# Narwee Parklands Care Community

# Noise Impact Assessment for SSDA

**Principal Healthcare Finance**

Report Reference: 220575 – Narwee Parklands Care Community – Noise Impact Assessment for SSDA – R0

Date: 22 November 2022

Revision: R0

Project Number: 220575

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## DOCUMENT CONTROL

| | |
|---|---|
| Project Name: | Narwee Parklands Care Community |
| Project Number: | 220575 |
| Report Reference: | 220575 – Narwee Parklands Care Community – Noise Impact Assessment for SSDA – R0 |
| Client: | Principal Healthcare Finance |

| Revision | Description | Reference | Date | Prepared | Checked | Authorised |
|---|---|---|---|---|---|---|
| 0 | For Information | 220575 – Narwee Parklands Care Community – SSDA – R0 | 22/11/22 | George Kinezos | Ben White | Ben White |
| 1 | For Information | 220575 – Narwee Parklands Care Community – SSDA – R0 | 24/11/22 | George Kinezos | Ben White | Ben White |

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# 1 INTRODUCTION

This Acoustic Assessment accompanies an Environmental Impact Statement (EIS) pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) in support of an application for a State Significant Development (SSD-45024776)

The development is for a Residential Aged Care Facility on land bound by Karne Street, North to the west and residential dwellings to the west and Richard Podmore Dog Park to the South.

## 1.1 Planning Secretary's Environmental Assessment Requirements (SEARs)

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

**12. Noise and Vibration**

- Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.

## 1.2 SEARs Satisfaction Table

In addressing the requirements of SEARs item 12 above, each item is addressed in the following section:

**Table 1 SEARs Satisfaction Table**

| Acoustic Assessment SEARs Satisfaction Table | | |
|---|---|---|
| **SEAR** | **SEAR Requirements** | **Document Reference** |
| 12 | *Provide a Noise and Vibration Assessment in accordance with:* | - |
| | *The relevant NSW Environmental Protection Authority (EPA) Guidelines.* | |
| | *Details the Construction and Operational Noise and Vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures to be implemented* | *Refer to Section 7* |

## 1.3 Relevant Guidelines

The Acoustic Criteria that has been adopted in this assessment include requirements from the following guidelines or legislative documents:

- Canterbury Local Council Development Control Plan (DCP) 2012
- 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 *Environmental Noise Control Manual (ENCM) 1994;*
- NSW EPA (formerly, Department of Environment and Climate Change) *Assessing Vibration: a technical guideline 2006 (AV-TG)*;
- Australian & New Zealand Standard AS/NZS 2107:2016 *Acoustics-Recommended design sound levels and reverberation times for building interiors*;
- German DIN 4150: Part 3 – 1999 *"Effects of Vibration on Structure"* (DIN 1999);
- British Standard BS 6472-2008 – *Evaluation of Human Exposure Vibration in Buildings (1Hz to 80Hz)*
- ASHREA *"Sound and Vibration Control" 2007.*

## 1.4 Proposal

The proposed development is for the construction and operation of a new Residential Aged Care Facility that will accommodate 165 beds.

The proposed development is an aged care facility and includes:

- Cater for High Care Residents, with a dedicated Memory Care Neighbourhood (MCN) of up to 15 residential places neighbourhoods on ground floor, with an overall building height of 3 Levels with a secured basement carpark;
- 165 Beds will consist of 10 companion rooms and 145 single rooms with single ensuites, external access to either patios or balconies for the majority of rooms except for Memory Care Neighbourhood.
- The proposed development will also consist of an entrance area, service entry, BOH, MCN, private rooms, common areas, wellness centre café, social hub, outdoor dining, balconies and gardens.
- The facility will have a kitchen, including servery's that have the capacity to serve the entire facility.
- New or augmented infrastructure services including electrical supply, hydraulic services (sewer and water) and fire services.

The assessment has been based on the project architectural drawings including the Group GSA architectural drawings dated November 2022.

## 1.5 Site Description

The site is located at 59-67 Karne Street North, Narwee within Canterbury-Bankstown and is formerly described as Lots D&C in DP403467, Lot 2 in DP518877 And Lot 2 & 3 in DP 16063.

The site is located within the Canterbury-Bankstown local government area approximately 750m North of the Narwee Shopping precinct.

The Narwee shopping precinct contains an Australian Post Office, Dental and Medical Centre and various takeaway food outlets.

Details of the project site are included in Figure 1 below.

**Figure 1 Project Site Plan – Sourced SixMaps**

# 2 SURROUNDING RECEIVERS

The nearest sensitive noise receivers are identified below.

**Receiver 1:** Single and two storey residential dwellings located to the north of the site adjoining the northern boundary. Receivers are located on the southern side of Grove Street from (No. 66-84). These receivers will be known as *Grove Street Receivers* in this report and have been highlighted in Figure 2 below.

**Receiver 2:** Single and two storey residential dwellings located to the east of the project site adjoining the eastern boundary. These residential dwellings are located to the south of Grove Street whilst bounding the eastern boundary of the project site, these dwellings include 58c and 64 Grove Street. These receivers will be known as the *Eastern Grove Street Receivers* in this report and have been highlighted in Figure 2 below

**Receiver 3:** Single and two storey residential dwellings located to the south west of the project site across Arilla Avenue are located on the southern side of Arilla Avenue, these dwellings include 2-2a, 74a and 74 Arilla Avenue. These Receivers will be known as the *Arilla Street Receivers* in this report and have been highlighted in Figure 2 below.

**Receiver 4:** Duel storey town house residential dwellings located to the west of the project site across Karne Street, North are located on the western side of Karne Street, North. These dwellings include 78 Karne Street, North and 1 Arilla Avenue. These Receivers will be known as the Karne Street, North Receivers in this report and have been highlighted in Figure 2 below.

A map showing the site location as well as nearest receivers is provided in Figure 2 below. This figure also shows the location of onsite unattended measurements which were conducted as part of this assessment.

**Figure 2 Site Map, Measurement Location and Surrounding Receivers – Site map Sourced from SixMaps**

# 3 ACOUSTIC NOISE SURVEY

## 3.1 Onsite Noise Measurements

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

### 3.1.1 Unattended Noise Monitoring

An unattended noise survey was conducted between Monday the 9th of November 2022 – to the 16th of November 2022 towards the western side of the project site as shown in Figure 2 above. This survey was conducted to measure the existing background noise level. All data in the graphs presented in Appendix B have ben been corrected (i.e., raw data is presented).

Instrumentation for the survey comprised one Rion NL-42 sound level meter (Serial number 1000233) Calibration of the logger 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 The charts present each 24-hour period and show the LA1, LA10, $L_{Aeq}$ and LA90 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.

#### 3.1.1.1 Results in accordance with the NSW EPA Noise Policy for Industry 2017 (RBLs)

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 LA90 (15minute) and LAeq noise levels are presented in Table 2.

Data affected by adverse meteorological conditions and by spurious and uncharacteristic events have been excluded from the results, and also excluded from the data used to determine the noise emission criteria. Meteorological information has been obtained from the Canterbury (ID 066194) which is located within 10km of the project site. Levels presented below are processed results with extraneous weather events removed.

**Table 2 Measured Ambient Noise Levels corresponding to the NPI's Assessment Time Periods**

| Measurement Location | 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) |
| Proposed Project Site (Lots D&C in DP403467, Lot 2 in DP518877 And Lot 2 & 3 in DP 16063) | 55 | 62 | 53 | 57 | 46 | 56 |

*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 $L_{A90}$ noise levels during the evening and night periods are equal to the recommended minimum noise levels to be adopted by the NSW EPA NPI.
- Measured $L_{A90}$ noise levels during the daytime are below the minimum prescribed noise levels outlined in the NPI (i.e., 35dBA $L_{A90}$ (7:00am to 6:00pm)). Therefore, for the purpose of this assessment we will adopt the minimum noise levels during the day period.
- All measured noise levels are similar to those typically found in a suburban amenity area.

#### 3.1.1.2 Results in accordance with the NSW Department of Planning "Development near Rail Corridors and Busy Roads – Interim Guideline"

In determining the required façade construction for the proposed building in accordance with the internal noise level requirements of NSW Department of Planning "Development near Rail Corridors and Busy Roads – Interim Guideline", measured noise levels are shown based on the time periods defined by the SEPP below.

Data affected by adverse meteorological conditions and by spurious and uncharacteristic events have been excluded from the results, and also excluded from the data used to determine the noise emission criteria.

**Table 3 Measured Ambient Noise Levels corresponding to the "Development near Rail Corridors and Busy Roads – Interim Guideline" Assessment Time Periods**

| Measurement Location | Daytime [1] 7:00 am to 10:00 pm | Night-time [1] 10:00 pm to 7:00 am |
|---|---|---|
| | $L_{Aeq\ (whole\ period)}$[2] (dBA) | $L_{Aeq\ (whole\ period)}$[2] (dBA) |
| Proposed Project Site (Lots D&C in DP403467, Lot 2 in DP518877 And Lot 2 & 3 in DP 16063) – See Figure | 62 | 56 |

*Note 1 For Monday to Sunday, Daytime 7:00 am – 10:00 pm; Night-time 10:00 pm – 7:00 am.*

*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.*

# 4 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.

## 4.1 External Noise Emission Criteria

### 4.1.1 Canterbury Development Control Plan (DCP) 2012

Acoustic requirements relevant to noise emitted from the building are not provided in the Canterbury DCP 2012 document. Therefore, requirements of the NSW EPA Noise Policy for Industry 2017 and Road Noise Policy 2011 will be adopted. Each is discussed in detail below.

