24-28 Middle Harbour, Lindfield

SSD Noise Impact Assessment

MHR Lindfield Investments Pty Ltd

Report Reference: 250228 – 24-28 Middle Harbour, Lindfield – SSD Noise Impact Assessment – R4

Date: 12 January 2026

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Project Number: 250228

PULSE WHITE NOISE ACOUSTICS Suite 601, L6, 32 Walker St, North Sydney NSW 2060
P 1800 4 PULSE (1800 478 573) **E** info@pwna.com.au **pwna.com.au** ABN 95 642 886 306

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PREPARED BY:

Pulse White Noise Acoustics Pty Ltd
ABN: 95 642 886 306
Address: Level 6, 32 Walker Street, North Sydney, 2060
Phone: 1800 4 PULSE

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1 CONSULTANT DECLARATION

Table 1 Consultant Declaration Table

PROJECT DETAILS	
PROJECT NAME	
Application number	SSD-82548708
Address of subject land	24, 26 and 28 Middle Harbour Road, Lindfield
Lot / DP	Lot 13 DP5374, Lot 1 DP119944, Lot 14 DP5374, Lot 1 DP92386, Lot 1 DP312386, Lot 16DP5374 & Lot768 DP752031
APPLICANT DETAILS	
Applicant name	MHR Lindfield investments Pty Ltd
REPORT DETAILS	
Name of report this declaration relates	*Noise and Vibration Impact Assessment*
Report reference no.	*250228 – Middle Harbour Road, Lindfield – SSD Noise and Vibration Impact Assessment – R3*
Report date	10/12/2025
Company name (inc. ABN / ACN)	Pulse White Noise Acoustics Pty Ltd (ABN: 95 642 886 306)
Author name	Ben White
Author qualifications	Mech Enge (Usyd)
Author address	Suite 601, Level 6, 32 Walker Street, North Sydney NSW 2060
DECLARATION BY CONSULTANT	
Name	Pulse White Nosie Acoustics Pty Ltd
Registration no.	N/A
Organisation registered with	AAS
Declaration	The undersigned declares that *Noise and Vibration Impact Assessment*: • has been prepared in accordance with the following policy, guidelines, or legislative requirements: ○ Ku–Ring–Gai Council (CoS) Local Environmental Plan (LEP) 2015 ○ Ku–Ring–Gai Council (CoS) Development Control Plan (DCP) 2024. ○ Australian & New Zealand AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors. ○ NSW EPA Noise Policy for Industry (NPI) 2017. ○ NSW EPA Road Noise Policy (RNP) 2011. ○ NSW EPA Interim Construction Noise Guideline (ICNG) 2009. ○ NSW EPA (formerly, Department of Environment and Climate Change) Assessing Vibration: a technical guideline 2006 (AV-TG). ○ Australian Standard AS 2670.2 1990 - Evaluation of Human Exposure to Whole Body Vibration - Part 2: Continuous and Shock Induced Vibration in Buildings (1 Hz to 80 Hz).

- British Standard BS 6472 - 2008 - Evaluation of Human Exposure Vibration in Buildings (1 Hz to 80 Hz).
- German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

- contains all available information relevant to the environmental assessment of the development, activity or infrastructure to which the *Noise and Vibration Impact Assessment* relates;
- does not contain information that is false or misleading;
- identifies and addresses the relevant Planning Secretary's environmental assessment requirements (SEARs) for the project;
- identifies and addresses the relevant statutory requirements for the project, including any relevant matters for consideration in environmental planning instruments to which the *Noise and Vibration Impact Assessment* relates;
- contains a consolidated summary of the proposed or necessary mitigation measures.

Signature	
Date	10th December 2025

2 INTRODUCTION

Pulse White Noise Acoustics Pty Ltd has been engaged by MHR Lindfield Investments Pty Ltd to undertake a Noise Impact Assessment (NIA) for the SSD submission of the residential development to be located at 24-28 Middle Harbour, Lindfield.

This report has been prepared to review and assess the noise and vibration elements of the development including operational noise on surrounding existing developments, noise and vibration intrusion from external sources and noise and vibration impacts associated with the construction of the development. This report also describes the relevant noise and vibration criteria and recommended acoustic mitigation measures required to ensure compliance.

This report accompanies a State Significant Development Application that comprises the construction and operational use of a nine (9) storey residential flat building (RFB) and ancillary land uses to support the functions intended for the Site. The Proposal will exemplify and showcase a State-of-the-Art and modernised residential development that complements the desired future streetscape character; and builds on the fundamental necessities required to achieve local, regional and state planning/strategic objectives with respect to the shortage of housing opportunities and housing affordability. Accordingly, consent is sought for the construction of a nine (9) storey RFB, which seeks to include 17% affordable housing as well as a Build-to-Rent component.

A list of Acoustic terminology used within this report has been included in Appendix A of this report.

2.1 Planning Secretary's Environmental Assessment Requirements (SEARs)

This report addresses the relevant Secretary's Environmental Assessment Requirements (SEARs), namely:

10. Noise and Vibration

- Provide a noise and vibration impact 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.

2.2 SEARs Satisfaction Table

In addressing the requirements of SEARs item 10 above, each item is addressed in the following section:

Table 2 SEARs Satisfaction Table

Acoustic Assessment SEARs Satisfaction Table		
SEAR	**SEAR Requirements**	**Document Reference**
10	*Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines*	Refer to section 4
	The assessment must detail construction and operational noise	Refer to section 6.1.5 for operational noise. Refer to section 6.4 for construction noise.
	…. vibration impacts on nearby sensitive receivers and structures	Refer to section 6.4 for construction vibration.
	…. and outline the proposed management and mitigation measures that would be implemented	Refer to section 9

2.3 Agency Comments

Agency comments received regarding the acoustic reporting include the following:

Noise Impact Assessment	Revise the Noise Impact Assessment (NIA) to address the following: a) consider the noise level targets / triggers and provide the predicted operational and construction noise level impact to identified adjoining residential receivers including the effect of mitigation measures (with post mitigation noise levels); b) consider the operational noise impact on the occupants arising from the use of lower-ground floor amenities / common room, ground, Level 4 and the rooftop communal open spaces. Include recommended mitigation measures and hours of operation (as necessary) to address any noise impact to future apartments or adjoining residential properties; c) air conditioner 'condenser farm' rooms are proposed to be located within the stair/lift core on each level of the building. Clarify the predicted noise transmission impact from the proposed rooms to the immediately adjacent apartment bedrooms and the ventilation of the rooms, noting they are shown as fully enclosed spaces; d) clarify whether the proposal includes a 'cooling tower', noting this is referred to in the NIA, but not shown on the drawings.
Visual Impact	Update the Visual Impact Assessment to:

Detailed response to the agency comments includes the following:

1. Predicted construction noise levels are included in this report and in Section 9.4 of this report.
    a. The assessment includes the proposed requirements for the project such that project trigger noise level will be achieved, including those included in Section 6.1.5. At this stage of the project predicted operational noise levels as we would require detailed selections of all plant and equipment include detailed design of the building services with all noise levels of the proposed mechanical equipment. A detailed assessment of mechanical building services will be completed as part of the detailed design of the project and will acoustic mitigations required such that compliance with the relevant project trigger noise levels will be achieved. Details of the specific noise mitigations will be included in the projects CC documentation.
2. Sections 8.4.1 and 8.4.2 include the details of the required assessment for the external and internal communal areas as requested in item b) above.
3. Section 8.1.1 includes the assessment of condensers, this report includes additional assessment and comments regarding the proposed condensers located on each level of the project, see details included in Section 8.1.1.
4. The reporting does not include any refence to roof top cooling towers.

2.4 Proposal

The Proposal comprises the construction and operational use of a nine (9) storey residential flat building (RFB) and ancillary land uses to support the functions intended for the Site. The Proposal will exemplify and showcase a State-of-the-Art and modernised residential development that complements the desired future streetscape character; and builds on the fundamental necessities required to achieve local, regional and state planning/strategic objectives with respect to the shortage of housing opportunities and housing affordability.

Accordingly, consent is sought for the construction of a nine (9) storey RFB, which seeks to include 17% affordable housing as well as a Build-to-Rent component (as identified as on the Architectural Plans provided in Appendix 1).

It is recommended that the following 'Description of Development' is used in all Technical Reports to ensure consistency:

The Proposal comprises a Residential Flat Building including in-fill affordable housing and Build-to Rent housing at 24, 26 and 28 Middle Harbour Road, Lindfield. The Proposal is for the purposes of residential development which seeks to provide a range of diverse housing types to meet the needs of the wider community

And/or

Specifically, the proposal seeks consent for the following works:

- *Demolition of the existing structures;*
- *Associated tree removal;*
- *Associated bulk earthworks involving cut and fill works;*
- *Construction of a nine (9) storey RFB comprising 94 residential units (of which 20 are affordable units and 32 are Build-to-Rent units) with basement car parking (192 spaces);*
- *Associated services and infrastructure installation/augmentation; and*
- *Associated landscaping works.*

The Proposal includes those works as identified in the below table from the Willowtree Planning Consultant brief dated 5th May 2025

Figure 1 Table of Development Particulars from Willow Tree Planning

Site Area	4,757 m^2
Building Type	Residential Flat Building
Gross Floor Area	15,456 m^2
Affordable Housing Gross Floor Area	2,731 m^2 (17% of the total)
Floor Space Ratio (FSR)	3.25:1
Building Height	28.6 m
Number of Levels	9
Units	93 residential units, 20 affordable housing units, 32 build-to-rent (BTR) units
Car Parking	168 car parking spaces

3 SITE DESCRIPTION AND SURROUNDING RECEIVERS

The proposed development includes the residential project to be located at 24-28 Middle Harbour, Lindfield.

The Identified Portion of land that is subject of this proposal is described as the parcels outlined in in the below table from the Willowtree Planning Consultant brief dated 5th May 2025

Figure 2 Table of Site Identification from Willow Tree Planning

TABLE 1: SITE IDENTIFICATION	
Street Address	**Legal Description**
24 Middle Harbour Road	Lot 13 DP5374
26 Middle Harbour Road	Lot 1 DP119944 Lot 14 DP5374
28 Middle Harbour Road	Lot 1 DP1192386 Lot 1 DP312386 Lot 16 DP5374 Lot 768 DP752031

The Site is subject to the applicable provisions outlined within the *State Environmental Planning Policy (Housing) 2021* (Housing SEPP) and *Ku-ring-gai Local Environmental Plan 2015* (KLEP2015). The Site comprises a total area of approximately 4,757m2. The Site is roughly square in shape and is approximately 65m wide, with a depth ranging between 70-78m. The frontage along Middle Harbour Road to the south east is approximately 65m. The Site is zoned as R2 Low Density Residential under the KLEP2015.

The Site comprises three (3) existing detached residential properties that have a mixture of one (1) and two (2) storeys with separate vehicular access points from Middle Harbour Road. Middle Harbour Road is a two way local road (a single lane in each direction) under the control of the Council with parallel car parking and verges incorporating street trees and footpaths on both sides of the road. To the south, east, north and west are residential properties similar in scale and design to the residential properties located within the Site, with the immediate surrounding area also being zoned as R2 Low Density Residential. Further north and west is Lindfield Town Centre, which includes a variety of uses and a higher density of development, including further height, comprising R3 Medium Density Residential, R4 High Density Residential and E1 Local Centre zones. Lindfield railway station is approximately 500m to the north west of the Site, which offers regular services to the Sydney Central Business District (CBD).

The Site is located approximately 330m east of the Pacific Highway, which is a major arterial route, providing regular buses servicing the Lindfield Learning Village, Killara, Gordon and Chatswood. The Site is approximately 15km from the Sydney CBD.

The nearest sensitive receivers are the residential land surrounding the Site to the north, south, east, and west. Accordingly, planned management, mitigation and protection measures will be implemented as part of the Proposal, to preserve the amenity of the Site and surrounding sites and maintain the streetscape character intended for the locality.

The Site and Proposal are subject to the provisions outlined within KLEP2015, whereby the primary Environmental Planning Instrument (EPI) pertaining to zoning (KLEP2015) categorises the Site within the R2 Low Density Residential zone, as displayed in the below figures.

Figure 3 Site Identification from Willow Tree Planning - Reference: WTJ25-073

Figure 1. Land Zoning Applicable to the Site under the KLEP 2015 (Source: NSW Legislation, 2025)

The nearest receiver to the proposed project site have been detailed below:

- **Receiver 1:** Single and duel level residential dwellings located to the north of the proposed project site from 15-25 Russell Street, Lindfield.
- **Receiver 2:** Single and duel level residential dwellings located to the east of the proposed project site from 30 Middle Harbour Road to 54 Trafalgar Avenue, Lindfield.
- **Receiver 3:** Located to the south of the project site to the southern side of Middle Harbour Road, is located a series of single and duel level residential dwellings. These properties are located from 21 – 31 Middle Harbour Road, Lindfield.
- **Receiver 4:** Located to the west of the project site is located a series of residential dwellings these properties are single and duel level, located from 18 - 22 Middle Harbour Road, Lindfield.

A site map has been provided above which identifies the site, the surrounding receivers and monitoring locations, see the above figure.

3.1 Background

The proposed redevelopment of the Site will deliver essential housing supply, choice, and affordability to meet the needs of Ku-ring-gai's growing population. Strategically positioned near key transport links and services, the Proposal will provide convenient access to jobs while aligning with the locality's strategic goals. By redeveloping and renewing the existing land, the Proposal aims to revitalise the area, enhancing its contribution to the community's long-term growth and sustainability.

3.2 Proposed Development

A site map has been included below to identify the proposed development and surrounding receivers. the location of both the unattended and attended monitoring positions onsite have been included in Figure 4 below and the proposed site layout is included in Figure 5 and Figure 6.

