intrusion

Based on discussions with the operator of the adjacent childcare centre, it is confirmed that there is an active outdoor play area along the site's eastern boundary. The potential risk of noise intrusion from the outdoor play area into on-site noise sensitive spaces have been assessed.

The *AAAC Guideline* provides guidance a methodology to quantify the expected noise emissions from an outdoor play area based on the age and number of children.

The childcare centre is expected to accommodate up to 50 children with the following age spread summarised in **Table 29**.

Table 29 Proposed Number of Children per Age Range

Age Range	Children Capacity
0 to 2 years (infant)	10
2 to 3 years (toddlers)	20
3 to 5 years (preschoolers)	20

The cumulative impact from the childcare centre's operation at sensitive receivers will be assessed with the following assumptions and parameters detailed in the sections below.

5.3.3 Childcare Centre – Outdoor Play Area

The *AAAC Guideline* stipulates that noise emissions from outdoor play areas are associated with noise from children. Various factors influence the overall perceived noise level including:

- Number of children vocal at any one time (assumed to be one in 2).
- Activity that the children are engaged in.
- Type of voice (shout to whisper).
- Age of the children.
- Directionality of voice.
- Distance between the children and the receiver point for outdoor and indoor areas.
- Height of the child (i.e. whether standing or seated) for outdoor areas.
- Reverberation ('echo') in the room for indoor or semi-enclosed areas.

Specifically, the age of children greatly influences the overall noise emissions, and this has been categorised for groups of 10 children by age range summarised in **Table 30.**

Table 30 Effective Sound Power Levels for Groups of 10 Children Playing – Sourced from *Table 1 AAAC Guideline*

Age of Children (years)	Sound Power Levels dB at Octave Band Centre Frequencies (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
0 to 2	54	60	55	72	74	71	67	64	78
2 to 3	61	67	73	79	81	78	74	70	85
3 to 5	64	70	75	81	83	80	76	72	87

Note 1: If applicable, an adjustment to the above sound power levels of -6 dB could be applied in each age group for children involved in passive play.

Note 2: For simplicity, based upon a review of World Health Organization (WHO) data, a single recommended source height of 1 metre is suggested as the source heights

6.0 Assessment of Impacts

6.1 Construction Noise

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

The assessment shows the predicted impacts based on the exceedance of the management levels.

A summary of the predicted noise levels (without mitigation) for the various work activities is shown in **Table 31**. For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted, as the noise levels presented in this report are based on each scenario occurring at the site boundary which is the closest point to each receiver.

In reality, there would frequently be periods when construction noise levels are much lower than the worst-case levels predicted as well as times when no equipment is in use and no noise impacts occur.

Table 31 Construction noise levels at nearby receiver locations, dBA

ID	Receiver Type	NML (Daytime)	HNAL[1]	Predicted Noise Level – $L_{Aeq(15minute)}$ (dBA)		
				Site establishment / Hoarding construction	Demolition	Building Construction
R01	Residential	67	75	82	90	95
R02	Residential	73	75	81	90	92
R03	Commercial (Police Station)	70	-	102	109	111
R04	Residential	67	75	72	83	85
R05	Residential	67	75	77	87	89
R06	Commercial (Childcare centre)	60	-	81	91	110

Note 1. Highly noise affected level as per description in **Table 5**.

6.2 Construction Vibration

The major potential sources of vibration from the proposed construction activities would likely be during:

- 'Demolition' when large hydraulic hammer is being used
- 'Building Construction' when vibratory roller is being used

Vibration offset distances have been determined from the *CNVG* minimum working distances for cosmetic damage and human comfort (see **Table 10**). The assessment for the potential worst-case scenario adopts the use of a large vibratory roller (>18 tonnes) and pile boring.

Minimum safe working distances have been included in **Table 32**.

Table 32 Recommended Minimum Working Distances from Vibration-intensive Equipment in Worst-Case Scenario

Plant Item	Rating/Description	Minimum Distance	
		Cosmetic Damage	Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	
Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory Roller	> 300kN (>18 tonne)	25 m	100 m

6.3 Operational Noise Assessment

6.3.1 Rooftop Mechanical Plant

SLR developed a SoundPLAN noise model to assess the noise breakout from the rooftop plant room to the nearest on-site and off-site sensitive receivers. The preliminary mechanical plant layout and operational noise levels assumed are summarised in **Section 5.2.1**.

The existing scenario has been assessed and the predicted noise levels to the surrounding off-site receivers are summarised in **Table 33**.

Table 33 Predicted Façade Noise Level to Off-site Receivers due to Rooftop Plantroom Operation

Receiver Location	Period	Noise Level LAeq(15minute) (dBA)			Compliance
		Project Noise Trigger Level	Predicted (worst-case)	Exceedance	
R01 - 140 Maroubra Road Maroubra NSW 2035	Daytime	62	48	-	Yes
	Evening	59	48	-	Yes
	Night-time	48	48	-	Yes
	Daytime	60	44	-	Yes

Receiver Location	Period	Noise Level LAeq(15minute) (dBA)			Compliance
		Project Noise Trigger Level	Predicted (worst-case)	Exceedance	
R02 - 1 Bruce Bennetts Place Maroubra NSW 2035	Evening	60	44	-	Yes
	Night-time	59	44	-	Yes
R03 - 136 Maroubra Road Maroubra NSW 2035 (Police Station)	When in use	63	31	-	Yes
R04 - 116-132 Maroubra Road Maroubra NSW 2035	Daytime	62	43	-	Yes
	Evening	59	43	-	Yes
	Night-time	48	43	-	Yes
R05 - 165-167 Maroubra Road Maroubra NSW 2035	Daytime	62	31	-	Yes
	Evening	59	31	-	Yes
	Night-time	48	31	-	Yes
R06 - 140 Maroubra Road Maroubra NSW 2035 (Child care centre)	Daytime	63	39	-	Yes

6.3.2 Cumulative Impacts

The NSW Government *Cumulative Impact Assessment Guidelines for State Significant Projects* requires that the potential combined effect of cumulative impacts on all nearby industrial developments be considered when assessing potential noise impacts from state-significant projects.

Cumulative impacts can be caused by the compounding effects of multiple projects in an area, and by the accumulation of effects from past, current and future activities as they arise.

The *Noise Policy for Industry* states that it aims to limit continuing increases in cumulative industrial noise through the application of amenity noise levels, which are applicable to all industrial noise sources in an area.

The policy accounts for potential cumulative impacts by lowering the criteria for each individual development to ensure that the ambient noise level within an area from all industrial noise sources combined remains below the recommended amenity noise levels, where feasible and reasonable. As such (as discussed in **Section 4.3.2.3**), the potential cumulative impacts from the proposal and other potential sources of industrial noise in the area are accounted for in the proposal-specific PNTLs and, therefore, do not require further consideration.

6.3.3 External Communal Areas

A summary of the noise assessment at the nearest and most affected residential receiver R01 (Pacific Square) to the east is shown in **Table 34**. The predicted levels are compared to the intrusive screening level to determine the potential impact from the worst case external area usage i.e. all three areas in use simultaneously at maximum occupancy.

Table 34 Combined Communal Area Noise Assessment to Receiver R01

Receiver Location	Period[1]	Noise Level LAeq(15minute) (dBA)	Predicted Noise Level LAeq(15minute) (dBA)	Compliance
		Project Noise Trigger Level		
R01 - 140 Maroubra Road Maroubra NSW 2035	Daytime	62	52	Yes
	Evening	59	52	Yes

Note 1. Communal outdoor areas are expected to be restricted for use during the daytime and evening period only (7:00am to 10:00pm).

The above assessment indicates that noise from the use of all two communal external areas is predicted to comply with the intrusive screening criteria at the nearest receivers for daytime and evening periods.

6.3.4 Loading Dock

A noise assessment of the site's loading dock's activities has been undertaken based on the expected vehicle movements summarised in **Table 25**.

The noise level due to the loading dock's operation assessed at the worst-case affected external receiver is summarised in **Table 35**.

Table 35 Predicted Loading Dock Noise Levels

Receiver Location	Period[1]	Noise Level LAeq(15minute) (dBA)	Predicted Noise Level LAeq(15minute) (dBA)	Compliance
		Project Noise Trigger Level		
R01 - 140 Maroubra Road Maroubra NSW 2035	Daytime	62	38	Yes
	Evening	59	38	Yes
	Night-time	48	38	Yes
R02 - 1 Bruce Bennetts Place Maroubra NSW 2035	Daytime	60	38	Yes
	Evening	59	38	Yes
	Night-time	59	38	Yes

The above assessment indicates that noise from the use of site's loading dock is predicted to comply with the PNTL criteria at the nearest receivers for all periods of the day.

6.4 Noise Intrusion Assessment

Noise intrusion from external sources have been assessed to determine the minimum acoustic performance for external glazing summarised in **Section 7.2** to achieve compliance with the relevant internal noise criteria outlined in **Section 4.4**.

6.4.1 Traffic Noise Intrusion

SLR developed a SoundPLAN noise model for the study area to predict traffic noise from the surrounding roadways at the site's façade.

The model's accuracy was verified by comparing the predicted road traffic noise levels in SoundPLAN (expressed as $L_{Aeq,\ 15\text{-}hour}$ values) with the measured road traffic noise levels provided in **Table 28**.

The calculation point in the noise model was placed to align with the location and height of the noise logger and microphone used during the noise monitoring (refer to **Figure 1**). The model includes ground topography, buildings, and representative traffic noise sources from the proposal.

The predicted worst-case noise levels at the façade are summarised in **Table 36** and a detailed 3D façade noise map is included in **Appendix C**.

Table 36 Predicted Traffic Noise Level Summary

Occupancy	Level	Façade/Location	Predicted Noise Levels $L_{Aeq\ period}$ dB(A)	
			Day 7am – 10pm	Night-time 10pm – 7am
Retail	GL	Southern	66	-
Residential	L1	Southern	67	63
	L2	Northern	40	36
		Eastern	42	38
		Southern	67	63
		Western	48	44
	L3 – L6	Northern	46	42
		Eastern	42	38
		Southern	66	62
		Western	59	55
	L7 – L8	Northern	47	43
		Eastern	43	39
		Southern	62	58
		Western	59	55

6.4.2 Adjacent L1 Carpark to Sole Occupancy Units

Due to the proposed site layout involving the L1 carpark adjacency to a sole occupancy, it is expected that an acoustically sufficient partition should be implemented to preserve the internal acoustic amenity.

The National Construction Code 2022 (NCC) stipulates minimum acoustic performance for partitions separating critical spaces. The relevant requirements for a partition separating sole occupancy unit to a carpark has been summarised in **Table 37**. This is expected to be acoustically sufficient and will need to be further refined and reviewed at a later stage of design.

Table 37 NCC 2022 Acoustic Requirements

Construction	Laboratory Rating (Deemed to Satisfy)	Verification Method Requirements
Walls between sole occupancy units and a stairway, public corridor, public lobby or the like, or parts of a different classification	R_w not < 50 dB	$D_{nT,w}$ not < 45 dB

6.4.3 Childcare Centre Operation

As per the noise levels established by the *AAAC* summarised in **Table 29**, the predicted noise levels measured at the façade of the on-site receivers are summarised in **Table 38**.

Table 38 Predicted Façade Noise Level to On-site Receivers due to Outdoor Play Area Operation

Façade/Location	Level	Predicted Façade Noise Level $L_{Aeq, 15min}$ dB(A)
Eastern (facing outdoor play area)	L2	58
	L3 – L6	63
	L7 – L8	61

6.4.4 Off-site External Plant Operation

Based on the site survey and noise monitoring undertaken on the site's northern boundary, it was observed that mechanical noise through the elevated louvres from the building directly opposite the site (1 Bruce Bennetts Place Maroubra NSW 2035) is operational 24/7, resulting in a consistent source of industrial noise that is unlikely to be changed in the foreseeable future.

Therefore, the noise impacts from the mechanical plant have been assessed to the site's façade and the onerous noise levels are summarised in **Table 39**.

Table 39 Predicted Façade Noise Level to On-site Receivers due to Off-site Plant Operation

Façade/Location	Level	Predicted Façade Noise Level $L_{Aeq, period}$ dB(A)
Northern (along Piccadilly Place)	L2	58
	L3 – L6	68
	L7 – L8	66

6.4.5 Noise Generated by the Police Station

The police station is operational 24 hours a day with vehicle access at the rear of the proposed site via Piccadilly Place. Unattended monitoring conducted on-site at logger location L02 was used to determine the existing noise impact generated by the operation of the Police Station at the most exposed future façade to the proposal site.

The monitoring data was processed to establish the noise generated by the Police Station during the worse-case 1 hour Daytime and 1 hour Night-time period. The worst-case $L_{Aeq(1hour, Daytime)}$ and $L_{Aeq(1hour, Night-time)}$ noise levels are presented in **Table 40**.

Table 40 Noise Levels generated by the Police Station- Worse-case 1-hour (Daytime and Night-time)

Logger Location	Daytime dBA $L_{Aeq(1hour, Daytime)}$	Night-time dBA $L_{Aeq(1hour, Night-time)}$
L02, Rear Balcony	68	66

6.4.5.1 Maximum Noise Events and Sleep Disturbance

Audio recording was not conducted during the noise monitoring period, however the monitoring data for Location L02 has been reviewed to determine the highest maximum noise events (from all noise sources, including any sirens) measured during each night-time period. This is summarised in **Table 41**.

Table 41 Measured External Maximum Noise Level Events for Location L02

Starting Date of Night-time Period	Noise Level (dBA)	
	Highest Measured Maximum Noise Level, LAmax dB	Number of Events Recorded Above 85 dBA
Tuesday, 15 November 2022	81	0
Wednesday, 16 November 2022	87	1
Thursday, 17 November 2022	88	2
Friday, 18 November 2022	82	0
Saturday, 19 November 2022	80	0
Sunday, 20 November 2022	85	1
Monday, 21 November 2022	88	1
Tuesday, 22 November 2022	86	2
Wednesday, 23 November 2022	84	0
Thursday, 24 November 2022	88	2
Friday, 25 November 2022	88	1
Saturday, 26 November 2022	81	0

The results in **Table 41** indicate that existing maximum noise levels exceed the 76 dBA sleep disturbance screening level included in **Table 14** during typical night-time periods. Therefore, a detailed maximum noise level event assessment has been completed which considers the magnitude and frequency of maximum noise events and resultant internal noise levels which may cause sleep disturbance.

From the measured noise data summarised in **Table 40** a facade noise reduction of 31 dBA is required to achieve the internal L_{Aeq} noise goals. Therefore, based on the results in **Table 41**, this would result in the highest internal maximum noise levels across the monitoring period to range from 49 dBA to 57 dBA.

In accordance with RNP guidance (refer **Section 4.3.2.4**), maximum internal noise levels below 55 dBA are considered unlikely to awaken people from sleep, with one or two events per night with maximum internal noise levels below 70 dBA being unlikely to affect health and wellbeing significantly.

Based on the observed frequency of maximum noise events, it can be deduced that the majority of maximum noise events are less than 55 dBA and are unlikely to result in sleep awakening. Although the measured noise data suggests there are occurrences where the

predicted internal noise level would be greater than 55 dBA (observed up to 57 dBA), these events were infrequent and limited to only twice during the same night. As previously mentioned, the RNP denotes maximum internal noise levels of up to 70 dBA acceptable when limited to two events per night. Hence, where noise events are predicted to be greater than 55 dBA, it is unlikely to result in sleep awakening.

On that basis it is not considered that any further attenuation of maximum noise levels (including sirens) is required to meet the recommended sleep disturbance guidance.

