The New Primary School in Mulgoa Rise, 1-23 Forestwood Drive, Glenmore Park – Construction Noise Vibration Management Sub-Plan (CNVMSP)

School Infrastructure NSW

Level 8, 259 George Street,
Sydney, NSW, 2000

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1 INTRODUCTION

Pulse White Noise Acoustics (PWNA) has been engaged by Schools Infrastructure NSW (SINSW) to prepare a Construction Noise and Vibration Management Sub-Plan (CNVMSP) for the construction of *The New Primary School in Mulgoa Rise* ("the Project") along Forestwood Drive, Glenmore Park NSW.

This CNVMSP has been prepared to satisfy the requirements of Condition B16 of the Consent given in the *Notice of Determination – Approval* issued for Development Application No. SSD-11070211.

Onsite unattended noise levels have previously been determined for the project by PWNA in the site's *Review of Environmental Factors – Noise and Vibration Assessment* submitted as part of the SSD Application reference "210327_Mulgoa Rise Primary School_REF", dated 16th December 2021. These levels are adopted for this assessment.

A glossary of acoustic terminology used throughout this report is included in Appendix A.

1.1 Condition Satisfaction

In addressing the requirements of Conditions B17, C13 and C16 (see table below), each item is addressed in the following section:

Table 1 Condition Satisfaction Table

CEMP Condition Satisfaction Table		
Condition	**Condition Requirements**	**Document/Sub-Plan Reference**
Condition B17	The Construction Noise and Vibration Management Sub-Plan must address, but not be limited to, the following:	-
	(a) be prepared by a suitably qualified and experienced noise expert;	Refer to Appendix D: Author Curriculum Vitae (CV) – Page 72
	(b) describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);	Refer to section 3.1.1 – Page 16.
	(c) describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;	Refer to section 5 – Page 31.
	(d) include strategies that have been developed with the community for managing high noise generating works;	Refer to section 5.4.5 – Page 36.
	(e) describe the community consultation undertaken to develop the strategies in condition B17(d);	
	(f) include a complaints management system that would be implemented for the duration of the construction; and	Refer to section 5.5 – Page 36.
	(g) include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the implemented management measures in accordance with the requirements of condition B14	Refer to section 5.2.3 & 5.3.2 – Page 36 & 35.

1.2 Environment Management Plan Checklist

As per Appendix A of the NSW Government's Environment Management Plan guideline the following preparation checklist has been populated.

Table 2 EMP Preparation Checklist

Requirement	Plan Reference	Yes/ No/ Not Applicable
Document preparation and endorsement		
Has the EMP been prepared in consultation with all relevant stakeholders as per the requirements of the conditions of consent? (Section 4.1)	Refer to section 5.4.5	Yes
Have the views of the relevant stakeholders been taken into consideration? Have appropriate amendments been made to the EMP and does the EMP clearly identify the location of any changes? (Section 4.1)	Refer to section 5.4.5	Yes
Has the EMP been internally approved by an authorised representative of the proponent or contractor? (Section 4.2)	Report issued to SINSW.	Yes
Version and Content		
Does the EMP describe the proponent's Environmental Management System (EMS) (if any), and identify how the EMP relates to other documents required by the conditions of consent? (Section 3.5.1)	-	Not Applicable
Does the EMP include the required general content and version control information? (Section 3.1)	Refer to Table 1	Yes
Does the EMP have an introduction that describes the project, scope of works, site location and any staging or timing considerations? (Section 3.2)	Refer to section 1	Yes
Does the EMP reference the project description? (Section 3.3)	Refer to section 1	Yes
Does the EMP reference a Community and Stakeholder Engagement Plan (or similar) or include community and stakeholder engagement actions (if required)? (Section 3.4)	Refer to section 0	Yes
Have all other relevant approvals been identified? Has appropriate information been provided regarding how each approval is relevant? (Section 4)	Refer to section 3	Yes
Has the environmental management structure and responsibilities been included? (Section 3.5.2)	-	Not Applicable
Does the EMP include processes for training of project personnel and identify how training and awareness needs will be identified? (Section 3.5.3)	-	Not Applicable
Does the EMP clearly identify the relevant legal and compliance requirements that relate to the EMP? (Section 3.5.3)	Refer to section 3	Yes
Does the EMP include all the conditions of consent to be addressed by the EMP and identify where in the EMP each requirement has been addressed? (Section 3.5.13)	Refer to section 3 and Table 1	Yes
Have all relevant guidelines, policies and standards been identified, including details of how they are relevant? (Section 3.5)	Refer to section 3	Yes
Is the process that will be adopted to identify and analyse the environmental risks included? (Section 3.5.5)	Refer to section 5	Yes
Have all the environmental management measures in the EIA been directly reproduced into the EMP? (Section 3.5.7)	Refer to section 3	Yes
Have any additional environmental management measures been included in the EMP? (Section 3.5.7)	Refer to section 5	Yes
Have environmental management measures been written in committed language? (Section 3.5.7)	-	Not Applicable

Have project environmental management measures, including hold points, been identified and included? (Section 3.5.6)	-	Not Applicable
Are relevant details of environmental monitoring that will be carried out included? (Section 3.5.8)	Refer to section 5	Yes
Have the components of any environmental monitoring programs been incorporated? (Section 3.5.8)	Refer to section 5	Yes
Are environmental inspections included? (Section 3.5.9)	Refer to section 5	Yes
Does the EMP document all relevant compliance monitoring and reporting requirements for the project? (Section 3.5.12 and 3.5.13)	Refer to section 5	Yes
Does the EMP describe the types of plans or maps (such as environmental control maps) that will be used to assist with the management of environmental matters on site? (Section 3.5.10)	-	Not Applicable
Does the EMP list environmental management documents? (Section 3.5.11)	-	Not Applicable
Is an auditing program referenced? (Section 3.5.13)	-	Not Applicable
Does the EMP include the incident notification and reporting protocols that comply with the relevant conditions of consent? (Section 3.5.15)	Refer to section 5	Yes
Does the EMP identify the project role/position that is responsible for deciding whether an occurrence is an incident? (Section 3.5.15)	Refer to section 5	Yes
Does the EMP describe a corrective and preventative action process that addresses the requirements? (Section 3.5.16)	Refer to section 5	Yes
Does the EMP include details of a review and revision process that complies with the requirements? (Section 3.6)	Refer to section 5	Yes

1.3 Development Overview

This acoustic assessment addresses the proposed development which includes a Core 21 school with 18 Home bases and 2 support classes, with the selected core facilities at Core 35, for the Hall, Library, Staff facilities and Admin. These facilities are distributed as follows (refer to Figure 1):

- Building A: Administrative offices, open office areas, interview rooms, library spaces, amenities.
- Buildings B2 and B3: Homebases, shared practical activity areas, amenities.
- Building C: Communal Hall, offices, storage spaces, canteen, amenities.
- Outdoor areas: Assembly space, games court, play space, covered outdoor learning areas (COLAs).
- Carpark comprising 17 car spaces for proposed stage.
- Waste collection area situated near the north-eastern corner of the project site.

It is proposed that the school will operate as follows:

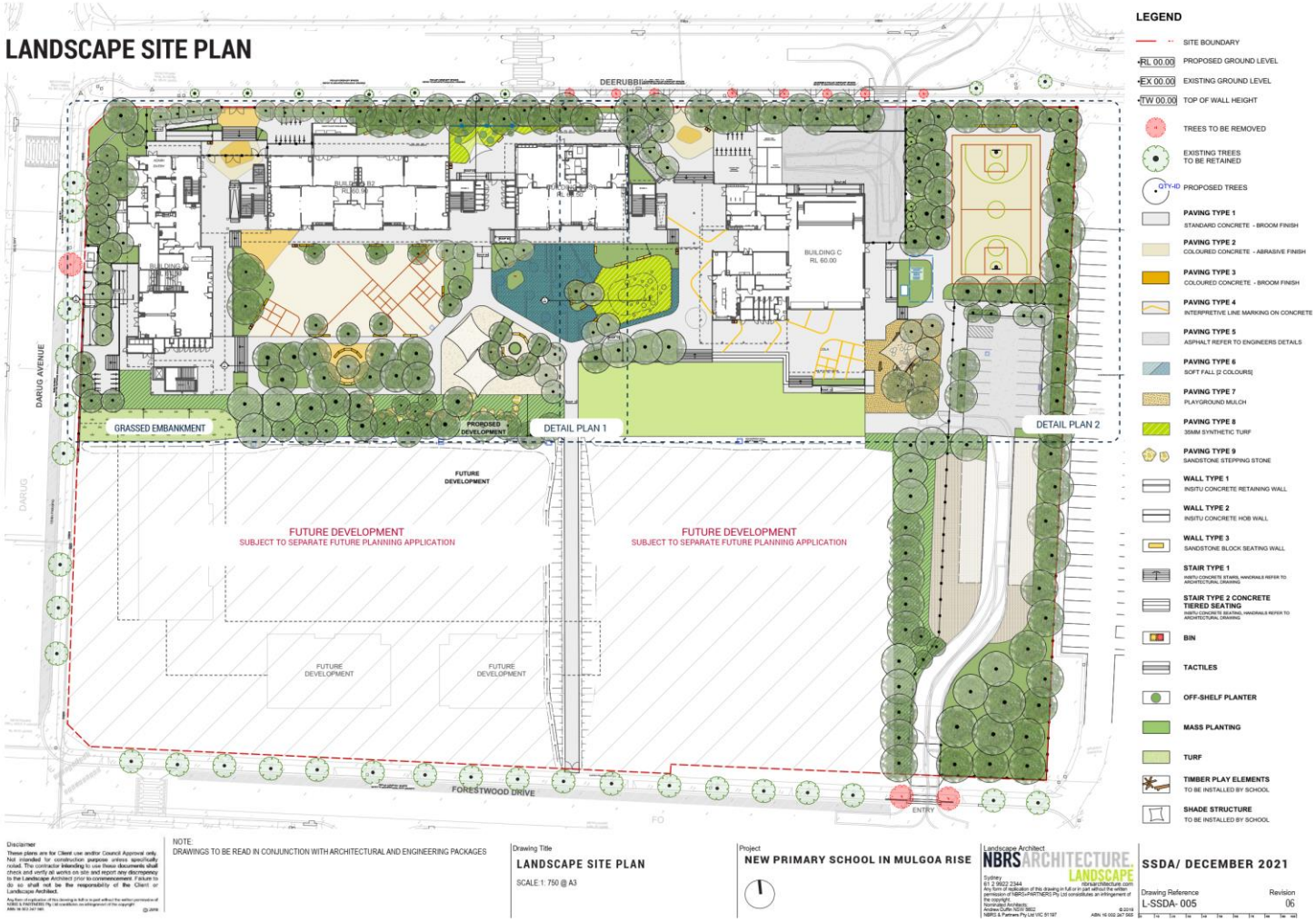
- School hours: 8:00 am to 4:00 pm.
- Out of hours: 7:00 am to 8:00 am; 4:00 pm to 6:00 pm.
- Vacation care hours: 7:00 am to 6:00 pm, Monday to Friday, during school holidays

Additionally, it is intended that the Communal Hall in Building C, and library in Building A; operate between 6:30 pm and 10:00 pm as part of the out of hours operation.

In the event of additional demand, the school can be expanded to a Core 35 primary school, facilitating future expansion of up to 26 additional home bases and 2 additional support classes. However, this will be the subject of a separate and future planning approval.

Based on the report titled "Transport and Traffic Assessment" (issued by PTC, dated 9 August 2021, referred herein as the *TTA Report*), it is understood the MRPS has a maximum capacity of 414 students. Additionally, it is advised that waste collection will be conducted weekly; with the waste collection area being accessible from Deerubbin Drive.

Figure 1 Landscape Site Plan (Drawing L-SSDA-005)



1.4 Site Layout

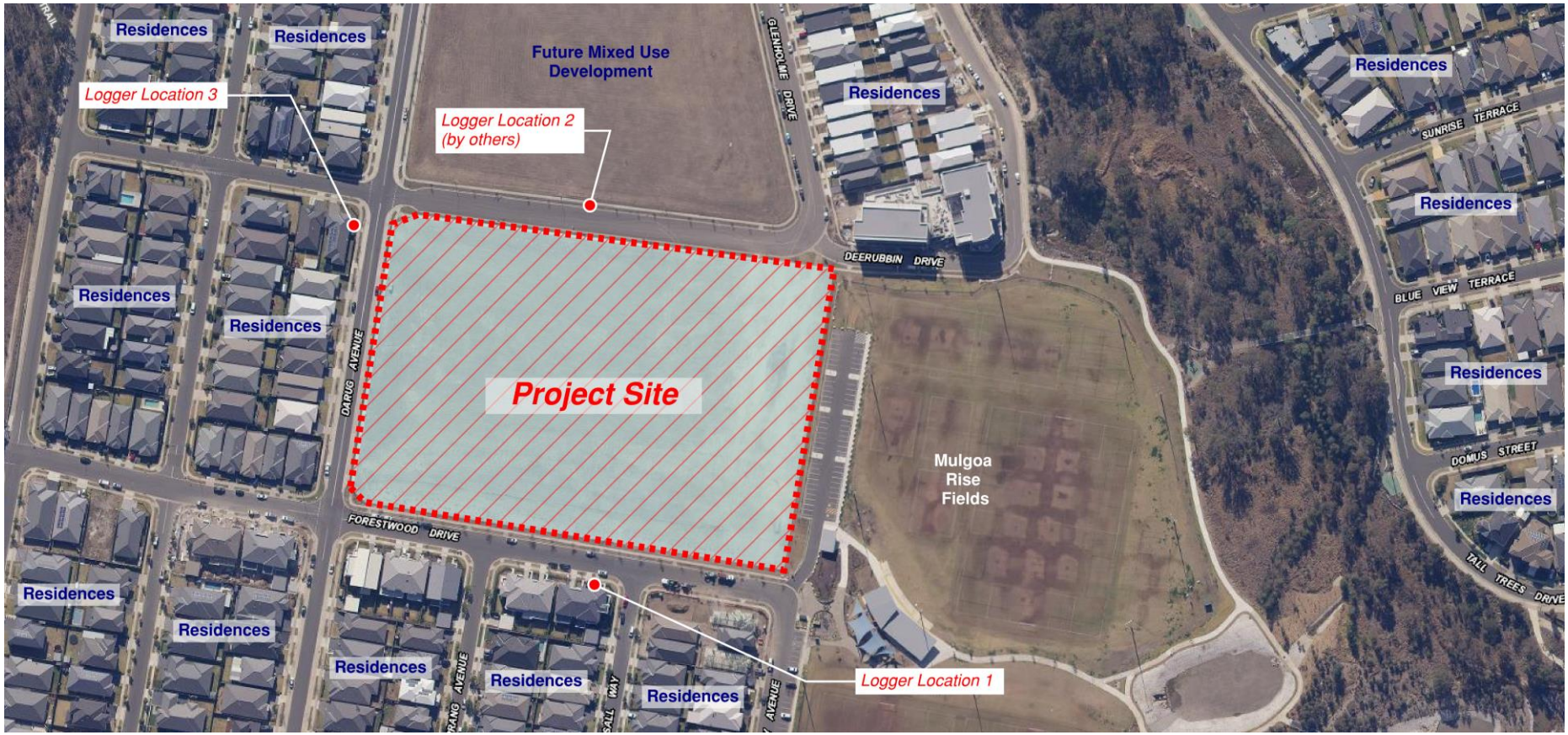
The MRPS is surrounded by the following premises which are also considered the nearest noise affected receivers (refer to Figure 2):

- Residences which are located along the western and southern property boundaries. Residences along the western property boundary are situated across Darug Avenue; and those along the southern property boundary are located across Forestwood Drive.
- A future mixed-use development which will be located across Deerubbin Drive (i.e. 90-98 Glenmore Ridge Drive), along the northern property boundary.
- Residences which are also situated along Deerubbin Drive, to the north-east and north-west from the site.
- A childcare centre located at Ground Level, 71 Deerubbin Drive, Glenmore Park. This only operates from Mondays to Fridays, 6:30 am to 6:00pm.
- Along the eastern property boundary: Active recreation areas (i.e. Mulgoa Rise Fields), and areas dedicated to environmental conservation.

Since the receivers listed above are the nearest affected receivers, the acoustic assessment discussed in this report is undertaken at these receivers.

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 Locations and Surrounding Receivers



2 EXISTING ACOUSTIC ENVIRONMENT

To determine the existing noise environment at the nearest affected receivers, the following has been considered:

- For residences along southern property boundary (i.e. across Forestwood Drive), unattended noise measurements were conducted in the vicinity of these residences (i.e. *Logger Location 1*). Survey methodology and measurement results are discussed in Sections 2.1 and 2.3 respectively.

- For residences facing western property boundary, along Darug Avenue, unattended noise measurements were conducted at 21 Darug Avenue (i.e. Logger Location 3). Refer to Sections 2.1 and 2.3 for survey methodology and measurement results respectively.

- For residences facing northern property boundary (i.e. along Deerubbin Drive), unattended noise measurements discussed in report titled *"Noise Impact Assessment Proposed Mixed-Use Development 90-98 Glenmore Ridge Drive Glenmore Park NSW"* (dated June 2020, issued by Reverb Acoustics Pty. Ltd.); are used. Location where these measurements were conducted is shown as *Logger Location 2* in Figure 2. Measurement results are discussed in Section 2.4.

  This latter report is referred herein as the *90-98 Glenmore Ridge Drive DA Acoustic Report*.

2.1 Unattended Noise Monitoring

For residences facing southern property boundary (i.e. along Forestwood Drive), and western property boundary (i.e. along Darug Avenue), noise levels were monitored at these residences in order to determine the existing noise levels. The unattended noise surveys for these residences were conducted as follows:

- Logger location 1 (representative for residences along Forestwood Drive): Noise measurements were undertaken in the front yard of residence at No 30 Forestwood Drive, Glenmore Park. These were conducted between Wednesday 17 March and Tuesday 30 March 2021.

