Narrabeen Education Precinct

Noise and Vibration Impact Assessment for Development Application (DA)

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Glossary

Term	Definition
dB	Decibel is the unit used for expressing sound pressure level (SPL) or power level (SWL).
dB(A)	Decibel expressed as an 'A – weighted' sound pressure level, based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds.
Frequency	The rate of repetition of a sound wave. Frequency is measured Hertz (Hz), or cycles per second. Human hearing ranges approximately from 20 Hz to 20 kHz (2000 Hz).
Ground-borne noise	The transmission of noise energy as vibration of the ground. The energy may then be re-radiated as airborne noise.
$L_{1(period)}$	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
$L_{10(period)}$	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
$L_{90(period)}$	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
$L_{Aeq(period)}$	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
L_{Amax}	The highest sound pressure level recorded over a measurement period.
Octave Band Centre Frequency	The most commonly used frequency bands are octave bands, in which the centre frequency of each band is twice that of the band below it.
Rating Background Level (RBL)	Rating background level is the overall single-figure background level representing each assessment period (day/evening/night) over a measurement period.
Sound Power Level (SWL)	Expressed in dB, it is the total acoustic energy radiated by a plant or equipment to the environment
Sound Pressure Level (SPL)	Expressed in dB, it is the level of noise measured by a standard sound level meter and requires a description of where the noise was measured relative to the source
Vibration	Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure-borne noise or human comfort issues respectively.

Initialisms

ACRONYM	Definition
CEMP	Construction Environmental Management Plan
DA	Development Application
DfMA	Design for Manufacture and Assembly
EFSG	Engineering Facilities Standards and Guidelines
ICNG	Interim Construction Noise Guideline (NSW EPA, 2009)
NMLs	Noise Management Levels
NPI	Noise Policy for Industry (NSW EPA, 2017)
MMC	Modern Methods of Construction
RBL	Rating Background Level
SI NSW	School Infrastructure NSW
NEP	Narrabeen Education Precinct
NNPS	Narrabeen North Public School
NSPS	Narrabeen Sports High School

1 Introduction

Acoustic Studio has been engaged by School Infrastructure NSW (SINSW) to assess the potential noise and vibration impacts of the proposed Narrabeen Education Precinct (NEP) redevelopment and upgrade works. The Project Site(s) include:

- Narrabeen North Public School, located at 6 Namona Street, Narrabeen
- Narrabeen Sports High School, located at 10 Namona St, Narrabeen

This acoustic assessment has been prepared in support of the Development Application (DA) for the project.

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the operation and construction of proposed changes to the school.
- Carry out noise surveys to quantify the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- Establishing the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- A quantitative assessment of main noise and vibration generating sources associated with construction.
- Carrying out a quantitative assessment of the main sources of operational noise including building services associated with the works.
- Assessing whether the relevant criteria can be achieved and, where applicable, recommending measures to minimise and mitigate potential impacts.

This report presents the findings of both the operational and construction noise and vibration assessments. It includes measured environmental noise survey data and environmental noise limits based on the measured noise levels in the area. Compliance with these limits will ensure that any noise from the overall development will not impact negatively on the nearest existing receivers and receivers which have been proposed for development. The report also provides recommendations for appropriate vibration level criteria during construction.

1.1 Project Overview

1.1.1 Proposal

The proposed Narrabeen Education Precinct development includes redevelopment of Narrabeen North Public School (NNPS) and Narrabeen Sports High School (NSHS). The Public School and High School have been identified by the NSW Department of Education (DoE) as requiring upgrade works.

NNPS
The works at NNPS upgrade the school including demolition of existing buildings (Blocks H and J), construction of three (3) new buildings with refurbishment of three (3) existing buildings (Blocks B, K and V).

NSHS
The works at NSHS upgrade the school including addition of new two (2) storey extension to Building A, construction of new single storey amenities building and refurbishment of four (4) existing buildings (Buildings A, B, C and K).

Development Application
This Development Application (DA) will seek consent for the following works at NNPS & NSHS:

The works the subject of the Development Application (DA) at NNPS comprise:

- Construction of a new two (2) storey building containing administration facilities, multi-purpose hall and out-of-school-hours care (OSHC) facility on the ground floor with staff facilities and amenities on the first floor; and
- New Covered Outdoor Learning Area (COLA).

The works the subject of the DA at NSHS comprise:

- Alterations and additions to Building A (Gymnasium) to create new stage for gymnasium and new two (2) storey addition comprising canteen, boys and girls changing rooms and staff room on the ground floor; and movement studio and two (2) new General Learning Spaces (GLS) on the first floor.