Figure 4 Site Map, Nearest affected receivers and monitoring locations

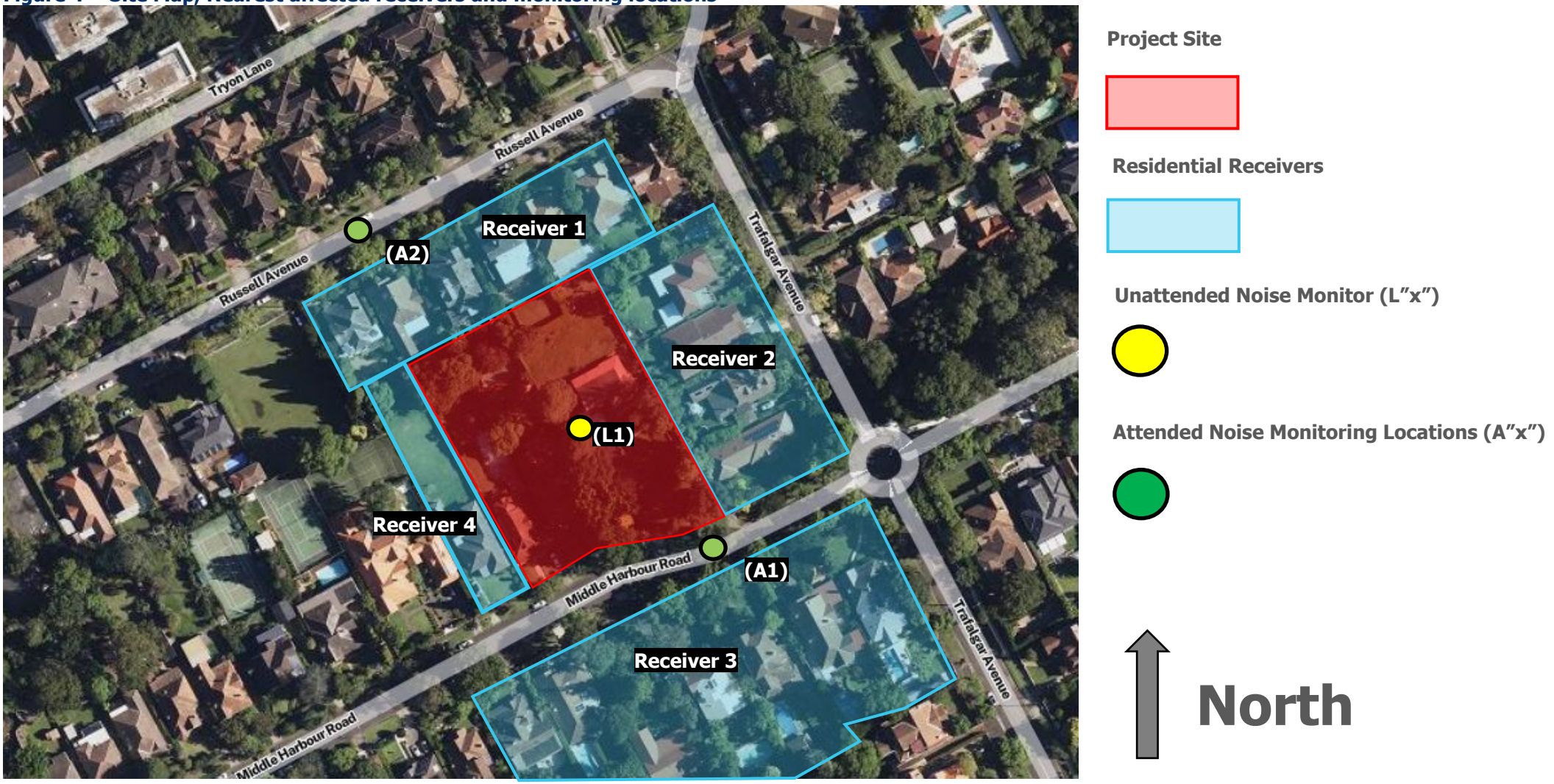


Figure 5 Lower Ground Floor Proposed Plan

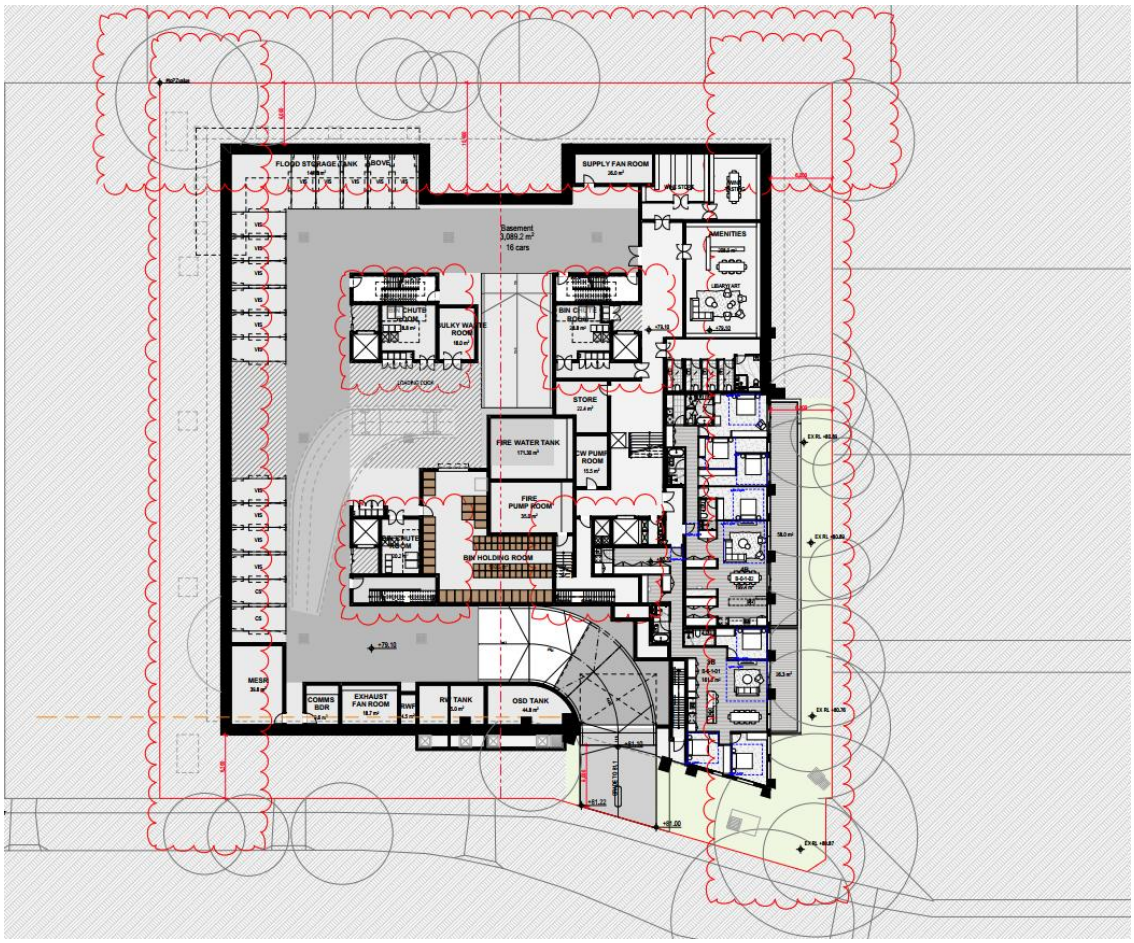
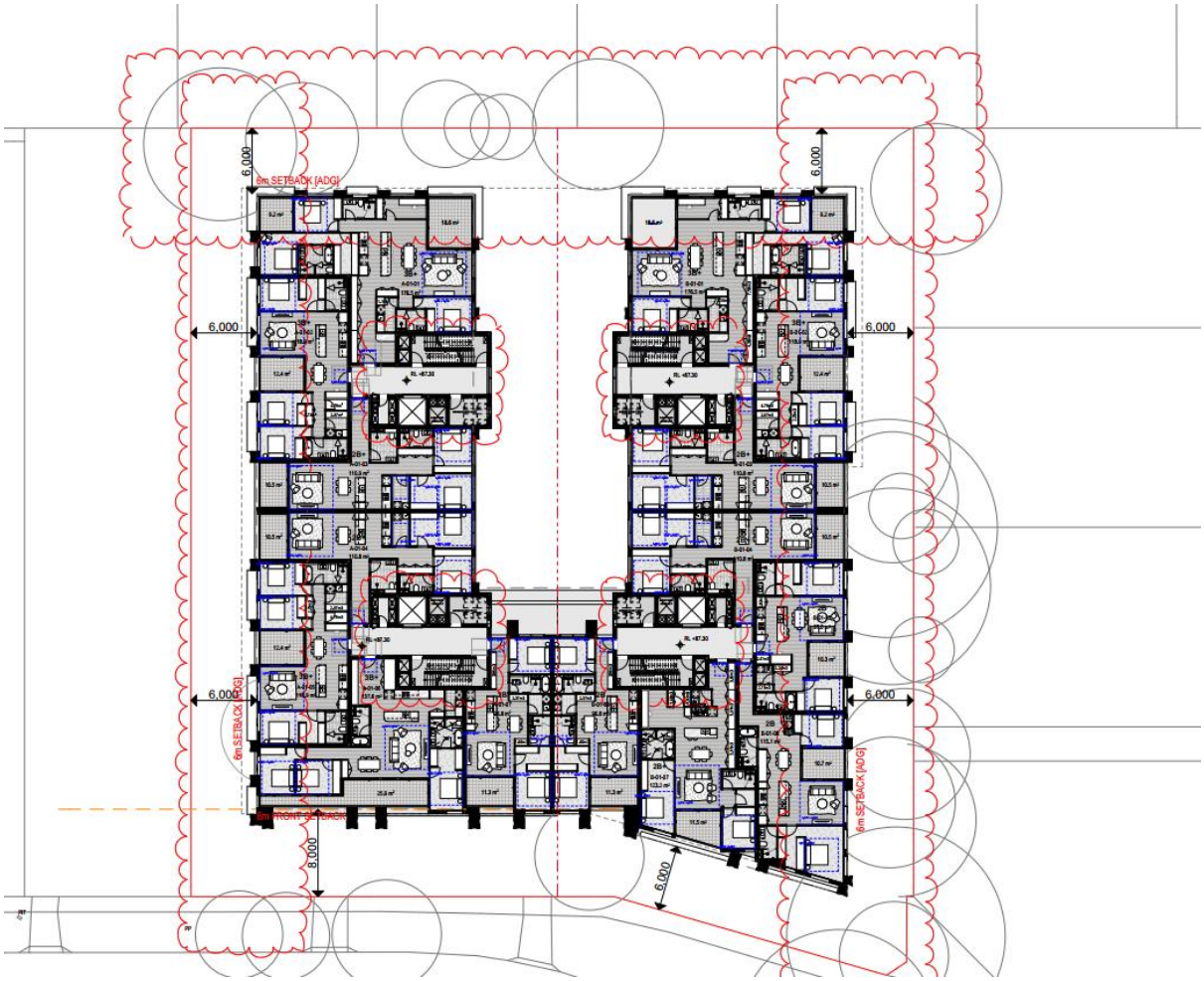


Figure 6 Typical Floor Plan (Level 01)



3.3 Relevant Guidelines

Acoustic criteria that has been adopted as part of this assessment include the requirements from the following guidelines or legislative documents:

- Ku-Ring-Gai Local Environmental Plan (LEP) 2015
- Ku-Ring-Gai Development Control Plan (DCP) 2024
- NSW NSW State Environmental Planning Policy 2021.
- NSW EPA Noise Policy for Industry (NPI) 2017.
- NSW EPA Road Noise Policy (RNP) 2011.
- NSW EPA Interim Construction Noise Guideline (ICNG) 2009.
- Australian Standard AS/NZS 2107:2016 'Acoustics – Recommended design sound levels and reverberation times for building interiors'.
- NSW EPA (formerly, Department of Environment and Climate Change) Assessing Vibration: A Technical Guideline 2006 (AV-TG).
- Australian Standard AS 2670.2 1990 - Evaluation of Human Exposure to Whole Body Vibration - Part 2: Continuous and Shock Induced Vibration in Buildings (1 Hz to 80 Hz).
- British Standard BS 6472 - 2008 - Evaluation of Human Exposure Vibration in Buildings (1 Hz to 80 Hz).
- German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

4 NOISE DESCRIPTORS AND TERMINOLOGY

Environmental noise constantly varies in level with time. It is therefore necessary to measure environmental noise in terms of quantifiable time periods and statistical descriptors. Typically, environmental noise is measured over 15-minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dB(A), the A indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' arithmetic does not apply, e.g. adding two sources of sound of an equal value results in an increase of 3dB (i.e. 60 dBA + 60 dBA = 63 dBA). 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 – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the LAeq, LA1, LA10 and LA90 noise levels. The LAeq noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period and is equivalent to a level that would have been experienced had the fluctuating noise level remained constant during the measured time period.

The LA1, LA10 and LA90 levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels are sometimes thought of as the typical maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included as Appendix A.

5 ACOUSTIC NOISE SURVEY

Measured noise levels from the onsite noise survey are outlined below.

5.1 Unattended Noise Monitoring

One unattended noise monitor were deployed to the site to survey existing background noise levels as well as ambient L_{Aeq} noise levels.

The monitoring location included one (1) unattended noise monitor in a central location within the proposed project see Location in Figure 4 above. This location was used for determining existing acoustic environment for the receivers surrounding the project site.

Onsite acoustic noise survey was conducted from Thursday 18th April 2025 to Sunday the 27th of April 2025. All data in the graphs presented in Appendix B have not been corrected (i.e., raw data is presented).

Instrumentation for the survey comprised one (1) Rion NL-42 sound level meter (serial number 01000233). Calibration of the monitor was checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the measured daily noise data are attached in Appendix B for Location 1. The charts present each 24-hour period and show the L_{A10}, L_{Aeq} and L_{A90} noise levels for the corresponding 15-minute periods. This data has been filtered to remove periods affected by adverse weather conditions based on weather information.

Based on the unattended noise measurements, the results of the survey have been presented below.

5.1.1 Results in accordance with the NSW EPA Noise Policy for Industry (NPI) 2017 (RBL's)

In order to assess the acoustical implications of the development at nearby noise sensitive receivers, the measured background noise data of the logger was processed in accordance with the NSW EPA's Noise Policy for Industry (NPI, 2017).

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver. It is the 90th percentile of the daily background noise levels during each assessment period, being day, evening and night. RBL $L_{A90\ (15minute)}$ and L_{Aeq} noise levels are presented in Table 3

Data affected by adverse meteorological conditions and by spurious and uncharacteristic events have been excluded from the results, also excluded from the data used to determine the noise emission criteria. Meteorological information has been obtained from the Sydney – Observatory Hill (ID66214) which is located within 30km. Levels presented below are processed results with extraneous weather events removed.

Table 3 Measured Ambient Noise Levels corresponding to the NPI's Assessment Time Periods

Measurement Location [4]	Daytime[1] 7:00 am to 6:00 pm		Evening[1] 6:00 pm to 10:00 pm		Night-time[1] 10:00 pm to 7:00 am	
	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)
Location 1 – 28 Middle Harbour, Lindfield - Central Site	41	59	36	48	30	43

Note 1 *For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am.*

Note 2 *The LA90 noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.*

Note 3 *The LAeq is the energy 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.*

Based on analysis of the measured noise levels and onsite observations we note:

- Measured LA90 noise levels during the day and evening periods (typically the hours a school would be in use) are above the minimum prescribed noise levels outlined in the NPI (i.e., 35dBA LA90 (7:00am to 6:00pm) and 30 dBA LA90 (6:00pm to 10:00pm)). As such project trigger noise levels will be based on the onsite noise levels, oppose to a minimum.
- Measured LA90 noise levels during the night period (typically non-standard hours of a school use) are equivalent to the minimum prescribed noise levels outlined in the NPI (i.e., 30 dBA LA90 (10:00pm to 7:00am)) for location 1 and above the minimum prescribed noise levels for location 2. As such project trigger noise levels will be based on the onsite noise levels, oppose to a minimum for all locations.

5.2 Attended Noise Survey

In addition to the unattended noise surveys detailed above, an onsite attended noise surveys have being undertaken around the site to support the measurements above.

Locations of the attended noise measurements are detailed in the Figure 4. Noise measurements have been undertaken along all boundaries adjacent to existing and future residential receivers.

Attended noise level testing was undertaken using a Bruel and Kjaer 2270 Class 1 Type 1 Sound Level Meter (SLM). The meter was calibrated before and after testing and no significant drift was recorded. The attended and unattended noise locations were selected to obtain suitable noise levels for the assessment of background noise levels ($L_{90\ (t)}$) as well as the impact from traffic movements ($Leq_{(t)}$).

Measured noise levels were:

- Location A1: 47dBA LA90 (15-minutes) and 53dBA LAeq (15-minutes)
- Location A2: 45dBA LA90 (15-minutes) and 54dBA LAeq (15-minutes)

Measured Attended Noise Level Measurements

Measurement Location	Measured Noise Level (dBA)	
	$L_{A90\ (15\text{-}minutes)}$ [1] (dBA)	$L_{Aeq\ (15\text{-}minutes)}$ [2] (dBA)
Location A1 – See Figure 4	47	53
Location A2 – See Figure 4	45	54

Note 1 *The LA90 noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.*

Note 2 *The LAeq is the energy 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.*

6 NOISE AND VIBRATION CRITERIA

All relevant noise and vibration criteria for the project is presented below. It has been separated into four main components: external noise emission criteria, building envelope criteria (façade), vibration criteria and construction noise/vibration criteria. Each are discussed in detail below.