7.0 Mitigation Measures

7.1 Construction Noise and Vibration Mitigation and Management Measures

The impacts during the construction of the proposal are predicted to be consistent with major construction work near sensitive receivers. No works outside of Standard Construction Hours are currently proposed.

The use of standard mitigation measures to minimise the impacts is considered sufficient to control the majority of the impacts. Examples of measures that could be applied to the work are provided in the Transport for NSW *Construction Noise and Vibration Guideline* is shown in **Table 42.**

Table 42 CNVG Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
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. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. 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)

Action Required	Applies To	Details
		• 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.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under Appendix C of the CNVG a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
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.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
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 during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration Airborne noise	See Appendix C of the CNVG for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
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 operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.

Action Required	Applies To	Details
Rental plant and equipment.	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.
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. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
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.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas.

Action Required	Applies To	Details
		Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
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. Appendix D of AS 2436:2010 lists materials suitable for shielding.
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.
Receptor control		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C of the CNVG for additional measures	Airborne noise Ground-borne vibration	In some instances, additional mitigation measures may be required.

A Construction Noise and Vibration Management Plan (CNVMP) would be prepared before any work begins. This would identify all potentially impacted receivers, assess the potential noise and vibration impacts from the proposal and provide details regarding how the impacts would be minimised through the use of all feasible and reasonable mitigation measures. The CNVMP would also contain procedures for handling complaints, should they occur, and detail any compliance monitoring requirements.

7.2 Façade Treatment Recommendation

Based on the predicted noise levels at the façade from all sources identified in **Section 6.4**, the minimum acoustic performance for glazed elements is derived to achieve compliance with the internal noise criteria summarised in **Section 4.4**.

The preliminary glazing recommendations are summarised in **Table 43**.

Table 43 Minimum Façade Acoustic Performance

Façade	Occupancy	Level	Minimum R_w	Typical Construction
North	Bedroom	All	R_w 42	12.38mm laminated / 12mm airgap / 10mm monolithic
	Living	All	R_w 33	6.38mm laminated
East	Bedroom	All	R_w 32	6.00mm monolithic
	Living	All	R_w 32	6.00mm monolithic

Façade	Occupancy	Level	Minimum R_w	Typical Construction
South	Bedroom	L1 – L6	R_w 37	12.38mm laminated
		L7 – L8	R_w 33	6.38mm laminated
	Living	L1 – L6	R_w 33	6.38mm laminated
		L7 – L8	R_w 32	6.00mm monolithic
West	Bedroom	All	R_w 32	6.00mm monolithic
	Living	All	R_w 32	6.00mm monolithic

It should be noted that the minimum specified performance refers to the system's overall performance including glazing and frame. It is recommended that the preferred system incorporates suitable acoustic seals to ensure the acoustic performance is achieved.

7.2.1 Mechanical Ventilation

To ensure that internal amenity levels are maintained in accordance with the relevant acoustic criteria outlined in **Section 4.4**, a mechanical ventilation system complying with the relevant ventilation requirements of the BCA and AS1668.2:2024 – Mechanical Ventilation in Buildings should be implemented.

The mechanical ventilation system will be designed to provide adequate fresh air supply while allowing windows to remain closed, thereby preventing intrusion of traffic and environmental noise into the building. This strategy is expected to be acoustically sufficient and can be further refined at a later stage of design.

8.0 Conclusion

SLR has been engaged to prepare a Noise and Vibration Impact Assessment (NVIA) for the proposed multi-use development at 138 Maroubra Road, Maroubra. The proposal includes a mixed-use development including residential and commercial.

The potential impacts from the proposal have been assessed against the Secretary's Environmental Assessment Requirements (SEARs) for SSD – 814266710 issued 31 March 2025 (SEARs).

A construction noise and vibration management plan has been incorporated in the NVIA to determine the potential impacts to existing surrounding receivers.

Operational noise from the site including; noise emission from the site's rooftop plantroom and equipment, loading dock activities, communal area and traffic generation have been undertaken, with the predicted noise levels to both onsite and offsite receivers being determined.

Noise intrusion from surrounding sources has also been considered including; traffic noise from Maroubra Road, childcare outdoor play area, external off-site plant room and Maroubra Police Station's operation.

The existing traffic noise impacts to the site from surrounding roadways has been determined based on SoundPLAN noise modelling and verified via on-site long-term noise monitoring.

SLR Consulting believe there are no site conditions, statutory or other requirements that would preclude this development from complying with the criteria defined in this report.

Appendix A Acoustic Terminology

138 Maroubra Road, Maroubra

Noise and Vibration Impact Assessment

Lindsay Bennelong Developments

SLR Project No.: 610.31029.00006

13 March 2026

1. Sound Level or Noise Level

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

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

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

2. 'A' Weighted Sound Pressure Level

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

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

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

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

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

3. Sound Power Level

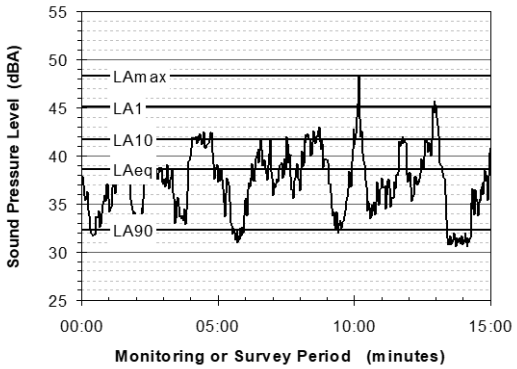
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

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

4. Statistical Noise Levels

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

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



Of particular relevance, are:

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

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

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

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

5. Frequency Analysis

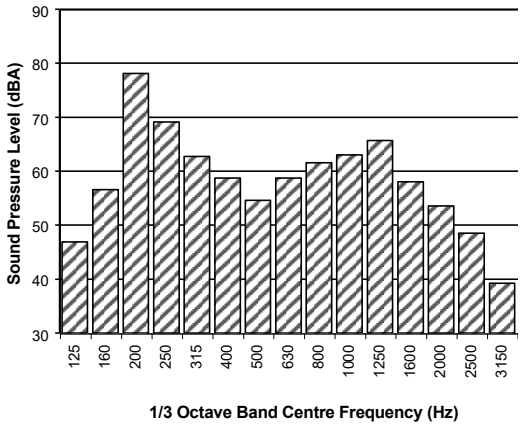
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

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

Frequency analysis can be in:

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

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



6. Annoying Noise (Special Audible Characteristics)

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

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

7. Vibration

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

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

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

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

8. Human Perception of Vibration

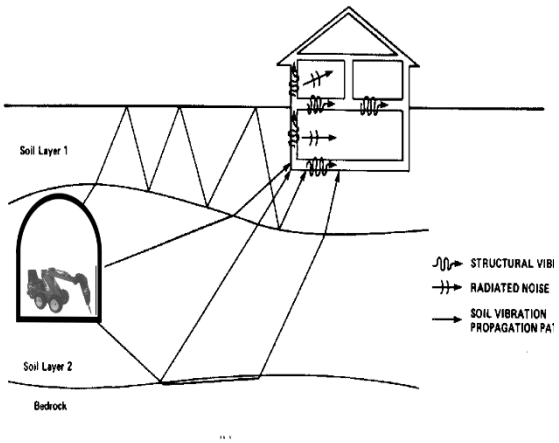
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience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