### 4.1.2 NSW EPA Noise Policy for Industry (NPI) 2017

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

The assessment of noise emissions from the operation of the building services and loading dock areas are required to be assessed in accordance with the requirements of the NSW EPA Noise Policy for Industry, which is detailed in this section of the report.

The NSW EPA has recently released a document titled Noise Policy for Industry (NSW NPfI) 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.

#### 4.1.2.1 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 (LAeq), 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.

#### 4.1.2.2 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 particular 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 LAeq,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. LAeq,period(traffic) minus 15 dBA).

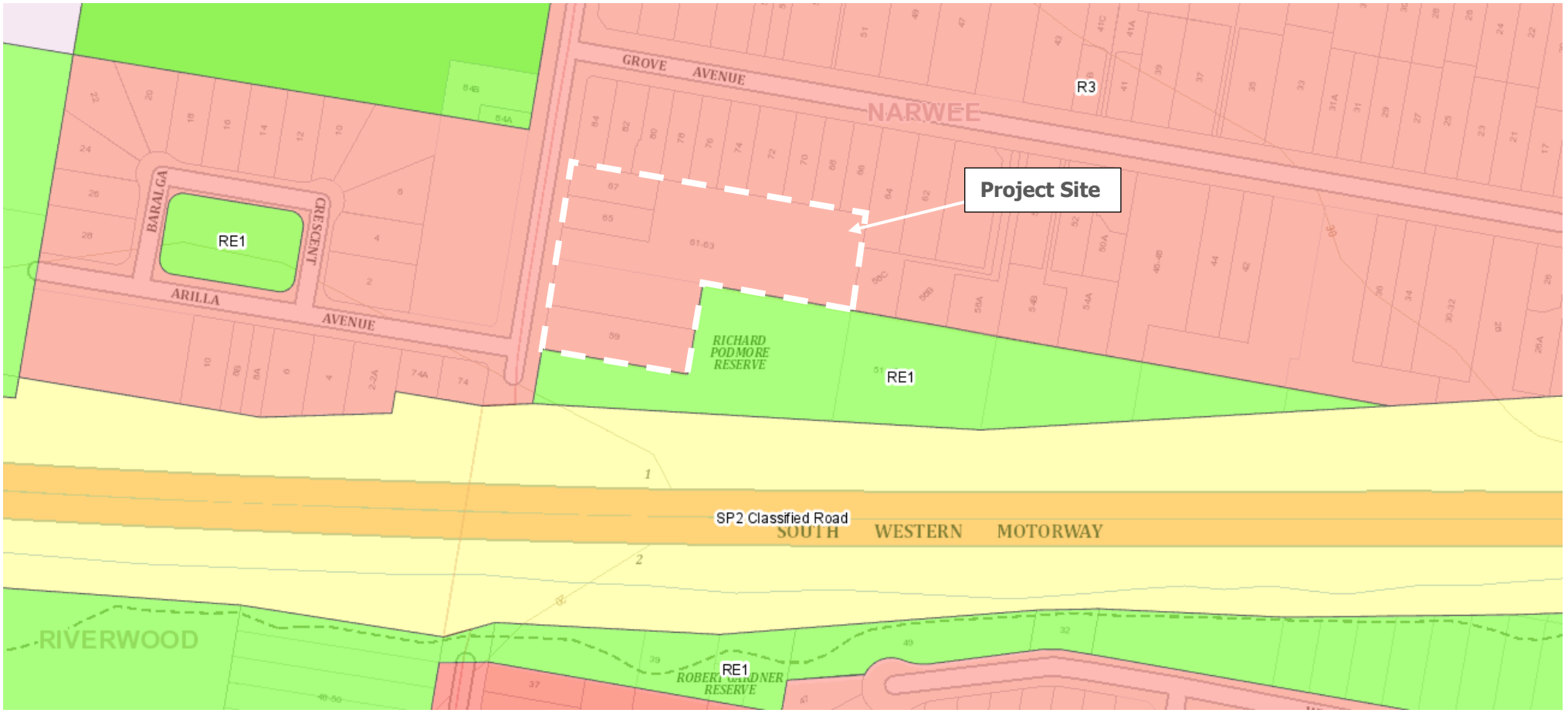
#### 4.1.2.3 Residential Receivers - Area Classification

The NSW NPI characterises 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 has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.

Figure 3 is obtained from the NSW ePlanning Spatial Viewer and shows the land zoning map of the proposed site and the nearest sensitive receivers.

**Figure 3 NSW ePlanning Spatial Viewer**



As shown above, the site and its surrounding receivers are within an area made up of R1 (residential). Based on classification of R1, using table 2.3 of the NPI (see below), the amenity category would an urban receiver. However, using the measured onsite noise levels we believe the most appropriate classification for the surrounding residential receivers is suburban.

**Figure 4 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<br>RU2 – rural landscape<br>RU4 – primary production small lots<br>R5 – large lot residential<br>E4 – environmental living | Daytime RBL <40 dB(A)<br>Evening RBL <35 dB(A)<br>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.<br>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<br>RU6 – transition<br>R2 – low density residential<br>R3 – medium density residential<br>E2 – environmental conservation<br>E3 – environmental management | Daytime RBL<45 dB(A)<br>Evening RBL<40 dB(A)<br>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<br>R4 – high density residential<br>B1 – neighbourhood centre (boarding houses and shop-top housing)<br>B2 – local centre (boarding houses)<br>B4 – mixed use | Daytime RBL> 45 dB(A)<br>Evening RBL> 40 dB(A)<br>Night RBL >35 dB(A) | **Urban** – an area with an acoustical environment that:<br>• 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<br>• has through-traffic with characteristically heavy and continuous traffic flows during peak periods<br>• is near commercial districts or industrial districts<br>• 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 urban receivers are shown below.

**Table 4 NSW NPI – Recommended LAeq Noise Source from Noise Sources**

| Type of Receiver | Indicative Noise Amenity Area | Time of Day1 | 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 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*

#### 4.1.2.4 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:
>
> - LAeq,15min 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
> - LAFmax 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater, a detailed maximum noise level event assessment should be undertaken.

#### 4.1.2.5 Project specific External Noise Emission Criteria

**(Assessment of Building Services and onsite vehicle noise)**

The intrusive, amenity and maximum noise event criteria for 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 building services 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. These are shown in bold text in Table 5.

**Table 5 Measured Ambient Noise Levels corresponding to the "Development near Rail Corridors and Busy Roads – Interim Guideline" Assessment Time Periods**

| Receiver Type | 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 [4] (dBA) | Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) | Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) |
|---|---|---|---|---|---|---|
| Surrounding Residences | Day | 50 | 55 | 62 | 60 | **53** |
| | Evening | 40 | 53 | 57 | 58 | **43** |
| | Night | 35 | 46 | 56 | 51 | **38** |

*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 – 1:00 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 – 1:00 am.*

*Note 2 Project Amenity Noise Levels corresponding to "Suburban" areas, equivalent to the Recommended Amenity Noise Levels minus 5 dBA.*

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

*Note 4 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*

*Note 5 According to Section 2.2 of the NSW NPI, the $L_{Aeq, 15\ minutes}$ is equal to the $L_{Aeq, period}$ + 3 dB.*

*Note 6 Project Noise Trigger Levels are shown in bold.*

### 4.1.3 NSW EPA (Formerly DECCW) NSW Road Noise Policy (RNP) 2011

This section of the report details the relevant noise assessment of noise resulting from additional traffic volumes on surrounding roadways.

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.

## 4.2 Noise Intrusion Criteria

### 4.2.1 Canterbury Development Control Plan (DCP) 2012

Acoustic requirements relevant to noise emitted from the development are not provided in the Canterbury DCP 2012 document. Therefore, requirements from the Australian/New Zealand Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors - (AS/NZS 2107:2016), see below.

### 4.2.2 Australian / New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors – (AS/NZS 2107:2016)

Recommended ambient noise levels and reverberation times for internal spaces are given in a number of publications including Table 1 of Australian / New Zealand Standard 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors". Unlike the previous version of this Standard, this latest edition 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.

Internal noise levels due to the combined contributions of external noise intrusion and mechanical ventilation plant should not exceed the maximum levels recommended in this Standard. The levels for areas relevant to this development are given in Table 6 below. The mid to maximum points of the internal noise level ranges are generally adopted as the internal design noise criteria for the combined effect of mechanical services and external noise intrusion. In this report we will confine our recommendations to dBA levels, however, where the background noise appears to be unbalanced, 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.

**Table 6 Recommended Design Sound Levels**

| Type of Occupancy/Activity | Design sound level range dBA ($L_{Aeq,t}$ ) | Project Design Noise Level [1] dBA ($L_{Aeq,t}$) |
|---|---|---|
| Residential Buildings— | | |
| Houses and apartments in suburban areas or near minor roads — | | |
| Sleeping areas (night-time) | 30 to 35 | 35 |
| Living areas (anytime) | 30 to 40 | 40 |
| Washrooms and toilets (anytime) | 45 to 55 | 50 |

*Note 1 Overall recommended level for mechanical services noise and intrusive noise, combined.*

Section 6.18 of 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).