6.1 External Noise Emission Criteria

6.1.1 Ku-Ring-Gai Local Environmental Plan (LEP) 2015

Acoustic requirements relevant to noise emitted from the building are provided in the Ku-ring-gai Council DCP. All other noise generated from the operation of the project site will be controlled by requirements of the NSW EPA NPI 2017 and RNP 2011 will be adopted. Each is discussed in detail below.

6.1.2 Ku–Ring-Gai Development Control Plan (DCP) 2024

Part 23 of the Ku-Ring-Gai Development Control Plan (DCP) 2024 states the following with regard to noise

'Noise levels associated with air conditioning, kitchen, bathroom, laundry ventilation, or other mechanical ventilation systems and plant either as an individual piece of equipment or in combination is not to be audible within any habitable room in any residential premises before 7am and after 10pm. Outside of these restricted hours noise levels associated with air conditioning, kitchen, bathroom, laundry ventilation, or other mechanical ventilation systems and plant either as an individual piece of equipment or in combination is not to emit a noise level greater than 5dB(A) above the background noise ($L_{A90,\ 15\ min}$) when measured at the boundary of the nearest potentially affected neighbouring properties. The background ($L_{A90,\ 15\ min}$) level is to be determined without the source noise present.'

6.1.3 NSW EPA Noise Policy for Industry (NPI) 2017

(Assessment of Onsite Vehicles)

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The NSW EPA has recently released a document titled Noise Policy for Industry (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

6.1.3.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the

intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

6.1.3.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient LAeq noise level should not exceed the level appropriate for the locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

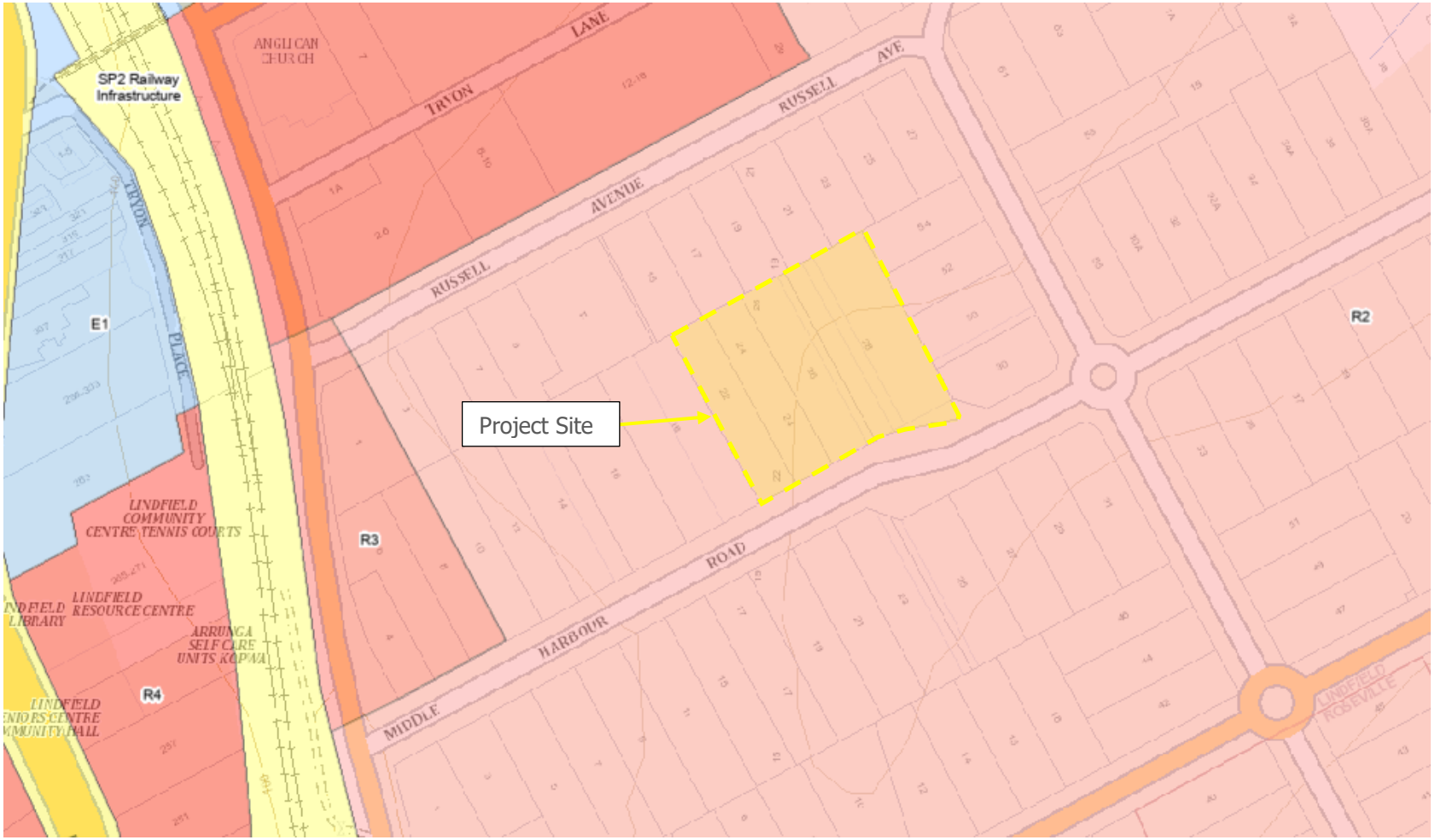
Project amenity noise level for industrial developments is specified as the recommended amenity noise level (Table 2.2 of the NPI) minus 5 dB(A). To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the LAeq,15min will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Where the resultant project amenity noise level is 10 dB or more lower than the existing traffic noise level, the project amenity noise levels can be set at 15 dB below existing traffic noise levels (i.e. $L_{Aeq,period(traffic)}$ *minus 15 dBA*).

6.1.3.3 Residential Receivers – Area Classification

The NSW NPI characteristics the "Suburban Residential" noise environment as an area that has the following characteristics:

- An acoustical environment that:
    - An area that has local traffic with characteristically intermittent traffic flows or with some limited commercial industry.
    - This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.


SP2 Railway Infrastructure
TRYON
LANE
ANGLICAN CHURCH
RUSSELL
AVENUE
AVE
E1
PLACE
Project Site
R2
R3
LINDFIELD COMMUNITY CENTRE TENNIS COURTS
LINDFIELD RESOURCE CENTRE
ARRUNGA SELF CARE UNITS KOPWA
R4
ROAD
HARBOUR
MIDDLE

As shown above, the site and its surrounding receivers are within an area made up of R2 type developments (Low Density Residential). Based on classification of R2, using table 2.3 of the NPI (see below), we believe that the most appropriate classification for the development site is suburban.

Figure 7 NPI Extract - Table 2.3 Determining which of the residential receiver categories applies

Table 2.3: Determining which of the residential receiver categories applies.

Receiver category	Typical planning zoning – standard instrument*	Typical existing background noise levels	Description
Rural residential	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime RBL <40 dB(A) Evening RBL <35 dB(A) Night RBL <30 dB(A)	**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 in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime RBL<45 dB(A) Evening RBL<40 dB(A) Night RBL <35dB(A)	**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 RBL> 45 dB(A) Evening RBL> 40 dB(A) Night RBL >35 dB(A)	**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.

Notes: *As cited in Standard Instrument – Principal Local Environmental Plan, New South Wales Government, Version 15 August 2014. RBL = rating background noise level.

Resultant amenity levels for suburban receivers are shown below.

Table 4 NSW NPI – Recommended L_{Aeq} Noise Levels from Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2] (dBA)
Residence	Suburban	Day	55
		Evening	45
		Night	40

Note 1 For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2 The L_{Aeq} is the energy 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

6.1.3.4 Maximum Noise Level Event (Sleeping Disturbance)

Section 2.5 of the NPI states the following:

> The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.
>
> Where the subject development/premises night-time noise levels at a residential location exceed:
>
> - $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
> - L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,
>
> a detailed maximum noise level event assessment should be undertaken.

As outlined in section 5.1 above, the measured rating background noise level during the night hours (10:00pm to 7:00am) is 30 dBA L_{A90} for receivers 2-4 and 36 dBA L_{A90} for receiver 1. Therefore, the resultant RBL + 15 dB is 45 dBA and 51 dBA respectively which is both below the minimum 52dBA L_{AFmax}. As such the 52 dBA will be adopted for this assessment.

6.1.4 NSW EPA (Formally DECCW) NSW Road Noise Policy (RNP)

(Assessment of Vehicles on Public Roads)

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

6.1.5 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions, derived from the measured data, are presented in Table 5. These criteria are nominated for the purpose of determining the operational noise limits for mechanical plant associated with the development which can potentially affect noise sensitive receivers.

For each assessment period, the lower (i.e., the more stringent) of the amenity or intrusive criteria are adopted, which are shown in bold text in Table 5.

Table 5 External noise level criteria in accordance with the NSW NPI and Ku-Ring-Gai Development Control Plan

Requirements of the New South Wales EPA Noise Policy for Industry (2014)						
Location	**Time of Day [1]**	**Project Amenity Noise Level, $L_{Aeq, period}$ [2] (dBA)**	**Measured $L_{A90, 15\ min}$ (RBL) [3] (dBA)**	**Measured $L_{Aeq, period}$ Noise Level (dBA)**	**Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)**	**Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)**
Residential Receivers	Day	50	41	53	46	**53**
	Evening	40	36	43	41	**43**
	Night	35	30	38	35	**38**
Commercial Receivers	When in use	60	-	-	-	**63**

Ku-Ring-Gai Council – Development Control Plan (DCP) 2015 – Requirements			
Location	**Time of Day**	**Measured $L_{A90, 15\ min}$ (RBL) [3] (dBA)**	**Resultant Trigger Level**
Residential Receivers	Day	41	**46**
	Evening	36	**41**
	Night	30	**35**

Note 1 For Monday to Saturday, Daytime 7:00 am – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 10:00 pm; Night-time 10:00 pm – 8:00 am.

Note 2 Project amenity noise level are shown as

Note 3 L_{A90} Background Noise or Rating Background Level.

Note 4 Project Noise Trigger Levels are shown in bold and underline.

Note 5 Resulting amenity noise levels are calculated as per below in accordance with section 2.4.1 of the NSW EPA NPI.

6.2 Noise Intrusion Criteria

Ku-ring-gai Council LEP or DCP documents do not provide any specific site numerical objectives, Therefore, requirements of Australian Standard AS/NZS 2107:2016 – Recommended design sound levels and reverberation times for building interiors will be adopted.

6.2.1 Australian Standard AS/NZS 2107:2016 – Recommend design sound levels and reverberation times for building interiors

In relation to design internal noise levels, standard AS/NZS 2107:2016 recommends a range with lower and upper levels (rather than "satisfactory" and "maximum" internal noise levels) for building interiors based on room designation and location of the development relative to external noise sources. This change has occurred due to the fact that sound levels below 'satisfactory' could be interpreted as desirable, but the opposite may in fact be the case. Levels below those which were listed as 'satisfactory' can lead to inadequate acoustic masking resulting in loss of acoustic isolation and speech privacy.

The levels for areas relevant to this development are given in 5 below. In this report we will confine our recommendations to dBA levels, however, where the background noise appears to be unbalanced, standard AS/NZS 2107:2016 provides direction in terms of suitable diagnostic tools that can be used to assess the spectrum distribution of the background noise.

Section 6.18 of standard AS/NZ 2107:2016 notes that the presence of discrete frequencies or narrow band signals may cause the sound level to vary spatially within a particular area and be a source of distraction for occupants. Where this occurs, the sound level shall be determined as the highest level measured in the occupied location(s).

The Table below below includes the recommended internal noise levels included within AS2107:2016 for various spaces.

Table 6 Recommended design sound levels as per standard AS/NZS 2107:2016

Type of Occupancy/Activity	Design sound level range ($L_{Aeq,t}$)
Corridors and Lobbies	45 – 50
Apartment common areas (e.g., foyer, lift lobby)	45 – 50
Residential – Living/working areas	35 – 45
Residential - Sleeping areas (night-time)	35 – 40

Generally, where the final noise levels are within +/- 2 dB of the specified level given above, the design criteria will be considered met. Both the upper and lower limits will need to be satisfied especially where privacy is important or where noise intrusion to be avoided.

6.2.2 Summary of Project Requirements

Based on the details included in the sections above the project internal noise levels requirements are summarised in the table below.

Figure 8 Summary of Internal Noise Level Criteria

Room Type	Project Internal Environmental Noise Level Requirements (Traffic and Train Noise)
Bedrooms	35 dBA $L_{Aeq,Fast\ 9\ hour\ (10pm\ -\ 7am)}$
Habitable Spaces	40 dBA $L_{Aeq,Fast\ 9\ hour\ (7am\ –\ 10pm)}$
Reception/Common Areas	45 dBA $L_{Aeq\ 15\ hours\ (7am\ -\ 10pm)}$
Corridors and Lobbies	
Fully enclosed corridors or lobbies (an internal area)	50 dBA $L_{Aeq\ 15\ hours\ (7am\ -\ 10pm)}$
Open corridors or lobbies (deemed an external area)	55 dBA $L_{Aeq\ 15\ hours\ (7am\ -\ 10pm)}$

6.3 Vibration Criteria

6.3.1 Ku-ring-gai Local Environmental Plan (LEP) 2015 & Development Control Plan (DCP) 2024

Vibration requirements relevant to vibration levels emitted from the building are not provided in the Ku-Ring-Gai Council LEP or DCP documents. Therefore, requirements of the NSW EPA AV-TG 2006, British Standard BS 7385: Part 2-1993 AND German DIN 4150: Part 3 – 1999 – Building Damage will be adopted. Each is discussed in detail below.

6.3.2 NSW EPA (formerly, Department of Environment and Climate Change) *Assessing Vibration: a technical guideline 2006* - Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled "*Assessing Vibration – A Technical Guideline*". (AV-TG). This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources
- Impulsive vibration – up to three instances of sudden impact e.g., dropping heavy items, per monitoring period.
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously.

Table 7 Continuous vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010

Table 8 Impulsive vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

Table 9 Continuous vibration velocity criteria (mm/s and dB re 10-9 m/s) 1 Hz-80 Hz, Z axis

Location	Assessment period	Z axis	
		Preferred Values	Maximum Values
Residences	Daytime	0.20 mm/s 106 dB	0.40 mm/s 112 dB
	Night-time	0.14 mm/s 103 dB	0.28 mm/s 109 dB

Table 10 Impulsive vibration velocity criteria (mm/s and dB re 10-9 m/s) 1 Hz-80 Hz, Z axis

Location	Assessment period	Z axis	
		Preferred Values	Maximum Values
Residences	Daytime	6 mm/s 136 dB	12 mm/s 142 dB
	Night-time	2 mm/s 126 dB	4 mm/s 132 dB

Table 11 Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26

6.3.3 British Standard BS 7385: Part 2-1993 AND German DIN 4150: Part 3 – 1999 – Building Damage

It is expected that the human comfort criteria will be more stringent than that corresponding to building damage.

Table 12 Structural damage criteria as per standard DIN 4150 Part 3 – 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz [1]	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note 6 For frequencies above 100Hz, at least the values specified in this column shall be applied.

6.4 Construction Noise and Vibration Criteria

6.4.1 Construction Noise Criteria

Relevant construction noise criteria applicable to this project are outlined below.

6.4.2 Ku-ring-gai Local Environmental Plan (LEP) 2015 & Development Control Plan (DCP) 2024

Acoustic requirements relevant to construction noise and vibration levels emitted from the site are not provided in the Ku-Ring-Gai Council LEP or DCP documents. Therefore, requirements of the NSW EPA ICNG 2009 will be adopted. Each is discussed in detail below.

6.4.2.1 NSW EPA (Former DECC) Interim Construction Noise Guideline (ICNG) 2009

Noise criteria for construction and demolition activities are discussed in the Interim Construction Noise Guideline (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works.
- Focus on applying all "feasible" and "reasonable" work practices to minimise construction noise impacts.
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours.
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage; and
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for residential receivers have been reproduced from the guideline and are listed in the table below.