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

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

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

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



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

Appendix B Statistical Ambient Noise Levels

138 Maroubra Road, Maroubra

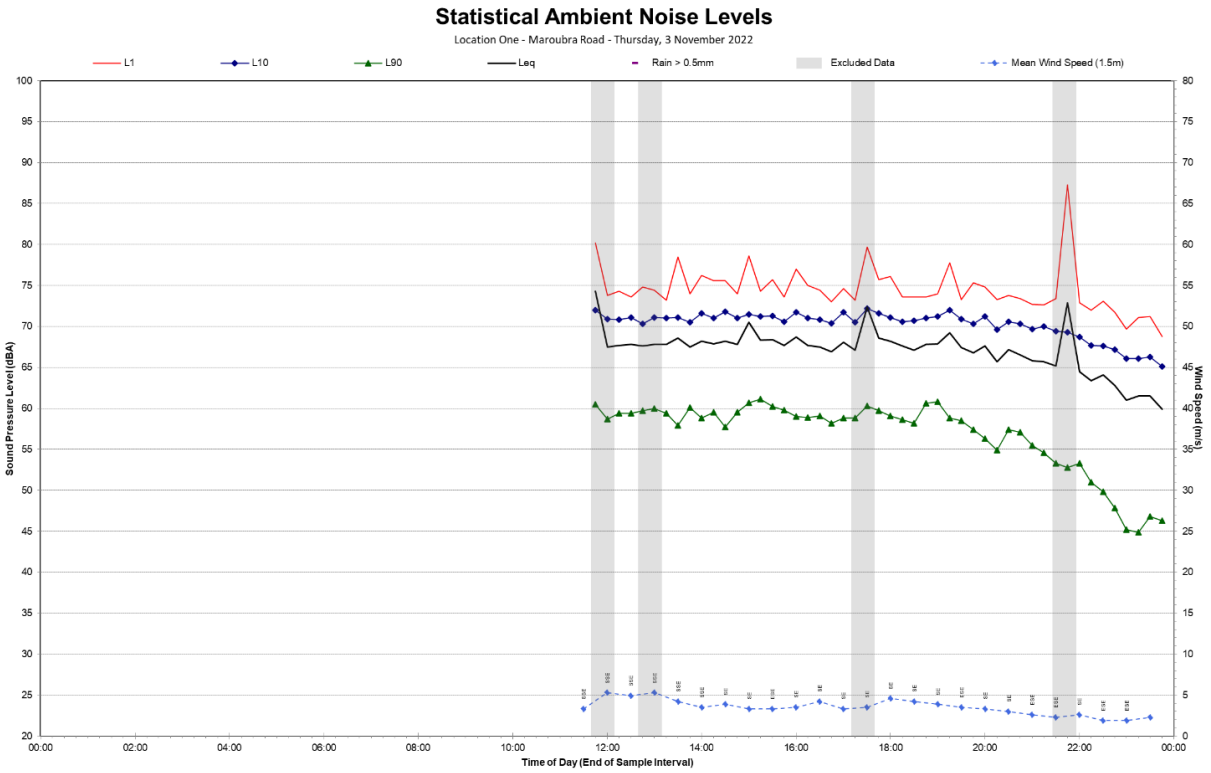
Noise and Vibration Impact Assessment

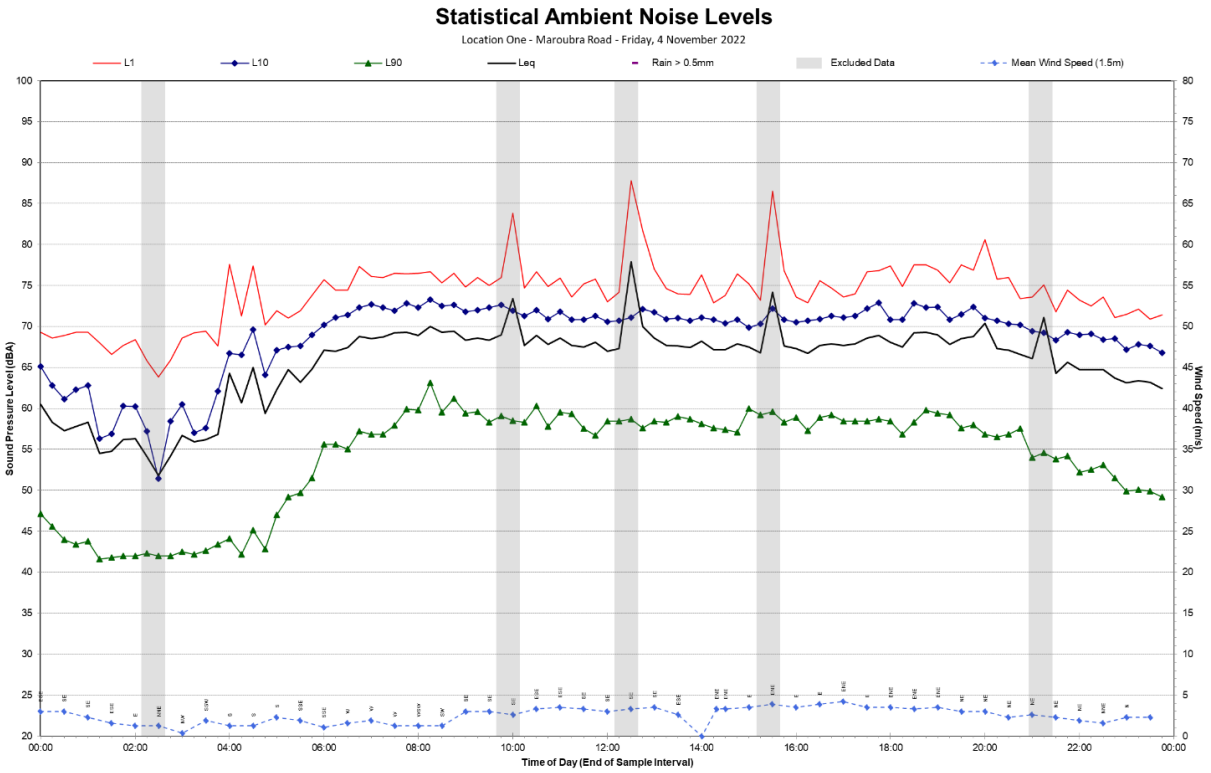
Lindsay Bennelong Developments

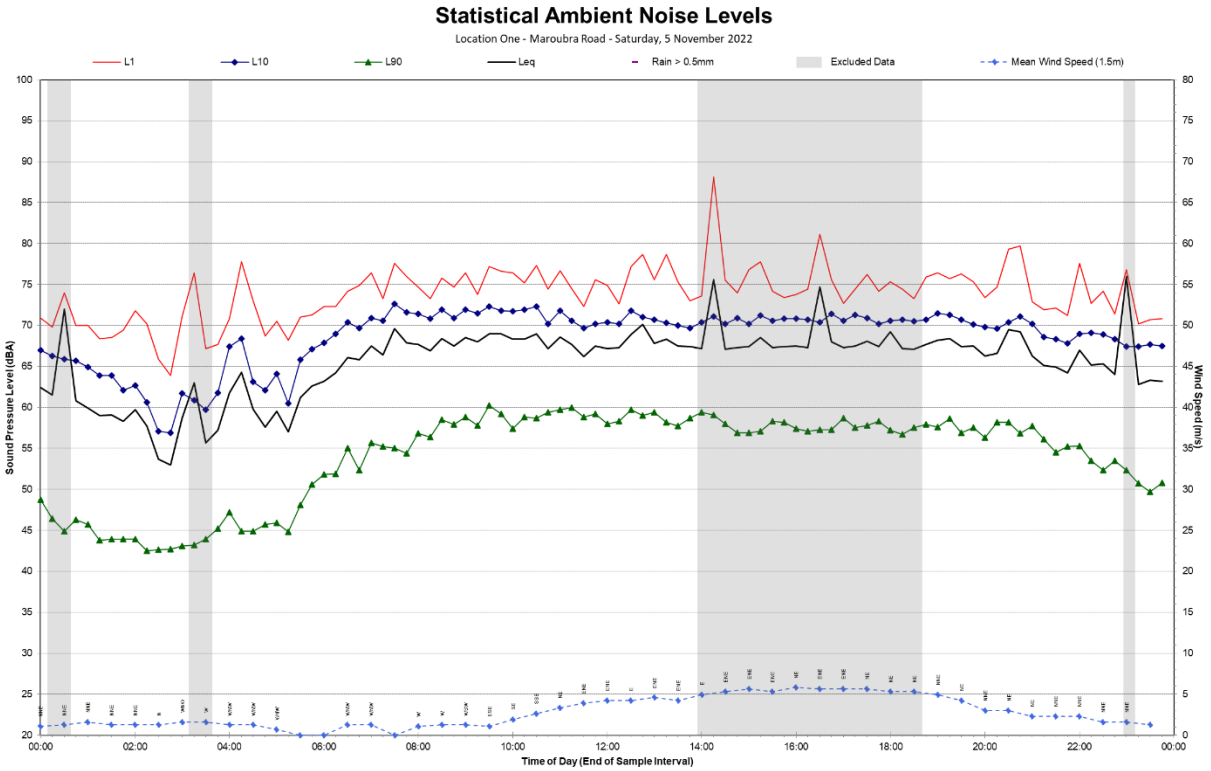
SLR Project No.: 610.31029.00006

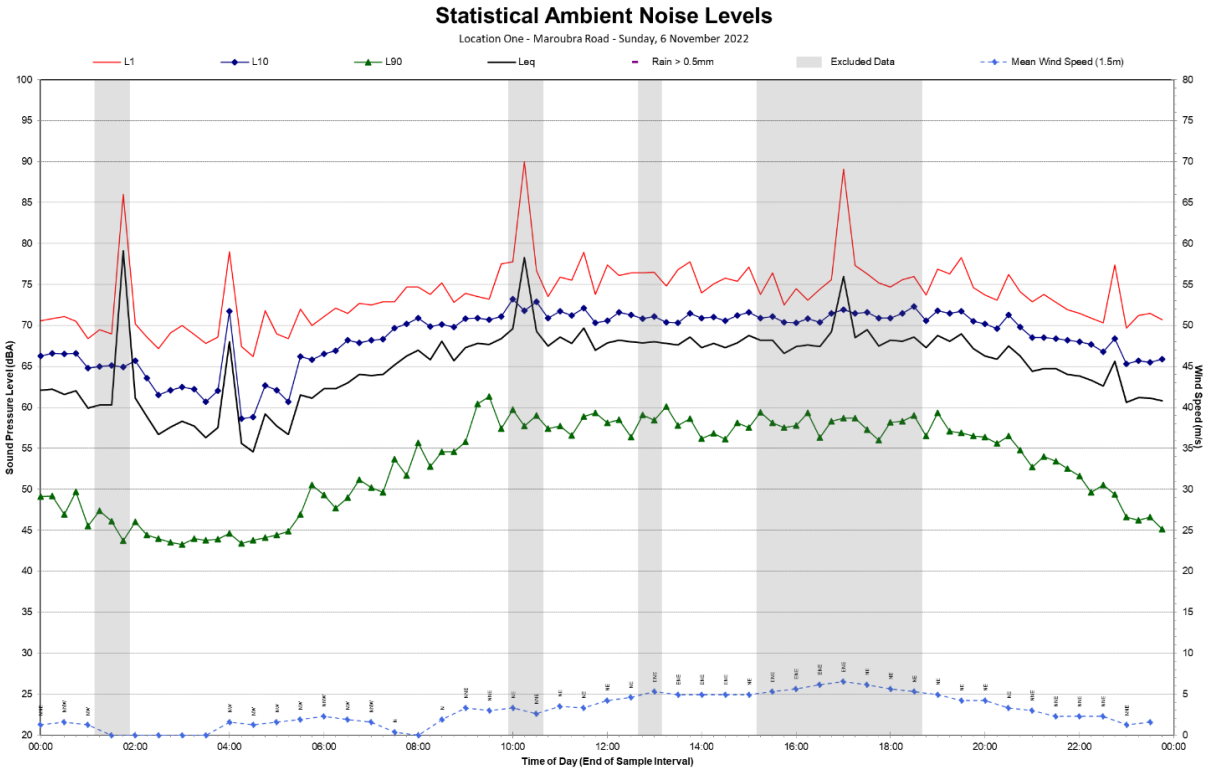
13 March 2026

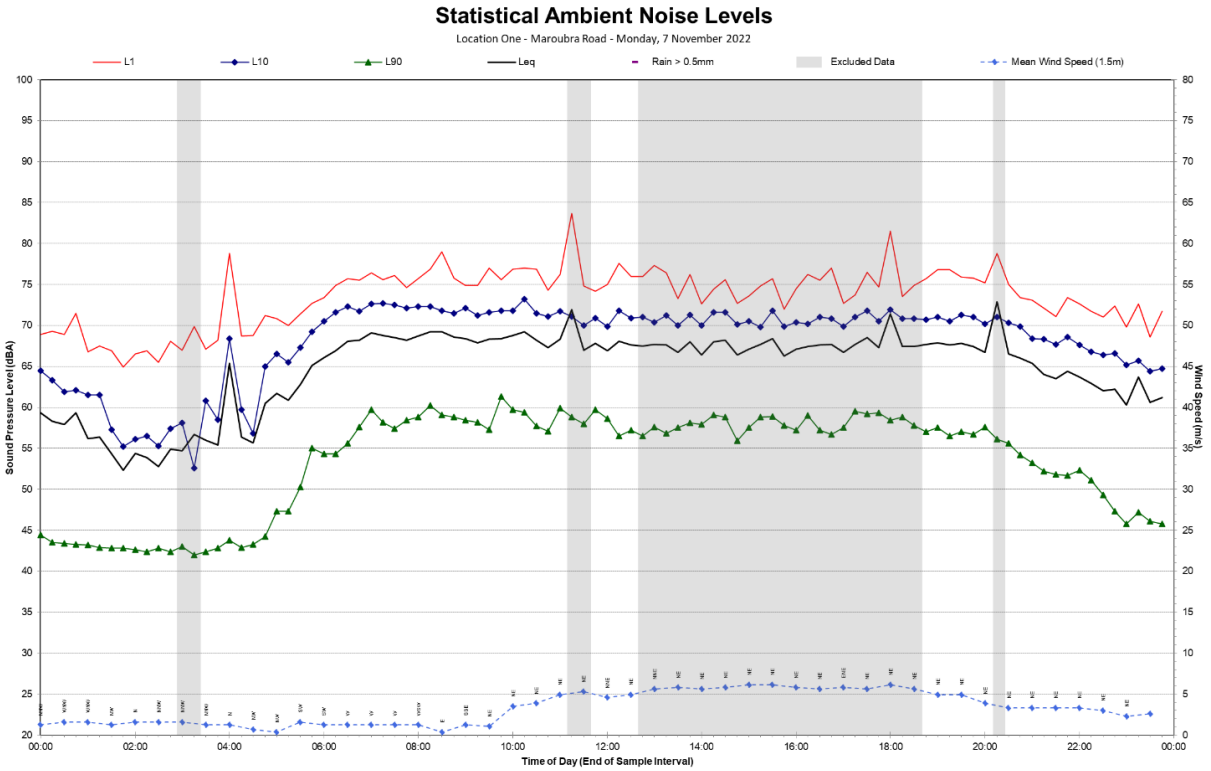
Logger L01 Location

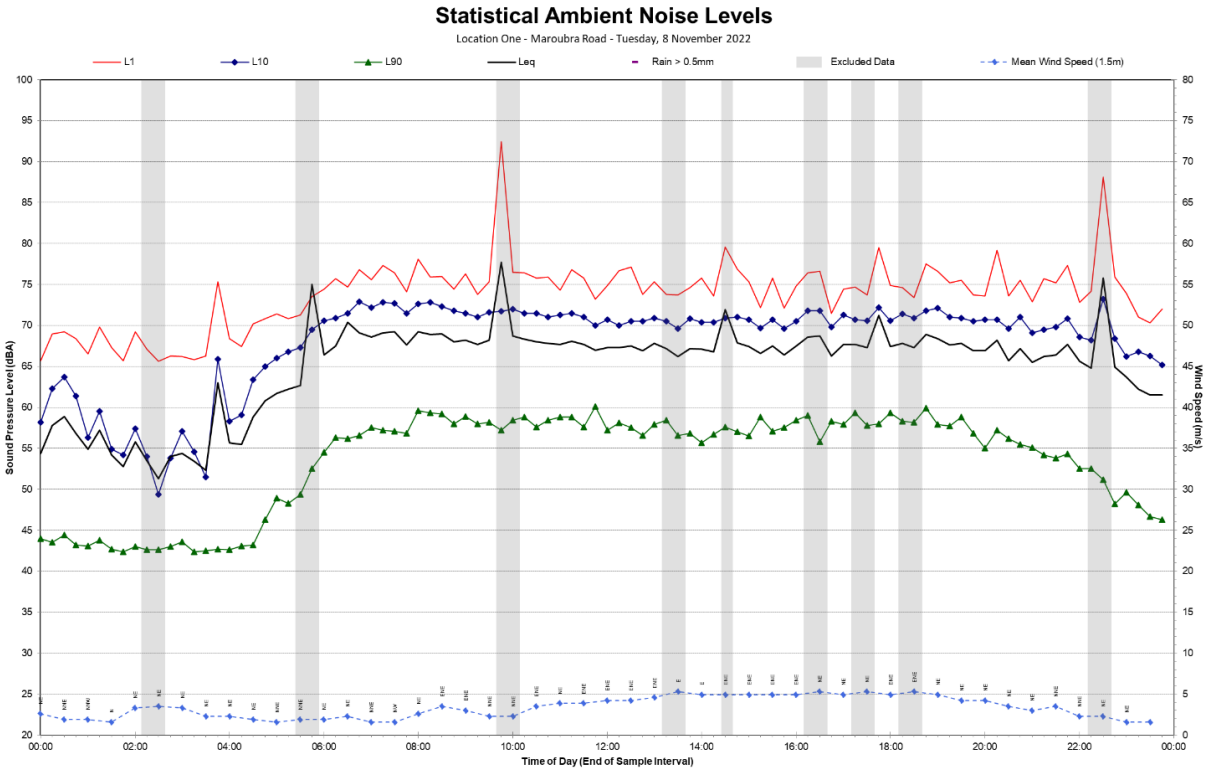


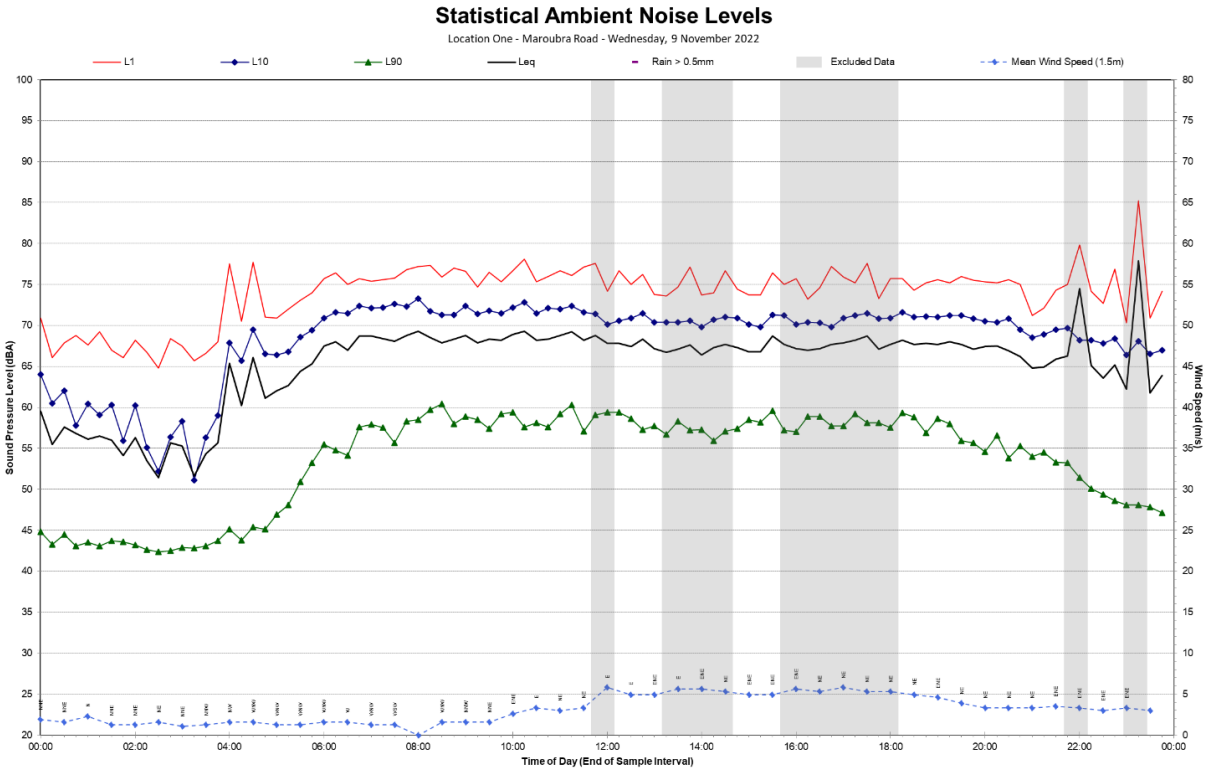


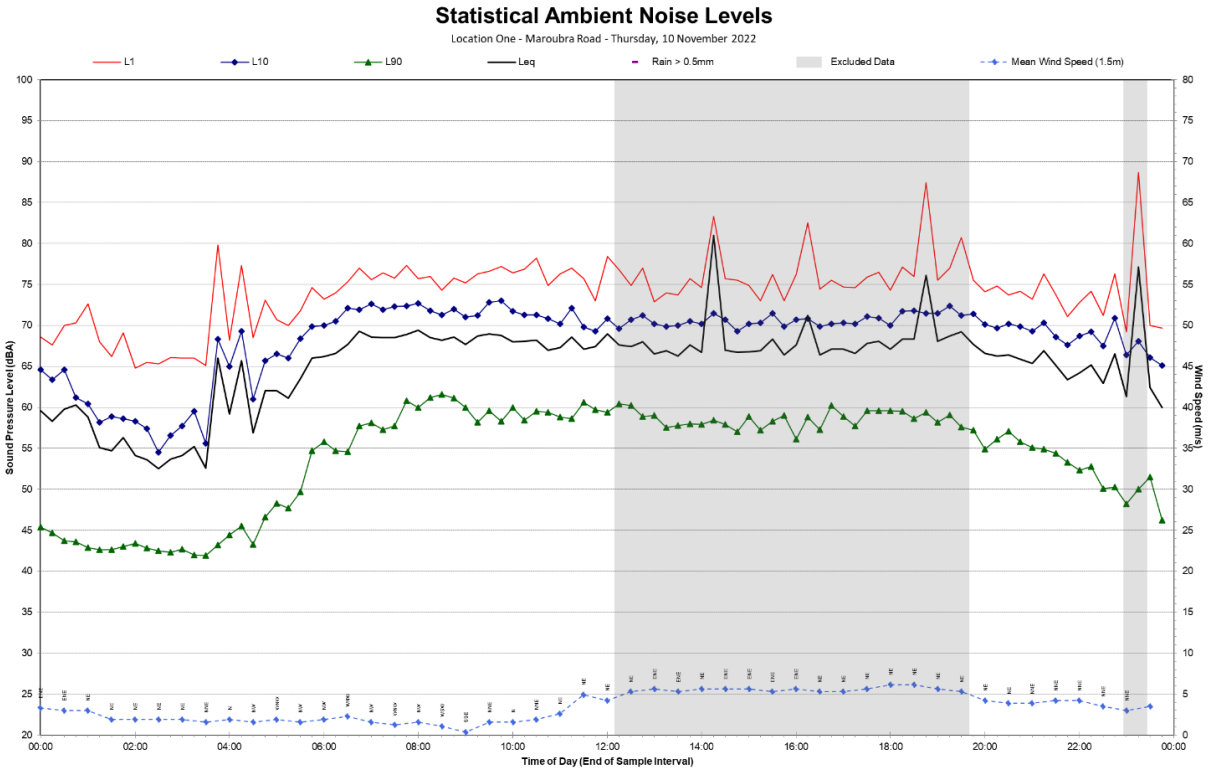

Statistical Ambient Noise Levels
Location One - Maroubra Road - Saturday, 5 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