  Instrumentation used: one Rion NL-42 noise logger (serial number 409024).

- Logger location 3 (representative for residences along Darug Avenue): Noise measurements were undertaken in the front yard of residence at No 21 Darug Avenue, Glenmore Park. These were conducted between Thursday 21 October and Friday 29 October 2021.

  Instrumentation used: one Svan 971 noise logger (serial number 74365).

Calibration of all noise loggers was checked prior to and following measurements using a Bruel & Kjaer Type 4230 sound calibrator (serial number 1275644). The calibrator emitted a calibration tone of 94 dB at 1 KHz. The drift in calibration did not exceed ±0.5 dB. All equipment carries 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 L_{A1}, 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 obtained from Badgerys Creek AWS weather station (ID 067108).

2.2 Noise Descriptors & Terminology

Environmental noise constantly varies in level with time. Therefore, it is 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 dBA, 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 sound sources of equal values result in an increase of 3dB (i.e. 60 dBA plus 60 dBA results in 63 dBA). A change of 1 dB or 2 dB in the sound level 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 L_{Aeq}, L_{A1}, L_{A10} and L_{A90} noise levels. The L_{Aeq} noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period. It represents the level that the fluctuating noise with the same acoustic energy would be if it were constant over the measured time period.

The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels can be considered as the 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.

2.3 Noise Monitoring Results – Logger Locations 1 & 3

The noise levels measured at logger locations 1 and 3, have been used to assess the noise impact of the development to the nearest noise affected receivers identified in Section 1.4. The time periods used are in accordance with those recommended in the NSW Environment Protection Authority's (EPA) Noise Policy for Industry (NSW NPI). The measurement results are presented in Table 3 below.

Table 3 Measured ambient noise levels in accordance with the NSW NPI

Measurement Location	Daytime 7:00 am to 6:00 pm		Evening 6:00 pm to 10:00 pm		Night Time 10:00 pm to 7:00 am	
	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Logger Location 1: No. 30 Forestwood Drive Glenmore Park	34 dBA	52 dBA	34 dBA	50 dBA	32 dBA	49 dBA
Logger Location 3: No. 21 Darug Avenue Glenmore Park	37 dBA	57 dBA	37 dBA	55 dBA	32 dBA	49 dBA

Notes:

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*
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*
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.*

2.4 Noise Monitoring Results – Logger Location 2

To determine existing ambient noise levels for residences near the northern and western property boundaries, the noise measurement results discussed in Section 2.1 of the 90-98 Glenmore Ridge Drive DA Acoustic Report; are used in our assessment. Table 4 below summarises these measurement results.

These measurements were conducted to establish the operational acoustic criteria for the future mixed-use development to be located at 90-98 Glenmore Ridge Drive. As discussed in Section 1.4, this development is situated along the northern property boundary of our project site.

Table 4 Measured ambient noise levels at 90-98 Glenmore Ridge Drive

Measurement Location	Daytime 7:00 am to 6:00 pm		Evening 6:00 pm to 10:00 pm		Night Time 10:00 pm to 7:00 am	
	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Logger Location 2 At southern property boundary of future mixed-use development at 90-98 Glenmore Ridge Drive	43 dBA	51 dBA	38 dBA	47 dBA	33 dBA	46 dBA

Notes:

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*
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*
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.*

3 NOISE AND VIBRATION CRITERIA

Relevant noise and vibration criteria for construction activities are detailed below.

3.1 Construction Noise Criteria

3.1.1 NSW EPA Interim Construction Noise Guideline (ICNG) – DECC 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 5 NMLs for quantitative assessment at residences

Time of Day	Noise Management Level $L_{Aeq(15minute)}$[1,2]	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	***"Noise Affected Level"*** 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 Level" 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 recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with 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 Noise Policy for Industry (EPA 2017).*

Note 3 *Requirements listed in the table above are in accordance with the Construction Hours listed in Condition C4 and C5.*

Construction noise levels at other noise receivers are outlined below:

- Construction noise levels within classrooms at schools and other educational institutions is not to exceed 45dB LAeq,15minute, when measured internally.
- Construction noise levels within places of worship is not to exceed 45dB LAeq,15minute, when measured internally.
- Construction noise levels at offices, retail outlets is not to exceed 70dB LAeq,15minute, when measured externally.

Based on the measured background noise levels summarised in section 2, and the NMLs outlined above the construction noise criteria to be used in this assessment are listed in below.

Table 6 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** **Monday to Friday:** **6:00pm to 7:00pm** **Saturday** **1:00pm to 4:00pm**
Residences along Forestwood Drive	**NML: 44 +** HNAL: 75	**NML: 39 +** HNAL: 44
Residences along Darug Avenue	**NML: 47 +** HNAL: 75	**NML: 42 +** HNAL: 47
Residences along Deerubbin Drive	**NML: 53 +** HNAL: 75	**NML: 48 +** HNAL: 53
Offices, retail outlets	NML: 70 (external)	
Active recreation areas (Mulgoa Rise Fields)	NML: 65 (external)	
Childcare centre (Ground Level, 71 Deerubbin Drive)	NML: 65 (external)	

3.1.2 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.

3.2 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. Refer to further discussion in Section 3.2.1.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 3.2.2.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 3.2.2.

3.2.1 Vibration Criteria – 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"*. (AVTG) This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources (refer to Table 7).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 8).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 9).

Table 7 Continuous vibration acceleration criteria (m/s^2) 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
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 8 Impulsive vibration acceleration criteria (m/s^2) 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
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 9 Intermittent vibration impacts criteria (m/s$^{1.75}$) 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
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

3.2.2 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).

3.2.2.1 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 10 and illustrated in Figure 3.

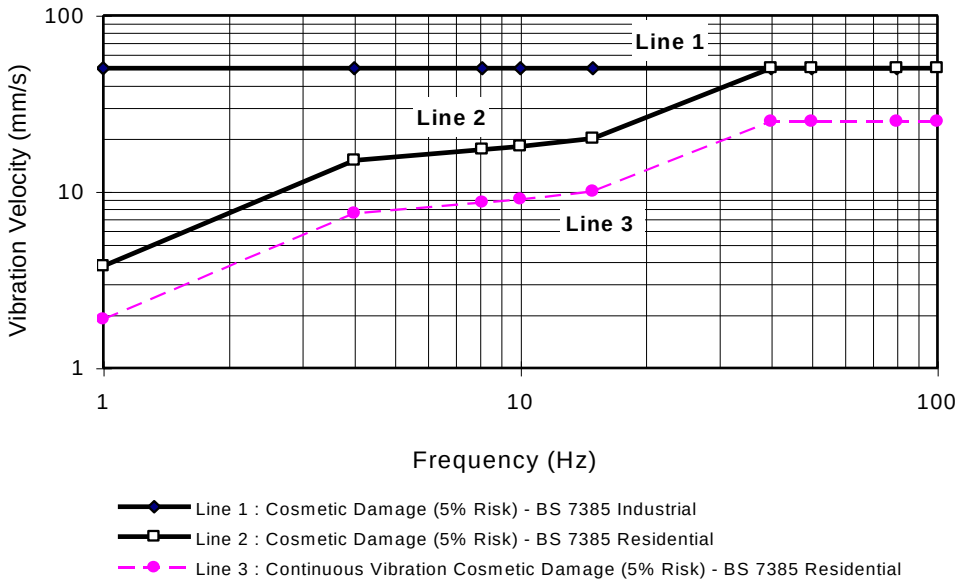
Table 10 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure 3	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 10 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 10 may need to be reduced by up to 50% (refer to Line 3 in Figure 3).

Figure 3 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 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 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.

3.2.2.2 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 11. The criteria are frequency dependent and specific to particular categories of structures.

Table 11 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 1: For frequencies above 100Hz, at least the values specified in this column shall be applied.

3.3 Ground-Borne Noise Criteria

According to the NSW EPA *Interim Construction Noise Guideline (*ICNG) 2009, the criteria for ground-borne noise at residences is defined as follows:

- Maximum internal noise levels of 40 dB LAeq(15mins) between 6:00pm and 10:00pm.

It is noted that the ground borne criteria will apply for construction works undertaken outside of standard hours. That is, work conducted during the evening period Monday to Friday between 6:00pm and 7:00pm only.

4 NOISE AND VIBRATION ASSESSMENT

4.1 Construction Noise Assessment

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 12 below.

Table 12 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	120
	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	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	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.

Table 13 RE01 – Summary of preliminary predicted construction noise levels –71 Deerubbin Drive, Glenmore Park

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	53 to 76	57 to 79	**Monday to Friday** 07.00-18.00 43 + 10 = **53** **Saturday** 08.00-13.00 43 + 10 = **53** **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to have the potential to exceed the BG + 10dBA including potential exceedances above the Highly Noise Affected Level of 75dBA. Recommended that acoustic mitigation measures as outlined in section 5.
	Power hand tools		52 to 75			
	Semi Rigid Vehicle		49 to 71			
Ground Works and Demolition	Excavator	119	55 to 78	62 to 84		
	Handheld jack hammer		50 to 72			
	Dump truck		48 to 70			
	Concrete saw		58 to 80			
	Skid steer		53 to 76			
	Power hand tools		52 to 75			
Structure	Handheld jack hammer	117	50 to 72	61 to 83		
	Concrete saw		58 to 80			
	Power hand tools		52 to 75			
	Welder		44 to 67			
	Concrete pump truck		53 to 76			
	Concrete agitator truck		51 to 74			
Internal Works	Power hand tools	109	52 to 75	52 to 75		
Common and External Works	Concrete agitator truck	117	51 to 74	60 to 83		
	Saw cutter		48 to 70			
	Dump truck		48 to 70			
	Concrete saw		58 to 80			
	Power hand tools		52 to 75			

Table 14 RE02 – Summary of predicted construction noise levels – 27 Darug Avenue, Glenmore Park

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	55 to 74	58 to 77	**Monday to Friday** 07.00-18.00 37 + 10 = **47** **Saturday** 08.00-13.00 37 + 10 = **47** **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to have the potential to exceed the BG + 10dBA including potential exceedances above the Highly Noise Affected Level of 75dBA. Recommended that acoustic mitigation measures as outlined in section 5.
	Power hand tools		54 to 73			
	Semi Rigid Vehicle		50 to 69			
Ground Works and Demolition	Excavator	119	57 to 76	63 to 82		
	Handheld jack hammer		51 to 70			
	Dump truck		49 to 68			
	Concrete saw		59 to 78			
	Skid steer		55 to 74			
	Power hand tools		54 to 73			
Structure	Handheld jack hammer	117	51 to 70	62 to 82		
	Concrete saw		59 to 78			
	Power hand tools		54 to 73			
	Welder		46 to 65			
	Concrete pump truck		55 to 74			
	Concrete agitator truck		53 to 72			
Internal Works	Power hand tools	109	54 to 73	54 to 73		
Common and External Works	Concrete agitator truck	117	53 to 72	61 to 81		
	Saw cutter		49 to 68			
	Dump truck		49 to 68			
	Concrete saw		59 to 78			
	Power hand tools		54 to 73			

Table 15 RE03 - Summary of predicted construction noise levels – 34 Forestwood Drive, Glenmore Park

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	59 to 74	63 to 77	**Monday to Friday** 07.00-18.00 34 + 10 = **44** **Saturday** 08.00-13.00 34 + 10 = **44** **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to have the potential to exceed the BG + 10dBA including potential exceedances above the Highly Noise Affected Level of 75dBA. Recommended that acoustic mitigation measures as outlined in section 5.
	Power hand tools		58 to 73			
	Semi Rigid Vehicle		55 to 69			
Ground Works and Demolition	Excavator	119	61 to 76	68 to 82		
	Handheld jack hammer		56 to 70			
	Dump truck		54 to 68			
	Concrete saw		64 to 78			
	Skid steer		59 to 74			
	Power hand tools		58 to 73			
Structure	Handheld jack hammer	117	56 to 70	67 to 82		
	Concrete saw		64 to 78			
	Power hand tools		58 to 73			
	Welder		50 to 65			
	Concrete pump truck		59 to 74			
	Concrete agitator truck		57 to 72			
Internal Works	Power hand tools	109	58 to 73	58 to 73		
Common and External Works	Concrete agitator truck	117	57 to 72	66 to 81		
	Saw cutter		54 to 68			
	Dump truck		54 to 68			
	Concrete saw		64 to 78			
	Power hand tools		58 to 73			

Table 16 CM01 - Summary of predicted construction noise levels – 71 Deerubbin Drive, Glenmore Park

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	53 to 76	57 to 79	**All days** All times Commercial = **70**	Works indicatively predicted to have the potential to exceed the noise management level when working near a receiver. Recommended that acoustic mitigation measures as outlined in section 5.
	Power hand tools		52 to 75			
	Semi Rigid Vehicle		49 to 71			
Ground Works and Demolition	Excavator	119	55 to 78	62 to 84		
	Handheld jack hammer		50 to 72			
	Dump truck		48 to 70			
	Concrete saw		58 to 80			
	Skid steer		53 to 76			
	Power hand tools		52 to 75			
Structure	Handheld jack hammer	117	50 to 72	61 to 83		
	Concrete saw		58 to 80			
	Power hand tools		52 to 75			
	Welder		44 to 67			
	Concrete pump truck		53 to 76			
	Concrete agitator truck		51 to 74			
Internal Works	Power hand tools	109	52 to 75	52 to 75		
Common and External Works	Concrete agitator truck	117	51 to 74	60 to 83		
	Saw cutter		48 to 70			
	Dump truck		48 to 70			
	Concrete saw		58 to 80			
	Power hand tools		52 to 75			

Table 17 AR01 - Summary of predicted construction noise levels – Mulgoa Rise Fields

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	55 to 72	58 to 76	**All days** All times Active Recreational Areas: **65**	Works indicatively predicted to have the potential to exceed the noise management level when working near a receiver. Recommended that acoustic mitigation measures as outlined in section 5.
	Power hand tools		54 to 71			
	Semi Rigid Vehicle		50 to 68			
Ground Works and Demolition	Excavator	119	57 to 74	63 to 81		
	Handheld jack hammer		51 to 69			
	Dump truck		49 to 67			
	Concrete saw		59 to 77			
	Skid steer		55 to 72			
	Power hand tools		54 to 71			
Structure	Handheld jack hammer	117	51 to 69	62 to 80		
	Concrete saw		59 to 77			
	Power hand tools		54 to 71			
	Welder		46 to 63			
	Concrete pump truck		55 to 72			
	Concrete agitator truck		53 to 70			
Internal Works	Power hand tools	109	54 to 71	54 to 71		
Common and External Works	Concrete agitator truck	117	53 to 70	61 to 79		
	Saw cutter		49 to 67			
	Dump truck		49 to 67			
	Concrete saw		59 to 77			
	Power hand tools		54 to 71			

Table 18 CC01 - Summary of predicted construction noise levels – Child Care Centre

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	53 to 76	57 to 79	**All days** All times External Play Areas: **65** (Defined as active recreation area)	Works indicatively predicted to have the potential to exceed the noise management level when working near a receiver. Recommended that acoustic mitigation measures as outlined in section 5.
	Power hand tools		52 to 75			
	Semi Rigid Vehicle		49 to 71			
Ground Works and Demolition	Excavator	119	55 to 78	62 to 84		
	Handheld jack hammer		50 to 72			
	Dump truck		48 to 70			
	Concrete saw		58 to 80			
	Skid steer		53 to 76			
	Power hand tools		52 to 75			
Structure	Handheld jack hammer	117	50 to 72	61 to 83		
	Concrete saw		58 to 80			
	Power hand tools		52 to 75			
	Welder		44 to 67			
	Concrete pump truck		53 to 76			
	Concrete agitator truck		51 to 74			
Internal Works	Power hand tools	109	52 to 75	52 to 75		
Common and External Works	Concrete agitator truck	117	51 to 74	60 to 83		
	Saw cutter		48 to 70			
	Dump truck		48 to 70			
	Concrete saw		58 to 80			
	Power hand tools		52 to 75			

4.2 Construction Traffic Noise Assessment

It is proposed that the construction traffic would access the site via Glennmore Ridge Drive, Darug Avenue and Bradley Street.

From the criteria discussed in Section 3, 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 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.

4.3 Vibration Assessment

In order to maintain compliance with the human comfort vibration criteria discussed in Section 3, it is recommended that the indicative safe distances listed in Table 19 should be maintained. These indicative safe distances should be validated at the start of construction works by undertaking measurements of vibration levels generated by construction and demolition equipment to be used on site.

If applicable, 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 to this sensitive equipment.

Additionally, any vibration levels should be assessed in accordance with the criteria discussed in Section 3. This information should also be included as part of the CNVMSP.

Table 19 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

5 NOISE AND VIBRATION MANAGEMENT PLAN

5.1 Acoustic Management Procedures

5.1.1 Summary of Management Procedures

Table 20 below summarises the management procedures recommended for airborne noise and vibration impacts. These procedures are also further discussed in the report. Hence, where applicable, links to further references are provided in Table 21 (next page).

Table 20 Summary of mitigation procedures

Procedure	Abbreviation	Description	Further Reference
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.	Refer to Section 5.7 For noise impact, also refer to Section 5.2 For vibration impact, also refer to Section 5.3
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.	Refer to Section 0.
Verification Monitoring	V	Monitoring to comprise of attended 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.	For noise impact, refer to Section 5.2.3 For vibration impact, refer to Section 5.3.2
Complaints Management System	CMS	Implement a management system which includes procedures for receiving and addressing complaints from affected stakeholders	Refer to Section 0
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. This will be undertaken in accordance with project engagement requirements including the School Infrastructure NSW Communications engagement team	Refer to Section 0.
Respite Offer	RO	Specific offer provided to stakeholders subjected to an ongoing impact, including activities generating noise levels above High Noise Impact levels.	Refer to Section 5.2.1

Procedure	Abbreviation	Description	Further Reference
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).	Refer to Section 5.7.1 and 5.7.2

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 5.1.2

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 0.

5.1.2 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 3). The allocation of these procedures is summarised in Table 21 below.