If tonal components are significant characteristics of the sound within a measurement time interval, an adjustment shall be applied for that time interval to the measured A-weighted sound pressure level to allow for the additional annoyance. If the background sounds include spectral imbalance, then the RC (Mark II) levels indicated in the Standard should be referenced (see also Appendix D of AS/NZ 2107:2016 for additional guidance).

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 is to be avoided.

## 4.3 Construction Noise and Vibration Criteria

### 4.3.1 Construction Noise Criteria

Relevant construction noise criteria applicable to this project are outlined below and include the relevant councils and NSW planning requirements.

### 4.3.2 Canterbury Council Development Control Plan (DCP) 2012

Acoustic requirements relevant to construction noise and vibration levels emitted from the site are not provided in the Canterbury DCP 2012 document. Therefore, requirements of the NSW EPA ICNG 2009 will be adopted. Each is discussed below.

#### 4.3.2.1 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 in order 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 7 NMLs for Quantitative Assessment at Residences**

| Time of Day | Noise Management Level $L_{Aeq(15minute)}$ [1,2] | How to Apply Table Header |
|---|---|---|
| Recommended Standard Hours:<br>Monday to Friday<br>7am to 6pm<br>Saturday 8am to 1pm<br>No Work on Sundays or public holidays<br><br>Or approved working hours as part of the projects consent conditions | Noise affected RBL + 10 dB | The noise affected level represents the point above which there may be some community reaction to noise.<br>• Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>• 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 75dBA | The highly noise affected level represents the point above which there may be strong community reaction to noise.<br>• 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:<br>○ 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.<br>○ 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 or approved working hours | Noise Affected<br>RBL + 5dB | • A strong justification would typically be required for works outside the recommended standard hours.<br>• The proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>• 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 3.1.1 and the NMLs outlined above, the construction noise criteria to be used in this assessment is listed in Table 8 below.

**Table 8 NMLs as basis for acoustic assessment**

| Receiver Type | Standard Hours<br>Monday to Friday<br>7:00am to 6:00pm<br>Saturday:<br>8:00am to 1:00pm | Outside Standard Hours<br>All hours not listed in the adjacent column |
|---|---|---|
| Residences<br>(Measured Externally) | **NAFL:**<br>**65**<br>(RBL (55) + 10dB)<br>**HNAL**<br>**75** | RBL + 5dB |

### 4.3.3 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.

#### 4.3.3.1 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 9 Continuous vibration acceleration criteria (m/s²) 1Hz – 80Hz**

| Location | Assessment period | Preferred Values | | Maximum Values | |
|---|---|---|---|---|---|
| | | z-axis | x- and y-axis | z-axis | x- and y-axis |
| Critical working areas (e.g. hospital operating theatres, precision laboratories) | Day or night-time | 0.0050 | 0.010 | 0.10 | 0.20 |
| Residences | Daytime | 0.010 | 0.0071 | 0.020 | 0.014 |
| | Night-time | 0.007 | 0.005 | 0.014 | 0.010 |
| Offices, schools, educational institutions and places of worship | Day or night-time | 0.020 | 0.014 | 0.040 | 0.028 |
| | | 0.04 | 0.029 | 0.080 | 0.058 |
| Workshops | Day or night-time | 0.04 | 0.029 | 0.080 | 0.058 |

**Table 10 Impulsive vibration acceleration criteria (m/s²) 1Hz-80Hz**

| Location | Assessment period | Preferred Values | | Maximum Values | |
|---|---|---|---|---|---|
| | | z-axis | x- and y-axis | z-axis | x- and y-axis |
| Critical working areas (e.g. hospital operating theatres, precision laboratories) | Day or night-time | 0.0050 | 0.010 | 0.10 | 0.20 |
| Residences | Daytime | 0.30 | 0.21 | 0.60 | 0.42 |
| | Night-time | 0.10 | 0.071 | 0.20 | 0.14 |
| Offices, schools, educational institutions and places of worship | Day or night-time | 0.64 | 0.46 | 1.28 | 0.92 |
| Workshops | Day or night-time | 0.64 | 0.46 | 1.28 | 0.92 |

**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 |
| Critical working areas (e.g. hospital operating theatres, precision laboratories) | 0.10 | 0.20 | 0.10 | 0.20 |
| Residences | 0.20 | 0.40 | 0.13 | 0.26 |
| Offices, schools, educational institutions and places of worship | 0.40 | 0.80 | 0.40 | 0.80 |
| Workshops | 0.80 | 1.60 | 0.80 | 1.60 |

#### 4.3.3.2 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).

#### 4.3.3.3 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 12 and illustrated in Table 12.

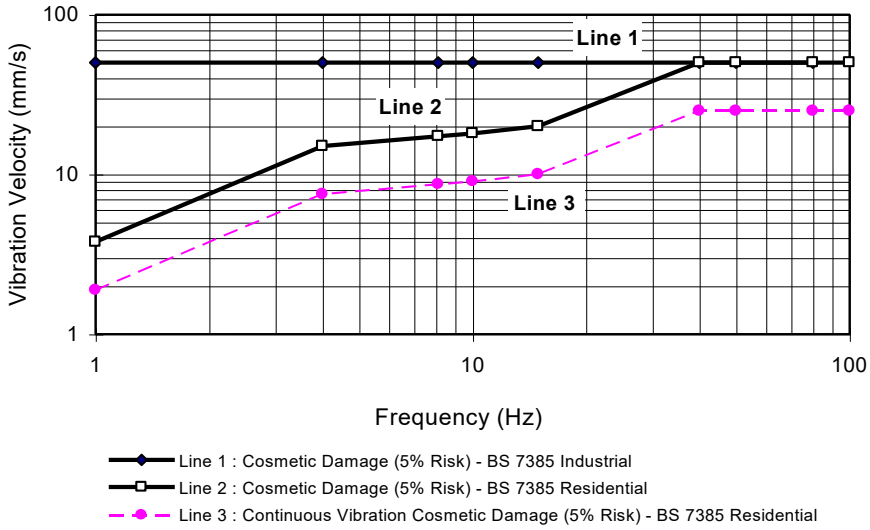
**Table 12 Transient vibration criteria as per standard BS 7385 Part 2 – 1993 Table**

| Line in Figure 5 | 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 Figure 5 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 Figure 5 may need to be reduced by up to 50% (refer to Line 3 in Figure 5)

**Figure 5 - BS7385 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 Table 10, 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 Table 10 should not be reduced for fatigue considerations.

#### 4.3.3.4 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 13. The criteria are frequency dependent and specific to particular categories of structures.

**Table 13 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 Hz1 | |
| 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 9 (e.g. buildings that are under a preservation order) | 3 | 3 to 8 | 8 to 10 | 8 |

### 4.3.4 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.

# 5 EXTERNAL NOISE INTRUSION ASSESSMENT

## 5.1 Façade Acoustic Treatments

Preliminary façade acoustic treatments based on the external levels from surrounding roads and other commercial operations as discussed in section 3.1.1 above are provided below.

### 5.1.1 Glazing Recommendations

The recommended sound transmission loss required to satisfy the internal noise level criteria outlined above are summarised in the table 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 14 Glazing Schedule – Bedroom Wards**

| Building | Façade Orientation | Occupancy Area | Minimum Glazing System Rating Requirements [1] | Recommended Construction |
|---|---|---|---|---|
| Narwee Parklands Care Community | Southern façade facing towards M5 motorway | Dwellings | Rw (C; Ctr) 35 (-1;-3) | 10.38mm Laminate OR 6/12/10 IGU |
| | | FOH/Lobby/Amenity rooms | Rw (C; Ctr) 35 (-1;-3) | 10.38mm Laminate OR 6/12/10 IGU |
| | Buildings B, E and I – Eastern façade element | Dwellings | Rw (C; Ctr) 35 (-1;-3) | 10.38mm Laminate OR 6/12/10 IGU |
| | All other façade orientations | Dwellings | Rw (C; Ctr) 30 (-1;-3) | 6.38mm Laminate OR 6/12/6 IGU |
| | | FOH/Lobby/Amenity rooms | Rw (C; Ctr) 30 (-1;-3) | 6.38mm Laminate OR 6/12/6 IGU |

Note 1 *These are preliminary selections, will be confirmed in the detailed design stage once the layouts and façade orientations are finalised.*

*Glazing recommendations have been formulated in conjunction with noise emission control mitigation measures*

### 5.1.2 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 15 Recommended Light Weight Wall Construction**

| Location | Occupancy Area [1] | Minimum External Wall Rating Requirements | Comments |
|---|---|---|---|
| All façade orientations | All room type | Rw (C;Ctr): 45 (-0;-11) | Standard building constructions including external cladding, timer or metal framing, internal plasterboard lining and insulation in the cavity. |

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.

### 5.1.3 External Roof Construction

If the proposed external building elements are inclusive of masonry or concrete elements, external roofs are acoustically acceptable without additional acoustic treatment.

If the external roofs are to be constructed from a lightweight sheet metal cladding. It is recommended the following minimum construction is installed.

**Table 16 Recommended Light Weight Roof Construction**

| Building | Occupancy Area | Minimum External Roof Rating Requirements | Comments |
|---|---|---|---|
| All room types | All room types | Rw (C;Ctr): 45 (-0;-9) | Standard construction including metal deck roofing, plasterboard ceilings and insulation in the ceiling cavity, similar to 50mm thick 11kg/$m^3$ type. |

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.

## 5.2 Alternative Ventilation Requirements

An assessment of the required internal noise levels within external windows open for natural ventilation has been undertaken.