Table 13 NMLs for quantitative assessment at residences

Time of Day	Noise Management Level $L_{Aeq(15minute)}$ [1,2]	How to Apply
Recommended hours: As per the approved hours of works included within consent documentation	Noise affected RBL + 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 level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. 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. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside the recommended standard hours above	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 practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should notify the community.

Note 1 Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).

Based on the measured background noise levels summarised in section 5.1, and the NMLs outlined above, the construction noise criteria to be used in this assessment are listed in within this assessment.

Table 14 NMLs as basis for the acoustic assessment

Receiver Types		NML, dB $L_{Aeq(15minute)}$	
		Standard Hours **Monday to Friday: 7:00am to 6:00pm** **Saturday: 8:00am to 1:00pm**	**Outside Standard Hours** **All hours not listed in the adjacent column.**
Residences (Measured externally)	Receivers 1, 2, 3, 4	**NAFL:** **52** (RBL (42) + 10dB) **HNAL** **75**	RBL + 5dB

Note 1 The LAeq is the energy 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.

6.4.3 Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed.
- Effects on building contents – where vibration can cause damage to fixtures, fittings, and other non-building related objects.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself.

6.4.3.1 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from AV-TG. This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources.
- Impulsive vibration – up to three instances of sudden impact e.g., dropping heavy items, per monitoring period.
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously.

Table 15 Continuous vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010

Table 16 Impulsive vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

Table 17 Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26

6.4.3.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration" (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

6.4.3.2.1 British Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 18 and illustrated in Figure 9.

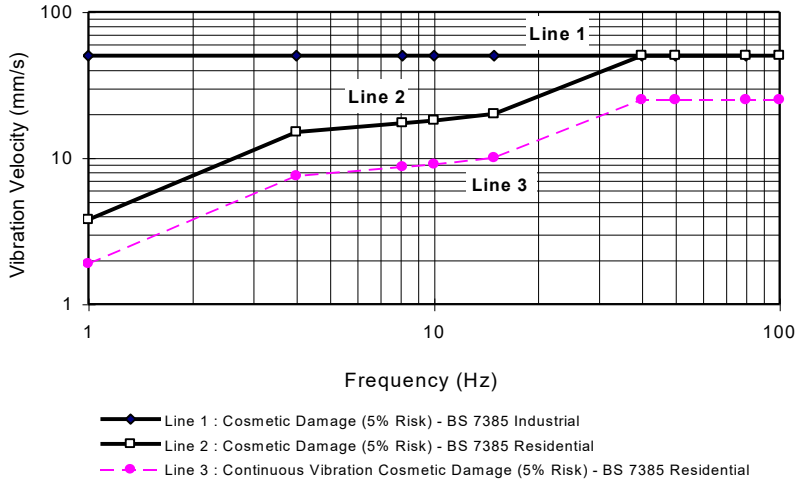
Table 18 Transient vibration criteria as per standard BS 7385 Part 2 – 1993

Line in Figure 9	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

Standard BS 7385 Part 2 – 1993 states that the values in Table 18 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such that it results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 18 may need to be reduced by up to 50% (refer to Line 3 in Figure 9).

Figure 9 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



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

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in , and major damage to a building structure may occur at values greater than four times the tabulated values.

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

6.4.3.2.2 German Standard DIN 4150 Part 3 - 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in Table 19. The criteria are frequency dependent and specific to particular categories of structures.

Table 19 Structural damage criteria as per standard DIN 4150 Part 3 – 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz [1]	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

6.4.4 Construction Traffic Noise Criteria

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

7 EXTERNAL NOISE INTRUSION ASSESSMENT

7.1 Façade Acoustic Treatments

Preliminary façade acoustic treatments based on the external levels measured above from surrounding roads and other environmental sources as discussed in the above sections and have been provided below.

Please note for windows, this performance is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Therefore, it is recommended that the window manufacturer should confirm that the required sound insulation can be achieved. It is anticipated that the window system should comprise Q-Lon (or equivalent) or fin seals with deep C channels as part of the window track **(i.e., Performance levels outlined above need to be achieved with glazed panels + frame + seals).**

Table 20 Recommended Glazing Construction

Spaces	Façade	Indicative Construction	Minimum Glazing System Rating Requirements
All Levels Habitable Spaces	Northern	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
	Eastern	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
	Southern	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
	Western	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
All Other Spaces	Northern	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
	Eastern	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
	Southern	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)
	Western	6.38mm Laminated Glass	Rw (C;Ctr): 30 (-1,-3)

It is recommended prior to the issue of a (CC) a further detailed review be undertaken (including additional noise measurements) to verify if future noise levels have increased resulting in a higher performing façade system.

7.1.1 External Wall Construction

External wall constructions which are constructed from a concrete or masonry construction will be acoustically sufficient and no further acoustic upgrading is required. However, for wall systems constructed from a lightweight cladding system, the following construction is recommended.

Table 21 Recommended Light Weight External Wall Construction

Location	Occupancy Area 1	Minimum External Wall Rating Requirements [1]
All other Facades	All Spaces	Rw (C;Ctr): 45 (-0;-11)

Note 2 Recommended performances are identical for each level.

If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

It is recommended prior to the issue of a (CC) a further detailed review be undertaken (including additional noise measurements) to verify if future noise levels have increased resulting in a higher performing façade system.

7.1.2 External Roof Construction

External roofs will be constructed from a lightweight sheet metal cladding. It is recommended the following minimum construction is installed.

Table 22 Recommended Light Weight Roof Construction

Building	Occupancy Area [1]	Minimum External Roof Rating Requirements [1]
All other Facades	All Spaces	Rw (C;Ctr): 45 (-0;-9)

Note 3 These are preliminary selections will be confirmed in the detailed design stage once the layouts and façade orientations are finalised.
Note 4 Recommended system does not address rain noise criteria. Further detailing is required for compliance with rain noise criteria.

If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

It is recommended prior to the issue of a Crown Certificate (CC) a further detailed review be undertaken (including additional noise measurements) to verify if future noise levels have increased resulting in a higher performing façade system.

8 OPERATIONAL NOISE EMISSIONS ASSESSMENT

Assessment of the potential noise emissions from the operation of the development and its potential for impacts on the adjacent land users are outlined below. Noise emissions expected from the operation of the building are mainly from any base building services (mechanical, electrical, hydraulic), vehicle movements around the site and on public roads and activity noise.

Each element is discussed in detail below.

8.1 Noise from Engineering Services

Noise associated with the operation of all engineering services whilst onsite must comply with the requirements listed in section 5.1 above. This includes (however not limited to) all mechanical plant (including ventilation systems and air conditioning plant), hydraulic plant (including hot water systems) and electrical systems.

At this stage of the project, the location of plant area and the likely size of the associated systems including the number of units are known, however not the final selections and associated noise level data.

In our experience, for this type of development the following mechanical systems would be installed, and their associated sound power levels are outlined below.

- Kitchen Exhaust Fan (KEF) – 65dBA (Lw) per unit.
- Air Conditioning Condensers 70dBA (Lw) per unit.
- Toilet Exhaust Fans (TEF) – Bathrooms – 55dBA (Lw) per unit.
- Heat Pumps – 85dBA (Lw) per unit.

It is anticipated that KEF serving apartments will discharge to the facade. From our modelling to achieve compliance at neighbouring properties acoustic treatment to a fan on the discharge (external) side will be required. Further details of the acoustic treatment will be formulated during the detailed design phase.

For toilet exhaust fans exhausting air from bathrooms, it is likely the fan will be installed within the ceiling cavity of the bathrooms and discharge air via façade, similar to above. The use of internal acoustic lining and fan vibration isolation will result in compliance. Further details of the acoustic treatment will be formulated during the detailed design phase.

With regards to air conditioning plant, the following preliminary treatments are recommended to be installed.

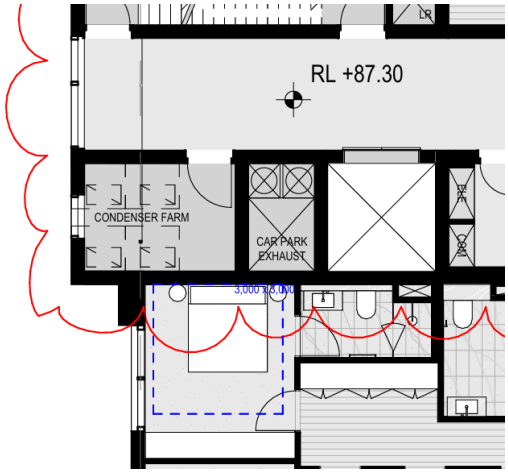
- Isolate the air conditioning condensers from the base building structure with a correctly sized vibration isolator.
- Night operation mode should be enabled between 10:00pm and 7:00am to provide between a 4-5dBA reduction.

A preliminary review of the building service to be installed within the project are likely going to require acoustic treatment to comply with the relevant acoustic criteria. At this stage treatments would be required to include typical treatments such as internally lined ductwork, VSD controllers, acoustic screens and the like.

Note: Prior to the issue of the Construction Certificate the recommended acoustic treatments for the engineering services should be reviewed to ensure final selections and mechanical airflow requirements are achieved.

8.1.1 Condenser Noise Assessment

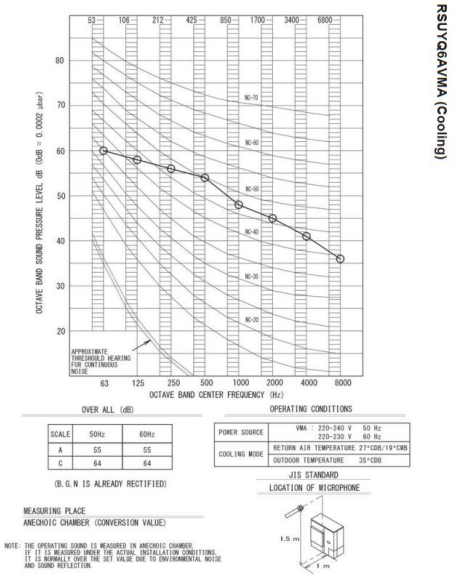
The project will include external residential condenser units which will be located on dedicated roof top plant areas and condenser farms on levels, including clusters of condensers. See the typical location included in the figure below.



Providing condenser equipment is selected using suitable noise level data, then acoustic treatments can be implemented such as screening, enclosures, and treatment to exhaust to ensure that the relevant noise emission criteria will be achieved. An assessment of the proposed equipment has been undertaken, based on selections for the proposed equipment and details are included below.

The projects design includes the selection of condenser equipment and locations, including typical condenser types and includes the following:

1. Condenser types – Dakin RSUYQ6AVMA type units with a noise level as detailed in the figure below.



Based on the expected noise levels the proposed roof top condenser locations compliance with the relevant project requirements can be achieved including screening to adjacent receivers details of which will be provide as part of the CC documentation of the project, including the following mitigations:

- All plant and equipment to be vibration isolated from the building structure.
- The bounding wall to the plantroom to include an acoustic performance of Rw 50 including discontinuous construction and required for compliance with the BCA/NCC.

8.2 Carpark Noise Emissions

It is noted that the carpark will be fully enclosed and mechanically ventilated. As a result, it is expected that noise emissions from the car park will have a negligible impact onto the nearest affected receivers.

8.3 Noise from Additional Traffic

Noise impacts from the increase in vehicle movements along the surrounding roadways is to be assessed in accordance with the NSW EPA Road Noise Policy (RNP) 2011.

A peak hour increase proposed for the number vehicles associated with the development will not exceed a 2dBA increase at the nearest residential receivers. As summarised in the NSW EPA RNP, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person and is therefore considered acoustically acceptable.

8.4 Acoustic Separation

As this project is still within the development approval phase, information regarding the proposed constructions that will be separating areas within the development is not known at this stage. As such, a detailed review of the constructions for compliance with the airborne and impact ratings from the National Construction Code cannot be undertaken. It is usual for such work to be conducted at the Construction Certificate (CC) stage of the development. The required airborne and impact ratings have been presented in Part F7 of the National Construction Code.

8.4.1 External Common Areas

As part of the project a number of external common areas are proposed including areas on Level 4 and the Level 8 rooftops.

Noise associated with communal areas is not well addressed in NSW. The Ku Ring Gai Council DCP provides general precautions regarding communal areas and their impact on surrounding receivers yet does not establish a quantitative criterion.

Additionally, the NSW EPA *Noise Policy for Industry* does not address noise emissions from communal areas. As such to ensure the acoustic amenity is reasonably maintained for the existing surrounding developments. To suitably protect from unreasonable noise impacts from the use of the external communal areas the following management controls are proposed to be include as part of the operation of the project:

1) External common areas are only to be used during the daytime and evening time which are as follows:
   a) (For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm.
   b) On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm)
2) Use of the common area is permitted for communal activities. The area is not to be used for high noise generating activities such as large gatherings, playing of loud music, organised events, parties or the like.
3) Amplified music is not permitted in the communal area or in the common room at any-time.
4) Signs must be installed within the area outlining the recommendations above.

Providing the recommended acoustic mitigations detailed in the points above are included to the external common areas the resulting noise emissions from the use of the external communal area will be acoustically acceptable.

8.4.2 Internal Common Areas

As part of the project there are a number of amenities and common areas including those on the lower ground floor, ground floor which are located within the building.

Noise resulting from the use of the internal communal areas will be acoustically mitigated including the use of the management controls and built controls including the following:

1) The use of internal common areas can be used at any time of the day, evening and nighttime periods.

2) Use of the common areas are permitted to include normal residential activities and are not to include high noise generating activities such as large gatherings, playing of loud music, organised events, parties or the like.

3) The playing of amplified music is not permitted within the internal areas including levels form background noise levels including levels of not greater than 60 dB(A) SPL within the spaces.

4) The external façade of the common areas are to include the following minimum constructions:

    a) Solid elements – construction with a minimum Rw 45 acoustic performance, including standard masonry or light weight construction.

    b) Glass windows and doors – minimum Rw 30 including 6.38mm laminated glass or greater.

5) Any common areas which include the use as a communal gym are to include an acoustically treated floor including that which is not less than 50mm thick such as Regupol type.

    a) Any gym equipment is to include spring loaded machines.

    b) The use of gyms are to be limited to periods excluding night time hours of 10pm to 7am.

6) Signs must be installed within the area outlining the recommendations above.

Providing the recommended acoustic mitigations detailed in the points above are included to the internal common areas the resulting noise emissions from the use of the communal area will be acoustically acceptable.

9 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

A preliminary acoustic assessment of the noise and vibrations impact during the construction of the school has been undertaken below.

9.1 Construction Activity Noise Assessment

A review of the noise levels likely to be emitted from the site because of the demolition and construction works has been undertaken. Based on the proximity of the surrounding receivers and the works area, we expect there is likely to be periods where noise emission are likely to exceed the *Noise Affected Level (NAL)* and in some cases the *Highly Noise Affected Level (HNAL)*. As such the works will require a site-specific *Construction Noise & Vibration Sub Plan (CNVMSP)* to be prepared for the site.

This plan should plan be undertaken in accordance with the relevant NSW EPA documents around noise and vibration (such as the ICNG and Assessing Vibration- a technical guideline.).

Outlined in sections 9.5 to 9.11 PWNA have provided detailed list of possible mitigation measures which could be implemented to reduce these expected noise levels at neighbouring properties. These are all to be considered as part of the preparation of this plan prior to the issue of a Construction Certificate (CC).

9.2 Construction Traffic Noise Assessment

From the criteria, it is noted that vehicle numbers on surrounding roads would need to increase by around 60% from existing traffic flows, for a 2 dB increase in road traffic noise to occur. As noted previously, a 2 dB increase in road traffic noise is not considered to be noticeable.