Other development works are occurring on the site under separate planning pathways including:

- Development without consent (REF); and
- Exempt development

The proposed development does not seek to increase staff or student numbers.

1.1.2 Site Description

The subject sites are located at 6 and 10 Namona Street, North Narrabeen (referred to as the Narrabeen Education Precinct) and falls within the local government area of Northern Beaches Council. The Narrabeen Education Precinct has a total area of 9.84 hectares. Narrabeen North Primary School (NNPS) is located on the northern side of Namona Street, North Narrabeen and is legally described as Lot 3 Deposited Plan (DP) 1018621. NNPS is surrounded by residential dwellings to the east, grassed sporting fields (Warriewood Valley Sportsground) to the north and Northern Beaches Indoor Sports Centre to the west.

NNPS contains two (2) Binishell domes (Block A and Block B) which are identified as a local heritage item under the *Pittwater Local Environmental Plan 2014*. The two (2) Binishell Domes are listed as State significant on DoE's Section 170 Heritage and Conservation Register. The Double Binishell Dome (Block B) is listed on the State Heritage Register (SHR).

Narrabeen Sports High School (NSHS) is located on the southern side of Namona Street and is legally described as Lot 12 DP 1119562. NSHS is surrounded by Pittwater Road to the east, Pittwater Sports Centre to the south and Mullet Creek to the west.

1.1.3 Noise and Vibration Assessment Scope

The scope of the noise and vibration assessment is limited to noise impacts associated with the upgrade and additions noted above to include:

- Operational noise associated with:
    - NNPS
        - New Building (Hall, staff, admin and COLA).
        - Construction noise and vibration associated with the new works.
    - NSHS
        - Alterations and additions to Block A (including Amenities, GLS and Movement Studio)
        - Refurbishment of existing Block A spaces
        - Construction noise and vibration associated with the new works.
- Assessment of existing school operations are excluded.