As part of the acoustic investigation internal noise levels within the development with windows open to provide for the requirement of natural ventilation has been undertaken. The assessment has been based on the requirements of the EPA's document - Development near Rail Corridors and Busy Roads, which outlines the following:

> *'If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia.'*

Based on the recorded noise levels undertaken as part of the acoustic survey of the site, and detailed in this report, internal noise levels within the future dwellings with the windows open for natural ventilation will be within the requirement of design noise levels + 10 dB(A) and therefore an alternative method of providing an outside air source is not required to be provided to the development (including all façade orientations).

# 6 OPERATIONAL NOISE EMISSION ASSESSMENT

Assessment of the potential noise emissions from the operation of the Narwee Parklands Care Community 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 and activity noise. Each major component is discussed in detail below.

## 6.1 Noise from Engineering Services

At this stage of the project, the following information is known regarding the mechanical conditioning/ventilation strategies:

- Locations of external plant areas are known and are provided on the architectural drawings.
- Indicatively, types and number of units are known.
- Exact selections and their associated noise level are not known at this stage.

As such, a detailed acoustic review cannot be undertaken at this stage. However, to ensure that proposed locations of external plant items are capable of being acoustically compliant with the noise objectives outlined above. Proof-of-concept assessment is undertaken below based off our experience on similar projects.

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) – Café – 75dBA (Lw) per unit.
- Air Conditioning Condensers – Office Areas, Learning Areas, Library etc. – 70dBA (Lw) per unit.
- Toilet Exhaust Fans (TEF) – Bathrooms – 55dBA (Lw)

It is anticipated that KEF serving the café will vertically discharge through the external roof. 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 acoustic treatment of the plant items will be required. Further details of the acoustic treatment will be formulated during the detailed design phase.

Regarding Air Conditioning condensers, further details of the acoustic treatment will be formulated during the detailed design phase.

# 7 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

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

## 7.1 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 each of the listed tasks are provided in table below.

**Table 17 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 and Demolition | Excavator | 112 | 119 |
| | Hand held jack hammer[1] | 111 | |
| | Dump truck[1] | 104 | |
| | Concrete saw[1] | 114 | |
| | Skid steer | 110 | |
| | Power hand tools | 109 | |
| Structure | Hand held jack hammer[1] | 106 | 117 |
| | Concrete saw[1] | 114 | |
| | Power hand tools | 109 | |
| | Welder | 101 | |
| | Concrete pump truck | 110 | |
| | Concrete agitator truck | 108 | |
| Internal Works | Power hand tools | 109 | 109 |
| Common and External Works | Concrete agitator truck | 108 | 117 |
| | 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.*

## 7.2 Predicted Construction Noise Levels

Predicted construction noise levels are presented below for each of the surrounding receivers in accordance with the NSW EPA ICNG.

**Table 18 Summary of preliminary predicted construction noise levels – Receiver 1 – Grove Street Receivers**

| 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 | 60 to 88 | 64 to 91 | **Monday to Friday**<br>07.00-18.00<br>55 + 10 = **65**<br><br>**Saturday**<br>08.00-13.00<br>55 + 10 = **65**<br><br>**Highly Noise Affected Level**<br>Standard Construction Hours<br>**75** | Works indicatively predicted to have the potential to exceed the internal noise management level when working near a receiver. |
| | Power hand tools | | 59 to 87 | | | |
| | Semi Rigid Vehicle | | 56 to 83 | | | |
| Ground Works and Demolition | Excavator | 119 | 62 to 90 | 69 to 96 | | |
| | Handheld jack hammer | | 57 to 84 | | | |
| | Dump truck | | 55 to 82 | | | |
| | Concrete saw | | 65 to 92 | | | |
| | Skid steer | | 60 to 88 | | | |
| | Power hand tools | | 59 to 87 | | | |
| Structure | Handheld jack hammer | 117 | 57 to 84 | 67 to 95 | | |
| | Concrete saw | | 65 to 92 | | | |
| | Power hand tools | | 59 to 87 | | | |
| | Welder | | 51 to 79 | | | |
| | Concrete pump truck | | 50 to 78 | | | |
| | Concrete agitator truck | | 58 to 86 | | | |
| Internal Works | Power hand tools | 109 | 44 to 72 | 44 to 72 | | |
| Common and External Works | Concrete agitator truck | 117 | 51 to 79 | 63 to 91 | | |
| | Saw cutter | | 55 to 82 | | | |
| | Dump truck | | 55 to 82 | | | |
| | Concrete saw | | 56 to 83 | | | |
| | Power hand tools | | 59 to 87 | | | |

**Table 19 Summary of preliminary predicted construction noise levels – Receiver 2 – Grove East Street Receivers**

| 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 | 60 to 88 | 64 to 91 | **Monday to Friday**<br>07.00-18.00<br>55 + 10 = **65**<br><br>**Saturday**<br>08.00-13.00<br>55 + 10 = **65**<br><br>**Highly Noise Affected Level**<br>Standard Construction Hours<br>**75** | Works indicatively predicted to have the potential to exceed the internal noise management level when working near a receiver. |
| | Power hand tools | | 59 to 87 | | | |
| | Semi Rigid Vehicle | | 56 to 83 | | | |
| Ground Works and Demolition | Excavator | 119 | 62 to 90 | 69 to 96 | | |
| | Handheld jack hammer | | 57 to 84 | | | |
| | Dump truck | | 55 to 82 | | | |
| | Concrete saw | | 65 to 92 | | | |
| | Skid steer | | 60 to 88 | | | |
| | Power hand tools | | 59 to 87 | | | |
| Structure | Handheld jack hammer | 117 | 57 to 84 | 67 to 95 | | |
| | Concrete saw | | 65 to 92 | | | |
| | Power hand tools | | 59 to 87 | | | |
| | Welder | | 51 to 79 | | | |
| | Concrete pump truck | | 50 to 78 | | | |
| | Concrete agitator truck | | 58 to 86 | | | |
| Internal Works | Power hand tools | 109 | 44 to 72 | 44 to 72 | | |
| Common and External Works | Concrete agitator truck | 117 | 51 to 79 | 63 to 91 | | |
| | Saw cutter | | 55 to 82 | | | |
| | Dump truck | | 55 to 82 | | | |
| | Concrete saw | | 56 to 83 | | | |
| | Power hand tools | | 59 to 87 | | | |

**Table 20 Summary of preliminary predicted construction noise levels – Receiver 3 – Grove East Street Receivers**

| 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 | 60 to 88 | 64 to 91 | **Monday to Friday**<br>07.00-18.00<br>55 + 10 = **65**<br><br>**Saturday**<br>08.00-13.00<br>55 + 10 = **65**<br><br>**Highly Noise Affected Level**<br>Standard Construction Hours<br>**75** | Works indicatively predicted to have the potential to exceed the internal noise management level when working near a receiver. |
| | Power hand tools | | 59 to 87 | | | |
| | Semi Rigid Vehicle | | 56 to 83 | | | |
| Ground Works and Demolition | Excavator | 119 | 62 to 90 | 69 to 96 | | |
| | Handheld jack hammer | | 57 to 84 | | | |
| | Dump truck | | 55 to 82 | | | |
| | Concrete saw | | 65 to 92 | | | |
| | Skid steer | | 60 to 88 | | | |
| | Power hand tools | | 59 to 87 | | | |
| Structure | Handheld jack hammer | 117 | 57 to 84 | 67 to 95 | | |
| | Concrete saw | | 65 to 92 | | | |
| | Power hand tools | | 59 to 87 | | | |
| | Welder | | 51 to 79 | | | |
| | Concrete pump truck | | 50 to 78 | | | |
| | Concrete agitator truck | | 58 to 86 | | | |
| Internal Works | Power hand tools | 109 | 44 to 72 | 44 to 72 | | |
| Common and External Works | Concrete agitator truck | 117 | 51 to 79 | 63 to 91 | | |
| | Saw cutter | | 55 to 82 | | | |
| | Dump truck | | 55 to 82 | | | |
| | Concrete saw | | 56 to 83 | | | |
| | Power hand tools | | 59 to 87 | | | |

**Table 21 Summary of preliminary predicted construction noise levels – Receiver 4 – Karne Street North Receivers**

| 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 | | 59 to 74 | 62 to 77 | **Monday to Friday**<br>07.00-18.00<br>55 + 10 = **65**<br><br>**Saturday**<br>08.00-13.00<br>55 + 10 = **65**<br><br>**Highly Noise Affected Level**<br>Standard Construction Hours<br>**75** | Works indicatively predicted to have the potential to exceed the internal noise management level when working near a receiver. |
| | Power hand tools | | 58 to 73 | | | |
| | Semi Rigid Vehicle | | 54 to69 | | | |
| Ground Works and Demolition | Excavator | 119 | 61 to 76 | 67 to 82 | | |
| | Handheld jack hammer | | 55 to 70 | | | |
| | Dump truck | | 53 to 68 | | | |
| | Concrete saw | | 63 to 78 | | | |
| | Skid steer | | 59 to 74 | | | |
| | Power hand tools | | 58 to 73. | | | |
| Structure | Handheld jack hammer | 117 | 55 to 70 | 66 to 81 | | |
| | Concrete saw | | 63 to 78 | | | |
| | Power hand tools | | 58 to 73 | | | |
| | Welder | | 50 to 65 | | | |
| | Concrete pump truck | | 49 to 64 | | | |
| | Concrete agitator truck | | 57 to 72 | | | |
| Internal Works | Power hand tools | 109 | 43 to 58 | 43 to 58 | | |
| Common and External Works | Concrete agitator truck | 117 | 50 to 65 | 61 to 77 | | |
| | Saw cutter | | 53 to 68 | | | |
| | Dump truck | | 53 to 68 | | | |
| | Concrete saw | | 54 to 69 | | | |
| | Power hand tools | | 58 to 73 | | | |

## 7.3 Construction Traffic Noise Assessment

It is assumed that the construction traffic would access the site via Karne Street, North

It is noted that vehicle numbers on surrounding roads would need to increase by around 60% from existing traffic flows, for a 2dB 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 phases, it is concluded that noise impacts from construction traffic is unlikely to have an impact at the nearest affected properties. As a result, no further assessment is required.