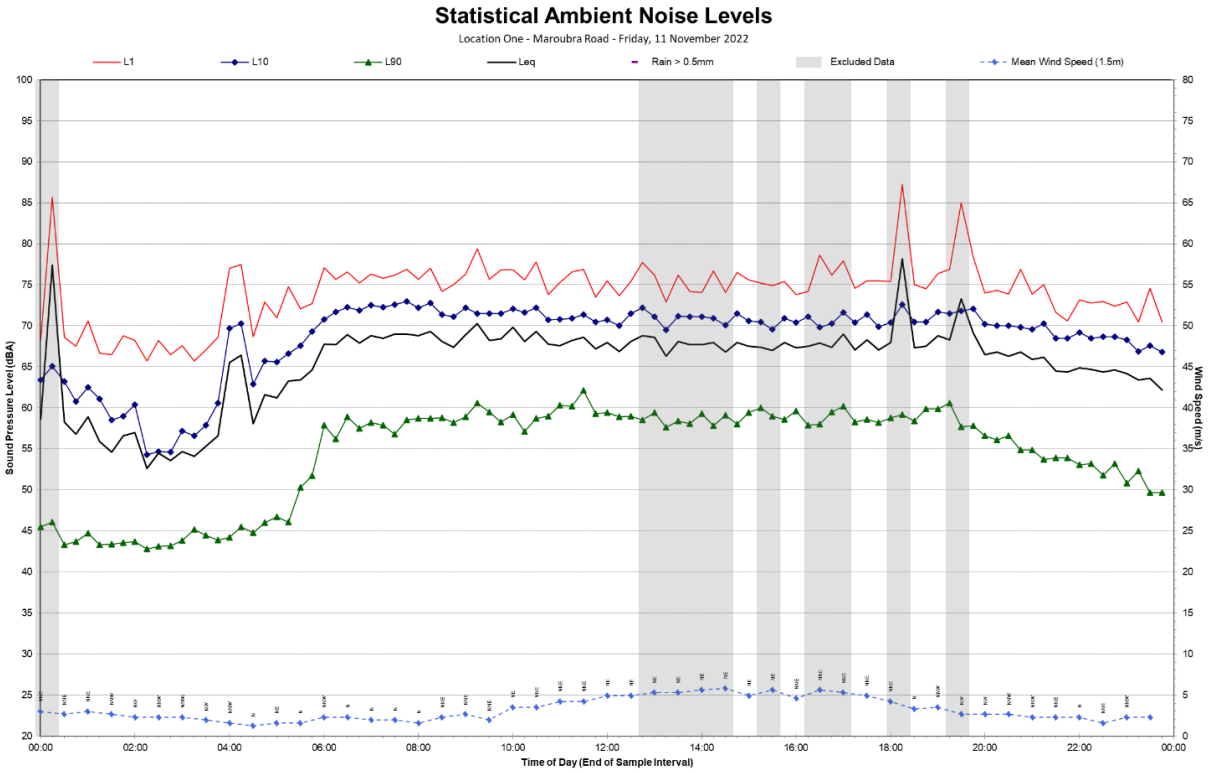

Statistical Ambient Noise Levels
Location One - Maroubra Road - Sunday, 6 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

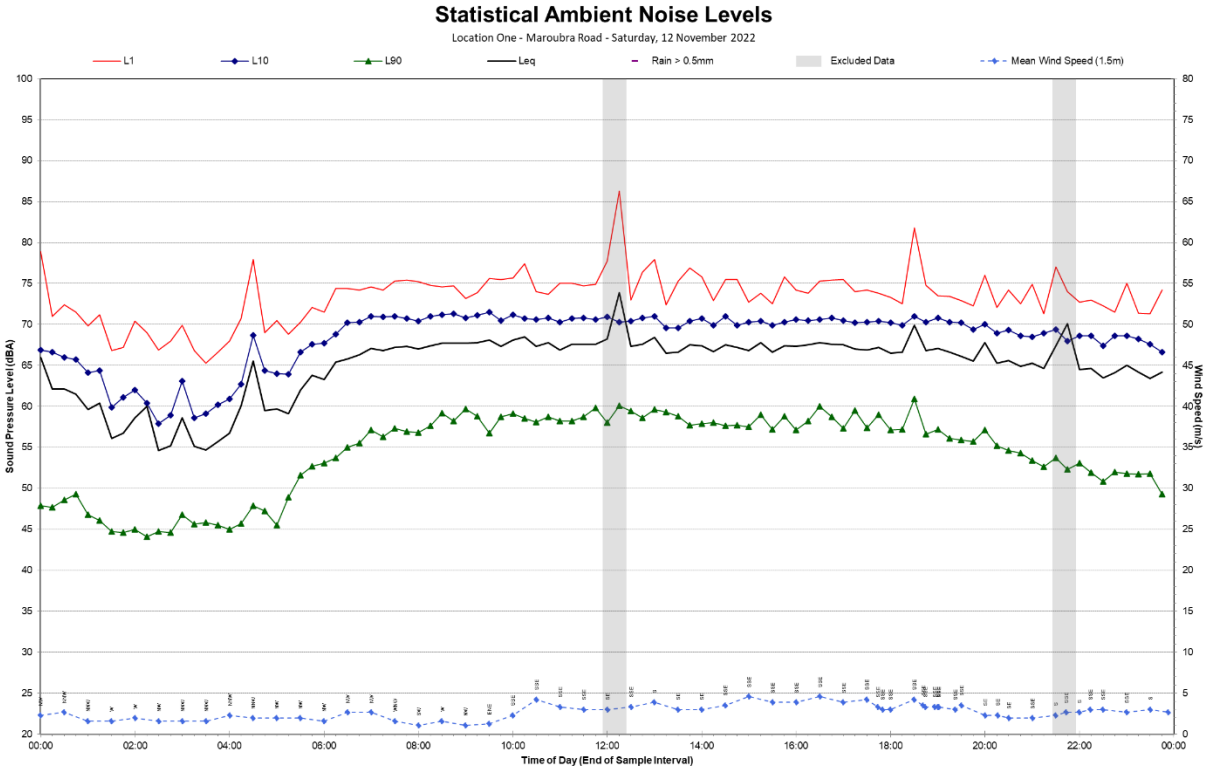

Statistical Ambient Noise Levels
Location One - Maroubra Road - Monday, 7 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

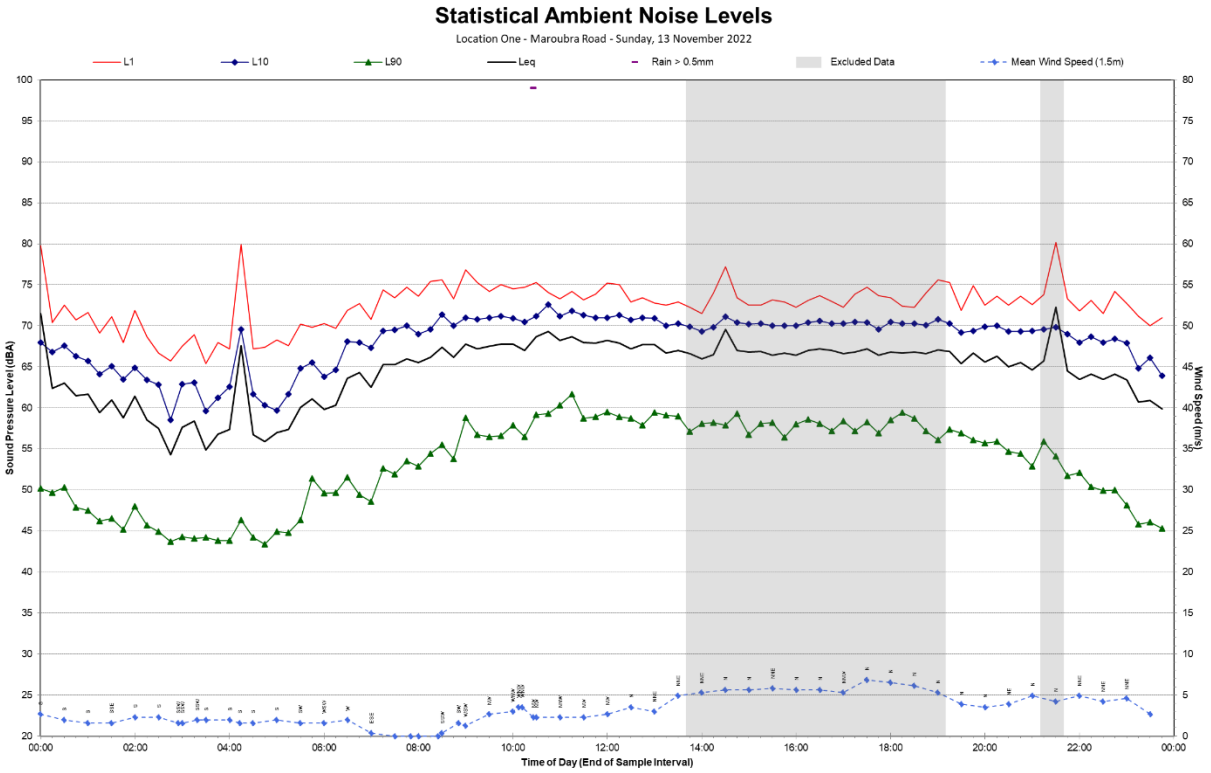

Statistical Ambient Noise Levels
Location One - Maroubra Road - Tuesday, 8 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

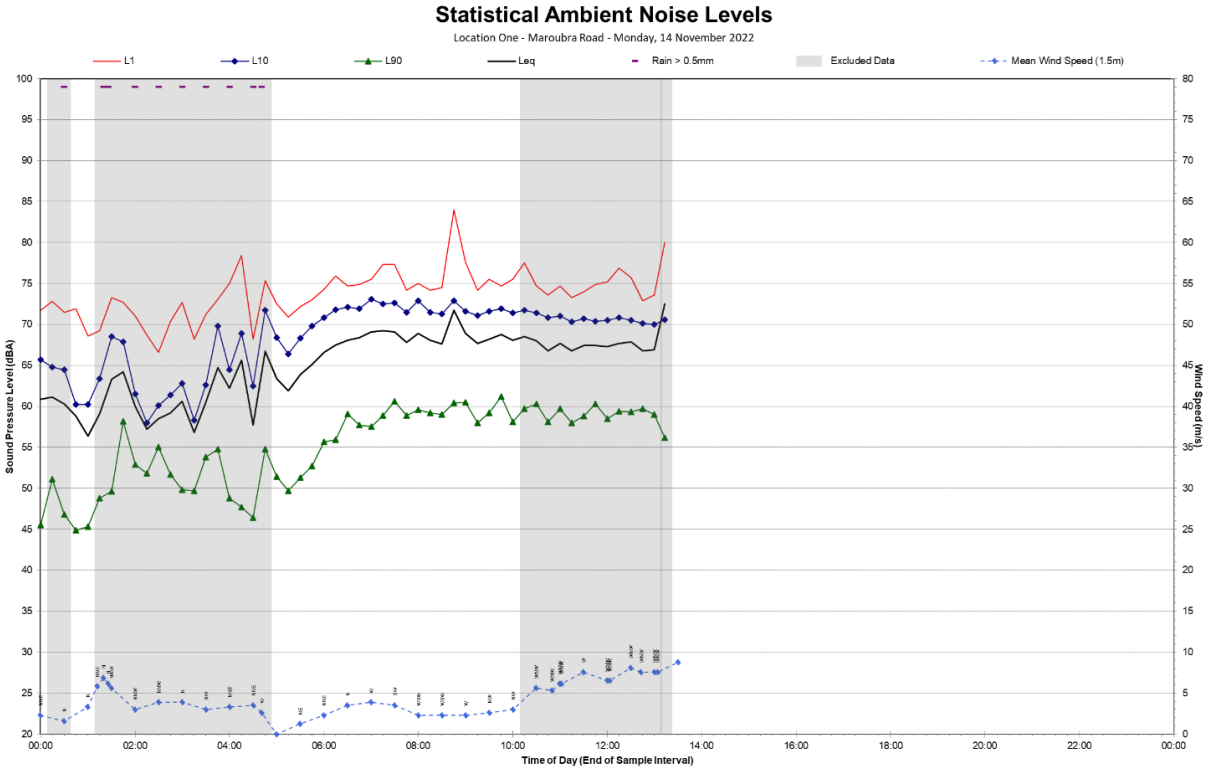

Statistical Ambient Noise Levels
Location One - Maroubra Road - Wednesday, 9 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location One - Maroubra Road - Thursday, 10 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

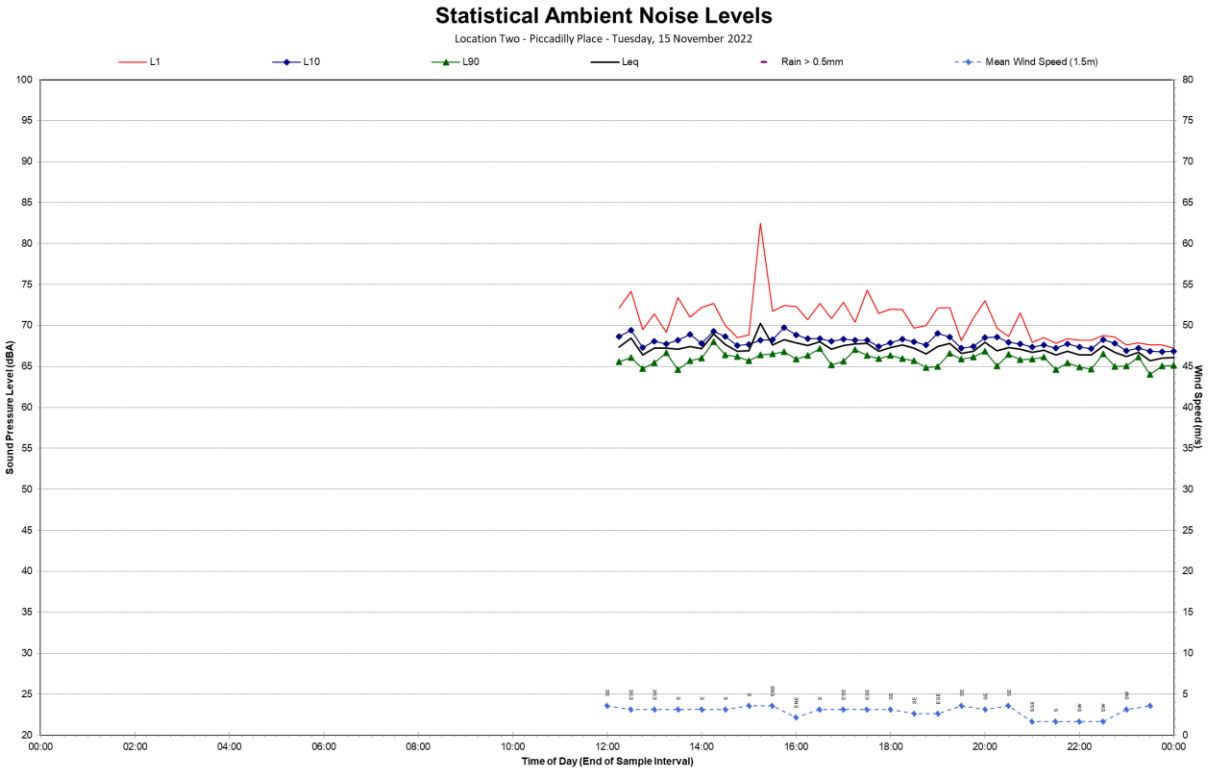

Statistical Ambient Noise Levels
Location One - Maroubra Road - Friday, 11 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