Table 21 Allocation of noise management procedures – residential receivers

Construction Hours	Exceedance over NML (dB)	Management Procedures (see Table 20)
Standard Hours	0 - 3	GMM
	4 - 10	GMM, PN, V [1], CMS, AC
	> 10	GMM, PN, V, CMS, SN, AC
	> 75	GMM, PN, V, CMS, SN, AC **& RO**
Outside Standard Hours	0 – 5	GMM, AC
	> 5	GMM, PN, V, CMS, SN, RO, AC

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

Please note the following regarding the allocation of these procedures:

- The exceedances have been estimated as part of the acoustic assessment, and these are summarised in Section 4.1.
- The allocation of procedures is based on the assumptions used for noise level predictions (refer to Section 4.1). Consequently, these allocations can be further refined once onsite works are undertaken and further development of the construction program.

For non-residential receivers (such as commercial), management measures are provided in Section 0.

5.1.3 Allocation of Vibration Management Procedures

Table 22 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 22 Allocation of vibration management procedures

Construction Hours	Exceedance Scenario	Management Procedures
Standard Hours	Over human comfort criteria (refer to Section 3)	GMM, PN, V, RO
	Over building damage criteria (refer to Section 3)	GMM, V, AC
Outside Standard Hours	Over human comfort criteria (refer to Section 3)	GMM, SN, V, RO, CMS
	Over building damage criteria (refer to Section 3)	GMM, V, AC

5.2 Site Specific Noise Mitigation Measures

5.2.1 Respite Periods

Predicted noise levels outlined in Section 4.1 indicate that in some cases when works are being undertaken within proximity of receiver boundaries, exceedances above the Noise Management Levels (NMLs) may occur. In addition, in accordance with Condition C8 respite periods are recommended for noisy activities. As such the following respite conditions are recommended in accordance with C8 or when works extended periods of noisy works are affecting a surrounding receiver above the HNAL of 75dBA. See below.

Table 23 Recommended Respite Periods

Monday to Friday	Saturday
7:00am to 9:00am – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	8:00am to 9:00am – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)
9:30am to 12:00pm – Works	9:00am to 12:00pm – Works
12:00pm to 2:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	12:00pm to 4:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)
2:00pm to 5:00pm – Works	
5:00pm to 7:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	

Note: Recommended respite periods for noisy works has been formulated in accordance with Condition C8 from the *Notice of Determination – Approval.*

5.2.2 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.

5.2.3 Noise Monitoring

Attended noise monitoring is recommended to be undertaken at the start of each major milestone of the project. It is proposed that these milestones are at the commencement of structural demolition and bulk excavation on the site.

These works should be undertaken by a qualified acoustical consultant directly engaged by the contractor.

The statistical parameters to be measured should include the following noise descriptors: LA90, LA10, and LAeq. All 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 addition to the above detailed measurements, should any ongoing complaints be received which have not been determined previously, it should be confirmed by conducting additional attended noise measurements.

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

5.2.4 Noise Mitigation Measures for Non-Residential Receivers

Where exceedances have been identified in Section 4, the following mitigation measures are recommended:

- Undertake general mitigation measures as discussed in Section 5.7
- Issue project updates to tenants in affected premises. The updates can include overview of current and upcoming works, as well as advanced warning of potential disruptions.
- Signage to be posted in order to provide stakeholders information regarding project details, emergency contacts and enquiry contact information.

5.2.5 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 the use of other equipment is not possible, however, a different process could be undertaken.

5.2.6 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).

5.2.7 Site Cranes (Permeant)

There are no permanent fixed cranes proposed for use during the construction of the project.

5.3 Vibration Mitigation Measures

5.3.1 General Comments

As part of the CNVMSP, 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, where feasible
- 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.

5.3.2 Vibration Monitoring

Based on the proximity of the surrounding receivers to the works magnitudes of vibration resulting from construction activities required to be undertaken on the site are not expected to approach structural damage vibration limits detailed in Section 4.2 of this report, therefore permanent continuous vibration monitoring is not recommended.

Similar to the measurement procedure outlined in the noise monitoring section, attended vibration monitoring is to be undertaken at the following periods:

- Commencement of any high vibration generating activities including hydraulic hammering, rock breaking or vibration rolling on the site works within the safe working distances outlined above.
- Receiver location in the event complaints resulting from construction activities resulting from the perception of vibration are experienced by the occupants of buildings within the vicinity of the site.

5.4 SINSW Complaints management process as outlined in the Community Communication Strategy (CCS)

5.4.1 Enquiries and complaints management

SINSW manages enquiries (called interactions in our CRM, Darzin), and complaints in a timely and responsive manner.

Prior to project delivery, a complaint could be related to lack of community consultation, design of the project, lack of project progress, etc.

As per our planning approval conditions, a complaints register is updated monthly and is publicly available on the project's website page on the SINSW website. The complaints register will record the number of complaints received, the nature of the complaints and how the complaint was resolved.

5.4.2 Complaints management process

If SINSW receives a complaint about the project during construction, it must be logged in our CRM system, actively managed, closed out and resolved by SINSW within 24-48 hours of receipt by the SINSW Community Engagement Manager, as outlined in Table 6 below. If this is not possible, the complaint must be escalated internally as required and resolved within 7 business days.

Complaints received via the following channels will be directed to the SINSW Community Engagement Manager for resolution:

- Phone: 1300 482 651 (24 hour toll free number)
- Email: schoolinfrastructure@det.nsw.edu.au
- Postal address: GPO Box 33, Sydney, NSW 2001
- Face to face
- School executive
- Project team

If the complainant is not satisfied with the SINSW response, and they approach SINSW for rectification, the process will involve a secondary review of their complaint as per the outlined process.

Complaints will be escalated when:

- An activity generates three complaints within a 24-hour period (separate complainants).
- Any construction site receives three different complaints within a 24-hour period.
- A single complainant reports three or more complaints within a three day period.
- A complainant threatens to escalate their issue to the media or government representative.
- The complaint was avoidable.
- The complaint relates to a compliance matter.

Complaints will be first escalated to the Senior Manager, Community and Engagement or Director of Communications for SINSW as the designated complaints handling management representatives for our projects. Further escalation will be made to the Executive Director, Office of the Chief Executive to mediate if required.

If a complaint still cannot be resolved by SINSW to the satisfaction of the complainant, we will advise them to contact the NSW Ombudsman - https://www.ombo.nsw.gov.au/complaints.

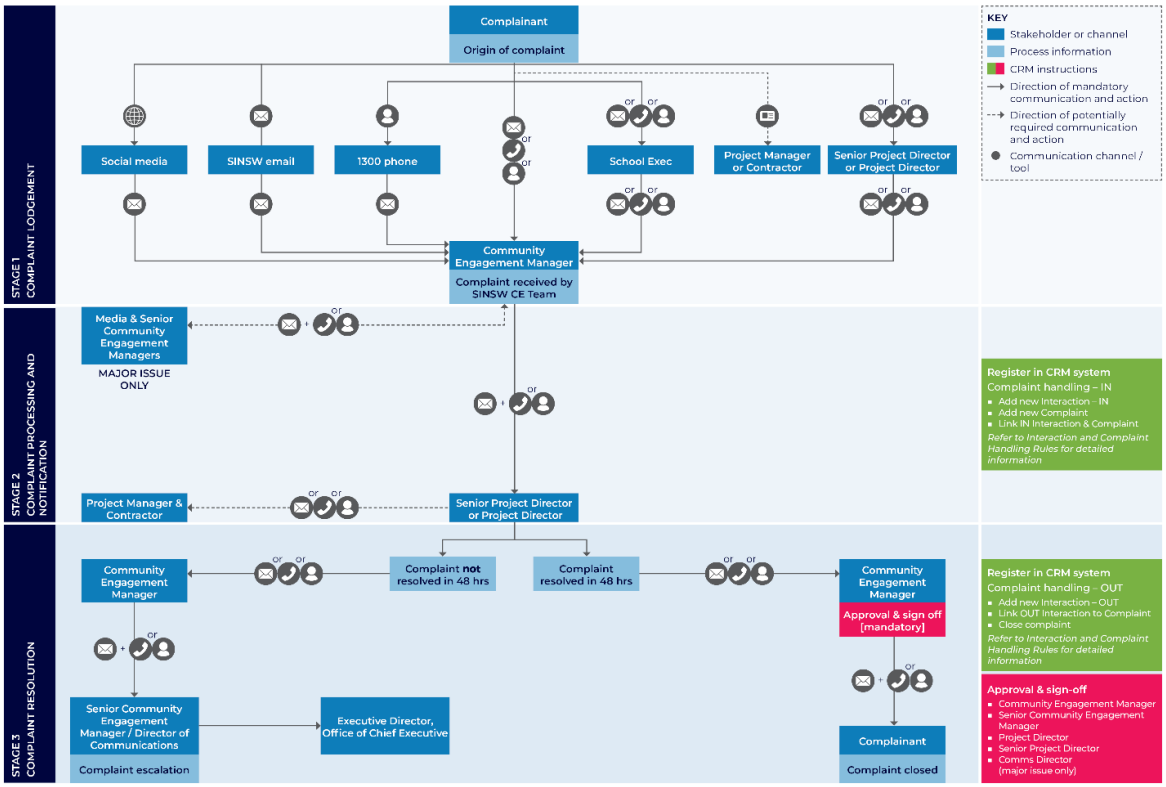
The below table summarises timeframes for responding to enquiries and complaints, through each correspondence method:

Table 24 Recommended Respite Periods

Complaint	Acknowledgement times	Response time
Phone call during business hours	At time of call – and agree with caller estimated timeframe for resolution.	Complaint to be closed out within 48 hours. If not possible, continue contact, escalate as required and resolve within 7 business days.
Phone call after hours*	Within two (2) hours of receiving message upon returning to office.	Following acknowledgement, complaint to be closed out within 48 hours. If not possible, continue contact, escalate as required and resolve within 7 business days.
Email during business hours	At time of email (automatic response)	Complaint to be closed out within 48 hours. If not possible, continue contact, escalate internally as required and resolve within 7 business days.
Email outside of business hours	At time of email (automatic response)	Complaint to be closed out within 48 hours (once return to business hours). If not possible, continue contact, escalate internally as required and resolve within 7 business days.
Letter	NA	Complaint to be closed out within 48 hours following receipt. If phone or email contact details are not provided a written response to be sent within 48 hours following receipt. If not possible, continue contact, escalate internally as required and resolve within 7 business days.
Interaction/ Enquiry		
Phone call during business hours	At time of call – and agree with caller estimated timeframe for response.	Interaction to be logged and closed out within 7 business days.
Phone call after hours	Within two (2) hours of receiving message upon returning to office.	Interaction to be logged and closed out within 7 business days.
Email during business hours	At time of email (automatic response)	Interaction to be logged and closed out within 7 business days.
Email outside of business hours	At time of email (automatic response)	Interaction to be logged and closed out within 7 business days.
Letter	N/A	Interaction to be logged and closed out within 10 business days following receipt.

The below diagram outlines our internal process for managing complaints.

COMPLAINTS MANAGEMENT PROCESS FLOW CHART



5.4.3 Complaints in common community languages

Complaints can be made in common community languages using the Translating and Interpreting Service (TIS), managed by the Department of Home Affairs. Community members can be connected to an interpreter by calling TIS on 131 450. TIS contact details are included on all project communications. Once TIS has the interpreter on the line, the interpreter and community member are connected to School Infrastructure and phone interpretation can begin. School Infrastructure NSW receives the complaint via the translator and begins the complaints management process as outlined above.

5.4.4 Community Notifications

Prior to the works onsite being undertaken, it is recommended that community consultation with the neighbouring affected parties be undertaken. These include:

Table 25 Receiver Locations

Receiver Type	Location
Residential	Deerubbin Drive Residences
Residential	Darug Avenue Residences
Residential	Forestwood Drive Residences
Commercial	Deerubbin Drive Commercial

The communication, however, should not be limited to the beginning of the onsite works but throughout, providing the community with constant updates on the progress and upcoming works. In our experience these could include:

- Project website.
- Email notifications; and
- Letterbox drops.

5.4.5 Community Engagement

In addressing the requirement for the community consultation when formulating onsite noise and vibration mitigation measures, we note the following.

Condition B16, item "e" from the consent, states:

(e) *describe the community consultation undertaken to develop the strategies in condition B16(d)*

Note: Condition B16(d) relates to the formulation of noise and vibration management strategies to manage high nose works.

In addressing the requirement of Condition B16(e), School Infrastructure NSW have requested feedback from the community in regard to the proposed noise and vibration mitigation measures as outlined in the November 2021 Project Update. Refer to Appendix E for Schools Infrastructure Project Notification, November 2021.

At the closure of the consultation period, no input was provided by the community in relation to the Construction Noise Vibration Management Sub-Plan.

5.5 Complaints Management System

Should complaints arise they must be dealt with in a responsible and uniform manner, therefore, a management system to deal with complaints is detailed above through SINSW.

5.6 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 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.

The Superintendent shall have access to view the Contractor's noise measurement records on request. The Superintendent may undertake noise monitoring if and when required.

5.7 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.

5.7.1 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 elevating work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

5.7.2 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, where feasible.
- Operating plant and equipment in the quietest and most efficient manner.

5.7.3 On Site Noise Mitigation

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

5.7.4 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 where possible.
- 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.

5.7.5 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.

5.7.6 Miscellaneous Comments

Deliveries should be undertaken, where possible, during standard construction hours.

Maximise hammer penetration (and reduce blows) by using sharp hammer tips. Keep stocks of sharp profiles at site and monitor the profiles in use.

"As per Consent Condition C15, where practicable, the use of "quackers" will be used to ensure noise impacts on surrounding noise sensitive receivers are minimised. This will not be implemented where it is deemed the use of quackers (as opposed to standard vehicle notification devices) would compromise the safety of construction staff or members of the public.

No public address system should be used on site.

6 CONCLUSION

Pulse White Noise Acoustics (PWNA) has been engaged by Schools Infrastructure NSW (SINSW) to prepare a Construction Noise and Vibration Management Sub-Plan (CNVMSP) for the construction of *The New Primary School in Mulgoa Rise* ("the Project") along Forestwood Drive, Glenmore Park.

This CNVMSP has been prepared to satisfy the requirements of Condition B16 of the Consent given in the *Notice of Determination – Approval* issued for Development Application No. SSD-11070211.

An assessment of potential noise and vibration impacts from the required processes to be undertaken during the construction period of the project (including demolition, excavation and construction) has been undertaken and suitable mitigation methods and community engagement has been detailed in this report.

Providing the recommendations in this report are included in the construction of the site, compliance with the relevant EPA's Interim Construction Noise Guideline Objectives and Items B16, C13 and C16 of the propjets *Conditions of Consent* can be achieved.

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

Regards

Matthew Furlong
Senior Acoustic Engineer
Pulse White Noise Acoustics

APPENDIX A: ACOUSTIC GLOSSARY

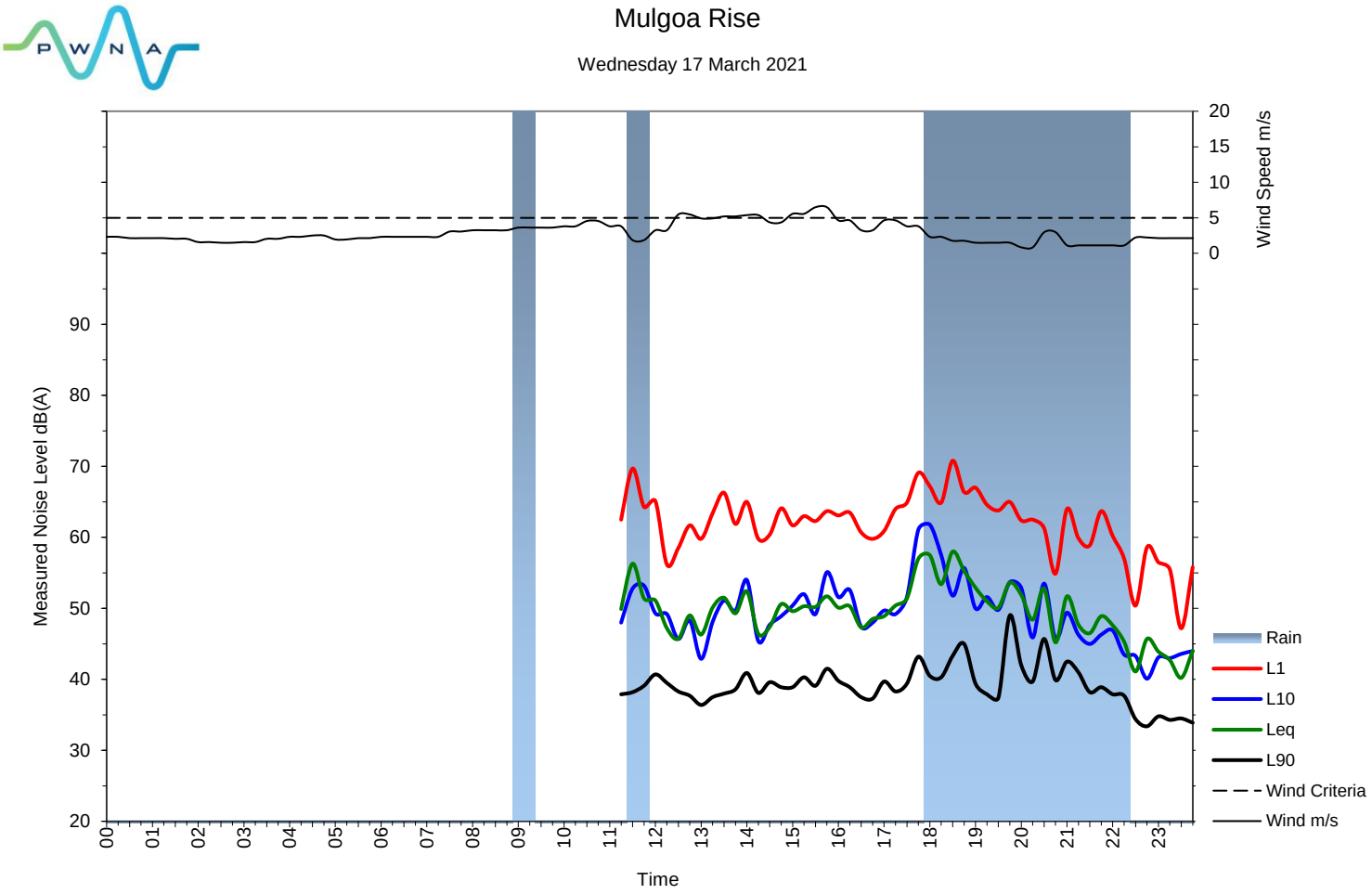
The following is a brief description of the acoustic terminology used in this report:

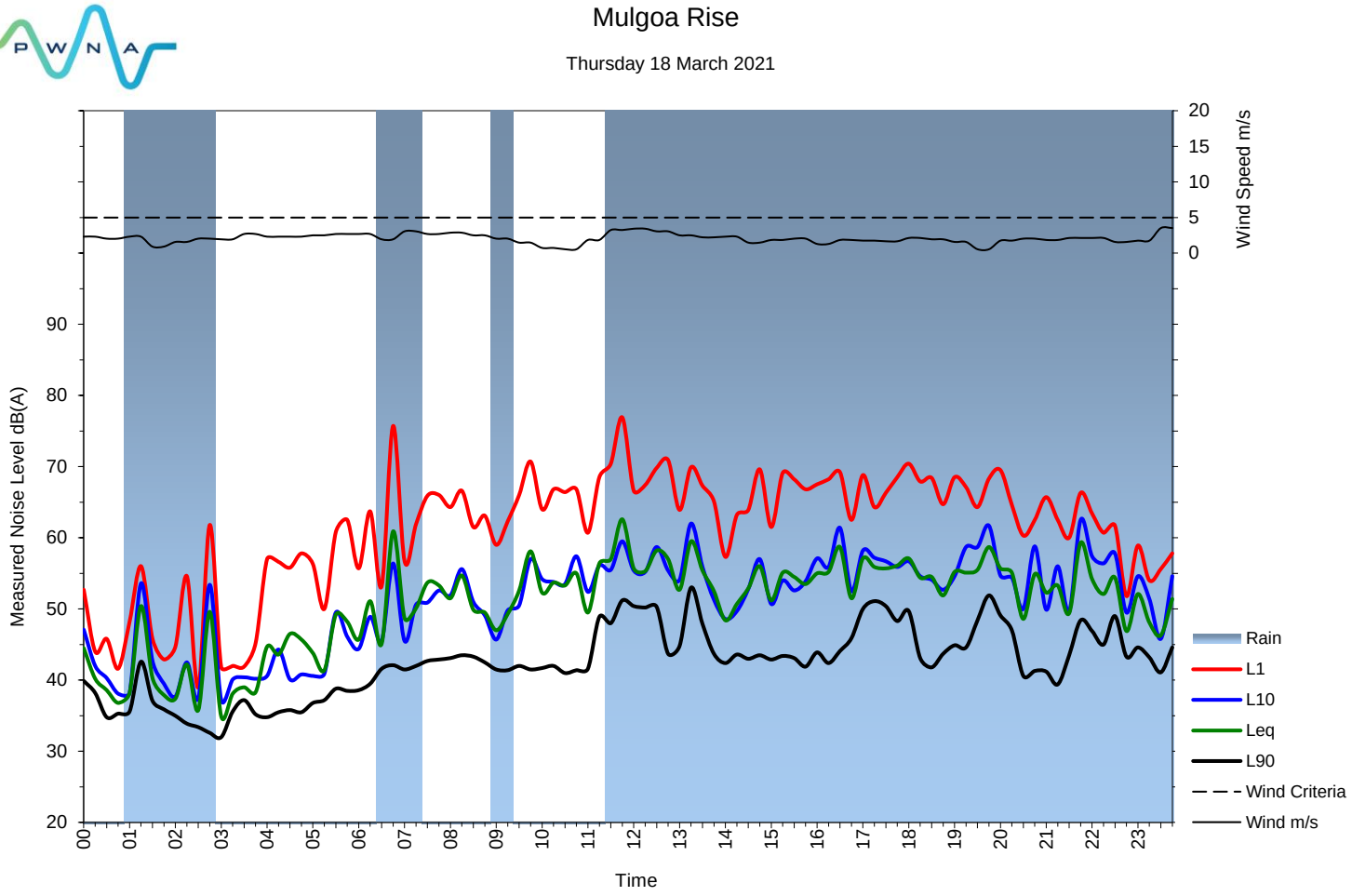
Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
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.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
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 L_{90} 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.
dB (A)	'A' Weighted overall sound pressure level