## 7.4 Vibration Assessment

In order to maintain compliance with the human comfort vibration criteria discussed in Section 4. It is recommended that the indicative safe distances listed in Table 22 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 4. This information should also be included as part of a *Construction Noise Vibration Management Plan* (CNVMP).

**Table 22 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 |

## 7.5 Acoustic Management Procedures

### 7.5.1 Summary of Management Procedures

Table 23 below summarises the management procedures recommended for airborne noise and vibration impact. These procedures are also further discussed in the report.

**Table 23 Summary of Mitigation Procedures**

| Procedure q | 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.<br>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.<br>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.<br>Alternatively, contractor could visit stakeholders individually in order to brief them in regards 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 7.5.2

For vibration, the criteria either correspond to human comfort, building damage or scientific and medical equipment. The applicant of these procedures is discussed in section 7.5.3

### 7.5.2 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 (refer to Section 4.3 for list of NMLs used in the acoustic assessment). The allocation of these procedures is summarised in Table 24 below.

**Table 24 Allocation of Noise Management Procedures – Residential Receivers**

| Table Header | Exceedance over NMLs (dB) | Management Procedures (see definition above) |
|---|---|---|
| **Standard Hours**<br>Mon-Fri: 7:00am to 6:00pm<br>Sat: 8:00am - 1:00pm | 0 – 3 | GMM |
| | 4 – 10 | GMM, PN, V 1, CMS, AC |
| | > 10 | GMM, PN, V, CMS, SN, AC |
| **Outside Standard Hours**<br>Sat: 1:00pm - 5:00pm | 0 – 10 | GMM, AC |
| | 11 – 20 | GMM, PN, V 1, CMS, AC |
| | >20 | GMM, PN, V, CMS, SN, RO, AC |
| *Note 1 Verification monitoring to be undertaken upon complaints received from affected receivers* | | |

### 7.5.3 Allocation of Vibration Management Procedures

Table 25 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 25 Allocation of vibration management procedures**

| Construction Hours | Exceedance Scenario | Management Procedures |
|---|---|---|
| **Standard Hours**<br>Mon – Fri: 7:00 am to 6:00 pm<br>Sat: 8:00 am – 1:00 pm | Over human comfort criteria (refer to section 4.3) | GMM, PN, V, RO |
| | Over building damage criteria (refer to section 4.3 ) | GMM, V, AC |
| **Outside Standard Hours**<br>Sat: 1:00 pm – 5:00 pm | Over human comfort criteria (refer to section 4.3 ) | GMM, SN, V, RO, CMS |
| | Over building damage criteria (refer to section 4.3 ) | GMM, V, AC |

## 7.6 Site Specific Noise Mitigation Measures

### 7.6.1 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.

### 7.6.2 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: $LA_{min}$, LA90, LA10, LA1, $L_{Amax}$ and $L_{Aeq}$. Unattended noise measurements should be conducted over consecutive 15 minute periods.

This monitoring should also be complemented by undertaking attended noise measurements in order 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.

### 7.6.3 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.

### 7.6.4 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).

## 7.7 Vibration Mitigation Measures

### 7.7.1 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 in order to validate the indicative safe working distances advised above 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 4.3 (i.e., criteria for structural damage, human comfort and impact to scientific or medical equipment).

### 7.7.2 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 (refer to Section 4.3).

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.

## 7.8 Community Consultation

### 7.8.1 Stakeholder Engagement

The overarching Communications and Stakeholder approach for the project, as well as the communications and engagement plans to support each stage of the development has been developed in line with guiding principles for capital projects, which centre on:

Proactive stakeholder engagement

- Proactive and transparent communications
- Coordinated information
- Collaboration

### 7.8.2 Stakeholders

The Project's stakeholder environment is complex. 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
- Workshops
- Door Knocks
- Letterbox Drops
- Email Notifications

## 7.9 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.

## 7.10 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.

## 7.11 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.

### 7.11.1 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 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.

### 7.11.2 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.

### 7.11.3 On Site Noise Mitigation

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

### 7.11.4 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.

### 7.11.5 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.

# 8 CONCLUSION

Pulse White Noise Acoustics Pty Ltd (PWNA) has undertaken a detailed acoustic assessment for the Narwee Parklands Care Community to be located along Karne Street North, Narwee. Review of existing onsite noise levels from nearby roadways has resulted in recommended acoustic treatments to the future buildings facades to ensure internal noise levels are within the permissible limits. These recommendations also assist with the control of noise emissions from the operation of the facility to comply with the relevant guidelines at nearby receivers.

If you have any additional questions please do not hesitate to contact us.

Kind Regards,

George Kinezos
**Acoustic Engineer**
PULSE WHITE NOISE ACOUSTICS PTY LTD

# APPENDIX A. APPENDIX 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<br>30dB(A) A quiet country park<br>40dB(A) Whisper in a library<br>50dB(A) Open office space<br>70dB(A) Inside a car on a freeway<br>80dB(A) Outboard motor<br>90dB(A) Heavy truck pass-by<br>100dB(A) Jackhammer/Subway train<br>110 dB(A) Rock Concert<br>115dB(A) Limit of sound permitted in industry<br>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]*<br>*(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. |

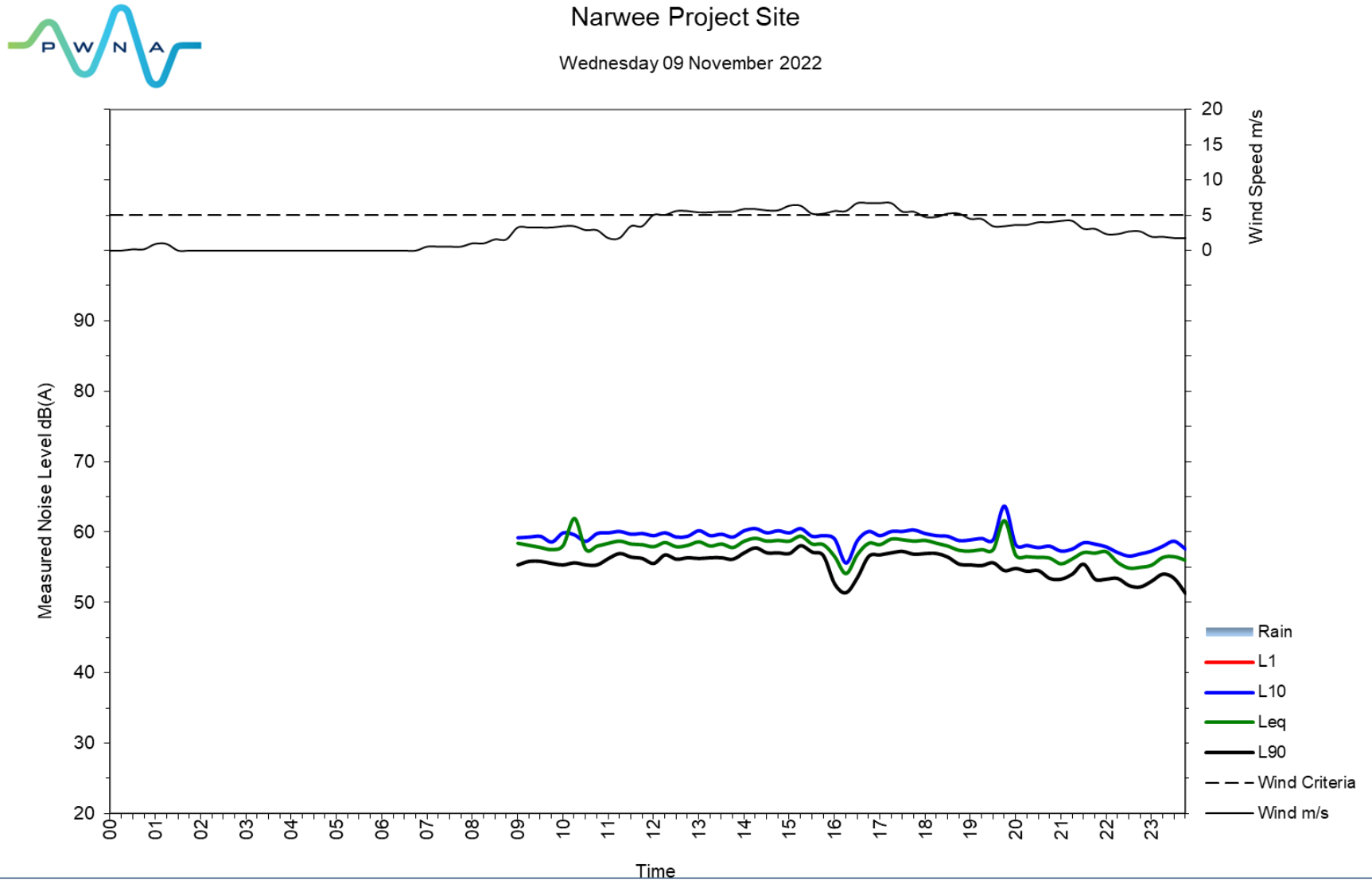
| | |
|---|---|
| *Impact sound isolation* | The resistance of a floor or wall to transmit impact sound. |
| *Impact sound pressure level [$L_i$]* | The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine. |
| *Normalised impact 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. |