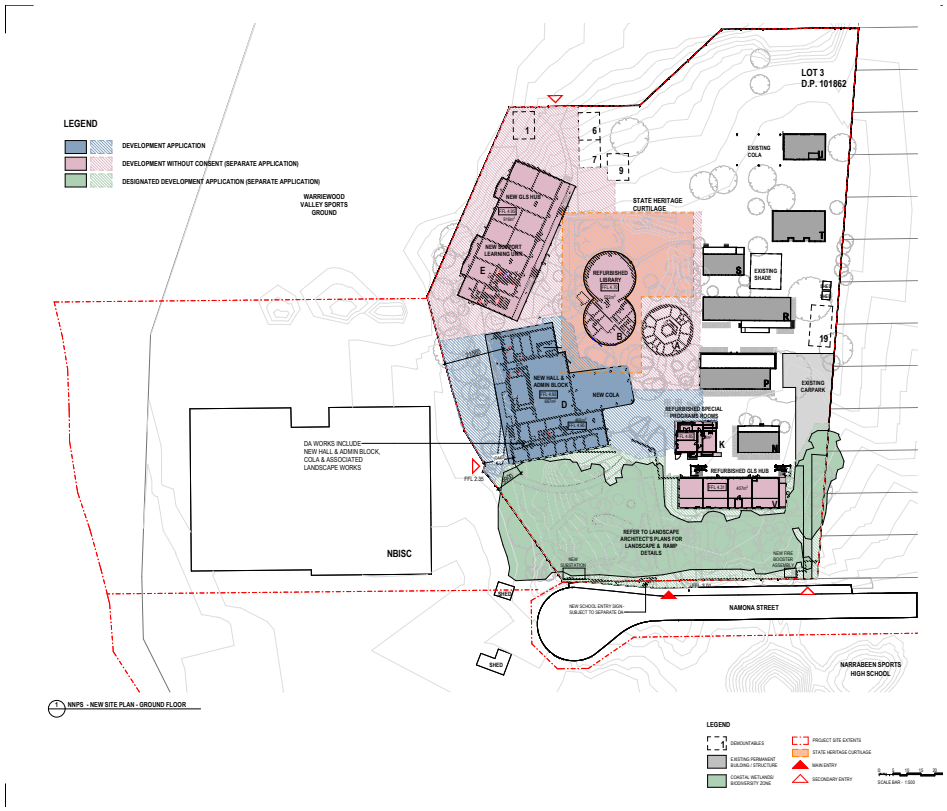


Figure 1: NNPS New Site Plan Layout – Ground Level

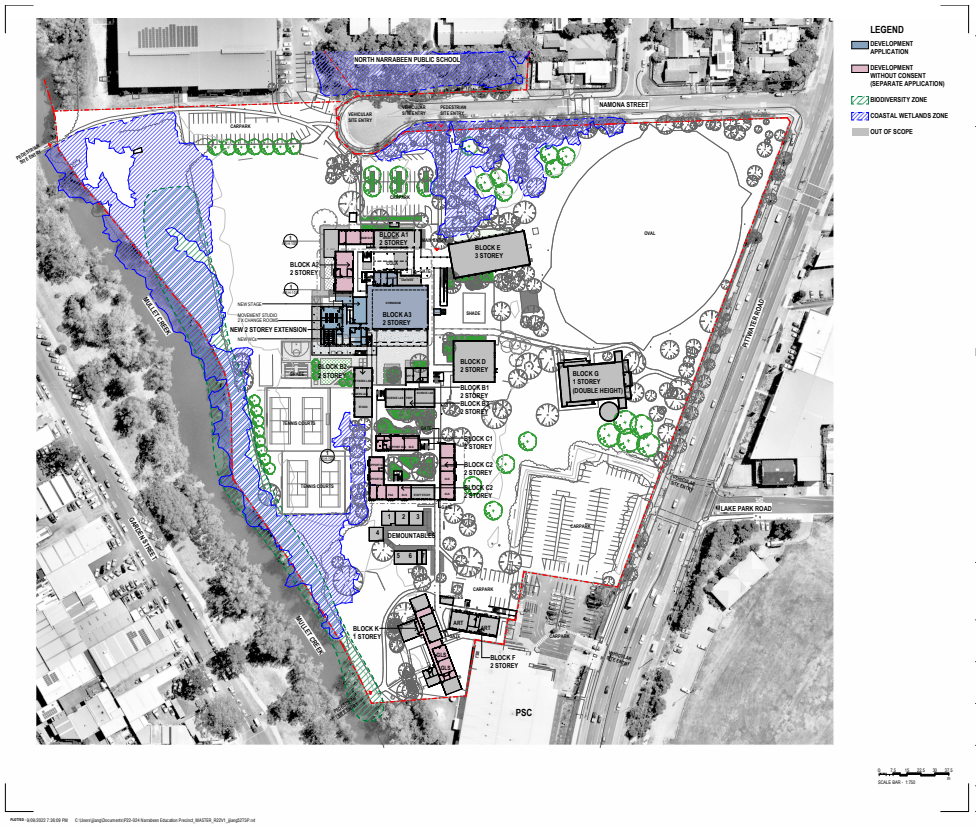


Figure 2: NSHS New Site Plan Layout – Ground Level

2 Surrounding Land Uses

2.1 Subject Site

The existing NEP site(s) are located within a suburban environment in Narrabeen, characterised by medium levels of activity throughout the day / evening and low noise levels in the night. The existing site is zoned as SP2 (educational establishment).
The following land-uses surround the project site:

- R2 - Low density residential.
- SP2 – Community facility.
- RU2 - Rural Landscape.
- B2 – Local Centre.
- RE1 – Public Recreation.
- SP2 – Infrastructure (Classified Road).
- B6 – Enterprise Corridor.
- C4 – Environmental Living (residential).

Figure 3: NEP Site(s) (red outline) and surrounding land uses

The following noise sensitive receivers surround the existing the project boundaries:

- Residential receivers
    - Residential dwellings to the north east of the site at the shared border, along Oak Street (considered reasonably most-affected for both school sites)
    - Residential dwellings to the east of the site, beyond Pittwater Rd
    - Residential dwellings to the west of the project site, along Garden St
    - Residential dwellings to the south west of the site
- Commercial Receivers
    - Businesses to the north of the site at Warriewood Square, across Jacksons Road
    - Pittwater Sports centre, top the south of the site at 1525 Pittwater Road
    - Northern Beaches Indoor Sports Centre to the west of the site, at Jacksons Rd.
    - Ted Blackwood Youth and Community Centre to the North of the site, across Jacksons Road
    - Businesses to the east of the site, across Pittwater road
- Industrial receivers
    - To the west of the site, along Garden St
- Active Recreation
    - Warriewood Valley Sports Ground, to the north west of the site
- Passive Recreation
    - Progress Park to the west of the site

Figure 4 presents the project site in context of the surrounding land uses, and displays long-term noise monitoring locations plus off-site, short term monitoring locations.