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

APPENDIX B: UNATTENDED NOISE MEASUREMENTS

Logger Location 1: No. 30 Forestwood Drive, Glenmore Park

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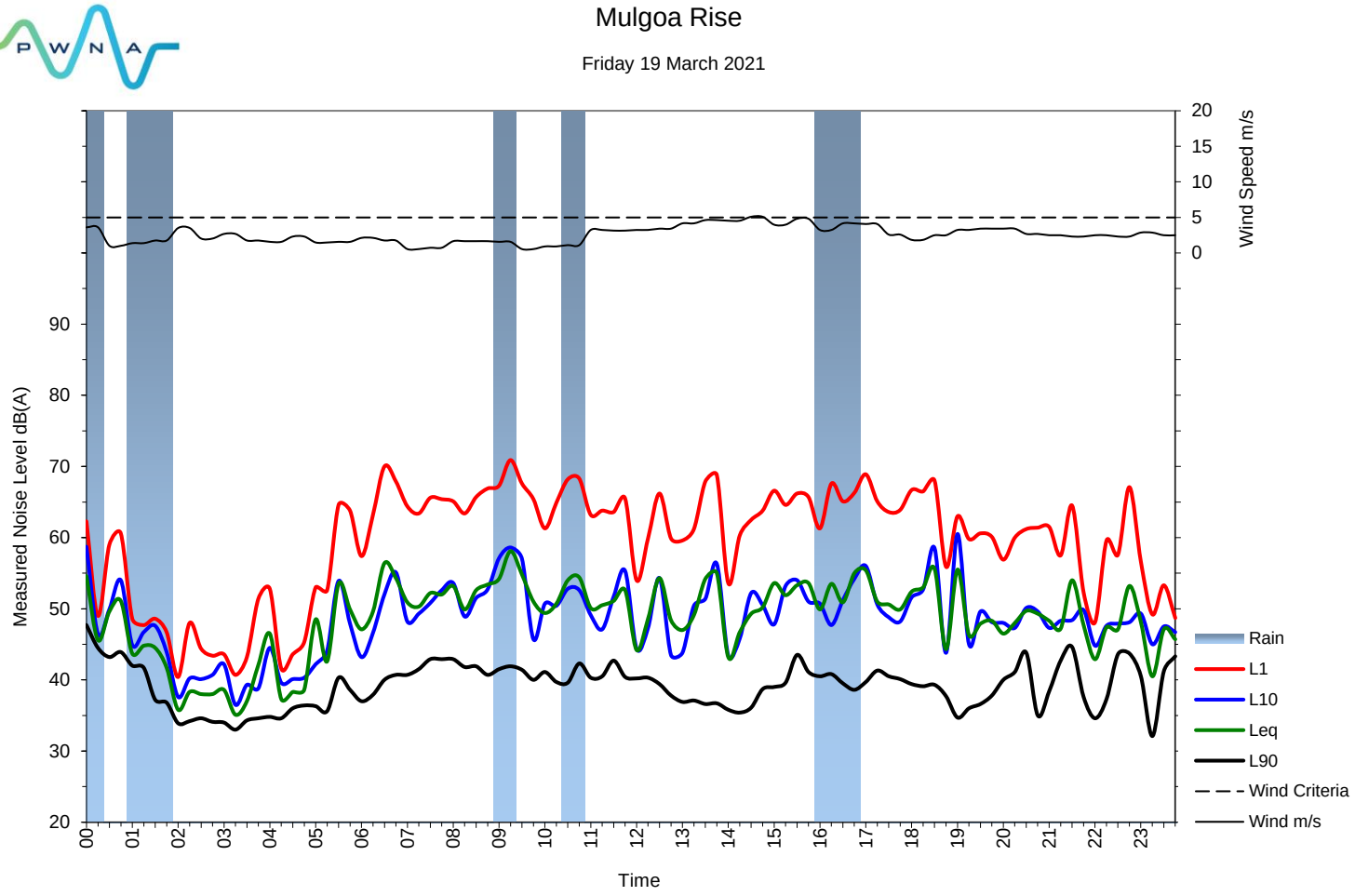
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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Rain
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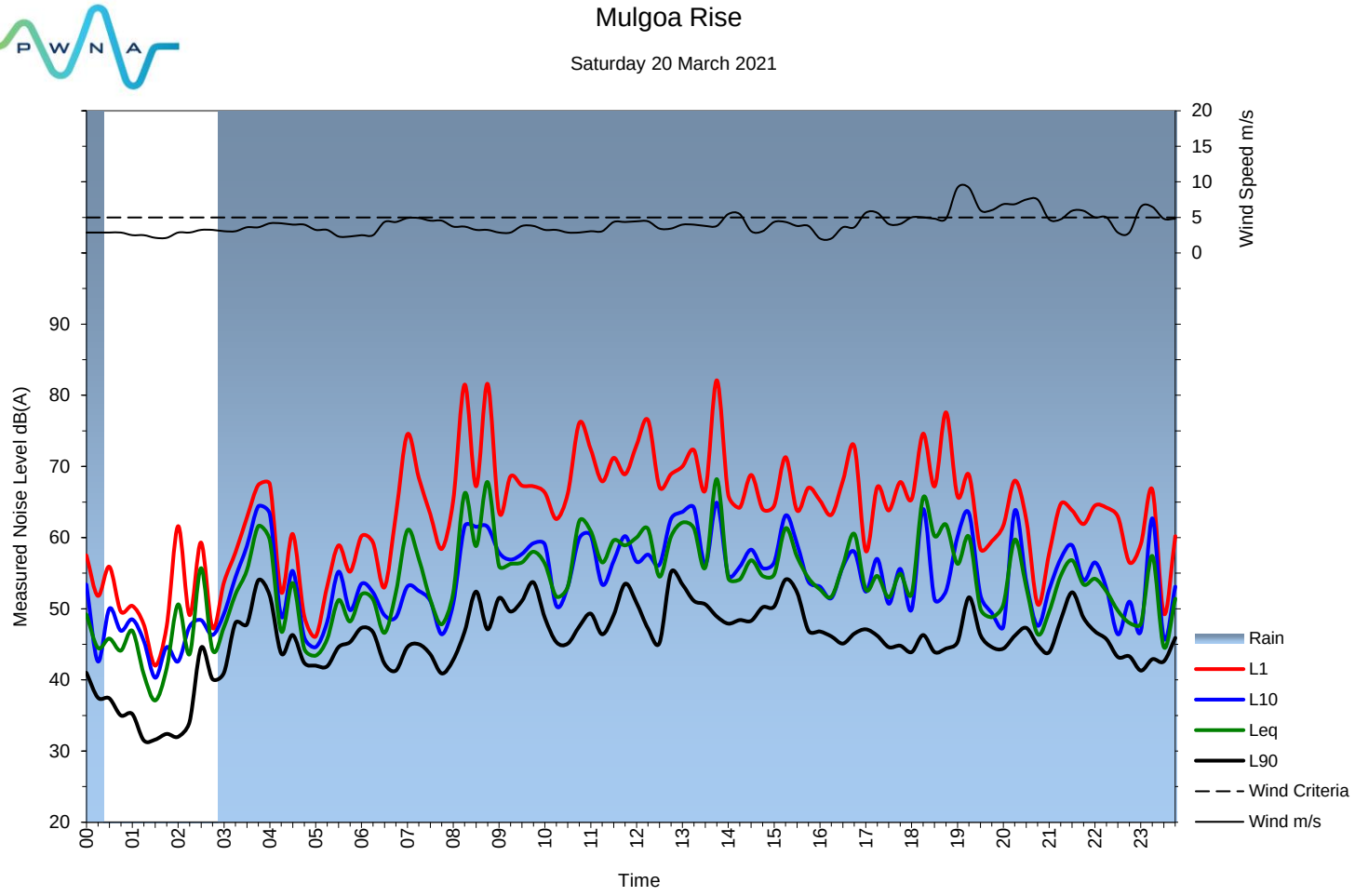
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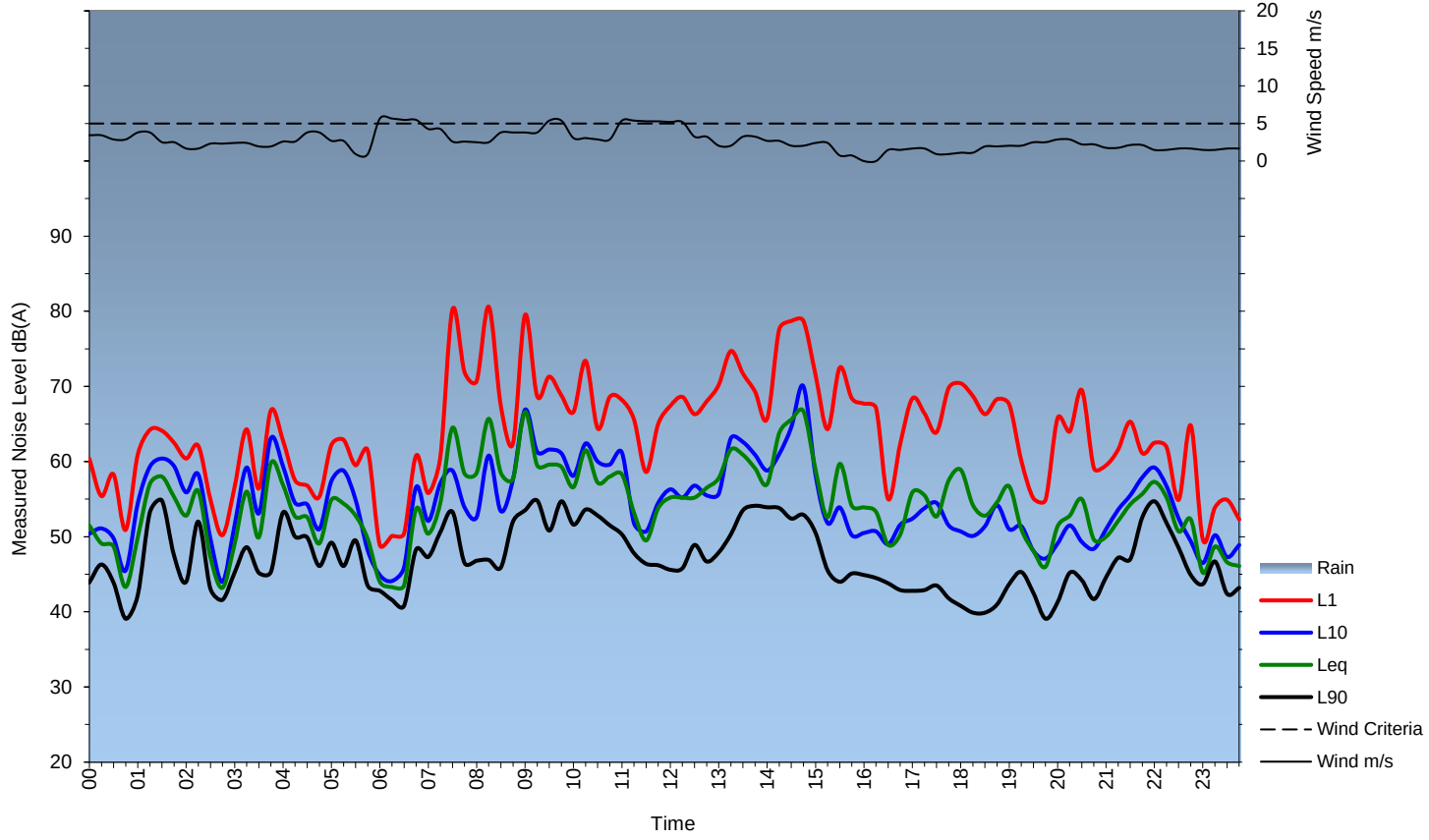
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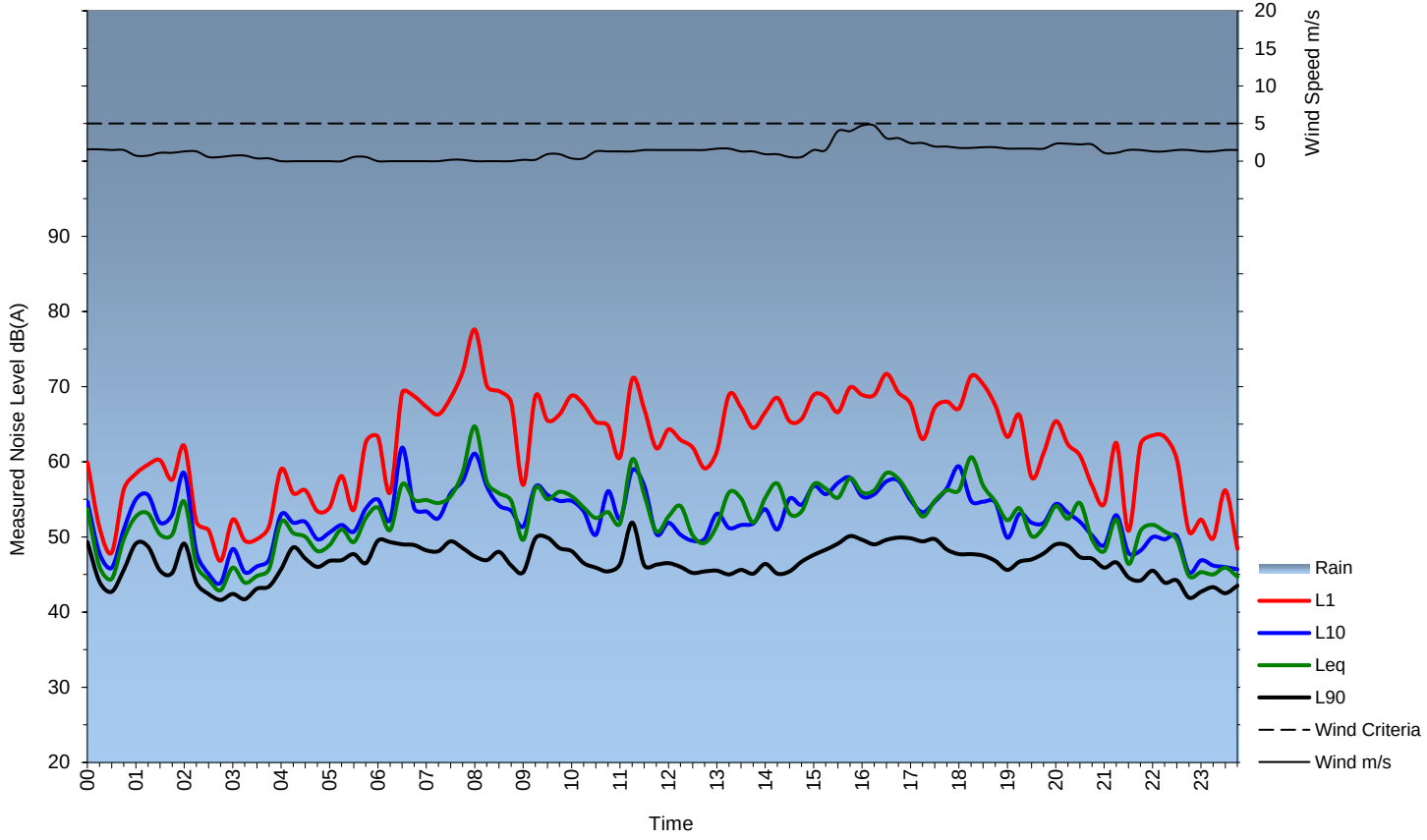
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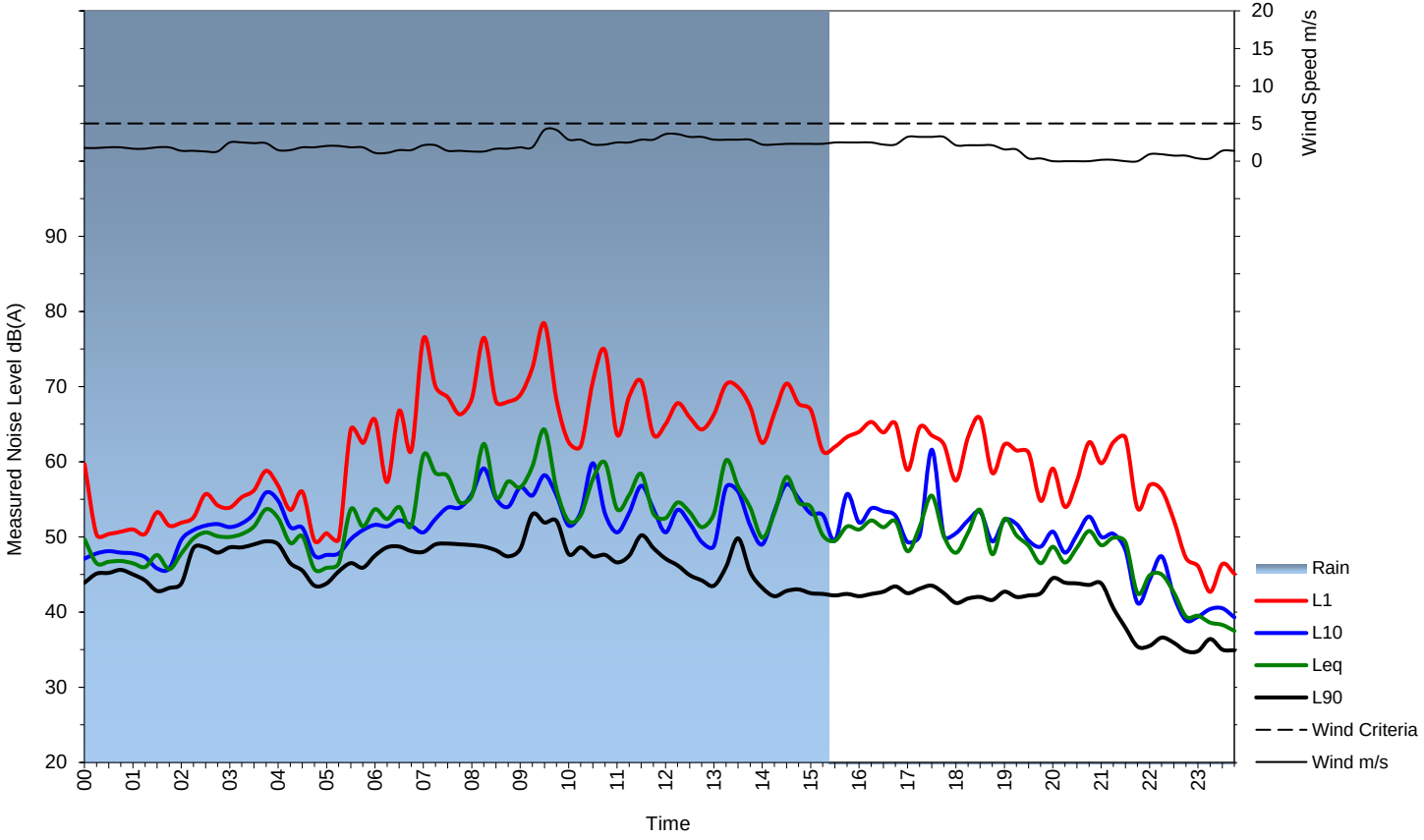
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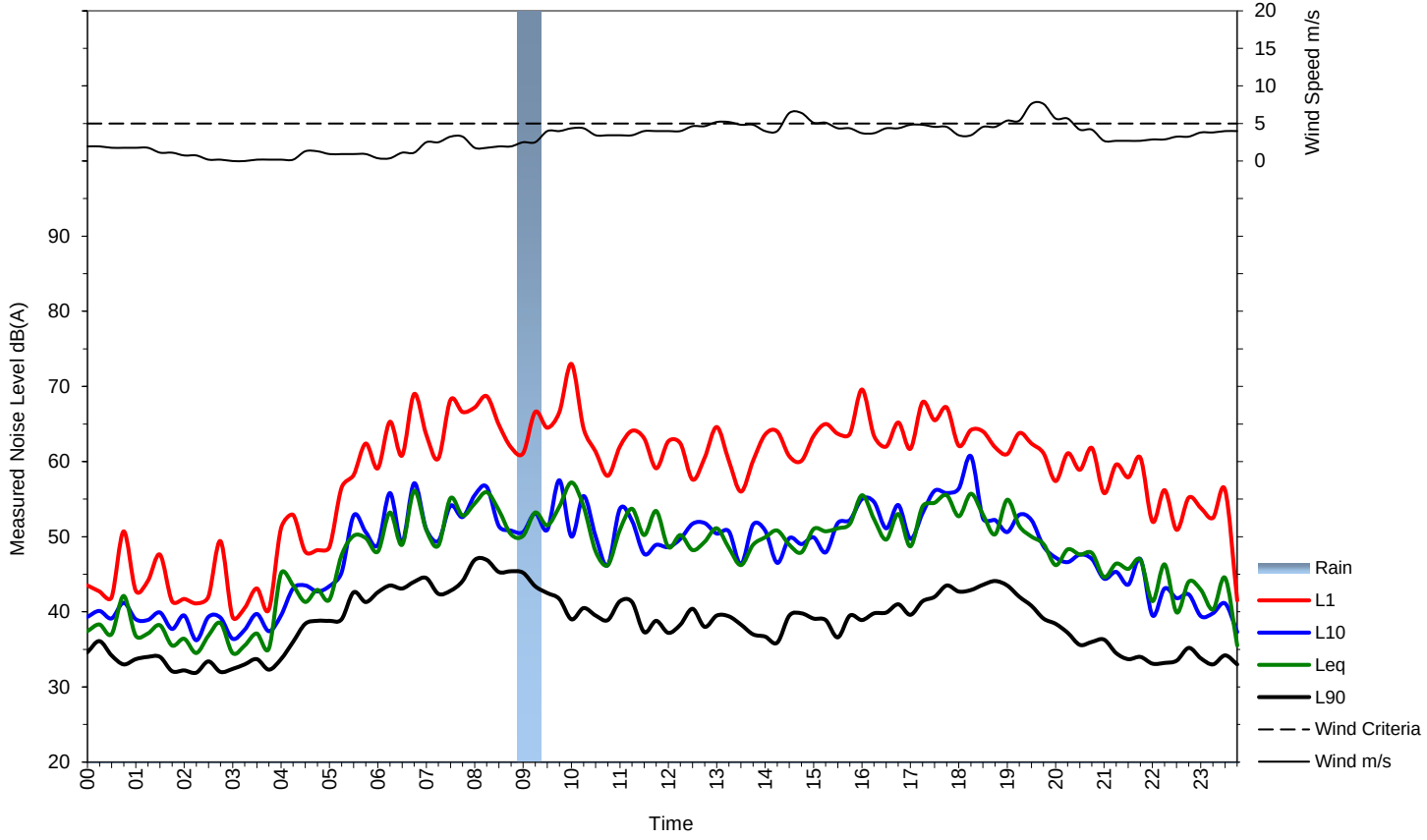
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Time
Rain