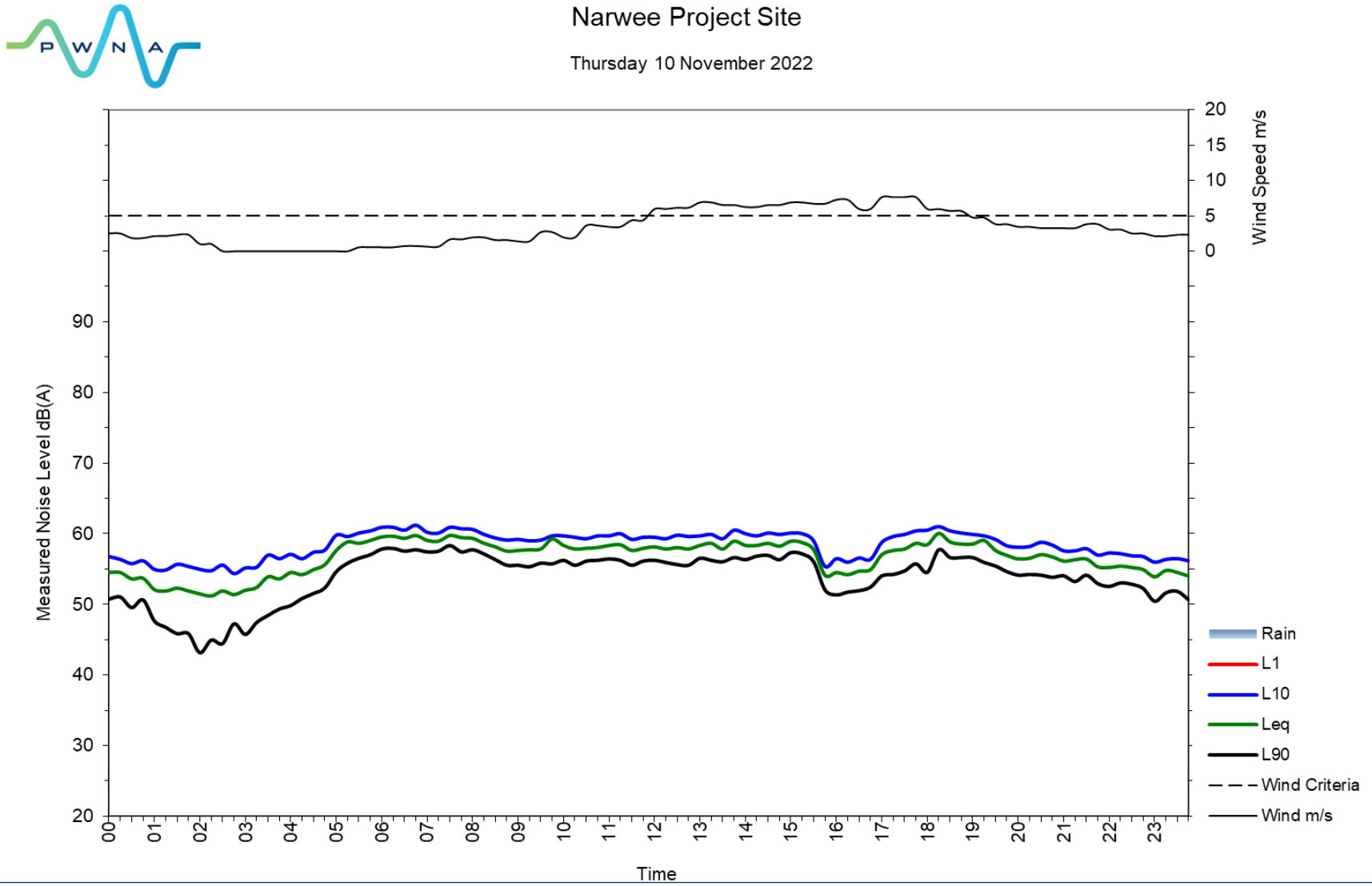
# APPENDIX B. UNATTENDED NOISE MONITORING RESULTS

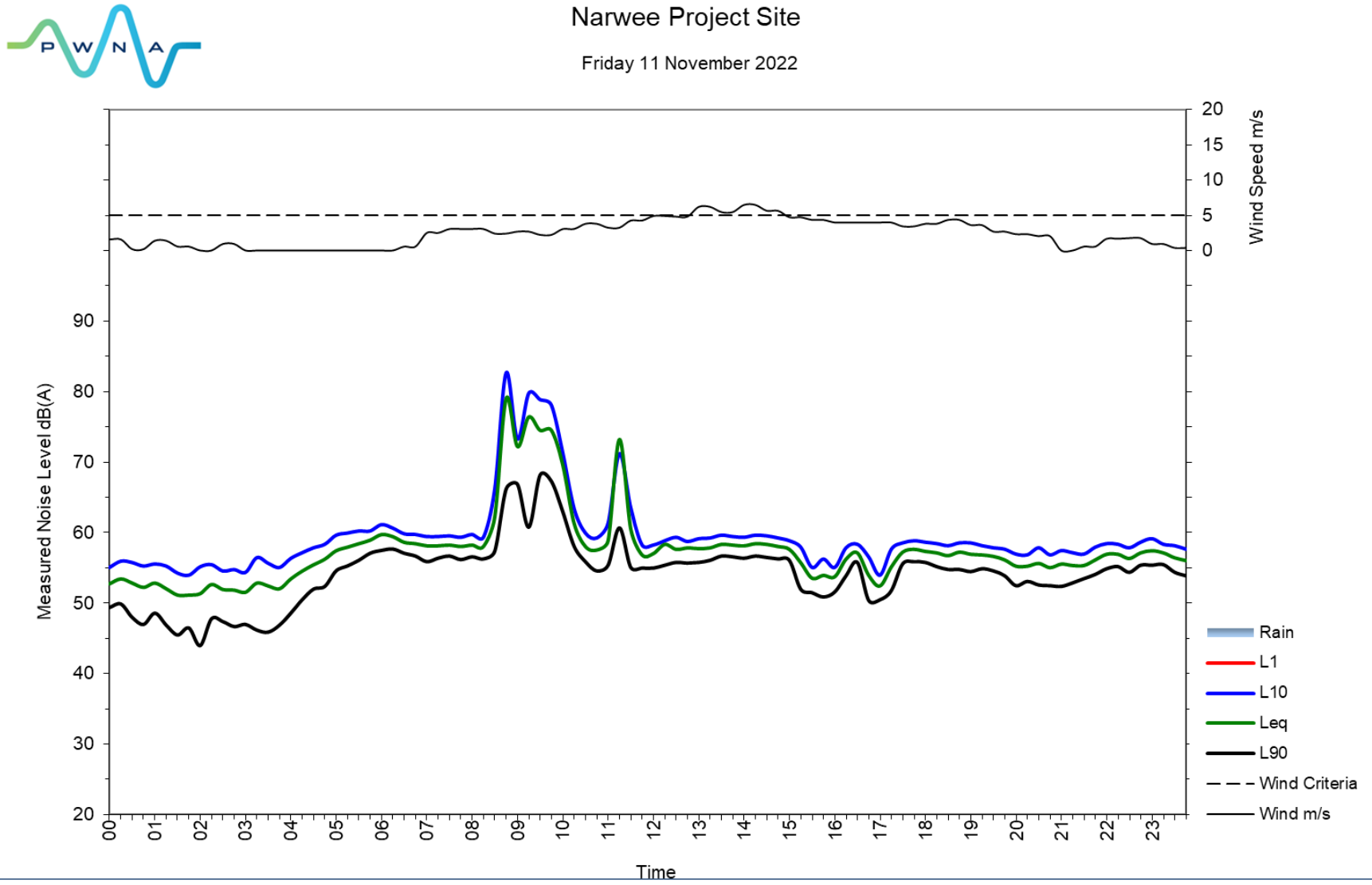
Weather Station: **Canterbury**

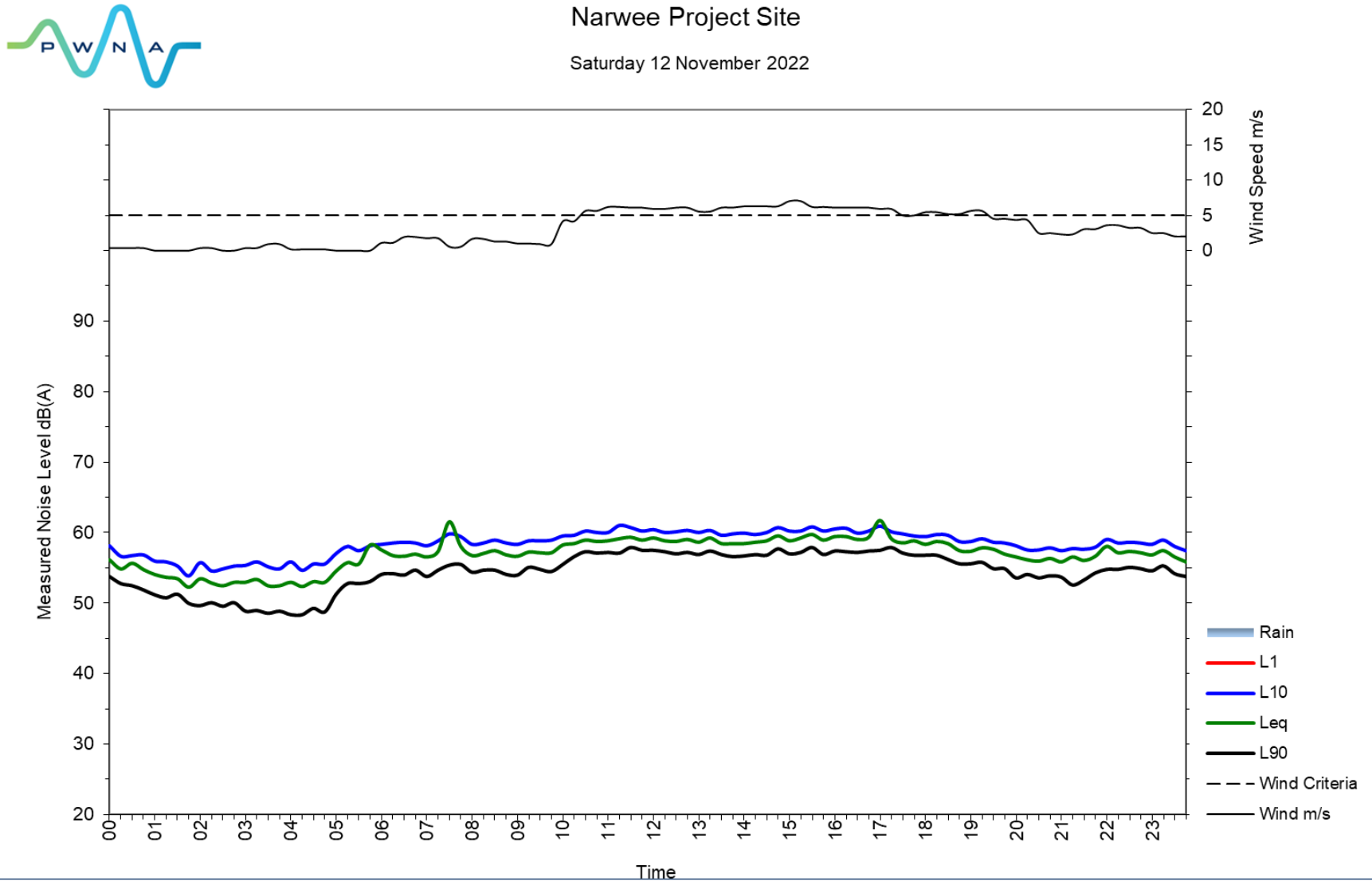
Weather Station ID: **066194**