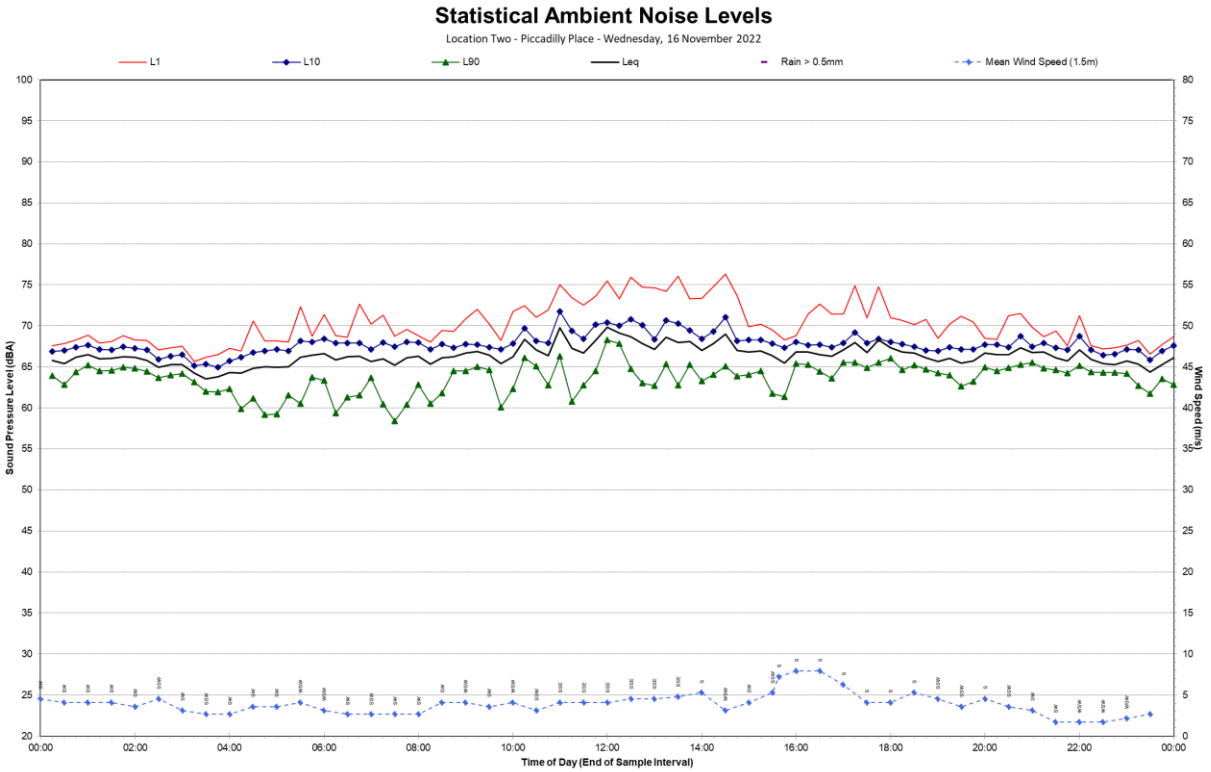

Statistical Ambient Noise Levels
Location One - Maroubra Road - Saturday, 12 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

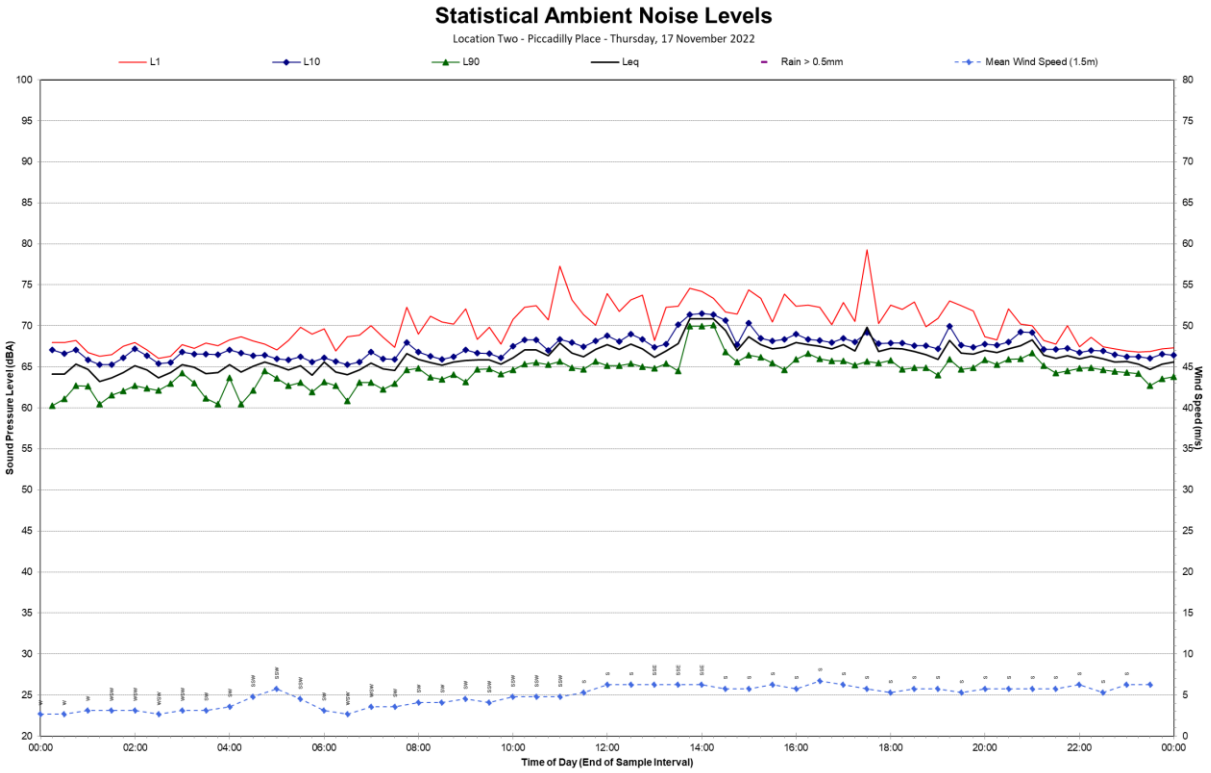

Statistical Ambient Noise Levels
Location One - Maroubra Road - Sunday, 13 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

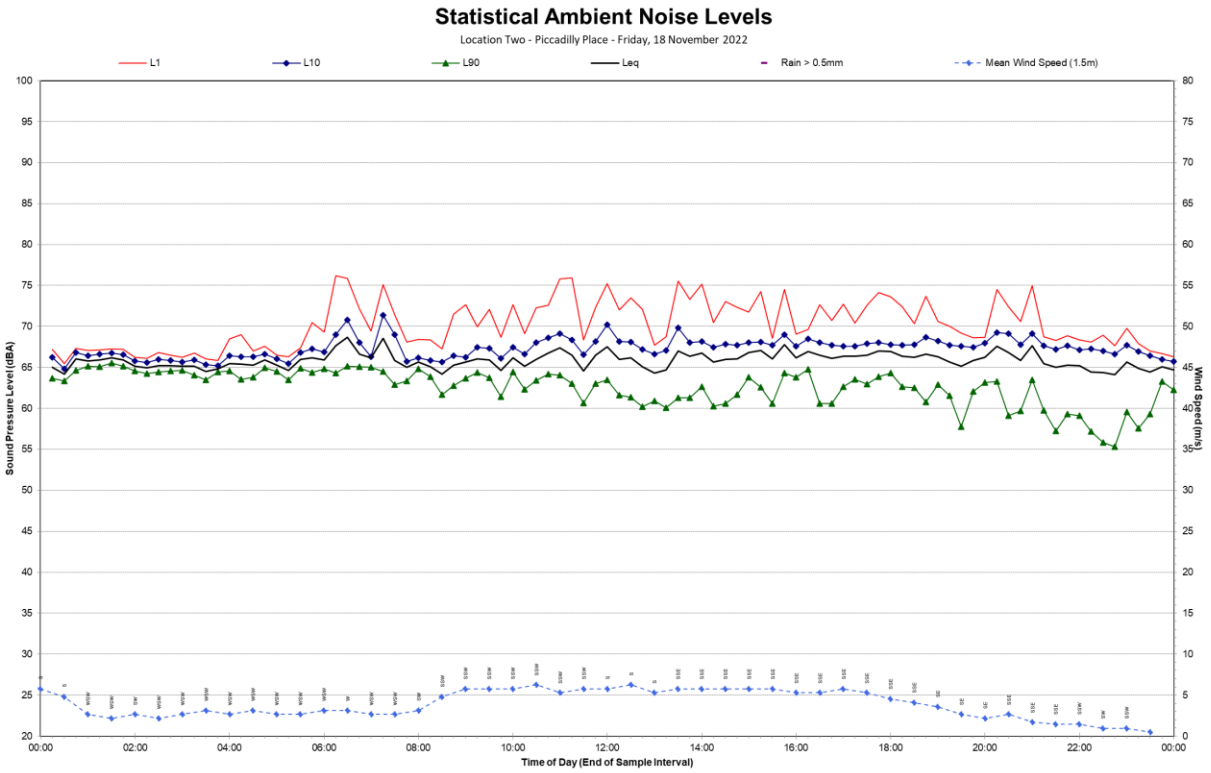

Statistical Ambient Noise Levels
Location One - Maroubra Road - Monday, 14 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