Based on the number of vehicles projected over each of the construction phases, it is concluded that noise impacts from construction traffic is required.

9.3 Vibration Assessment

In order to maintain compliance with the human comfort vibration criteria discussed in Section 6.3, it is recommended that the indicative safe distances listed in Table 23 should be maintained. These indicative safe distances should be validated prior to the start of construction works by undertaking measurements of vibration levels generated by construction and demolition equipment to be used on site.

Since the criteria for scientific or medical equipment (should any of these exist close to the site) can be more stringent than those required for human comfort, vibration validating measurements should be conducted at each site to determine the vibration level and potential impact onto this sensitive equipment.

Additionally, any vibration levels should be assessed in accordance with the criteria discussed in Section 6.4.3. This information should also be included as part of a Construction Noise Vibration Management Sub Plan (CNVMSP).

In order to maintain compliance with the human comfort vibration criteria discussed in Section 6.3, it is recommended that the indicative safe distances listed in Table 23 should be maintained. These indicative safe distances should be validated prior to the start of construction works by undertaking measurements of vibration levels generated by construction and demolition equipment to be used on site.

Since the criteria for scientific or medical equipment (should any of these exist close to the site) can be more stringent than those required for human comfort, vibration validating measurements should be conducted at each site to determine the vibration level and potential impact onto this sensitive equipment.

Additionally, any vibration levels should be assessed in accordance with the criteria discussed in Section 6.4.3. This information should also be included as part of a Construction Noise Vibration Management Plan (CNVMP).

Table 23 Recommended indicative safe working distances for vibration intensive plant

Plant	Rating / Description	Safe Working Distances (m)	
		Cosmetic Damage (BS 7385: Part 2 DIN 4150: Part 3)	Human Comfort (AVTG)
Vibratory roller	< 50 kN (Typically 1 – 2 tonnes)	5	15 – 20
	< 100 kN (Typically 2 – 4 tonnes)	6	20
	< 200 kN (Typically 4 – 6 tonnes)	12	40
	< 300 kN (Typically 7 – 13 tonnes)	15	100
	> 300 kN (Typically more than 13 tonnes)	20	100
Small hydraulic hammer	300 kg, typically 5 – 12 tonnes excavator	2	7
Medium hydraulic hammer	900 kg, typically 12 – 18 tonnes excavator	7	23
Large hydraulic hammer	1600 kg, typically 18 – 34 tonnes excavator	22	73
Vibratory pile driver	Sheet piles	2 – 20	20
Jackhammer	Hand held	1	Avoid contact with structure and steel reinforcements

9.4 Construction Activities Sound Power Levels (Lw)

Sound power levels have been predicted for the construction tasks identified in the project program. The equipment anticipated for use in each task is based on previous project experience. The sound power levels for the equipment likely to be used for the listed tasks are provided in the table below.

Table 24 Summary of predicted sound power levels.

Tasks	Equipment	Sound Power Levels (dBA re 1pW)	Aggregate Sound Power Level per Task (dBA re 1pW)
Site Establishment Works	Mobile crane	110	113
	Power hand tools	109	
	Semi Rigid Vehicle [1]	105	
Ground Works	Excavator	112	121
	Hydraulic Hammer	118	
	Piling Rig	110	
	Handheld jack hammer [1]	111	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Skid steer	110	
	Power hand tools	109	
Structure	Handheld jack hammer [1]	106	115
	Concrete saw [1]	114	
	Power hand tools	109	
	Welder	101	
	Concrete pump truck	110	
	Concrete agitator truck	108	
Internal Works	Power hand tools	109	104
Common and External Works	Concrete agitator truck	108	114
	Saw cutter [1]	104	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Power hand tools	109	

Note 1: An assumed time correction has been applied, this being 5 minutes of operation in any 15-minute interval.

Based on the details included in the table above the predicted construction noise impacts are included in the following tables.

Table 25 Receiver – 01 – Residential – Summary of preliminary predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	67 to 88	70 to 91	Standard Construction Hours: **Noise Management Level** **52** **Highly Noise Affected Level** **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours.
	Power hand tools		66 to 87			
	Semi Rigid Vehicle		58 to 78			
Ground Works and Demolition	Excavator	121	69 to 90	74 to 95		
	Hydraulic Hammer		75 to 96			
	Piling Rid		67 to 88			
	Handheld jack hammer		64 to 84			
	Dump truck		57 to 77			
	Concrete saw		67 to 87			
	Skid steer		67 to 88			
	Power hand tools		66 to 87			
Structure	Handheld jack hammer	115	59 to 79	73 to 93		
	Concrete saw		67 to 87			
	Power hand tools		66 to 87			
	Welder		58 to 79			
	Concrete pump truck		67 to 88			
	Concrete agitator truck		65 to 86			
Internal Works	Power hand tools	104	61 to 82	61 to 82		
Common and External Works	Concrete agitator truck	114	65 to 86	71 to 92		
	Saw cutter		57 to 77			
	Dump truck		57 to 77			
	Concrete saw		67 to 87			
	Power hand tools		66 to 87			

Table 26 Receiver – 02 – Residential – Summary of preliminary predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	67 to 88	70 to 91	Standard Construction Hours: **Noise Management Level** **52** **Highly Noise Affected Level** **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours.
	Power hand tools		66 to 87			
	Semi Rigid Vehicle		58 to 78			
Ground Works and Demolition	Excavator	121	69 to 90	74 to 95		
	Hydraulic Hammer		75 to 96			
	Piling Rid		67 to 88			
	Handheld jack hammer		64 to 84			
	Dump truck		57 to 77			
	Concrete saw		67 to 87			
	Skid steer		67 to 88			
	Power hand tools		66 to 87			
Structure	Handheld jack hammer	115	59 to 79	73 to 93		
	Concrete saw		67 to 87			
	Power hand tools		66 to 87			
	Welder		58 to 79			
	Concrete pump truck		67 to 88			
	Concrete agitator truck		65 to 86			
Internal Works	Power hand tools	104	61 to 82	61 to 82		
Common and External Works	Concrete agitator truck	114	65 to 86	71 to 92		
	Saw cutter		57 to 77			
	Dump truck		57 to 77			
	Concrete saw		67 to 87			
	Power hand tools		66 to 87			

Table 27 Receiver – 03 – Residential – Summary of preliminary predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	62 to 83	65 to 86	Standard Construction Hours: **Noise Management Level** **52** **Highly Noise Affected Level** **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours.
	Power hand tools		61 to 82			
	Semi Rigid Vehicle		53 to 73			
Ground Works and Demolition	Excavator	121	64 to 95	69 to 90		
	Hydraulic Hammer		70 to 91			
	Piling Rid		62 to 83			
	Handheld jack hammer		59 to 79			
	Dump truck		52 to 72			
	Concrete saw		62 to 82			
	Skid steer		62 to 83			
	Power hand tools		61 to 82			
Structure	Handheld jack hammer	115	54 to 74	68 to 88		
	Concrete saw		62 to 82			
	Power hand tools		61 to 82			
	Welder		53 to 74			
	Concrete pump truck		62 to 83			
	Concrete agitator truck		60 to 81			
Internal Works	Power hand tools	104	56 to 78	76 to 77		
Common and External Works	Concrete agitator truck	114	60 to 81	66 to 87		
	Saw cutter		52 to 72			
	Dump truck		52 to 72			
	Concrete saw		62 to 82			
	Power hand tools		61 to 82			

Table 28 Receiver – 04 – Residential – Summary of preliminary predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	67 to 88	70 to 91	Standard Construction Hours: **Noise Management Level** **52** **Highly Noise Affected Level** **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours.
	Power hand tools		66 to 87			
	Semi Rigid Vehicle		58 to 78			
Ground Works and Demolition	Excavator	121	69 to 90	74 to 95		
	Hydraulic Hammer		75 to 96			
	Piling Rid		67 to 88			
	Handheld jack hammer		64 to 84			
	Dump truck		57 to 77			
	Concrete saw		67 to 87			
	Skid steer		67 to 88			
	Power hand tools		66 to 87			
Structure	Handheld jack hammer	115	59 to 79	73 to 93		
	Concrete saw		67 to 87			
	Power hand tools		66 to 87			
	Welder		58 to 79			
	Concrete pump truck		67 to 88			
	Concrete agitator truck		65 to 86			
Internal Works	Power hand tools	104	61 to 82	61 to 82		
Common and External Works	Concrete agitator truck	114	65 to 86	71 to 92		
	Saw cutter		57 to 77			
	Dump truck		57 to 77			
	Concrete saw		67 to 87			
	Power hand tools		66 to 87			

9.5 Acoustic Management Procedures

9.5.1 Summary of Management Procedures

Table 29 below summarises the management procedures recommended for airborne noise and vibration impact. These procedures are also further discussed in the report.

Table 29 Summary of mitigation procedures

Procedure	Abbreviation	Description
General Management Measures	GMM	Introduce best-practice general mitigation measures in the workplace which are aimed at reducing the acoustic impact onto the nearest affected receivers.
Project Notification	PN	Issue project updates to stakeholders, discussing overviews of current and upcoming works. Advanced warning of potential disruptions can be included. Content and length to be determined on a project-by-project basis.
Verification Monitoring	V	Monitoring to comprise attended or unattended acoustic surveys. The purpose of the monitoring is to confirm measured levels are consistent with the predictions in the acoustic assessment, and to verify that the mitigation procedures are appropriate for the affected receivers. If the measured levels are higher than those predicted, then the measures will need to be reviewed and the management plan will need to be amended.
Complaints Management System	CMS	Implement a management system which includes procedures for receiving and addressing complaints from affected stakeholders
Specific Notification	SN	Individual letters or phone calls to notify stakeholders that noise levels are likely to exceed noise objectives. Alternatively, contractor could visit stakeholders individually in order to brief them in regard to the noise impact and the mitigation measures that will be implemented.
Respite Offer	RO	Offer provided to stakeholders subjected to an ongoing impact.
Alternative Construction Methodology	AC	Contractor to consider alternative construction options that achieve compliance with relevant criteria. Alternative option to be determined on a case-by-case basis. It is recommended that the selection of the alternative option should also be determined by considering the assessment of on-site measurements (refer to Verification Monitoring above).

The application of these procedures is in relation to the exceedances over the relevant criteria. For airborne noise, the criteria are based on NMLs. The allocation of these procedures is discussed in Section 9.5.2.

For vibration, the criteria either correspond to human comfort, building damage or scientific and medical equipment. The application of these procedures is discussed in Section 9.5.3.

9.5.2 Allocation of Noise Management Procedures

For residences, the management procedures have been allocated based on noise level exceedances at the affected properties, which occur over the designated NMLs. The allocation of these procedures is summarised in Table 30 below.

Table 30 Allocation of noise management procedures – Residential Receivers

Construction Hours	Exceedance over NML (dB)	Management Procedures (see definition above)
Standard Hours As recommended in Consent documentation	0 - 3	GMM, CMS, AC
	4 - 10	GMM, CMS, AC, V [1]
	11 - 20	GMM, CMS, PN, AC, V [1]
	≥ 21	GMM, CMS, PN, AC, SN, V [1]
	≥ 75dBA	GMM, CMS, PN, AC, SN, RO, V [1]
Outside Standard Hours (If applicable)	Specific NMP will be undertaken should this be required.	

Note 1 Verification monitoring to be undertaken upon complaints received from affected receivers.

9.5.3 Allocation of Vibration Management Procedures

Table 31 below summarises the vibration management procedures to be adopted based on exceedance scenarios (i.e., whether the exceedance occurs over human comfort criteria, building damage criteria, or criteria for scientific and medical equipment). Please note these management procedures apply for any type of affected receiver (i.e., for residences as well as non-residential receivers).

Table 31 Allocation of vibration management procedures

Construction Hours	Exceedance Scenario	Management Procedures
Standard Hours As recommended in Consent documentation	Over human comfort criteria (refer to Section 6.3)	GMM, CMS, AC, SN, V [1]
	Over building damage criteria (refer to Section 6.3)	GMM, CMS, AC, SN, VM, RO, V [1]
Outside Standard Hours (If applicable)	Specific VMP will be undertaken should this be required.	

Note 1 Verification monitoring to be undertaken upon complaints received from affected receivers.

9.6 Site Specific Noise Mitigation Measures

9.6.1 General Comments

The contractor will, where reasonable and feasible, apply best practice noise mitigation measures. These measures shall include the following:

- Maximising the offset distance between plant items and nearby noise sensitive receivers.
- Preventing noisy plant working simultaneously and adjacent to sensitive receivers.
- Minimising consecutive works in the same site area.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

In order to minimise noise impacts during the works, the contractor will take all reasonable and feasible measures to mitigate noise effects.

The contractor will also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

The contractor should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

9.6.2 Noise Monitoring

Noise monitoring, if required, will be performed by an acoustical consultant directly engaged by the contractor.

Noise monitoring for the excavation, compaction and construction works should be undertaken using statistical noise loggers. The statistical parameters to be measured should include the following noise descriptors: LA90, LA10 and LAeq. Noise measurements should be conducted over consecutive 15-minute periods.

This monitoring should also be complemented by undertaking attended noise measurements to:

- Differentiate between construction noise sources and other extraneous noise events (such as road traffic and aircraft noise)
- Note and identify any excessive noise emitting machinery or operation.

In the event of any complaints, the noise impact at the affected location should be confirmed by conducting attended noise measurements.

The survey methodology and any equipment should comply with the requirements discussed in Standard AS 1055.1-1997.

9.6.3 Alternate Equipment or Process

Exceedance of the site's NMLs should result in an investigation as to whether alternate equipment could be used, or a difference process could be undertaken.

In some cases, the investigation may conclude that no possible other equipment can be used, however, a different process could be undertaken.

9.6.4 Acoustic Enclosures/Screening

Typically, on a construction site there are three different types of plant that will be used: mobile plant (i.e., excavators, skid steers, etc.), semi mobile plant (i.e., hand tools generally) or static plant (i.e., diesel generators).

For plant items which are static it is recommended that, in the event exceedances are being measured due to operation of the plant item, an acoustic enclosure/screen is constructed to reduce impacts. These systems can be constructed from Fibre Cement (FC) sheeting or, if airflow is required, acoustic attenuators or louvres.

For semi mobile plant, relocation of plant should be investigated to either be operated in an enclosed space or at locations away from a receiver.

With mobile plant it is generally not possible to treat these sources. However, investigations into the machine itself may result in a reduction of noise (i.e., mufflers/attenuators etc).

9.7 Vibration Mitigation Measures

9.7.1 General Comments

As part of the CNVMP, the following vibration mitigation measures should be implemented:

- Any vibration generating plant and equipment is to be in areas within the site in order to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of construction plant and equipment; that is, smaller capacity plant.
- Minimise conducting vibration generating works consecutively in the same area (if applicable).
- Schedule a minimum respite period of at least 30 minutes before activities commence which are to be undertaken for a continuous 4-hour period.
- Use only dampened rock breakers and/or "city" rock breakers to minimise the impacts associated with rock breaking works.
- Conduct attended measurements of vibration generating plant at commencement of works to validate the indicative safe working distances advised in Table 23 and, consequently, to establish safe working distances suitable to the project. Measurements should be conducted at the nearest affected property boundary. These safe working distances should be defined by considering the vibration criteria discussed in Section 6.4.3 (i.e., criteria for structural damage and human comfort).

9.7.2 Vibration Monitoring

Vibration monitoring, if required, should be undertaken continuously at the nearest most affected structures.

The monitoring location would be on a stiff part of the structure (at the foundation) on the side of the structure adjacent to the subject demolition and construction works.

The vibration monitoring system will be configured to record the peak vibration levels and to trigger an audible/visual alarm when predetermined vibration thresholds are exceeded. The thresholds correspond to an "Operator Warning Level" and an "Operator Halt Level", where the Warning Level is 75% of the Halt Level. The Halt Level should be determined based on the vibration criteria for building contents and structure.