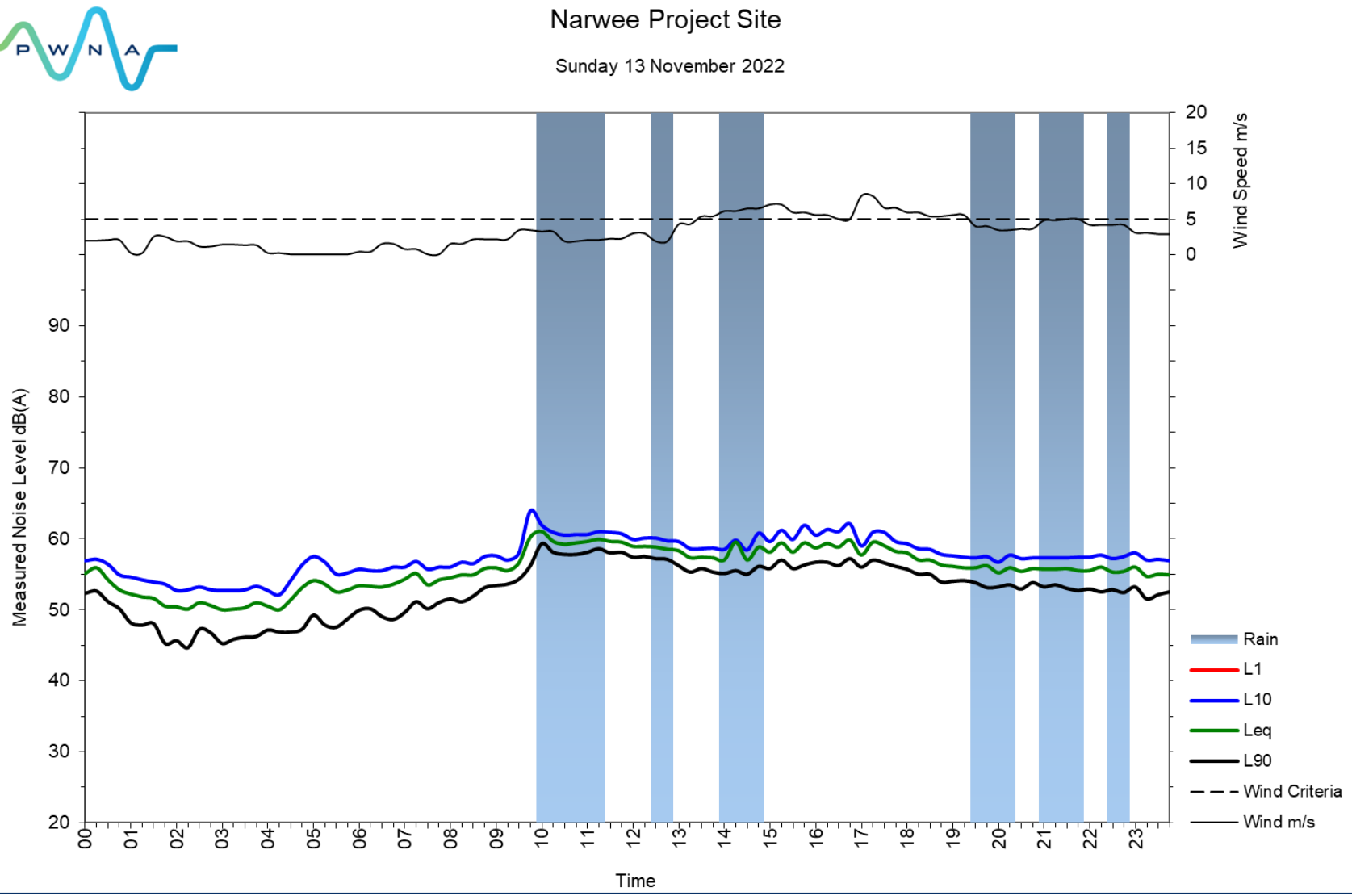
Co-Ordinates: Lat: -33.91, Lon: 151.11 Height: 3.0m

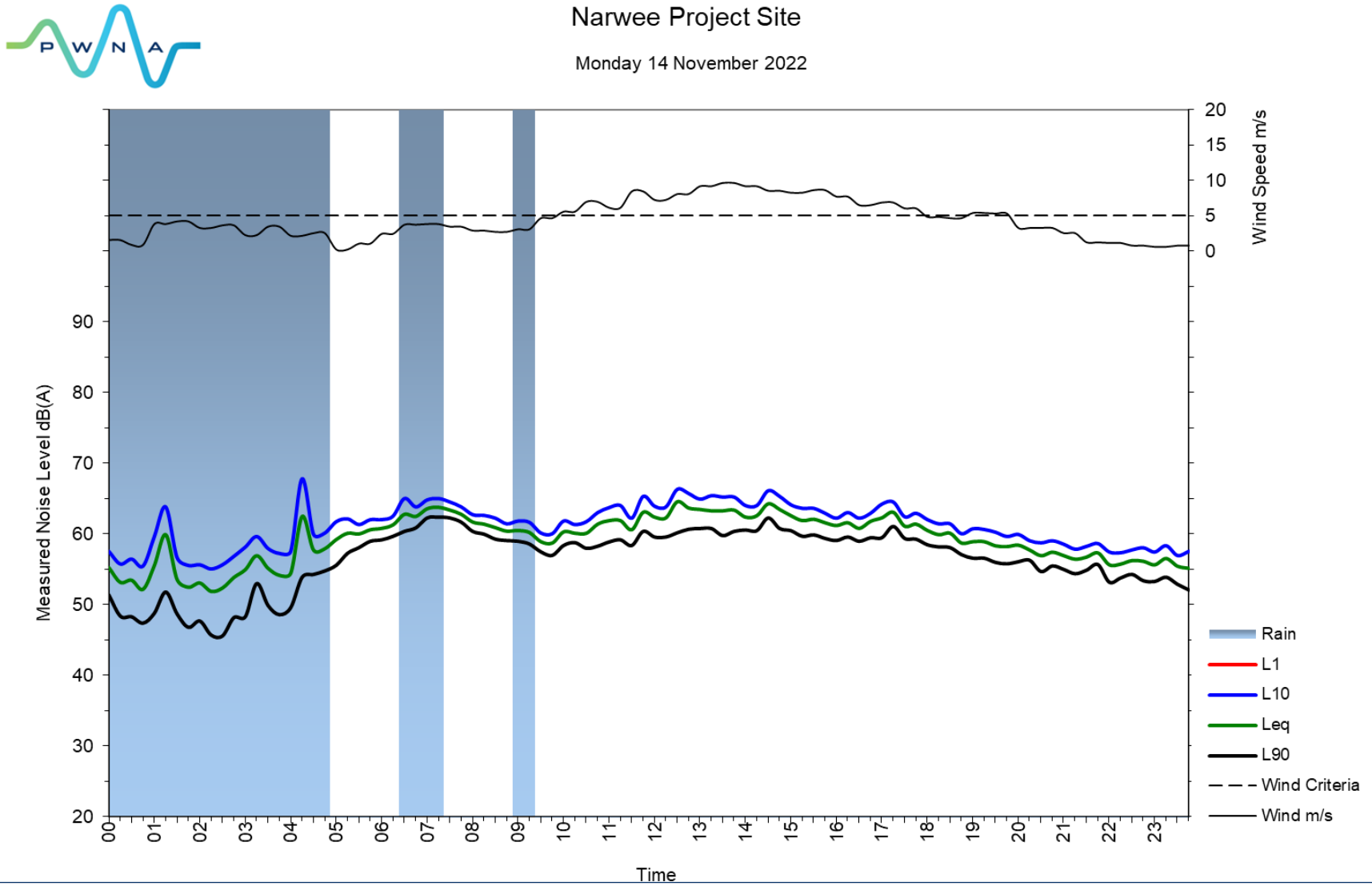

Narwee Project Site
Wednesday 09 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