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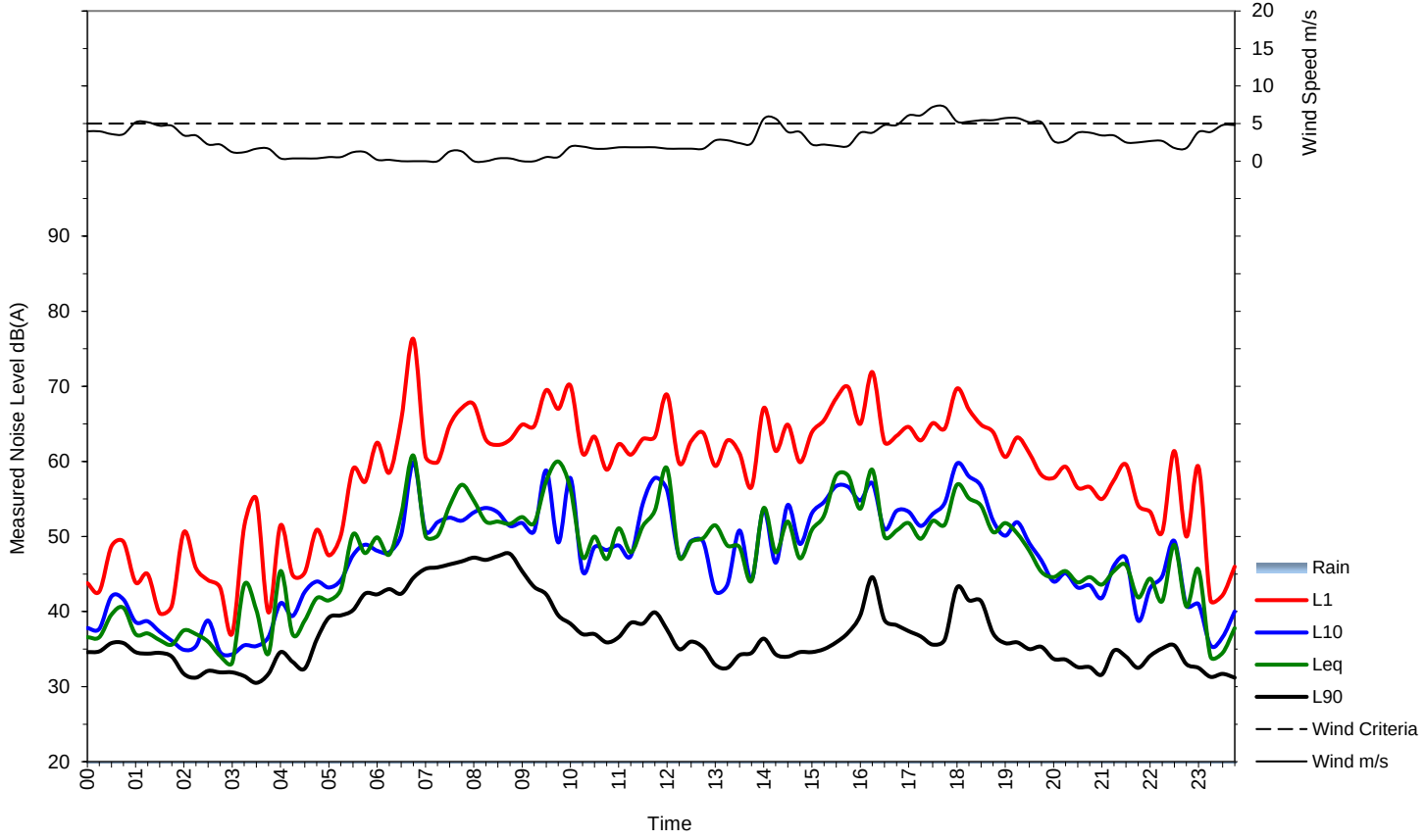
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Rain
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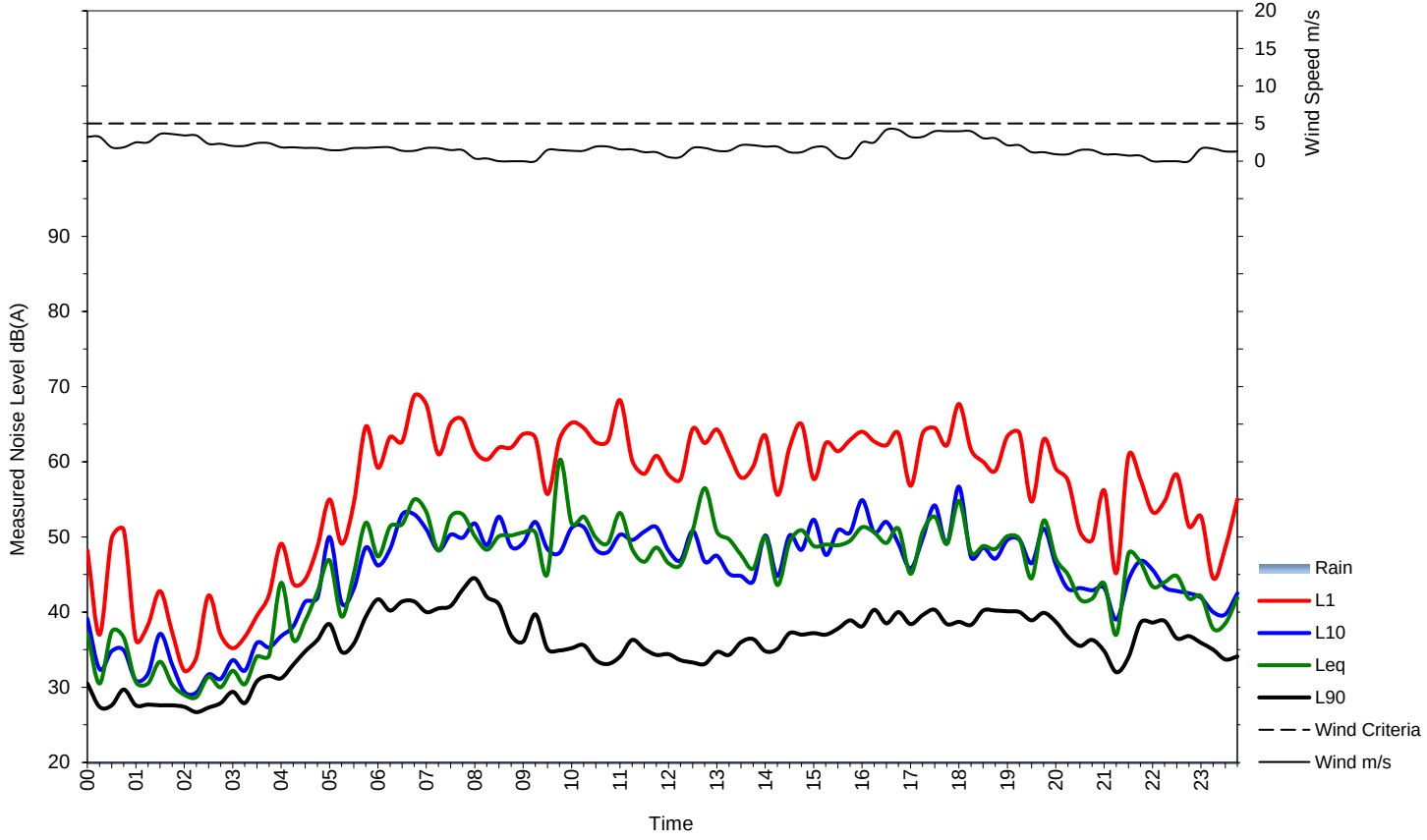
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Wind Criteria
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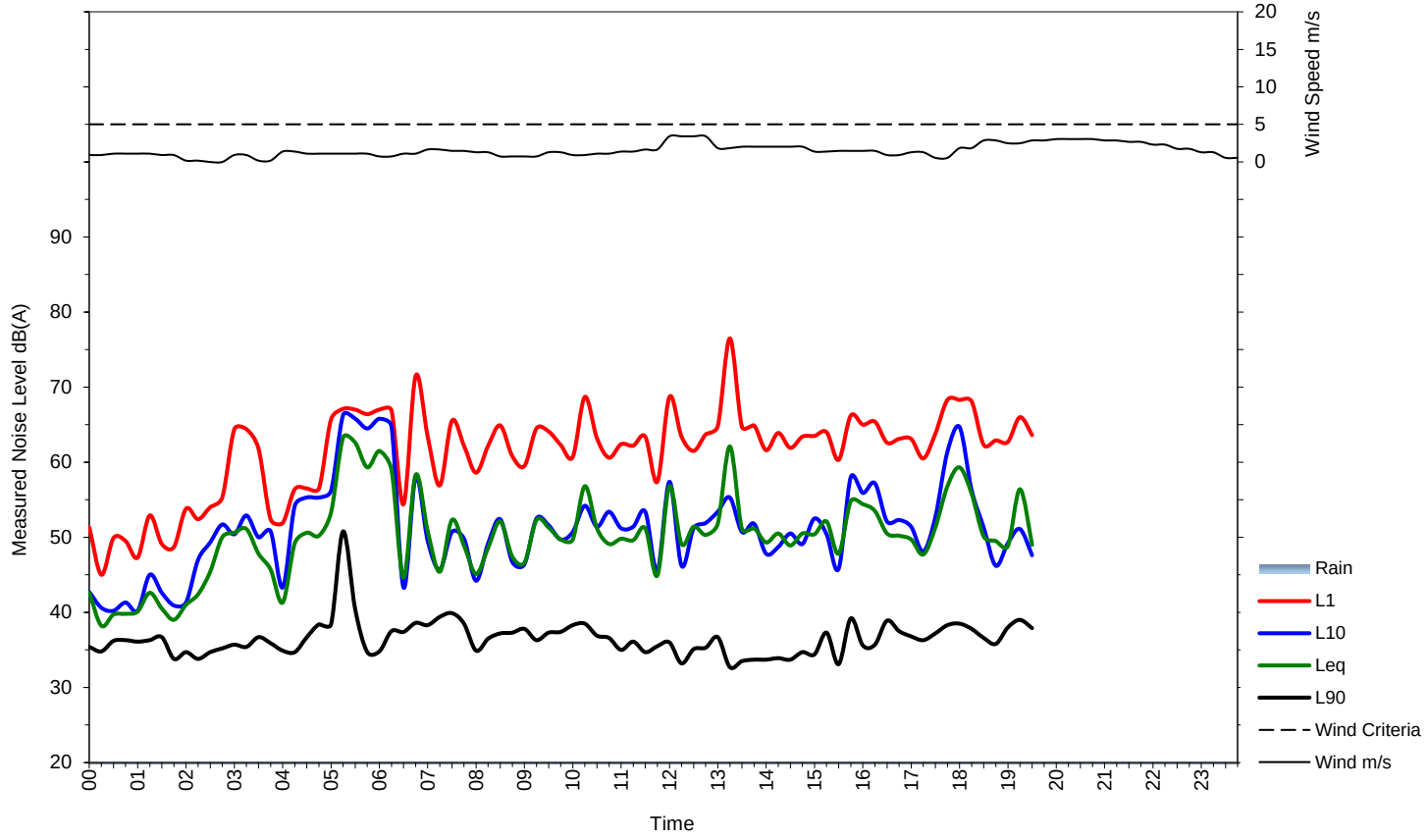
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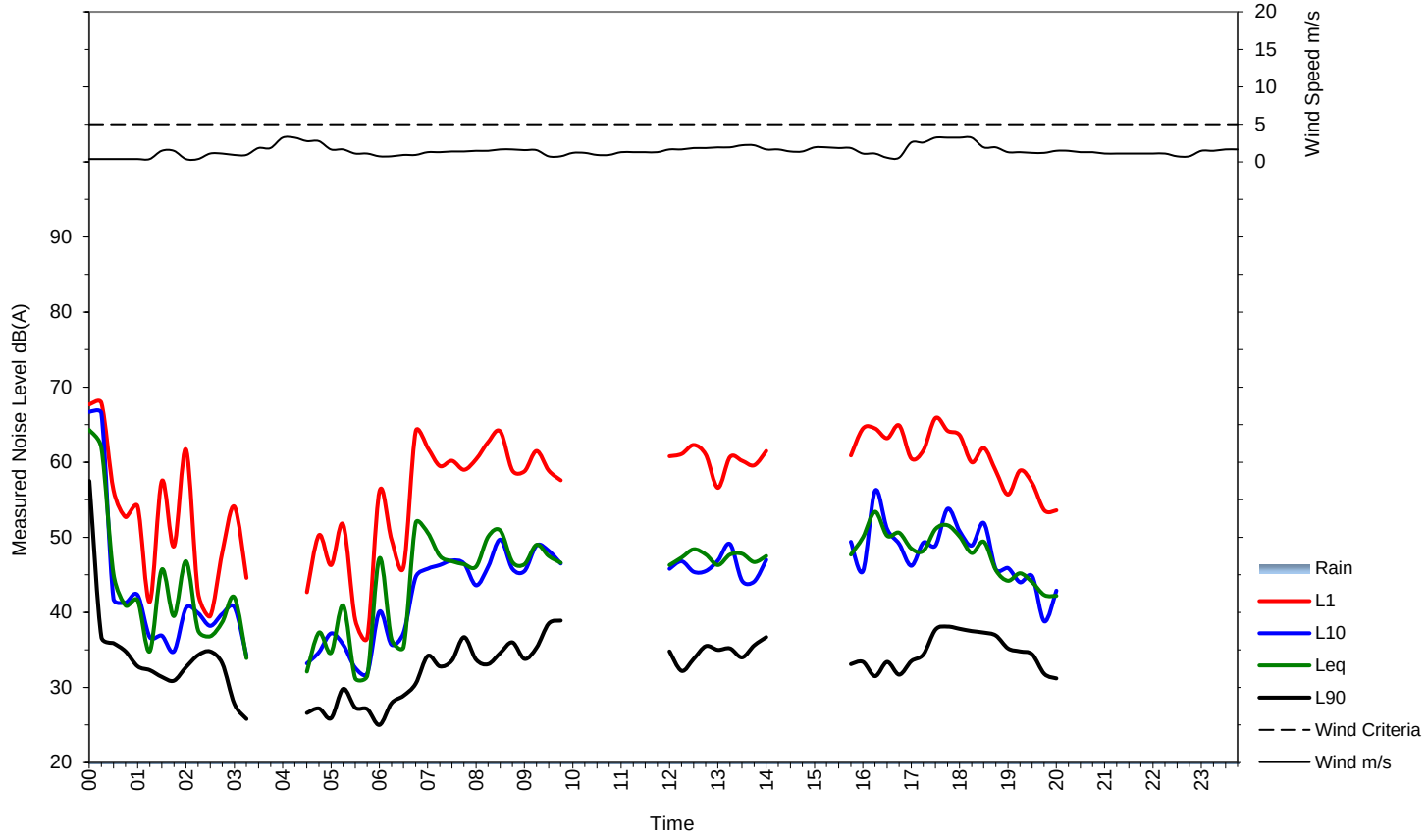
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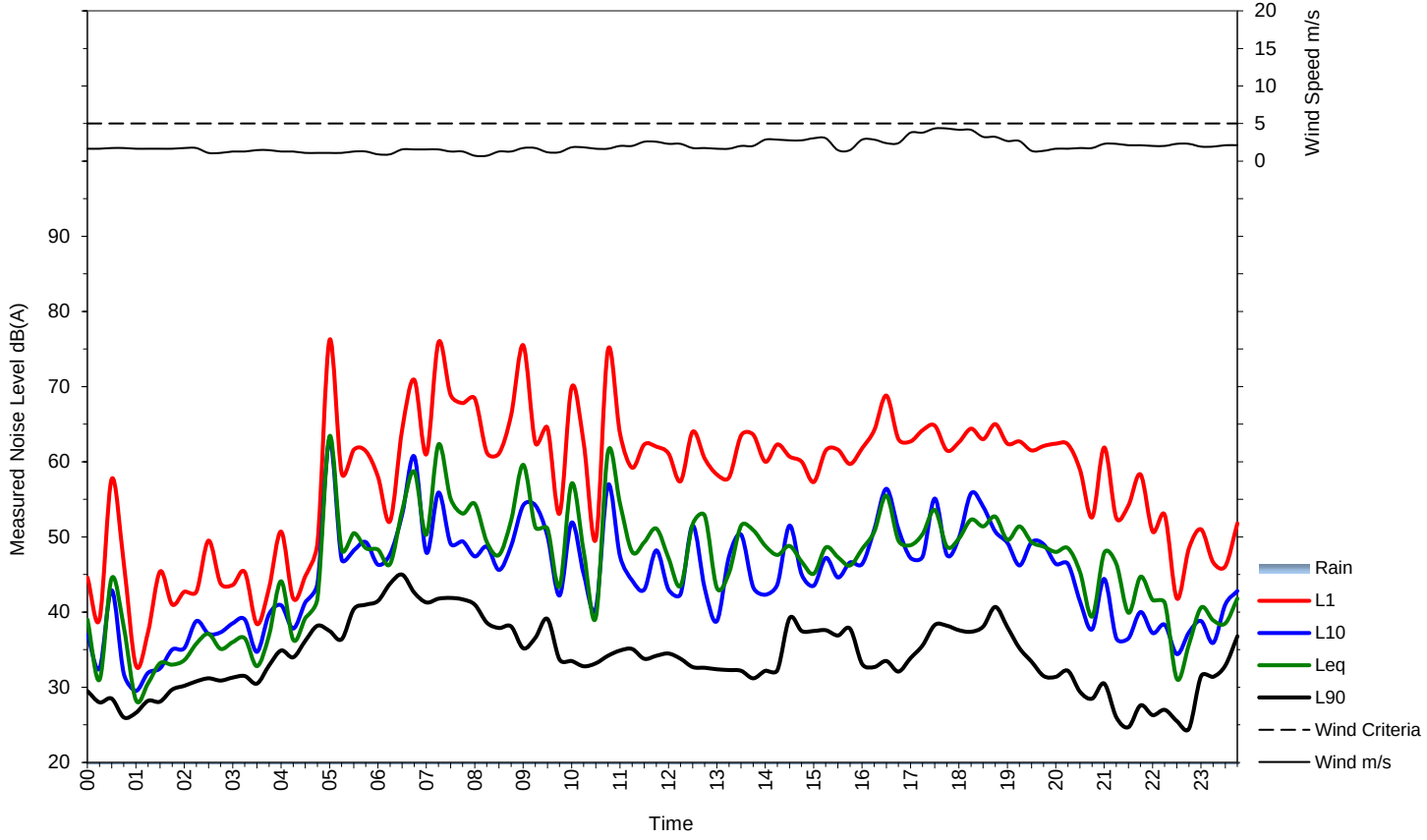
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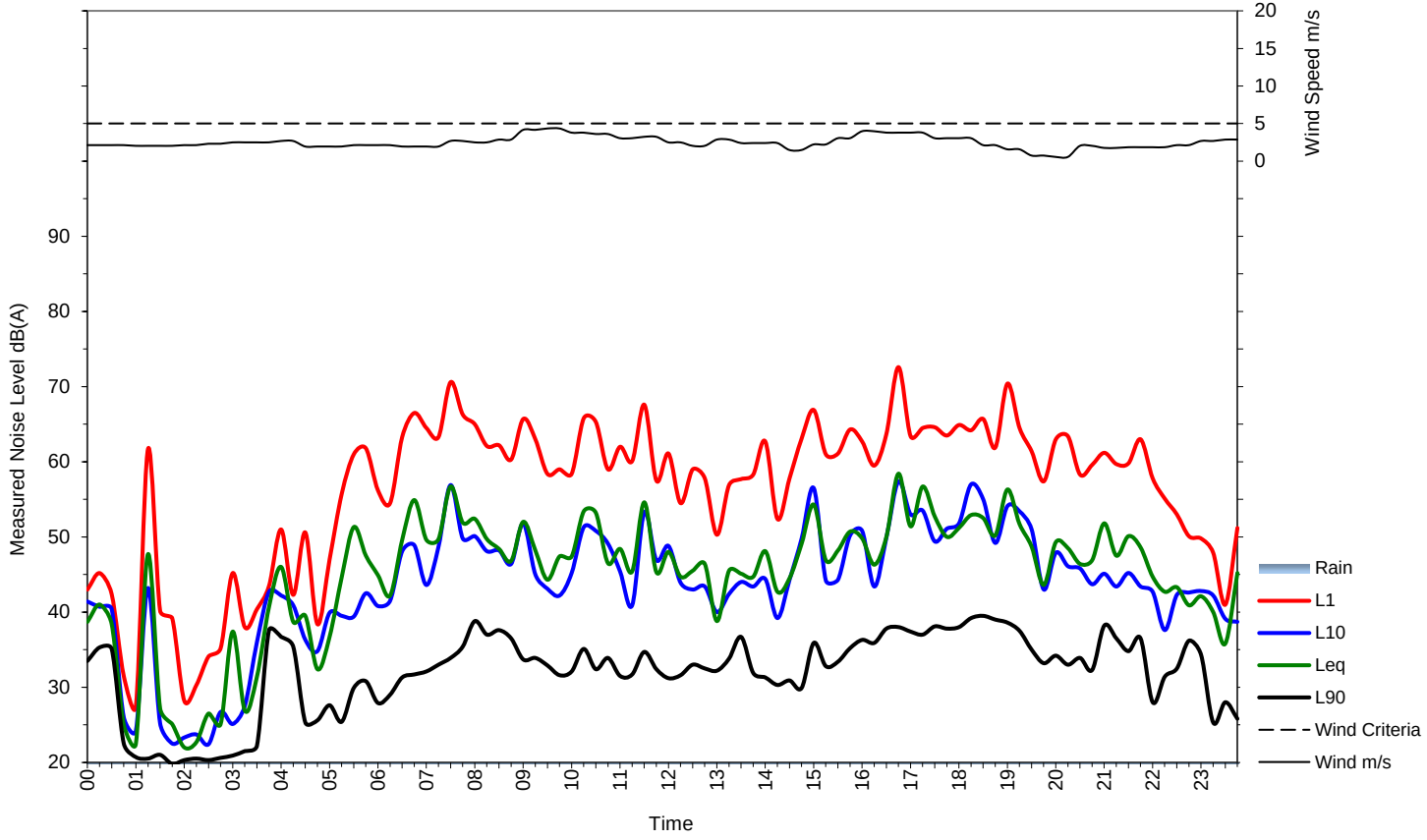
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Wind Criteria
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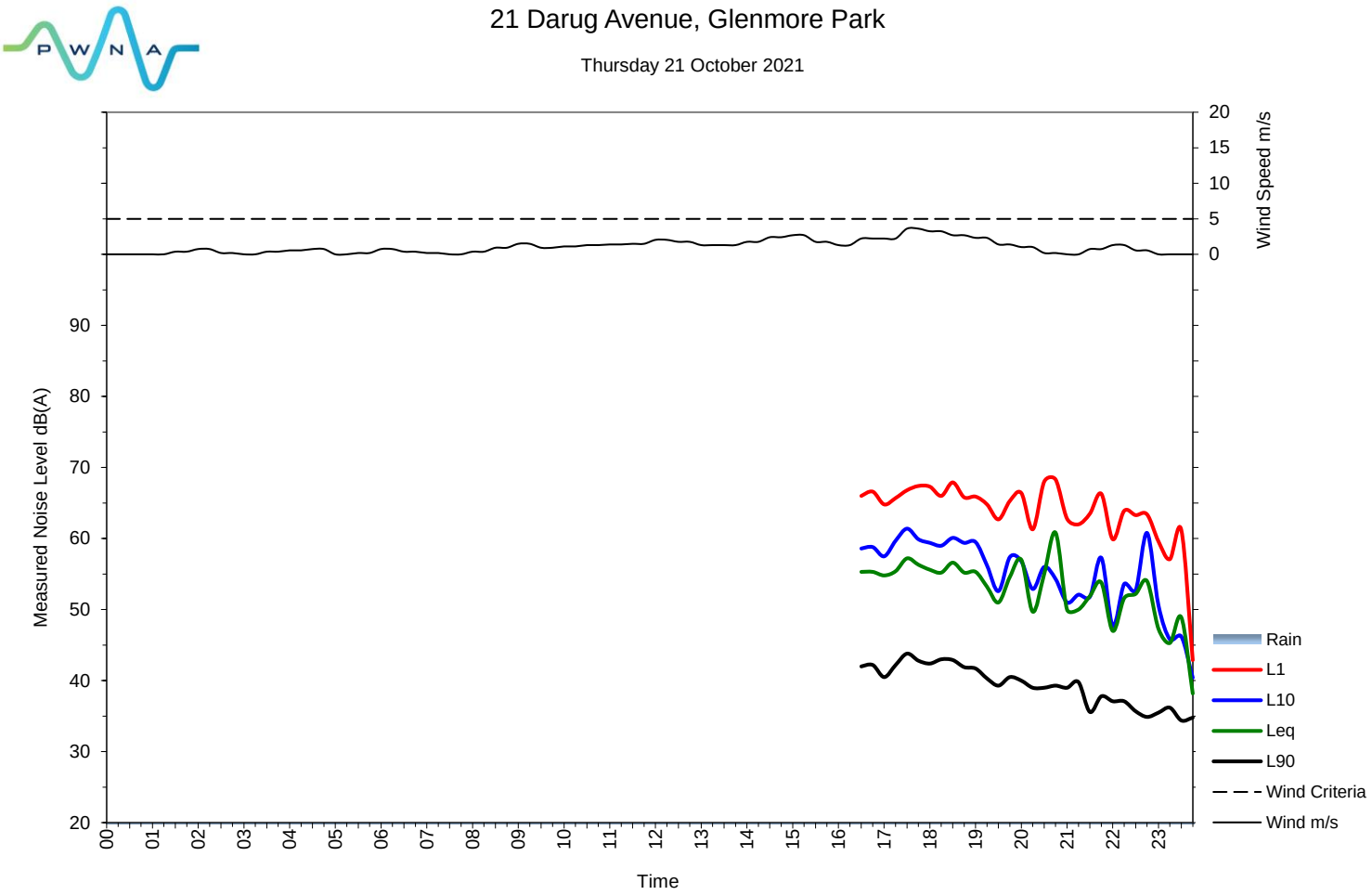
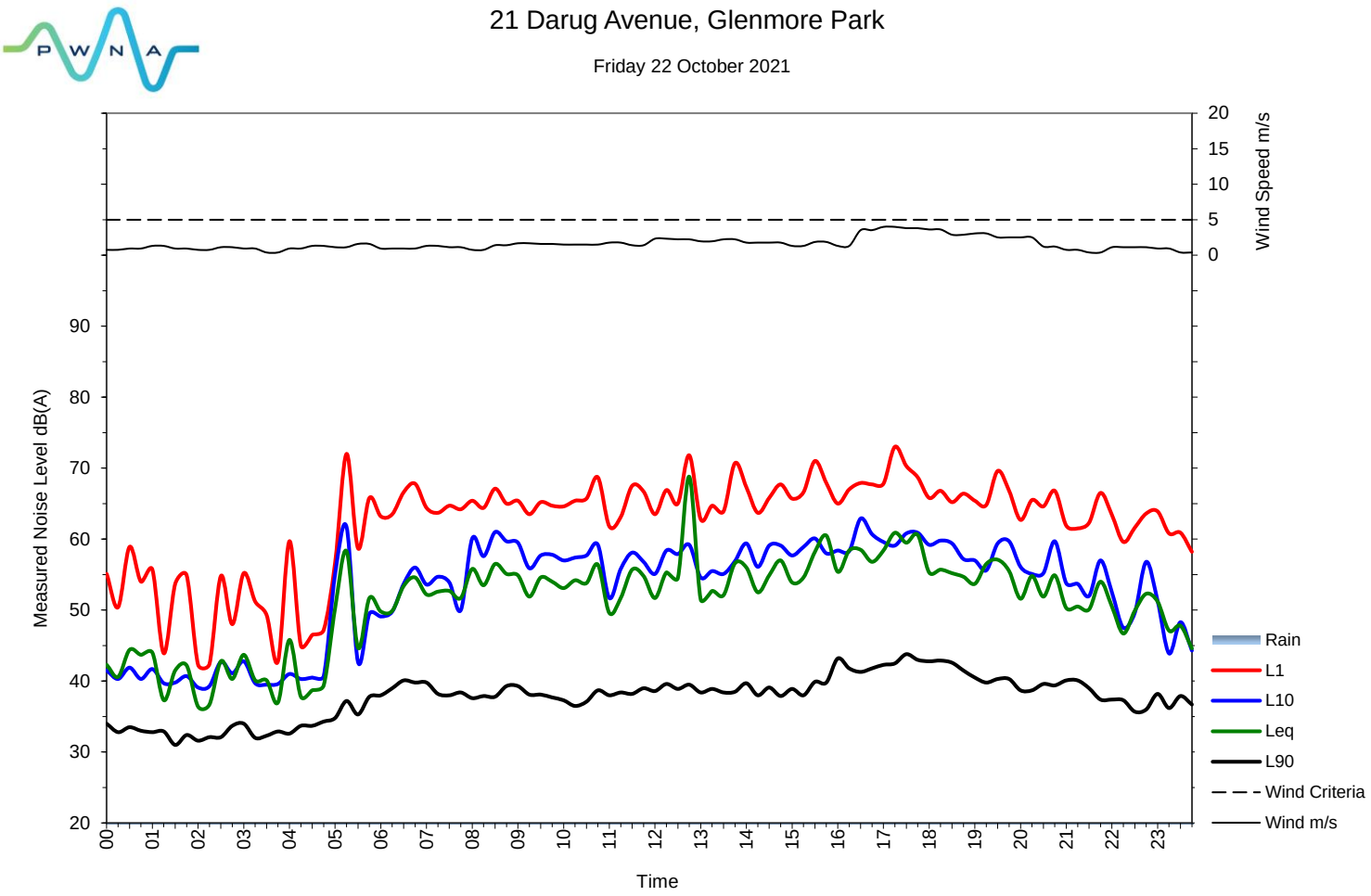
Logger Location 3: No. 21 Darug Avenue, Glenmore Park