Exceedance of the "Operator Warning Level" would not require excavation or demolition work to cease, but rather, alerts the site manager to proceed with caution at a reduced force or load.

An exceedance of the "Operator Halt Level" would require the contractor to implement an alternative excavation technique pending further analysis of the vibration frequency content in order to determine any potential exceedance of the criteria.

The vibration monitoring equipment would be downloaded and analysed by the acoustical consultant.

Reports of the measured vibration levels and their likely impacts would be prepared by the acoustical consultant and issued to the contractor.

9.8 Community Consultation

9.8.1 Stakeholder Engagement

The overarching Communications and Stakeholder Engagement Strategy for the project, as well as the Communications and Engagement plans to support each stage of the development which centre on:

- Proactive stakeholder engagement.
- Proactive and transparent communications.
- Coordinated information.
- Collaboration.

9.8.2 Stakeholders

The Project's stakeholder environment is complex and extensive. The Project team has developed a deep understanding of stakeholders and the engagement environment which has informed the timing, method, and level of engagement across all stages of the redevelopment. Key engagement methods include:

- Formal and information briefings and meetings
- Workshops.
- Door Knocks.
- Letterbox Drops.
- Email Notifications.

9.9 Complaints Management System

The Contractor is to establish a communication register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

All complaints should be investigated by the Contractor in accordance with the procedures outlined in Australia Standard 2436-2010. In addition, the following procedures are an example of the procedures that are to be specifically adopted for complaints relating to noise.

Upon receipt of a complaint the Contractor is to:

- Try to ascertain from the complaint which appliance is causing the problem i.e., inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.
- The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.
- The Project Manager is to provide a report on the incident to the relevant stakeholders.

- The Contractor is to provide a 24-hour telephone contact number and this number is to be prominently displayed on the site.

9.10 Contingency Plans

Contingency plans are required to address noise or vibration problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans could include:

- Stop the onsite works.
- Identify the source of the main equipment within specific areas of the site which is producing the most construction noise and vibration at the sensitive receivers; and
- Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered.
- In the event an alternate piece of equipment or process can be used, works can re-commence.
- In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant.

9.11 General Mitigation Measures (Australia Standard 2436-2010)

As well as the above project specific noise mitigation controls, AS 2436-2010 *"Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below, including the typical noise reduction achieved, where applicable.

9.11.1 Adoption of Universal Work Practices

- Regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
- Regular identification of noisy activities and adoption of improvement techniques.
- Avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby sensitive receivers.
- Where possible, avoiding the use of equipment that generates impulsive noise.
- Minimising the need for vehicle reversing for example (particularly at night), by arranging for one-way site traffic routes.
- Use of broadband audible alarms on vehicles and elevated work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

9.11.2 Plant and Equipment

- Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Selecting plant and equipment with low vibration generation characteristics.

- Operating plant and equipment in the quietest and most efficient manner.

9.11.3 On Site Noise Mitigation

- Maximising the distance between noise activities and noise sensitive land uses.
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

9.11.4 Work Scheduling

- Providing respite periods which could include restricting very noisy activities to time periods that least affect the nearby noise sensitive locations, restricting the number of nights that after-hours work is conducted near residences or by determining any specific requirements.
- Scheduling work to coincide with non-sensitive periods.
- Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers.
- Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
- Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

9.11.5 Source Noise Control Strategies

Some ways of controlling noise at the source are:

- Where reasonably practical, noisy plant or processes should be replaced by less noisy alternatives.
- Modify existing equipment: Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, trucks, etc. In order to minimise noise emissions, residential grade mufflers should be fitted on all mobile plant utilised on site.
- Siting of equipment: locating noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Regular and effective maintenance.

10 CONCLUSION

This noise and Vibration Impact Assessment (NVIA) has been prepared by Pulse White Noise Acoustics Pty Ltd on behalf of MHR Lindfield investments Pty Ltd for the construction and operation of a residential development on land located from 24-28 Middle Harbour Road, Lindfield (the site).

This report has been prepared to review and assess the noise and vibration elements of the development including operational noise on surrounding existing developments, noise and vibration intrusion from external sources (road) and noise and vibration impacts associated with the construction of the development. This report also describes the relevant noise and vibration criteria and recommended acoustic mitigation measures required to ensure compliance

A review of the existing onsite noise levels from the nearby roadways/rail corridors has resulted in recommended acoustic treatments to the future buildings facades to ensure internal noise levels are within permissible limits.

To control noise impacts at external receivers, recommended indicative treatments for major engineering services have been provided in section 8. From our review we have formulated the following opinion:

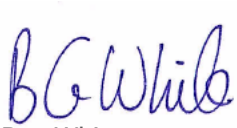
- At this stage of the project the exact selections/locations of plant items are not known. A preliminary assessment, however, has been carried out using our experience with similar types of developments and the typical plant items installed in each type of plant room.
- From this review we recommend the selection of high-performance acoustic treatment to ensure that the operation of the plant items comply with the project criteria. Therefore, it is recommended that prior to the issue of a Construction Certificate (CC) a detailed acoustic assessment is undertaken to ensure all cumulative noise from engineering services (including the roof plant room) comply with the requirements as listed in section 6.

An assessment of the impacts associated with the number of vehicles on surrounding public roads around the site predicted the impact to be less than 2dBA and is therefore compliant with the NSW EPA RNP.

Prior to the issue of the Construction Certificate it is recommended that a Construction Noise and Vibration Management Sub Plan (CNVMP) be undertaken to formulate relevant compliance with the objectives detailed above.

For any additional information please do not hesitate to contact the person below.

Regards



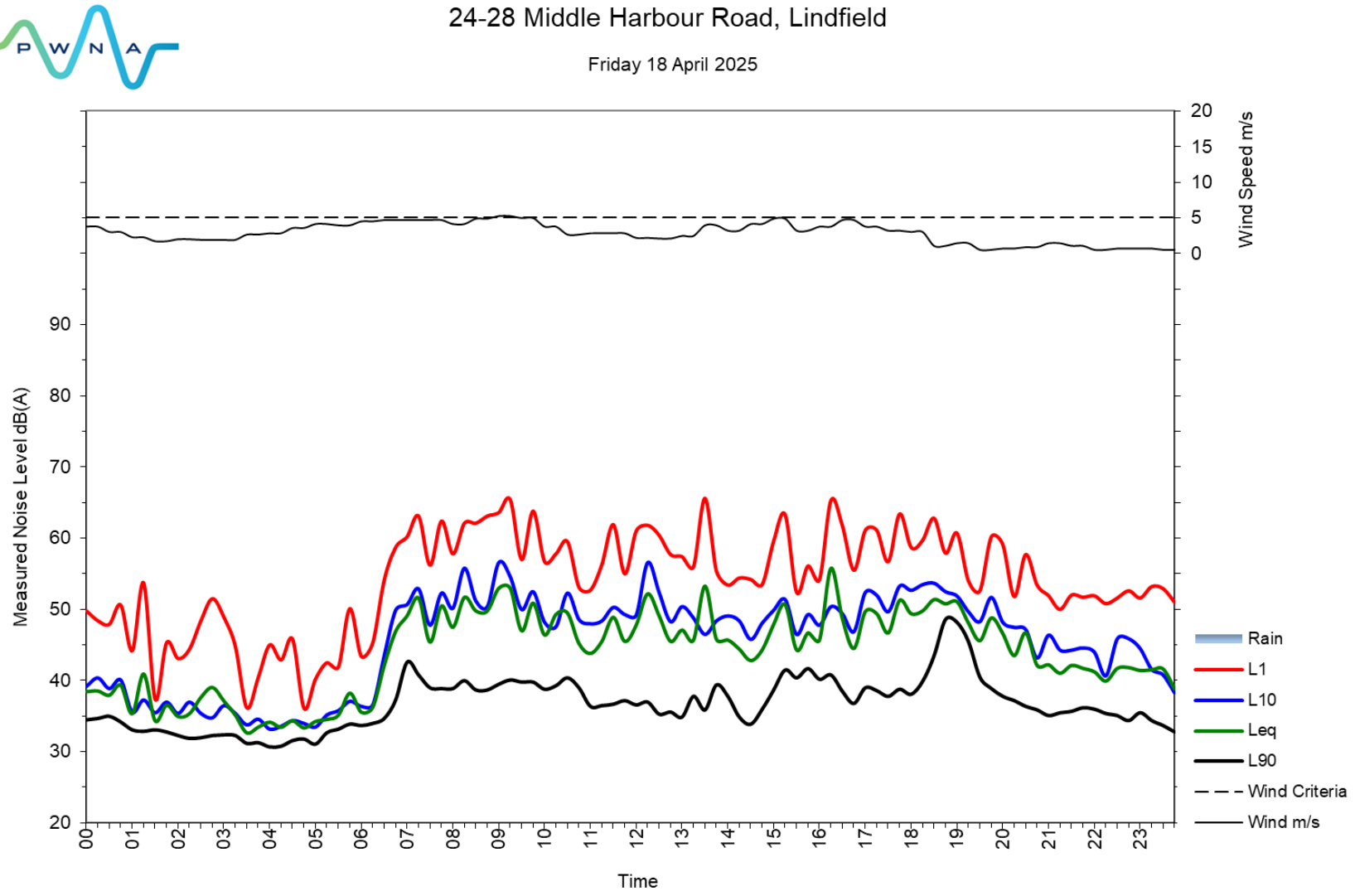
Ben White
Director
Pulse White Noise Acoustics