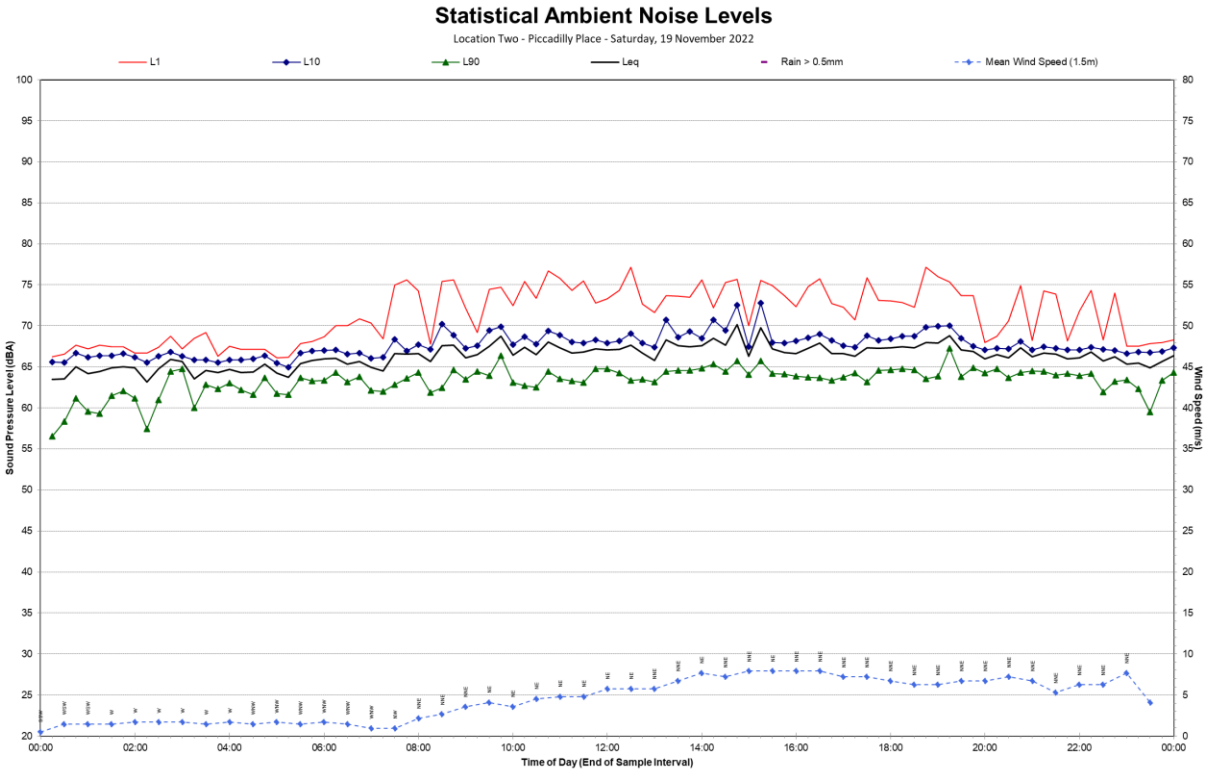
Logger L02 Location

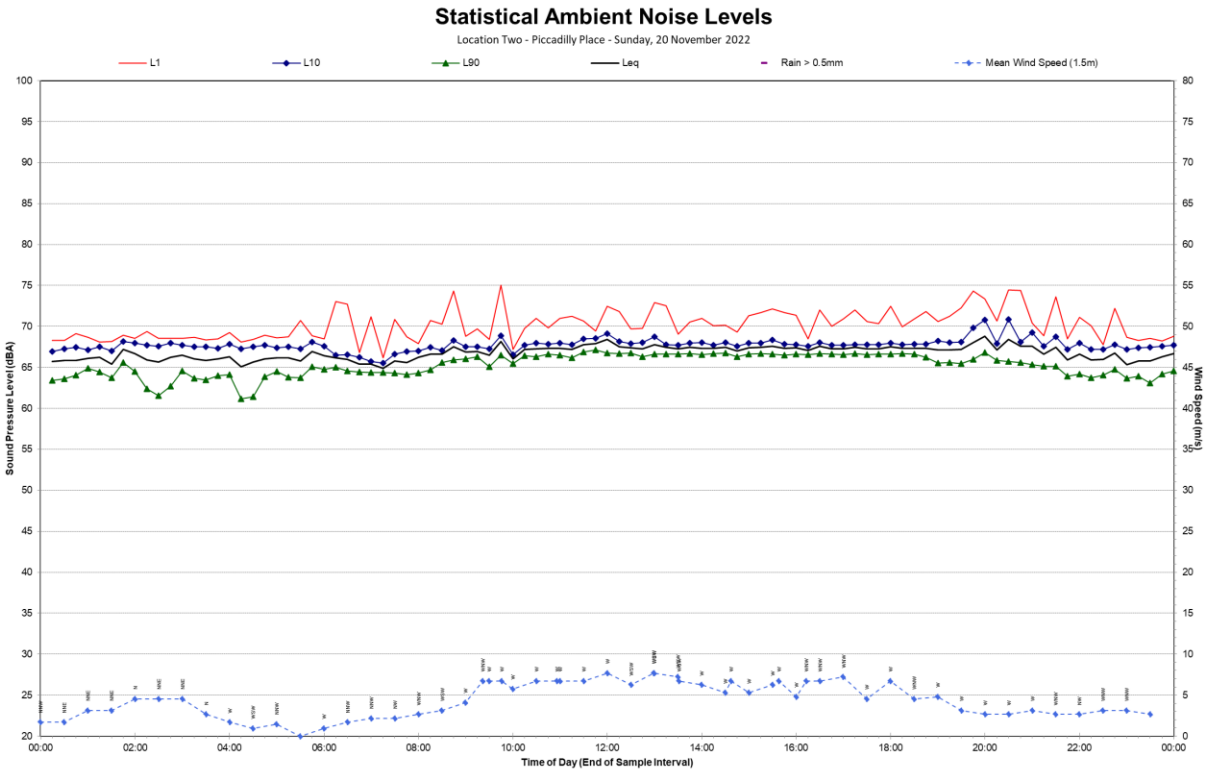


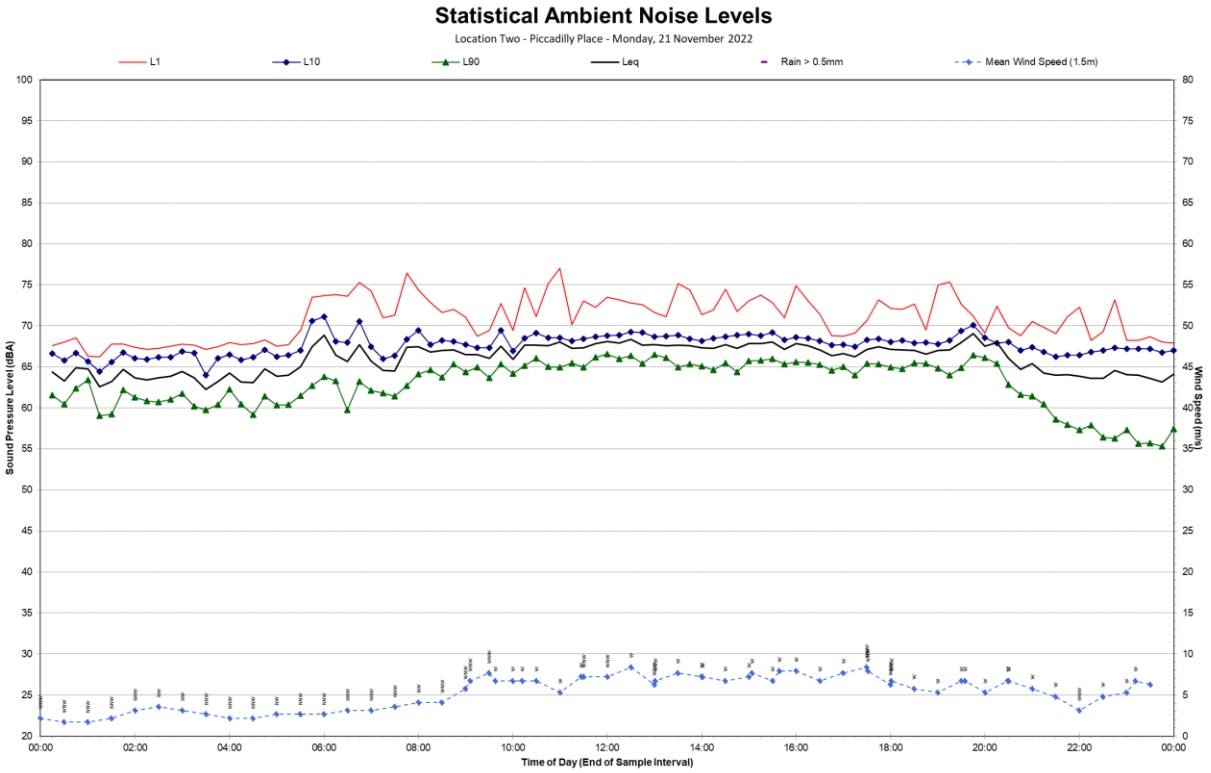


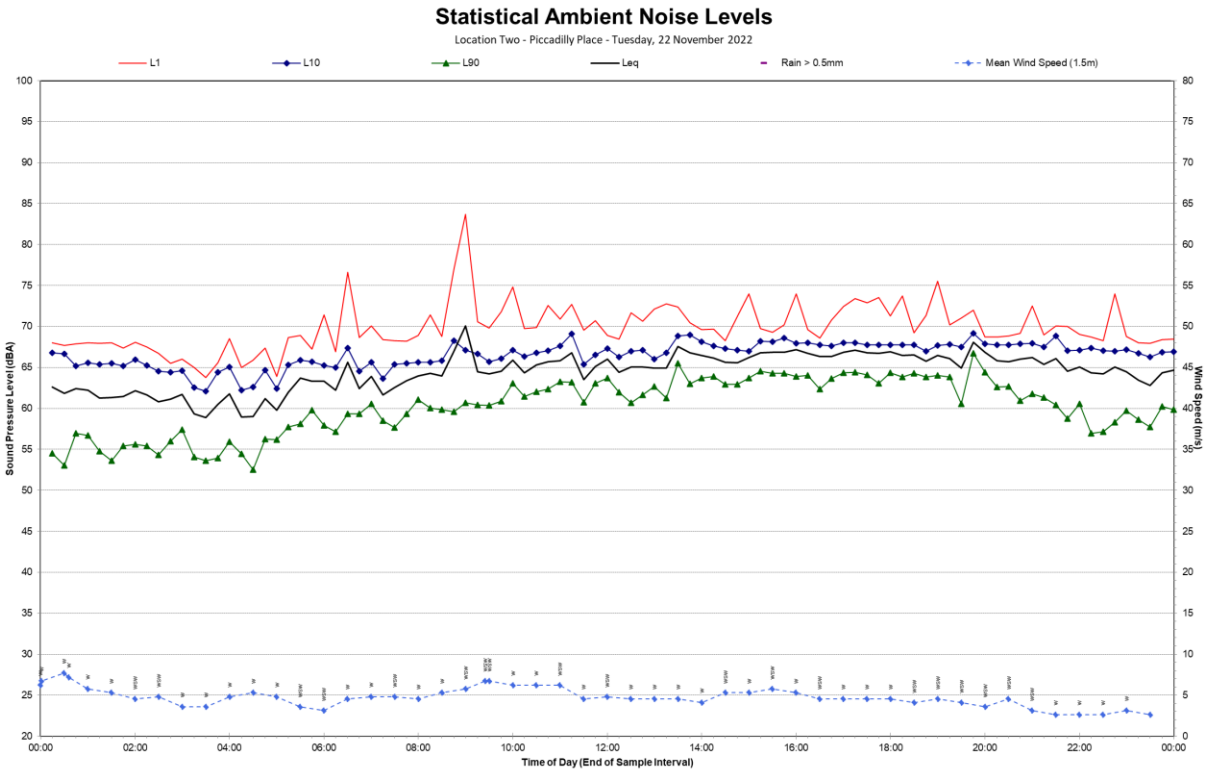

Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Thursday, 17 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

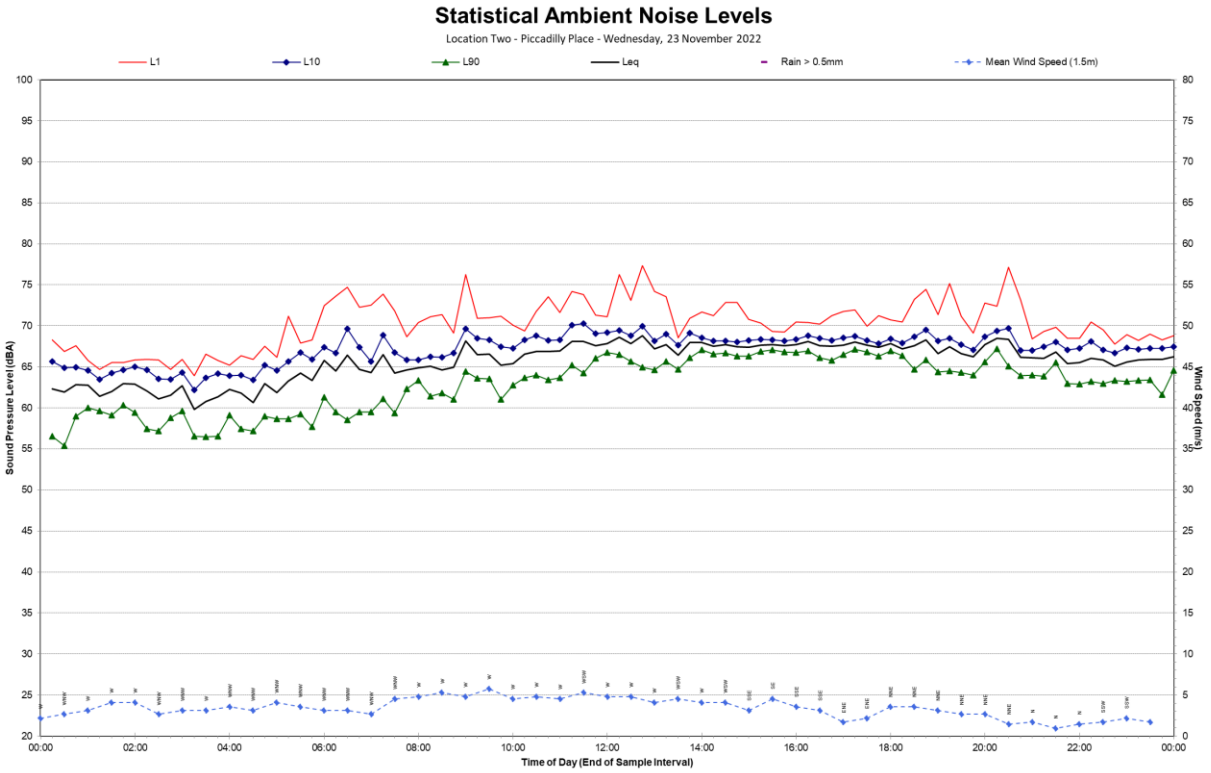

Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Friday, 18 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

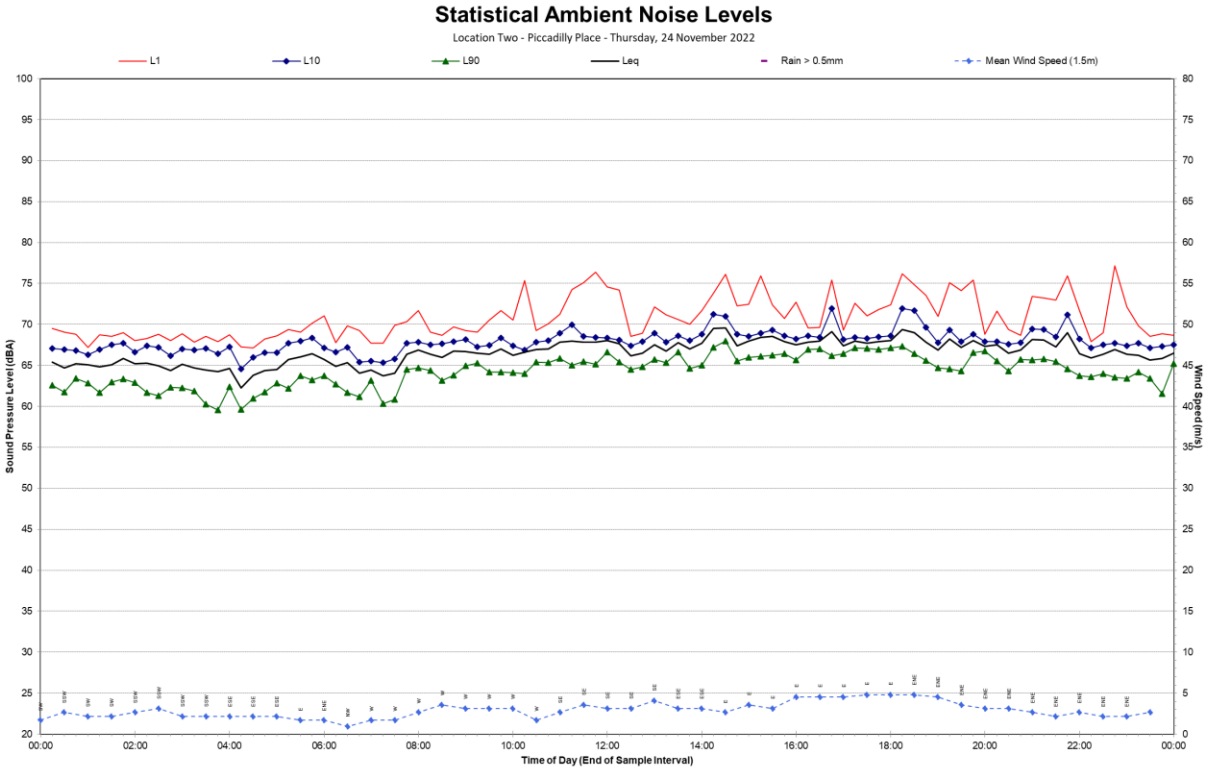

Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Saturday, 19 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

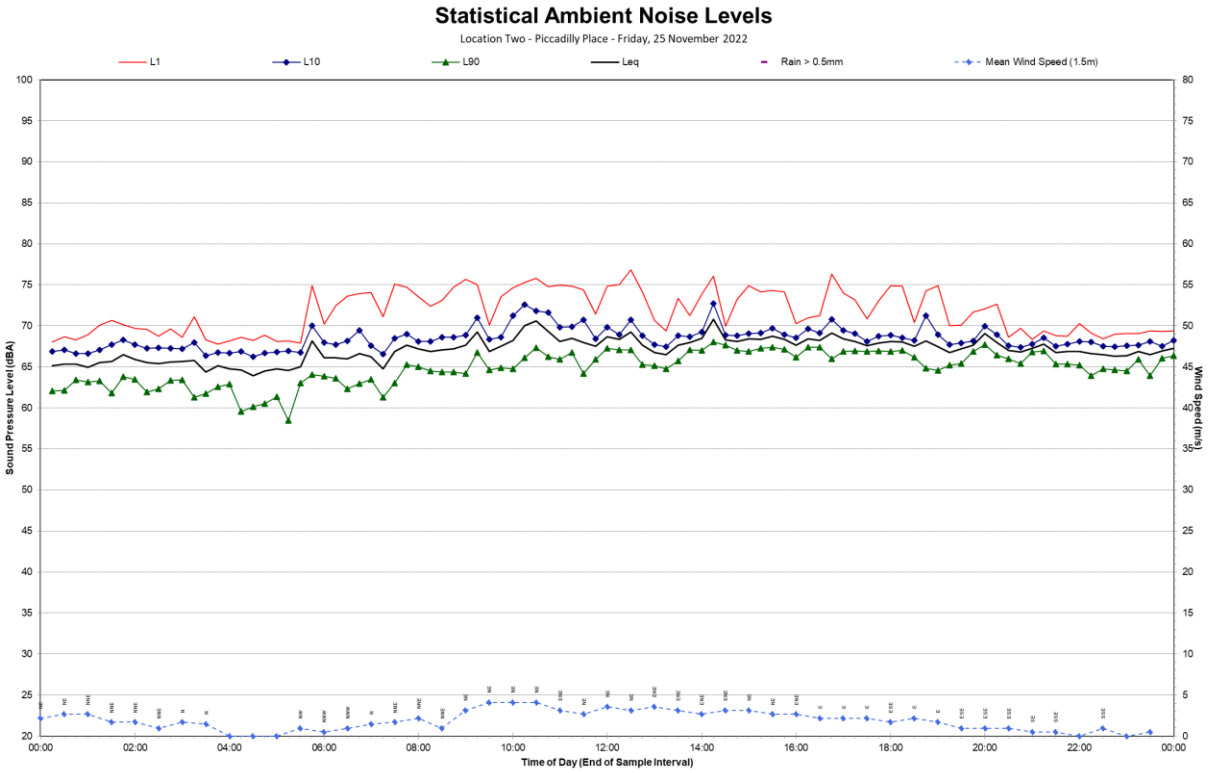

Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Sunday, 20 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