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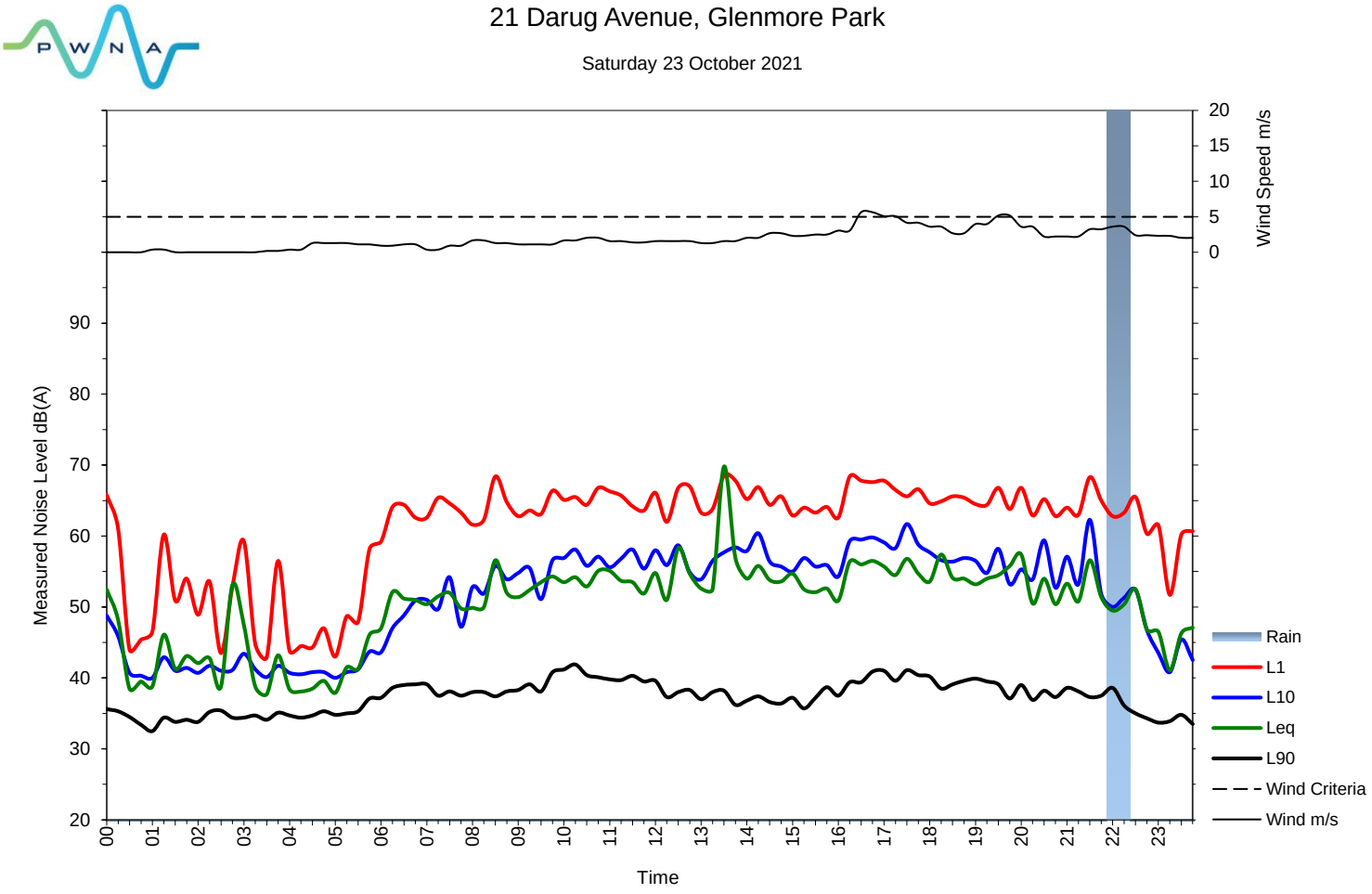
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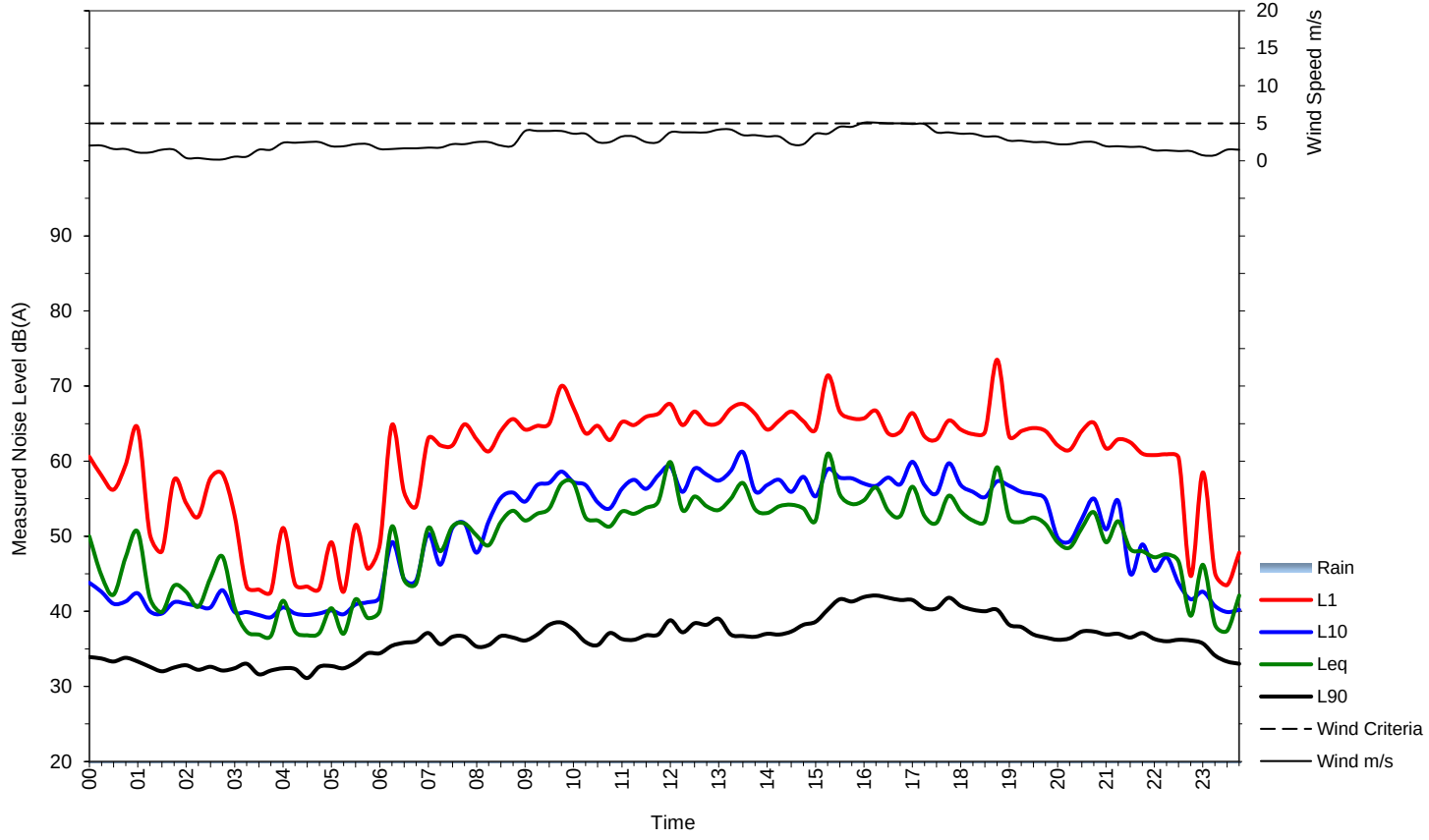
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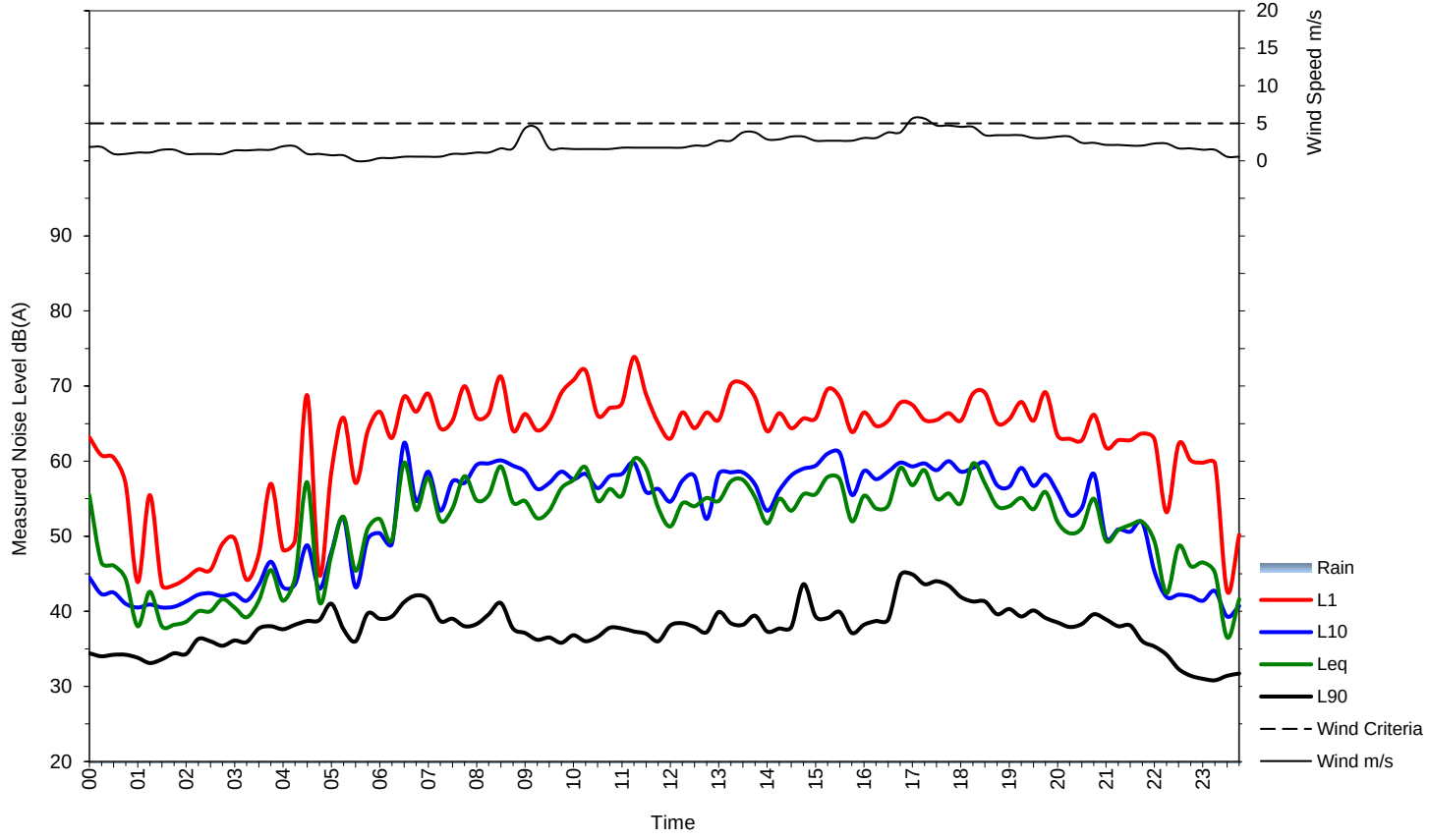
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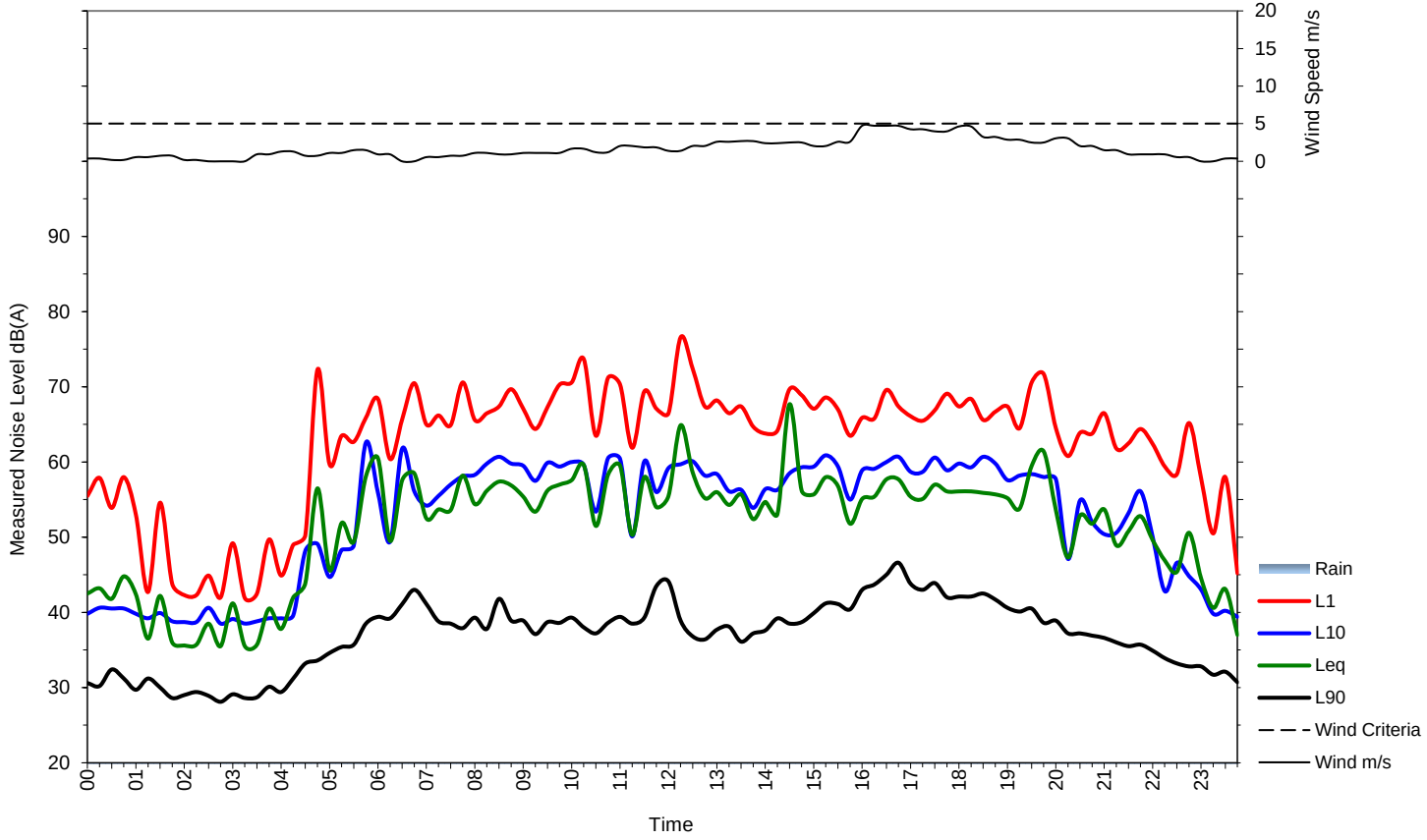
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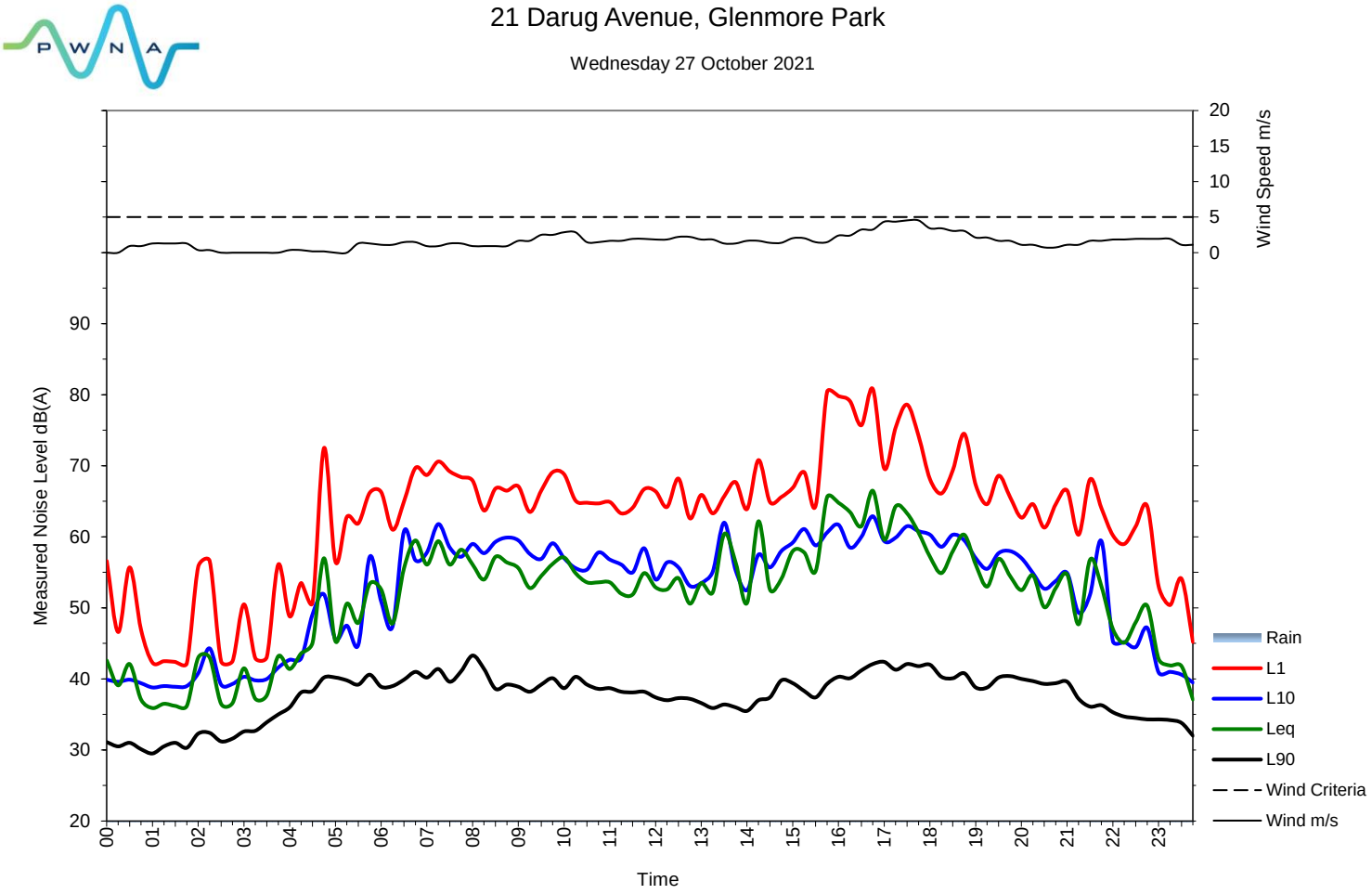
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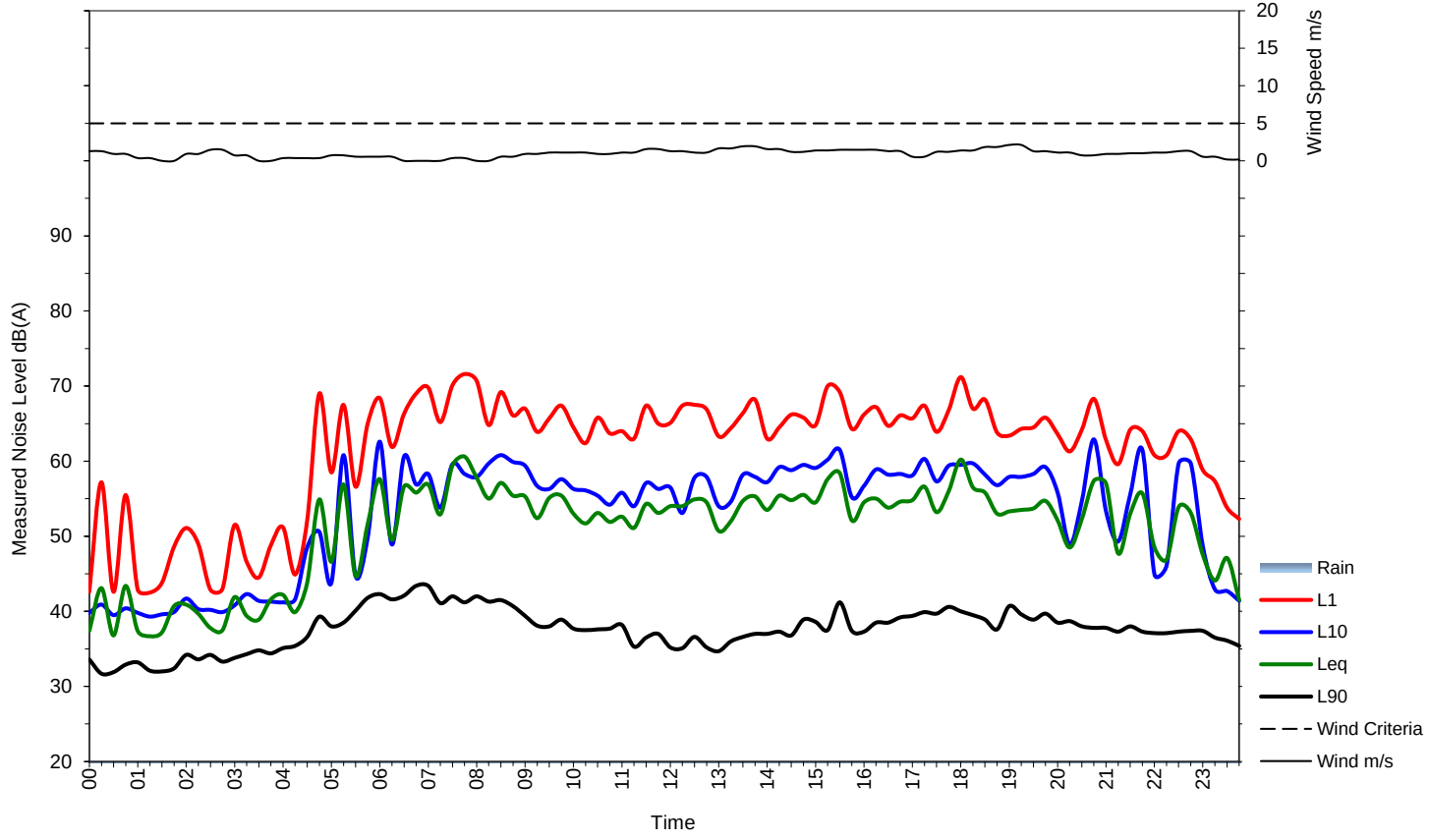
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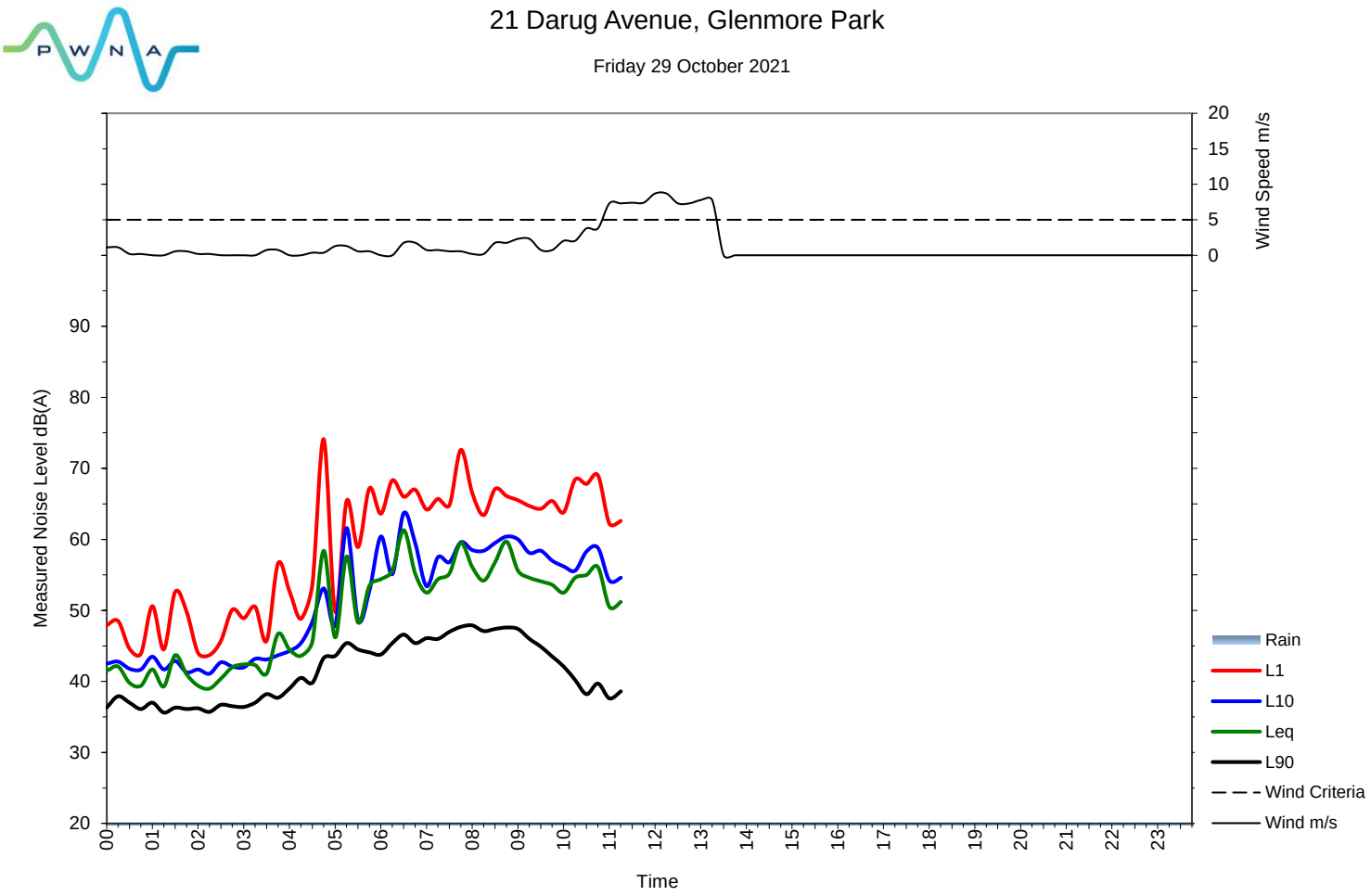
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Wind Speed m/s
Time
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Wind Criteria
Wind m/s