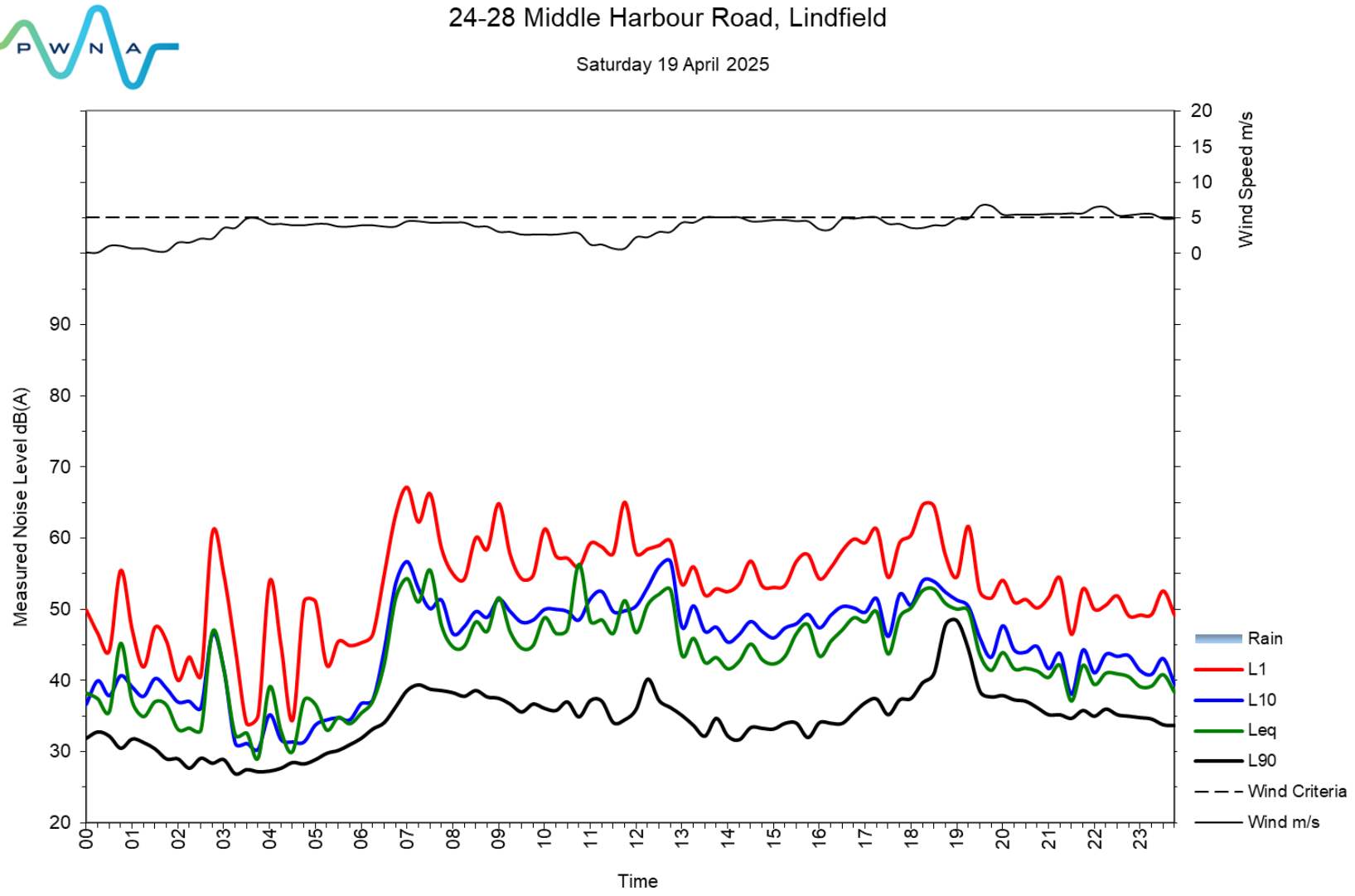
APPENDIX A. ACOUSTIC TERMINOLOGY

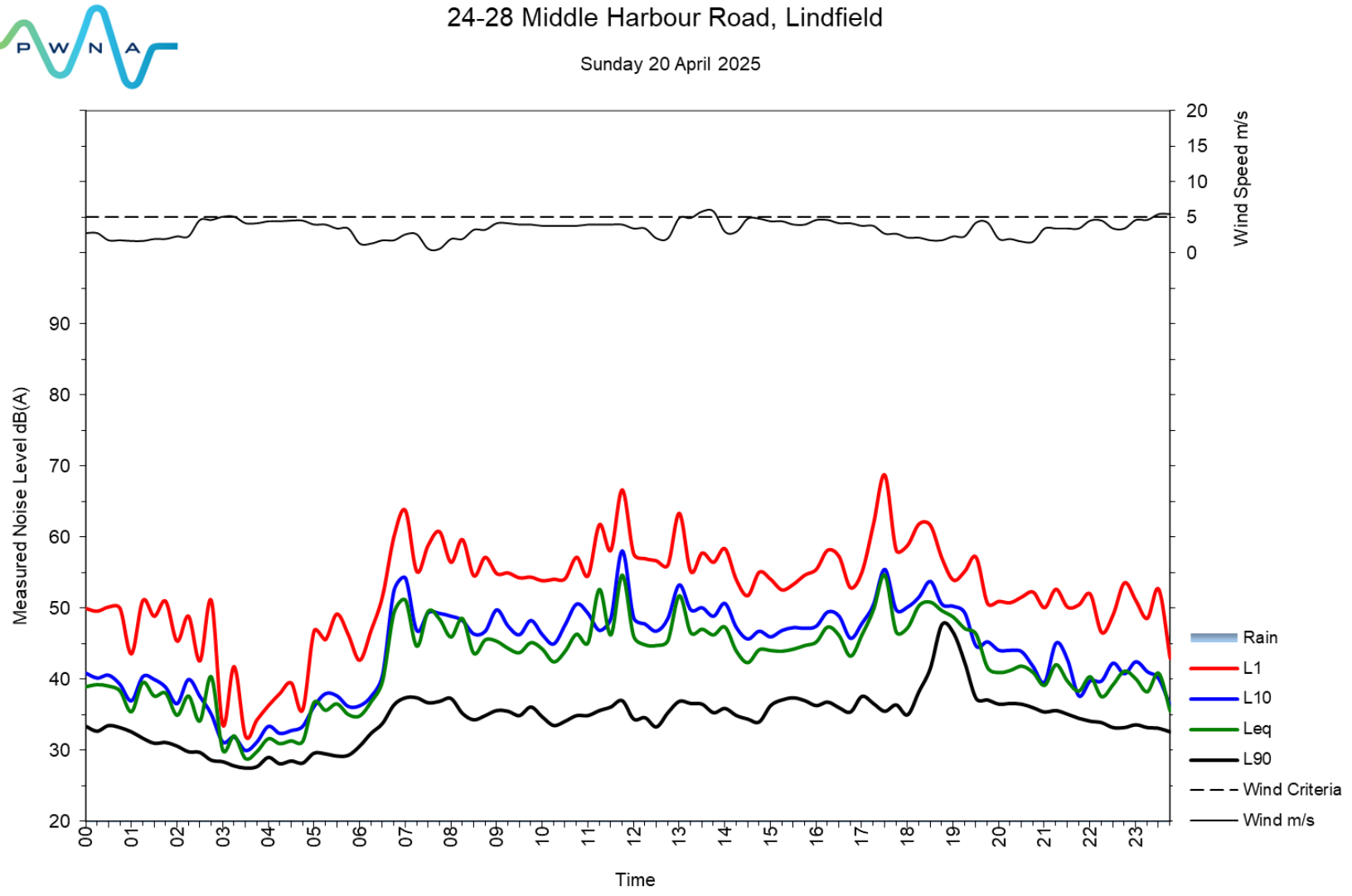
Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ambient sound	The all-encompassing sound at a point composed of sound from all sources near and far.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Reverberation	The persistence of sound in a space after the source of that sound has been stopped (the reverberation time is the time taken for a reverberant sound field to decrease by 60 dB)
Air-borne sound	The sound emitted directly from a source into the surrounding air, such as speech, television or music
Impact sound	The sound emitted from force of one object hitting another such as footfalls and slamming cupboards.
Air-borne sound isolation	The reduction of airborne sound between two rooms.
Sound Reduction Index [R] *(Sound Transmission Loss)*	The ratio the sound incident on a partition to the sound transmitted by the partition.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.
Level difference [D]	The difference in sound pressure level between two rooms.
Normalised level difference [D_n]	The difference in sound pressure level between two rooms normalised for the absorption area of the receiving room.
Standardised level difference [D_{nT}]	The difference in sound pressure level between two rooms normalised for the reverberation time of the receiving room.
Weighted standardised level difference [$D_{nT,w}$]	A single figure representation of the air-borne sound insulation of a partition based upon the level difference. Generally used to present the performance of a partition when measured in situ on site.
C_{tr}	A value added to an R_w or $D_{nT,w}$ value to account for variations in the spectrum.
Impact sound isolation	The resistance of a floor or wall to transmit impact sound.

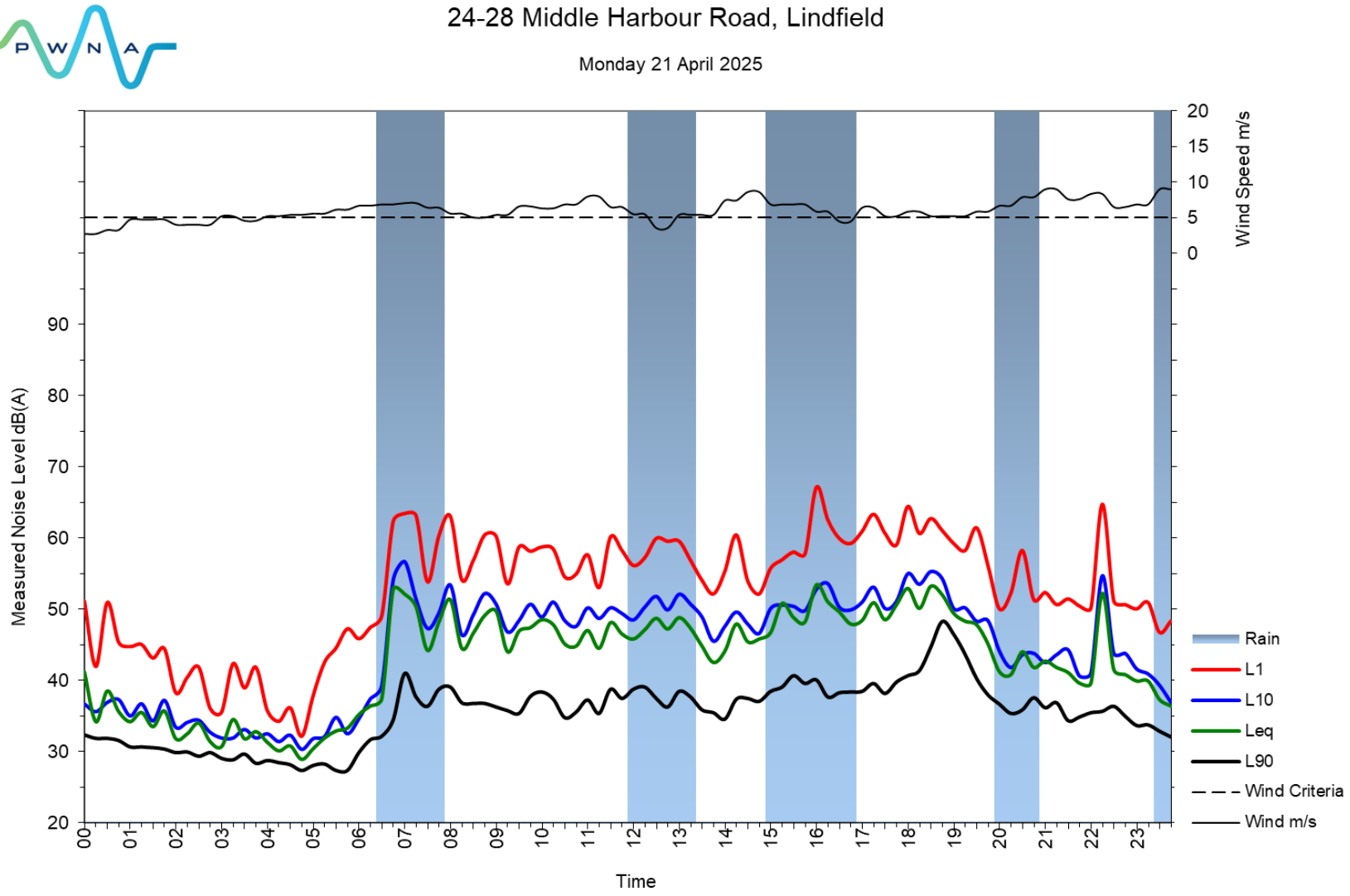
Impact sound pressure level [L_i]	The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine.
Normalised impact sound pressure level [L_n]	The impact sound pressure level normalised for the absorption area of the receiving room.
Weighted normalised impact sound pressure level [$L_{n,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in a laboratory.
Weighted standardised impact sound pressure level [$L'_{nT,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in situ on site.
C_I	A value added to an L_{nW} or $L'_{nT,w}$ value to account for variations in the spectrum.
Energy Equivalent Sound Pressure Level [$L_{A,eq,T}$]	'A' weighted, energy averaged sound pressure level over the measurement period T.
Percentile Sound Pressure Level [$L_{Ax,T}$]	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.
Speech Privacy	A non-technical term but one of common usage. Speech privacy and speech intelligibility are opposites and a high level of speech privacy means a low level of speech intelligibility. It should be recognised that acceptable levels of speech privacy do not require that speech from an adjacent room is inaudible.
Sound Pressure Level, LP dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.
Sound Power Level, Lw dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt
Noise Reduction	The difference in sound pressure level between any two areas. The term "noise reduction" does not specify any grade or performance quality unless accompanied by a specification of the units and conditions under which the units shall apply
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Background Sound Low	The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted, external ambient noise sources. Usually taken to mean the LA90 value
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
LMax	The maximum sound pressure level measured over a given period.
LMin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.

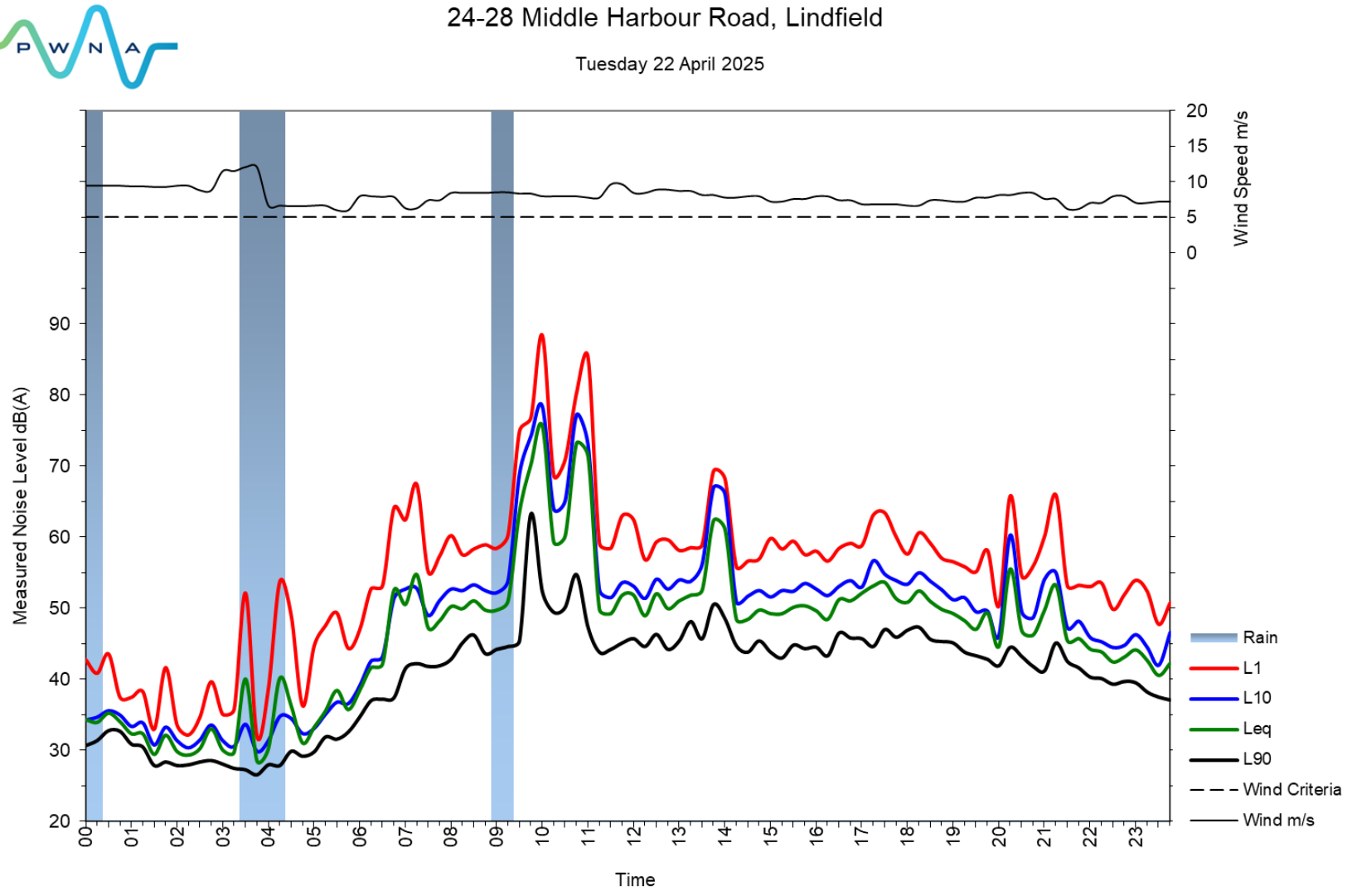
APPENDIX B. UNATTENDED NOISE MONITORING RESULTS

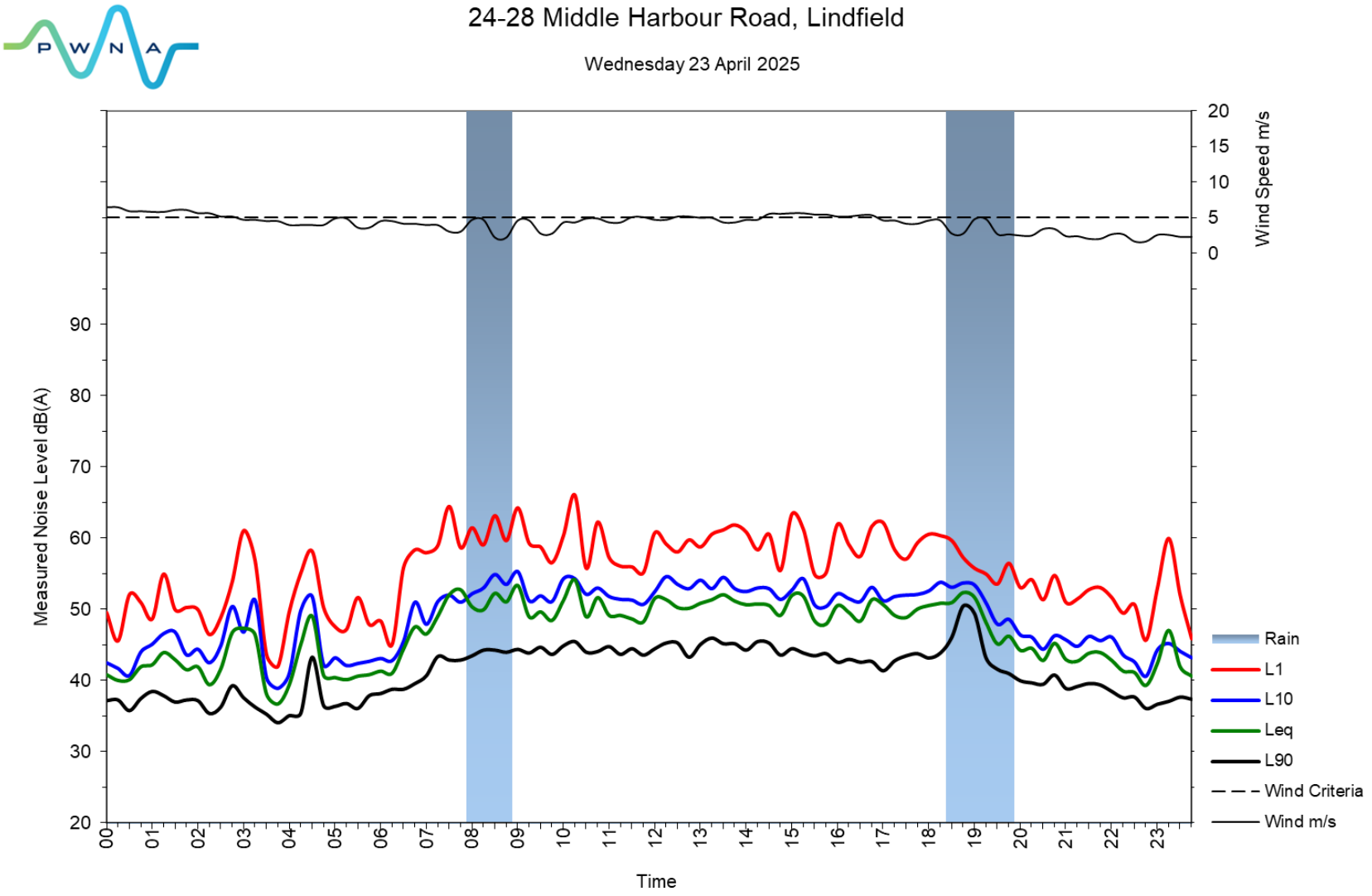

24-28 Middle Harbour Road, Lindfield
Friday 18 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