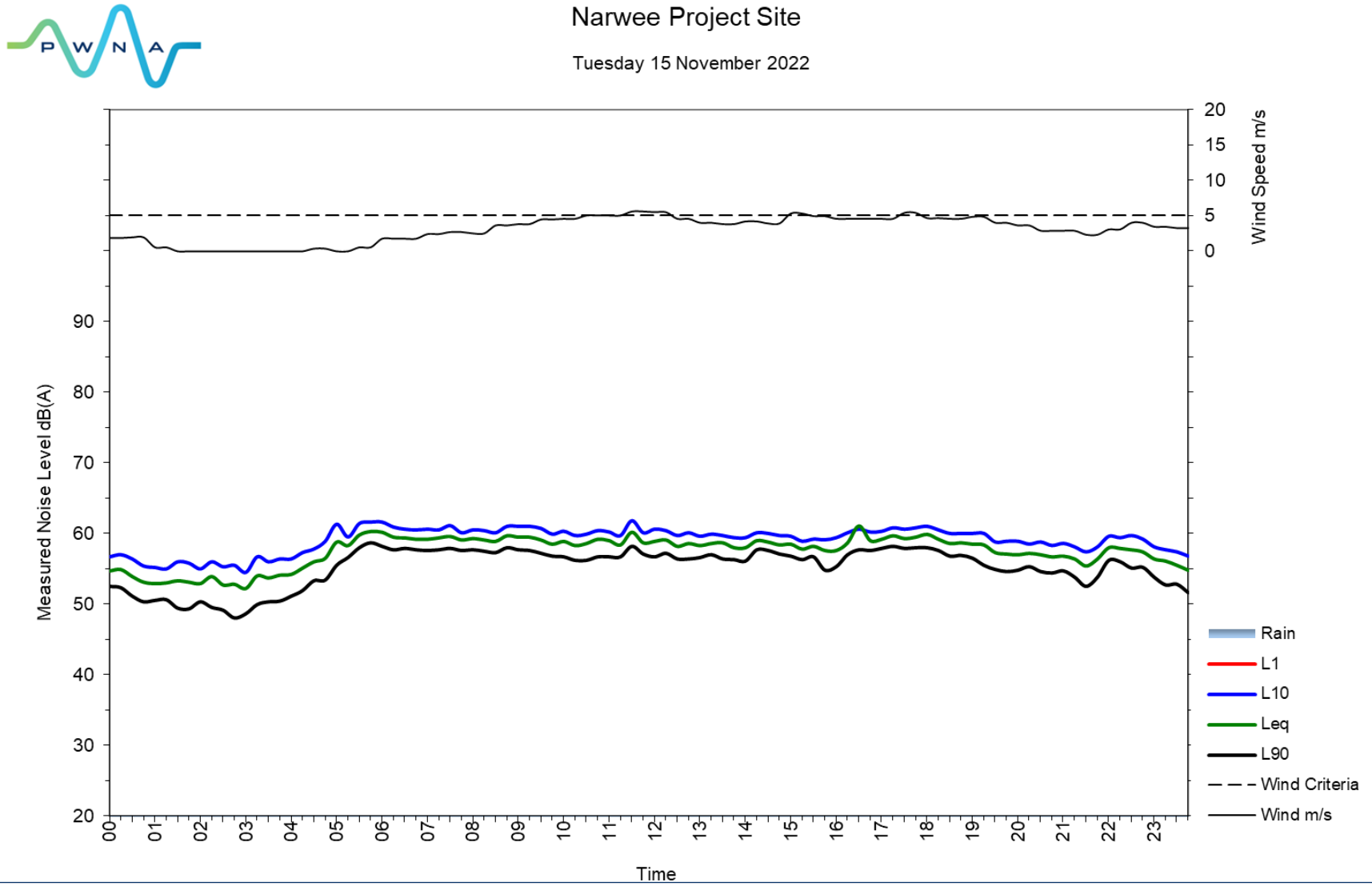

Narwee Project Site
Thursday 10 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

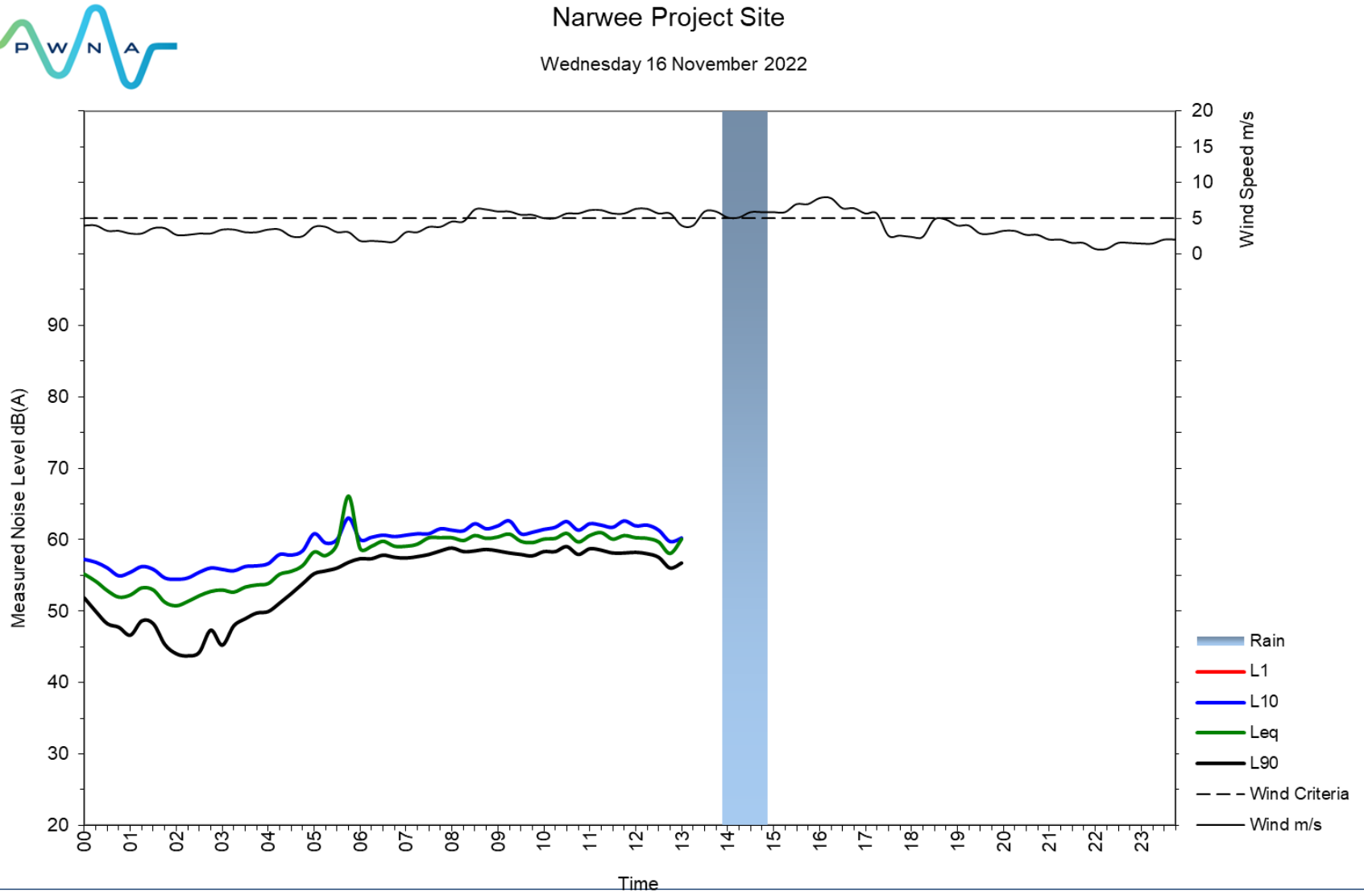

Narwee Project Site
Friday 11 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Narwee Project Site
Saturday 12 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Narwee Project Site
Sunday 13 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Narwee Project Site
Monday 14 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Narwee Project Site
Tuesday 15 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Narwee Project Site
Wednesday 16 November 2022
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s