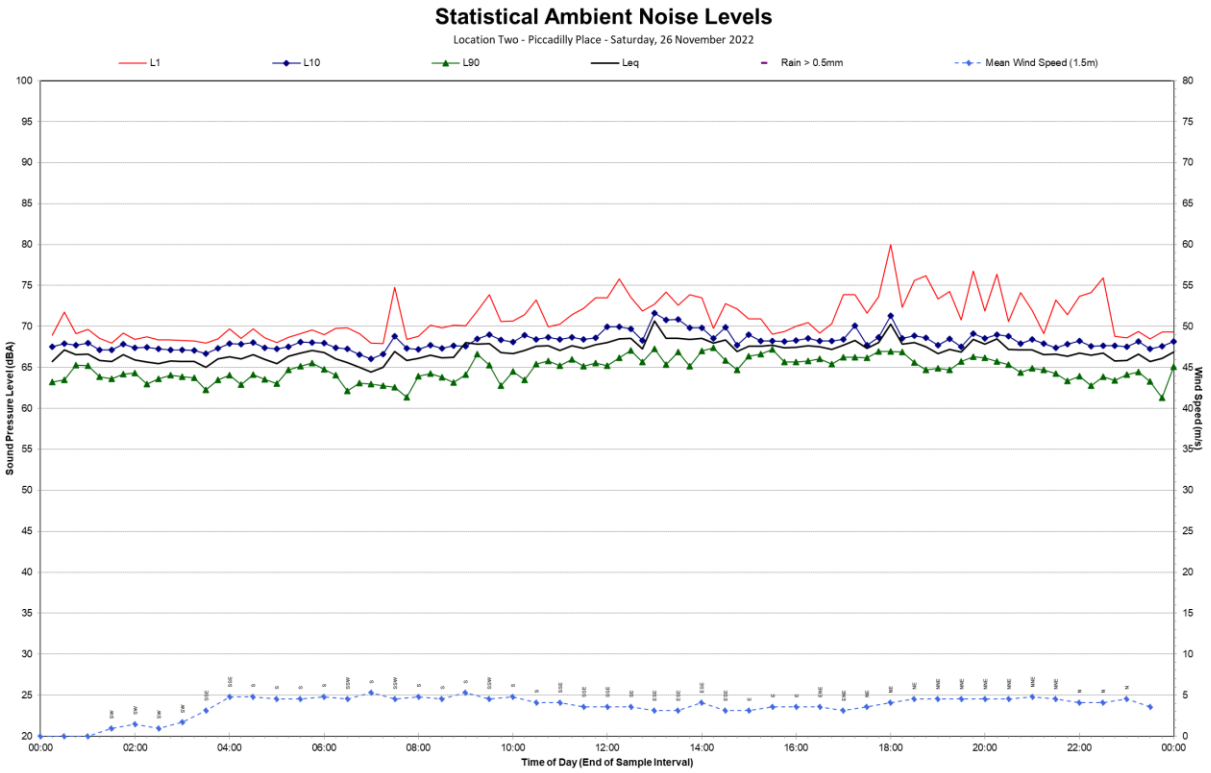

Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Monday, 21 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

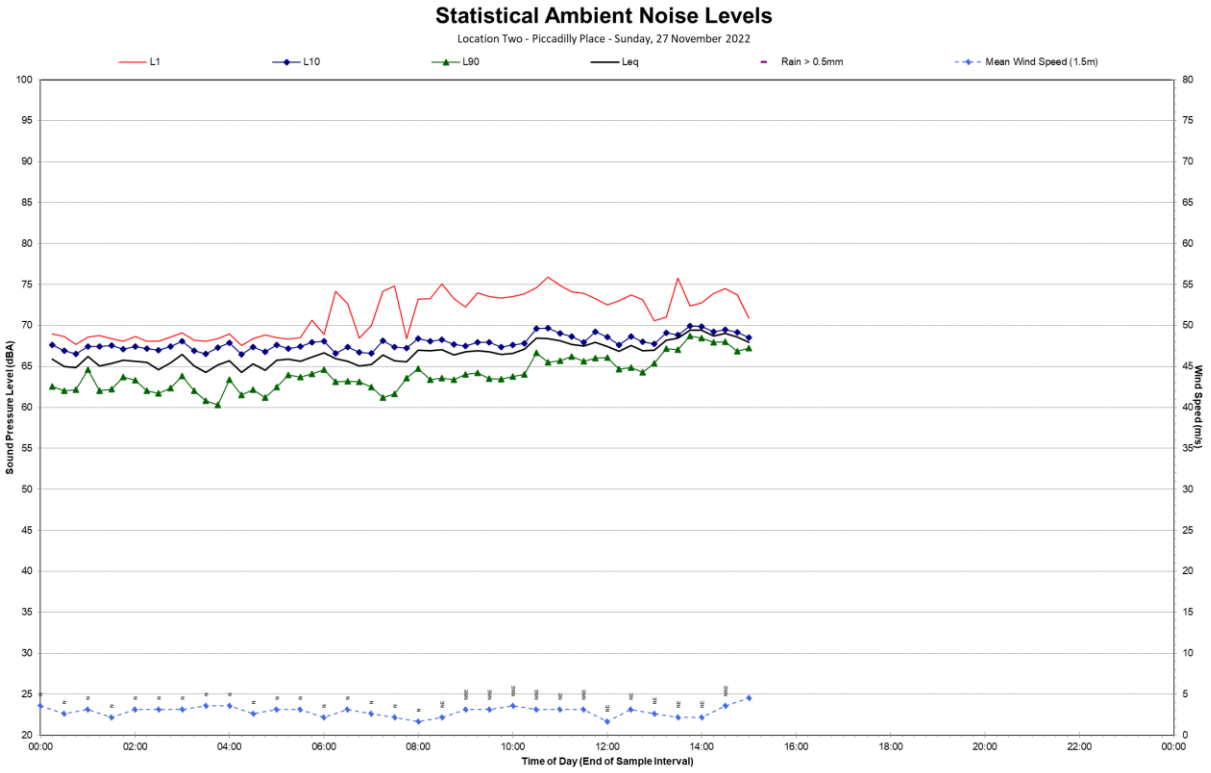

Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Tuesday, 22 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Wednesday, 23 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Thursday, 24 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Friday, 25 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Saturday, 26 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location Two - Piccadilly Place - Sunday, 27 November 2022
L1
L10
L90
Leq
Rain > 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