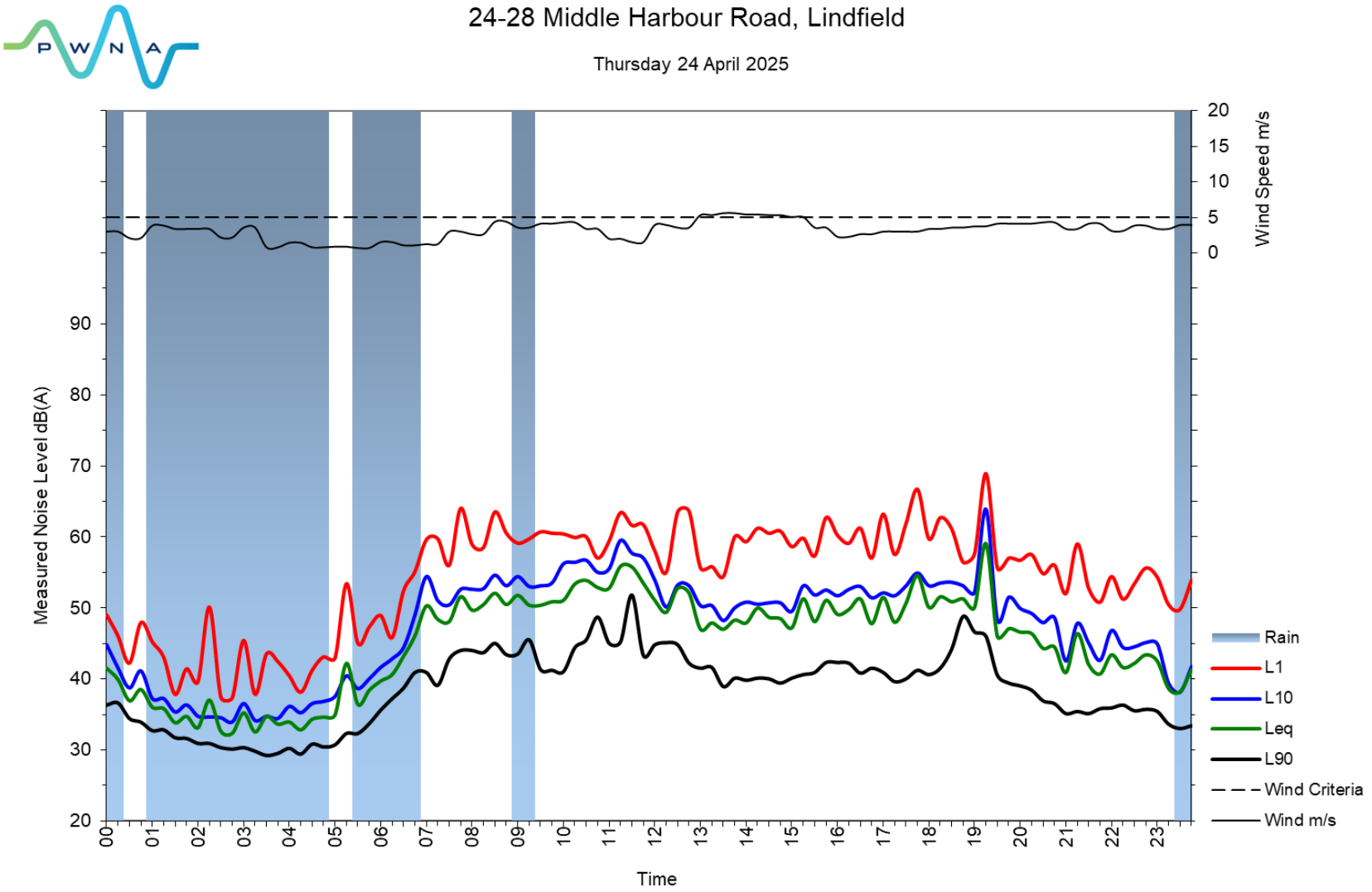

24-28 Middle Harbour Road, Lindfield
Saturday 19 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

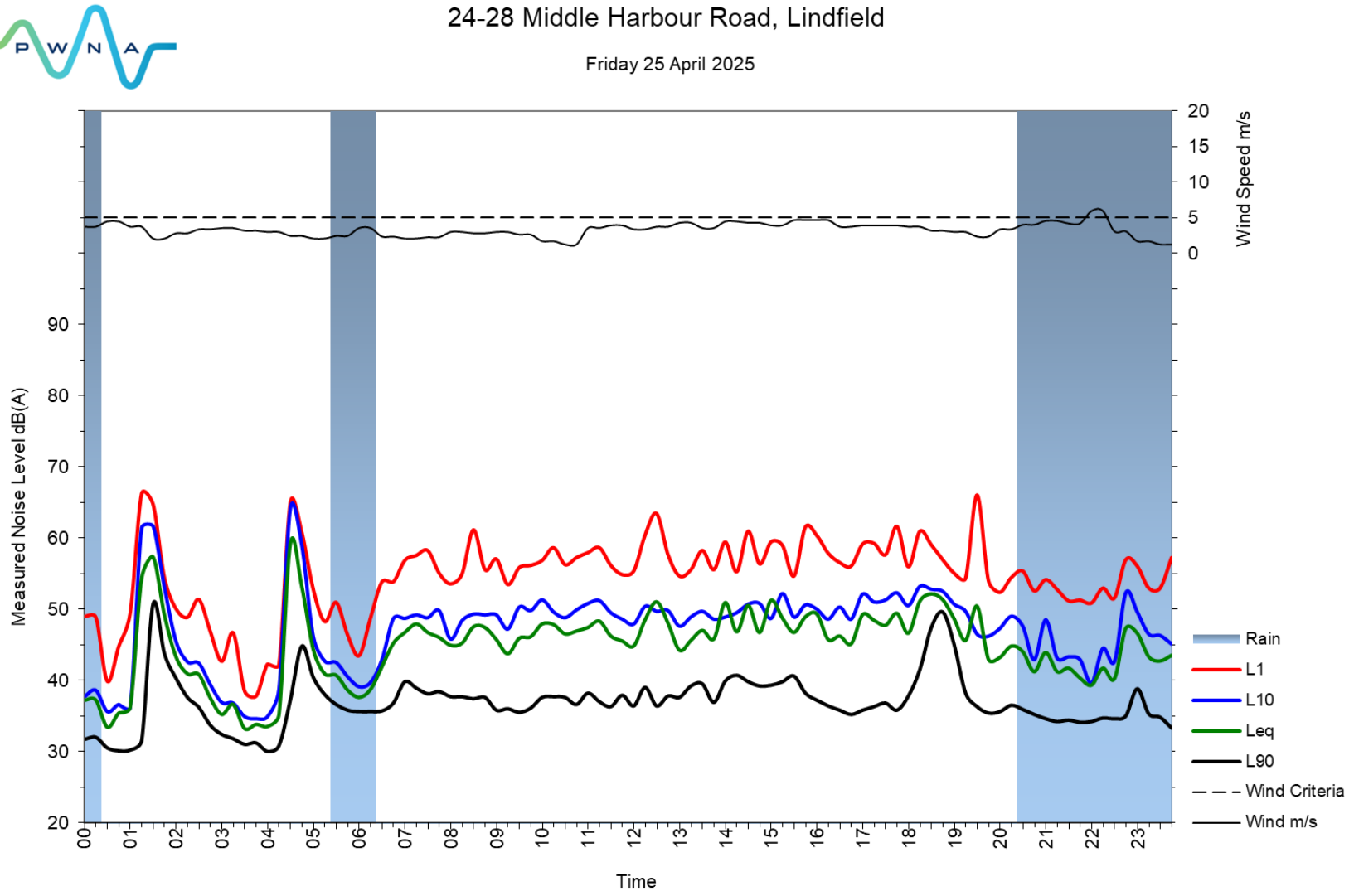

24-28 Middle Harbour Road, Lindfield
Sunday 20 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

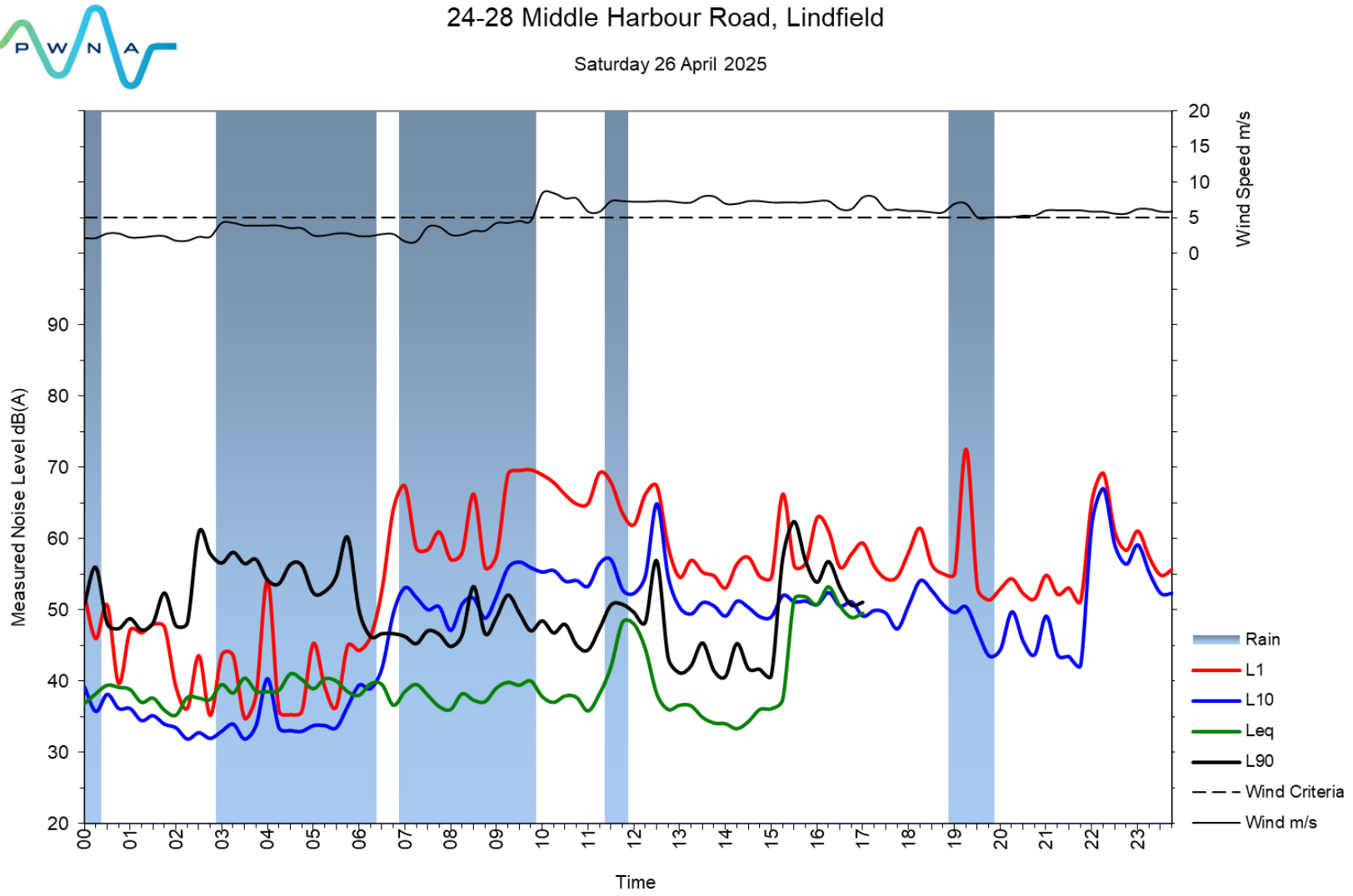

24-28 Middle Harbour Road, Lindfield
Monday 21 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

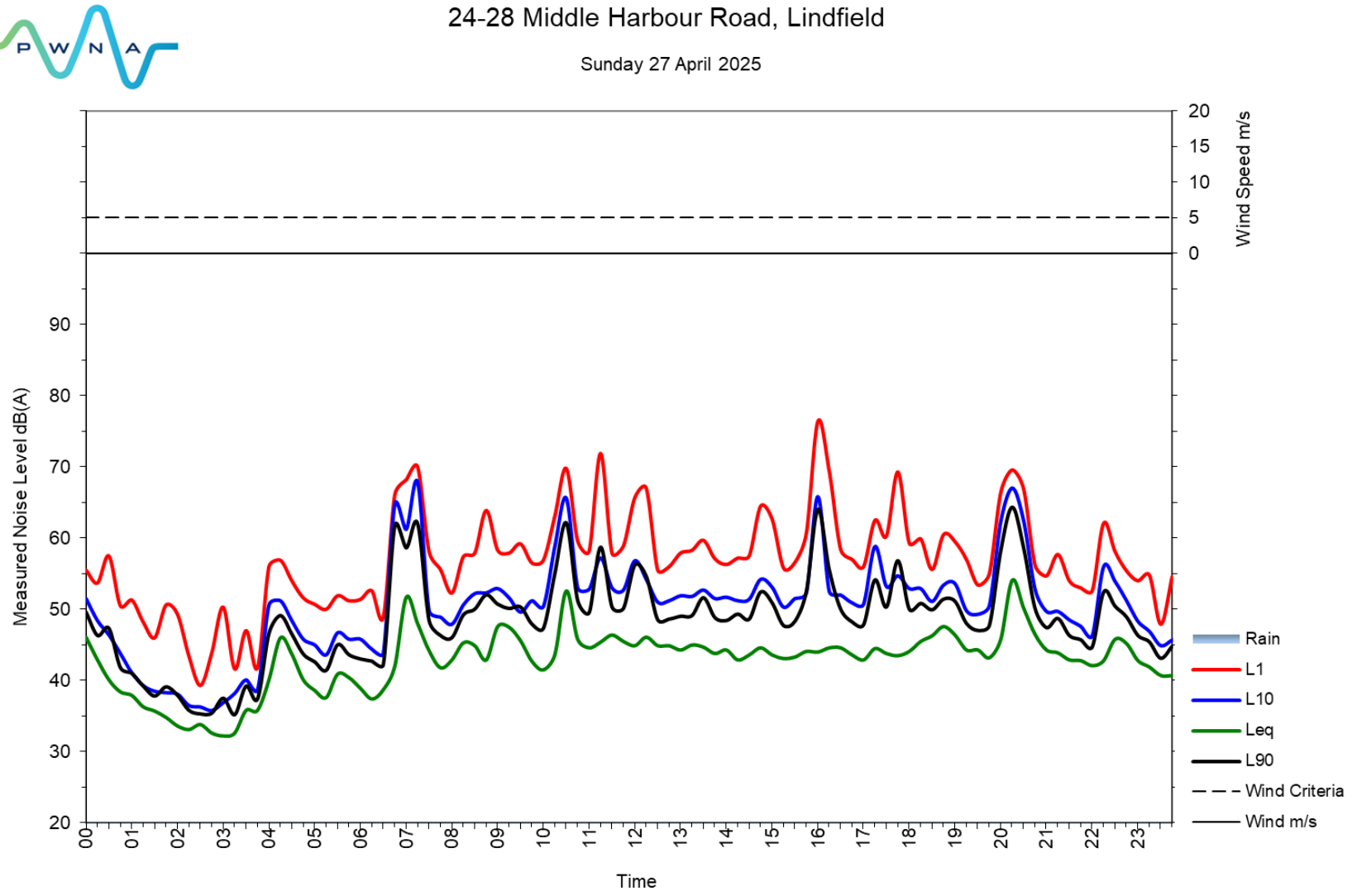

24-28 Middle Harbour Road, Lindfield
Tuesday 22 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


24-28 Middle Harbour Road, Lindfield
Wednesday 23 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


24-28 Middle Harbour Road, Lindfield
Thursday 24 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


24-28 Middle Harbour Road, Lindfield
Friday 25 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


24-28 Middle Harbour Road, Lindfield
Saturday 26 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


24-28 Middle Harbour Road, Lindfield
Sunday 27 April 2025
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s