APPENDIX C: NOISE & VIBRATION INVESIGATION CHECKLIST

The New Primary School in Mulgoa Rise – Noise & Vibration Investigation Checklist

Pulse White Noise Acoustics (PWNA) and Schools Infrastructure NSW (SINSW) have prepared the following noise and vibration investigation checklist to assist the onsite construction team in investigation any received noise and vibration complaint or identifying an exceedance over the management levels. This checklist should be completed in conjunction with *The New Primary School in Mulgoa Rise, Forestwood Drive, Glenmore Park– Construction Noise Vibration Management Sub-Plan (CNVMSP)* prepared by PWNA.

Should any noise and vibration complaint be received, SINSW must complete the following steps:

Exceedance/Complaint Information

Complaint reference number:..... .....

Date Received: .....

Location of Complaint: .....

Complainant Contact Details:.....

Step	Task	Completed Response
1	Pause onsite works	
2	Identify the main source(s) construction noise and/or vibration within specific areas of the site which is impacting the most at the sensitive receiver.	
3	Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered. ***(If no, skip to step 5)***	
4	In the event an alternate piece of equipment or process can be used, works can re-commence incorporating possible and practical mitigation measures.	
5	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. This may include additional respite periods.	

APPENDIX D: AUTHOR CURRICULUM VITAE (CV)

MATTHEW FURLONG
SENIOR ACOUSTIC CONSULTANT

QUALIFICATIONS

Bachelor of Creative Technology (Audio Engineering and Sound Production)

Matthew Furlong has 8 years' experience in delivering acoustic design on architectural, environmental and infrastructure projects, including conceptual, detailed design, construction and post-construction stages.

He has consulted for mixed use of commercial and residential developments, developing in-principle recommendations for the client and managing contractor providing detailed design advice as well as full construction services.

In addition to the above, Matthew has being part of many consulting teams in many education, health, fitouts and Land and Environmental Court (LEC) proceedings across the state.

SELECTED PROJECT EXPERIENCE

Residential Developments

- Acoustic Design for Crown Casino Sydney
- Acoustic Design and Construction Services 130 Elizabeth Street, Sydney (One30Hyde)
- Acoustic Design and Construction Services Trinity Terraces Rosebery
- Construction Services 1a Coulson Street, Erskinville
- Construction Services for the Erko Apartments Erskinville
- Construction Services for the Eve Apartments Erskinville
- Acoustic Design 54-56 Riley Street and 1 Crown Lane, Darlinghurst
- Development Application, Acoustic Design and Construction Services New Life Darling Harbour, 495 Harris Street, Ultimo
- Development Application, Acoustic Design and Construction Services Meriton Developments (Mascot, Rosebery, Epping, Parramatta, Pagewood, Bondi, Dee Why, Zetland, Waterloo, North Sydney, Sydney, Macquarie Park)
- Development Application, Acoustic Design and Construction Services Summer Hill Flourmill Stages 1, 2, 3 and 4.
- Acoustic Design and Construction Services Macquarie Park Village
- Acoustic Design and Construction Services Ryde Gardens
- Acoustic Design and Construction Services Tempo Apartments Victoria Road Drummoyne
- Development Application, Acoustic Design and Construction Services Winston Hills Mall Residential
- Construction Services Presbyterian Aged Care Paddington
- Acoustic Design and Construction Services Wahroonga Nursing Home
- Acoustic Design and Construction Anglicare Castle Hill (ARV)
- Acoustic Design and Construction Cardinal Freeman Village, Ashfield

MATTHEW FURLONG
SENIOR ACOUSTIC CONSULTANT

Commercial / Educational / Health Facilities

- Formulation of the new Victorian Health Engineering Guidelines (Acoustics)
- Development Application and Acoustic Design 210-220 George Street Sydney
- Acoustic Design and Construction Services 151 Clarence Street, Sydney
- Development Application for 390-396 Pitt Street, Haymarket
- Acoustic Design and Construction Services Chifley Plaza Internal Works
- Development Application 371-375 Pitt Street, Sydney
- Construction Services Fitout of the Department of Premier and Cabinet
- Noise Investigations for Transport NSW (Chatswood and Burwood)
- SSDA and Acoustic Design Meadowbank Education Precinct
- CNVMP and Construction Services Anzac Park Public School
- CNVMP and Construction Services Alexandria Park Public School
- Construction Services for Wagga Wagga Base Hospital Stage 2
- Construction Services for North Shore Public Hospital
- SSDA and Acoustic Design for Concord Repatriation General Hospital
- SSDA and Acoustic Design Nepean Public Hospital
- Construction Services for South East Regional Hospital (Bega)
- Acoustic Design for North Shore Health Hub
- Acoustic Design Sydney Children's Hospital Stage 1 & Children's Comprehensive Cancer Centre (SCH1/CCCC), Randwick

Licensed Premises

- Development Application for The Cauliflower Hotel, Waterloo
- Development Application for Christopher Hanna Salon and Bar, 13-15a Bridge Street, Sydney

Industrial Developments

- Acoustic Design Erskine Park Industrial Area
- Acoustic Design and Construction Services Snackbrands Orchard Hills

APPENDIX E – SCHOOL INFRASTRUCTURE (SI) *NEW PRIMARY SCHOOL IN MULOGA RISE – PROJECT UPDATE JANUARY 2022*