Appendix C Operational Traffic Façade Noise Maps

138 Maroubra Road, Maroubra

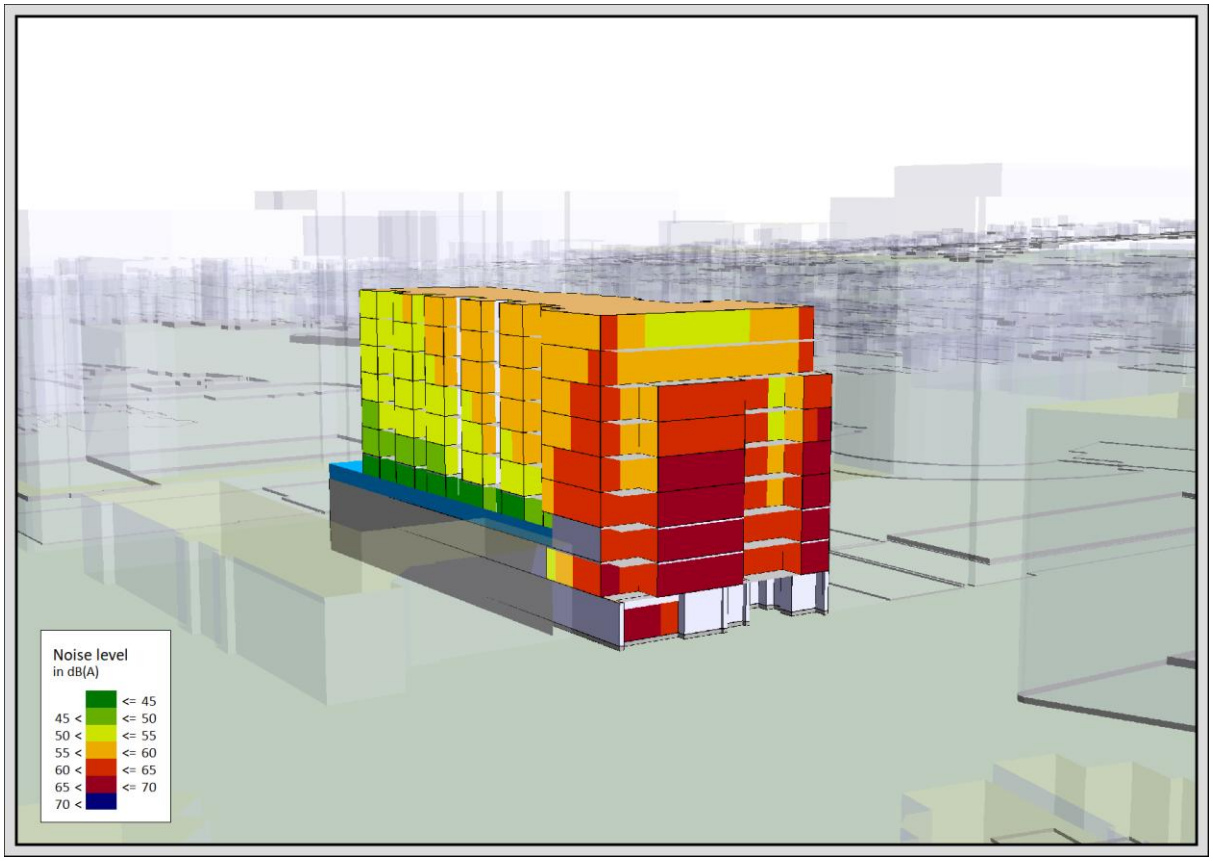
Noise and Vibration Impact Assessment

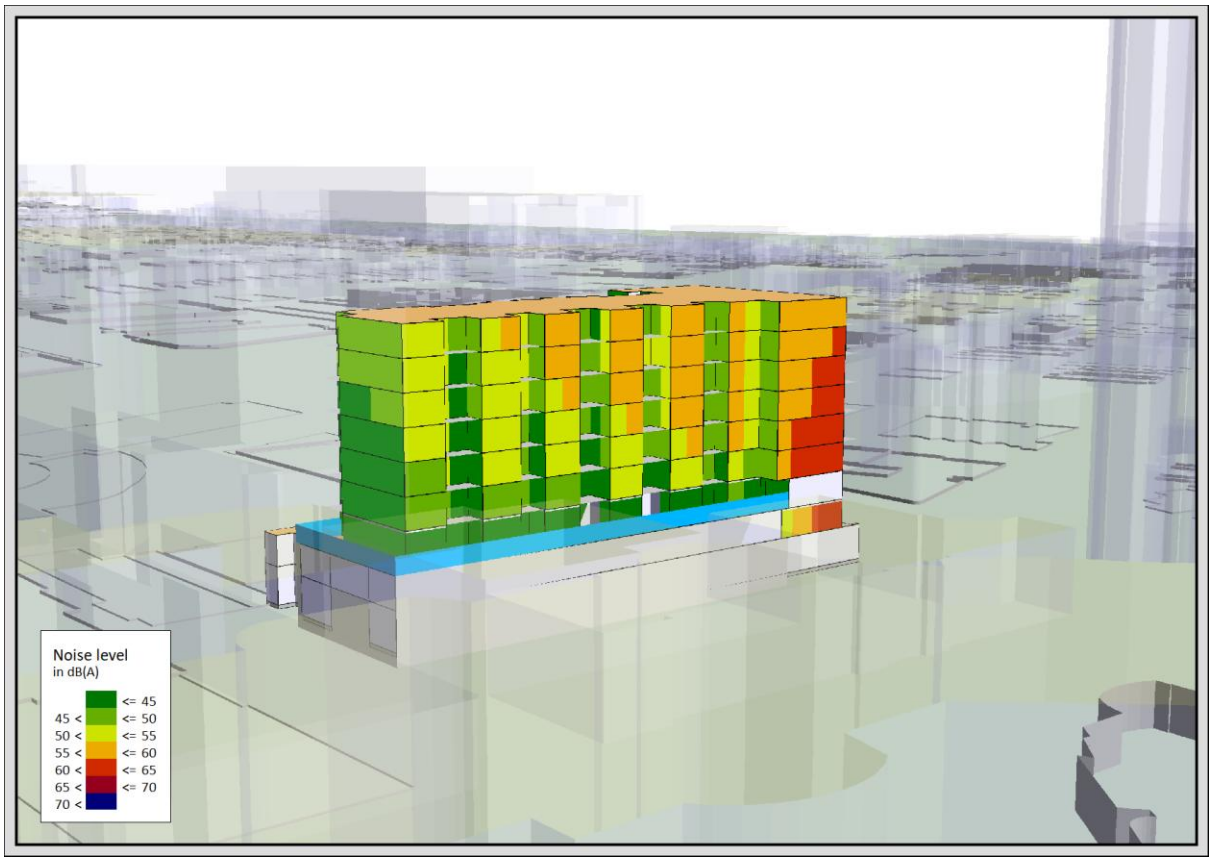
Lindsay Bennelong Developments

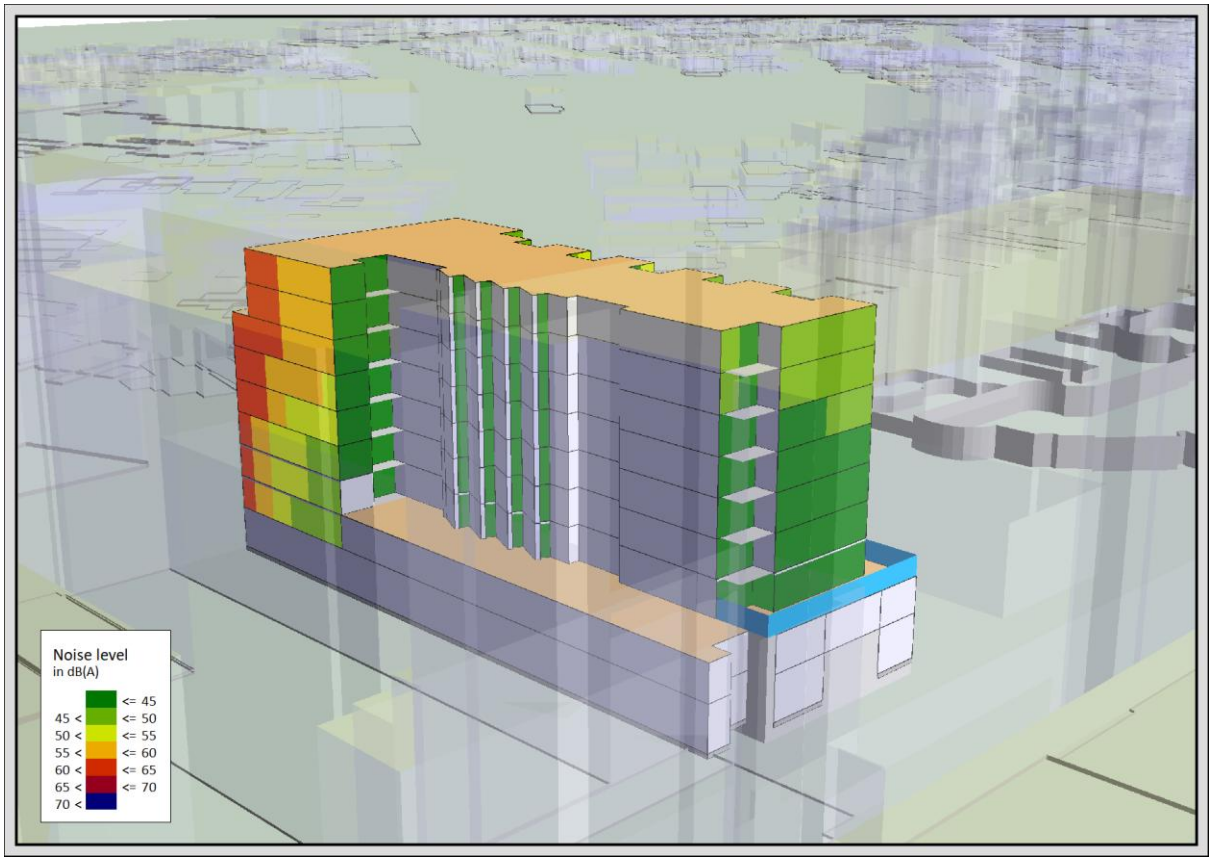
SLR Project No.: 610.31029.00006

13 March 2026

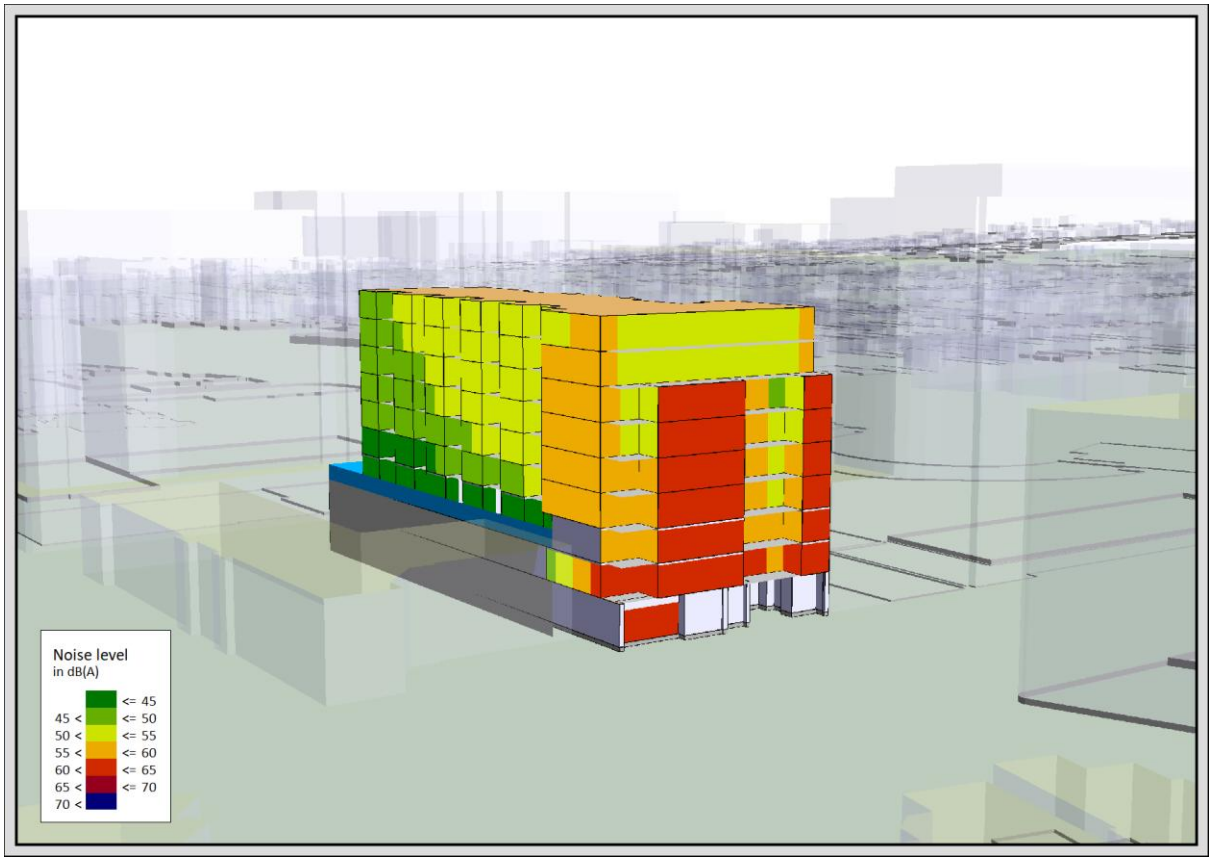
Day Traffic Noise

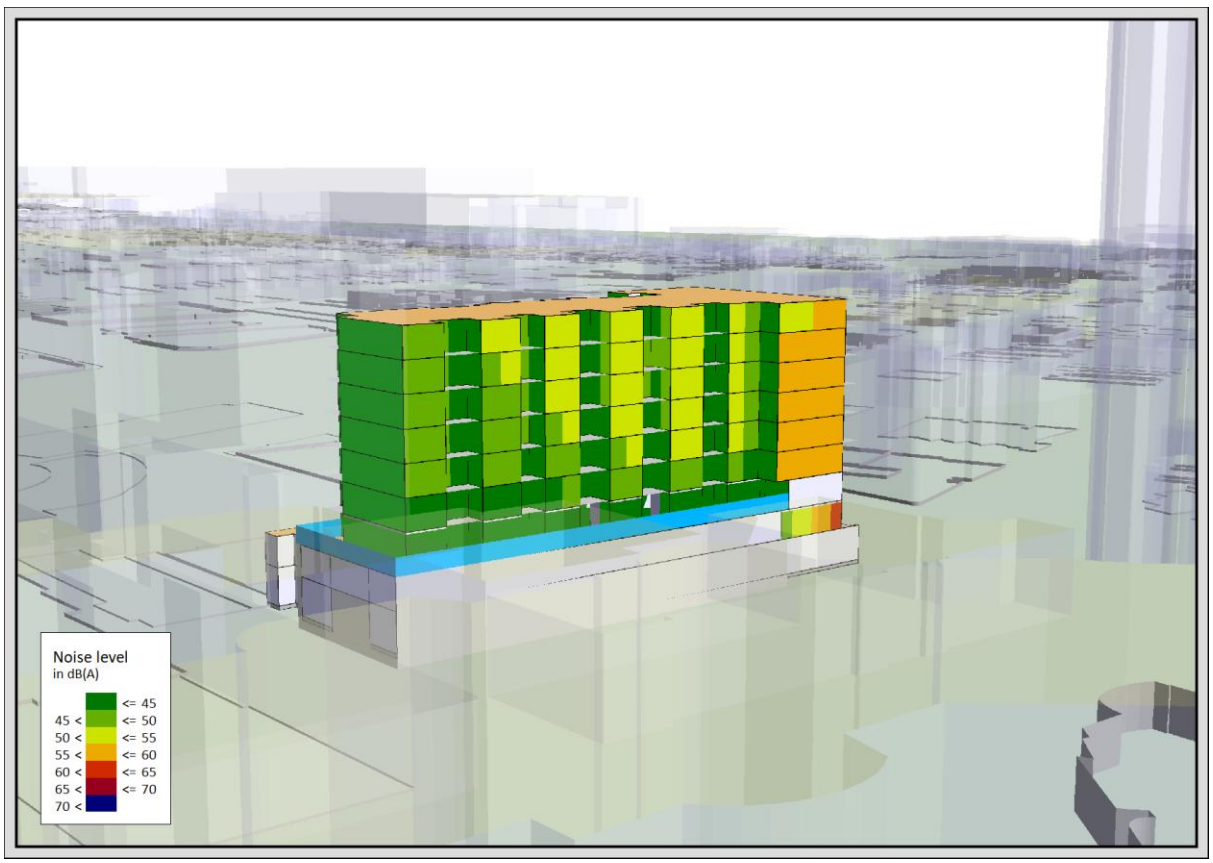


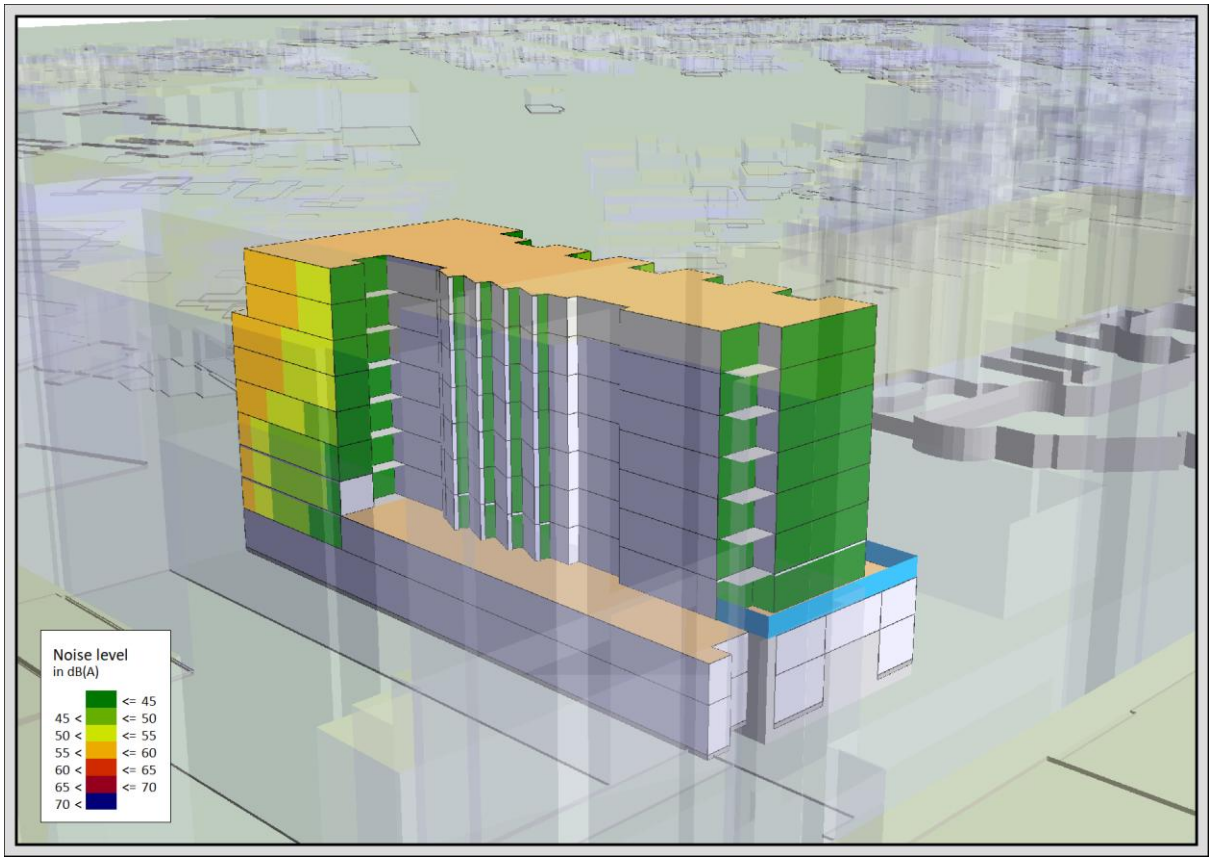


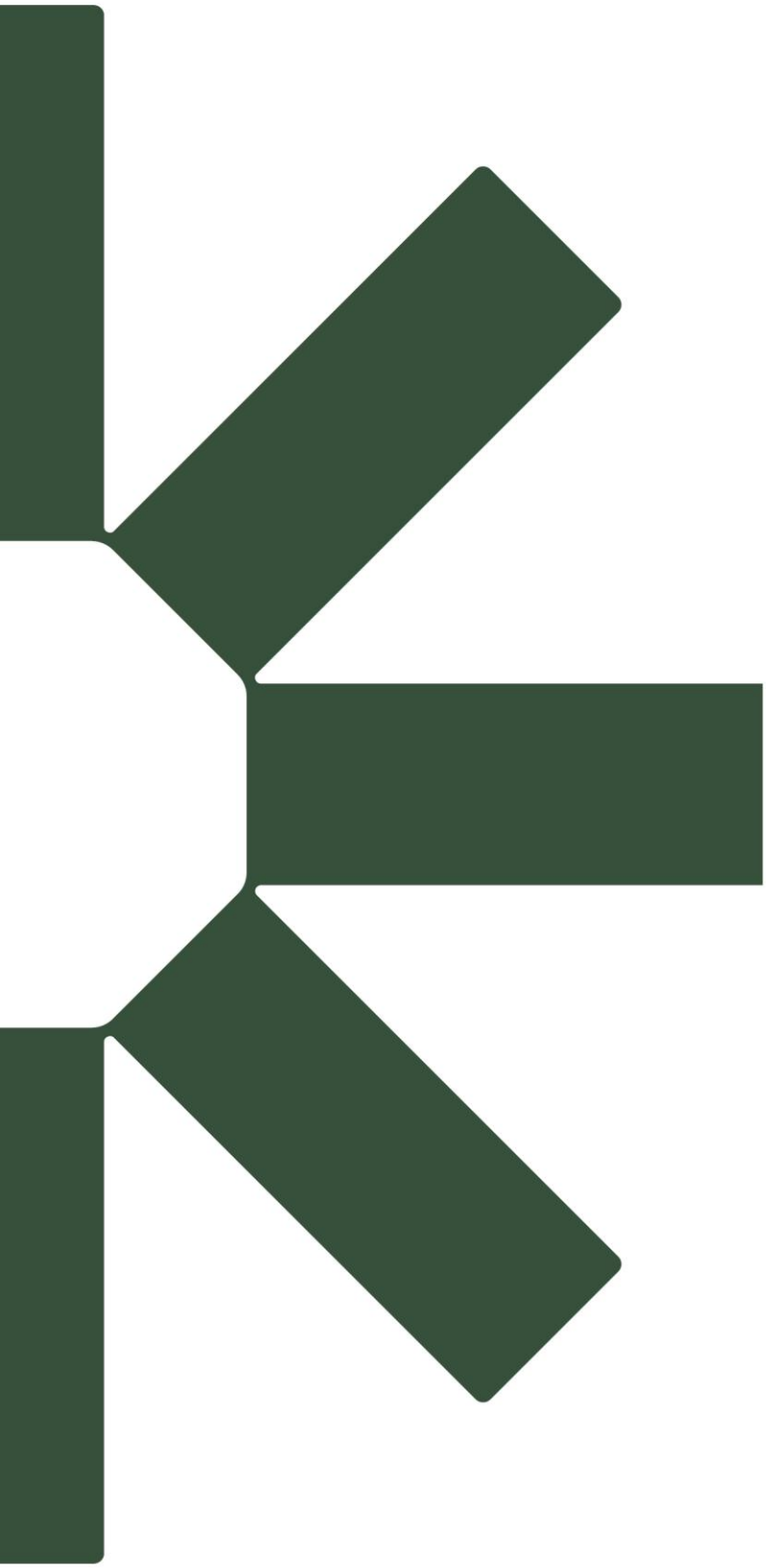

Noise level
in dB(A)
<= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <

Night-time Traffic Noise






Noise level
in dB(A)
<= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 < <= 65
65 < <= 70
70 <



Making Sustainability Happen