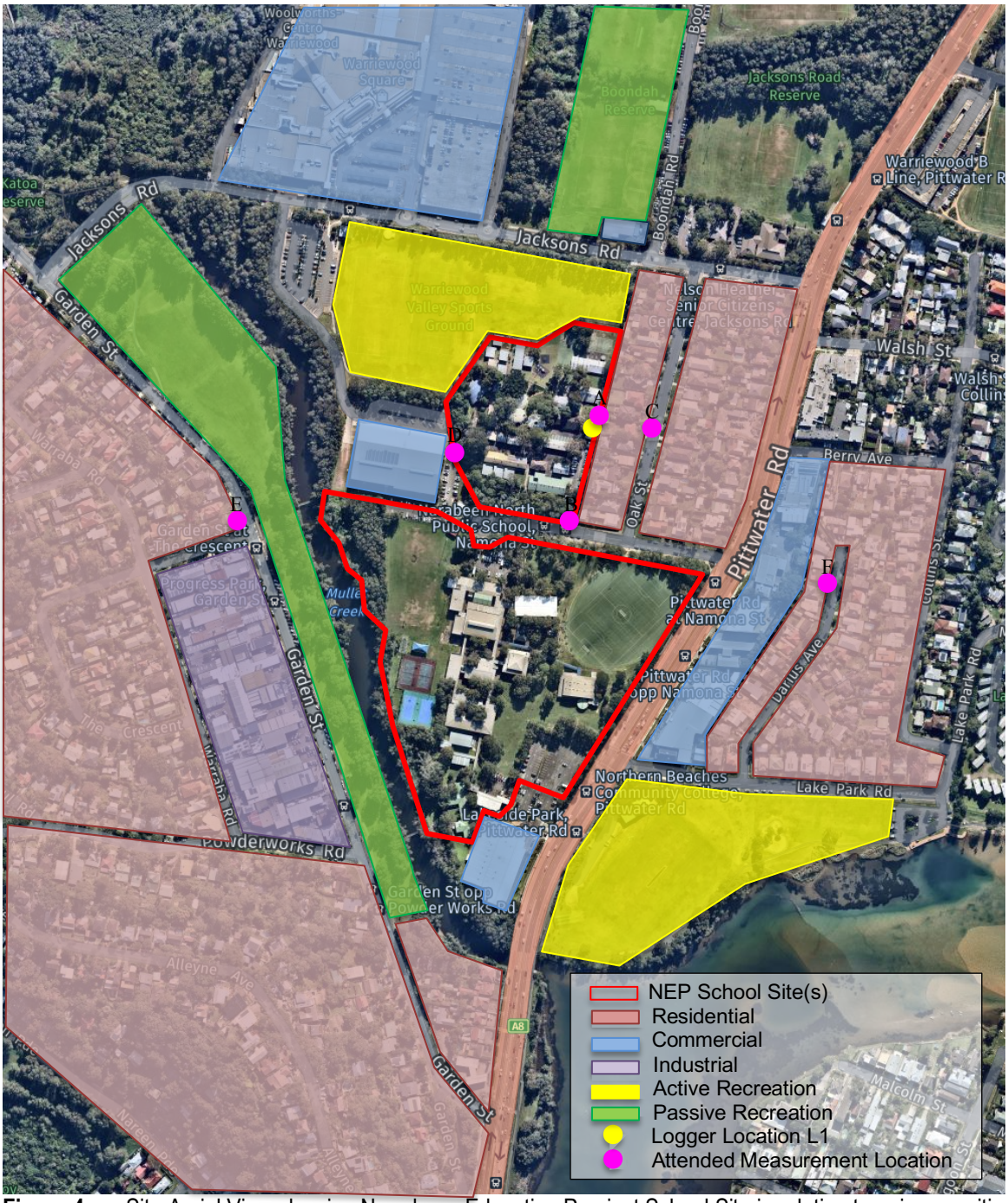


Figure 4: Site Aerial View showing Narrabeen Education Precinct School Site in relation to noise-sensitive receivers, and locations of long- and short-term noise monitoring. Source: Nearmap.

3 Existing Noise Environment

3.1 General Survey Information

A survey of the existing noise environment at and around the site was conducted through unattended noise monitoring to continuously record the noise levels on the site.
Unattended long-term noise monitoring was carried out for the following periods:

- Period 1 – Friday 8th April to Friday 15th April 2022 (during school holidays)
- Period 2 – Tuesday 26th April to Monday 2nd May 2022 (during school term)

Unattended long-term noise monitoring was carried out with the following noise loggers:

- Logger 1 (All periods): Ngara (Serial Number 878190).

The noise loggers recorded L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} noise parameters at 15-minute intervals continuously for the measurement period. The calibration of the loggers was checked before and after use and no variations were noted.
Operator attended, short-term monitoring was also carried out as follows:

- Monday 2nd May 2022.

The short term monitoring was conducted in order to supplement the long-term outdoor data across the site and at key surrounding receivers, and to obtain spectral noise data for traffic noise at the proposed site. These short-term measurements included measurements at the property boundaries of the closest residential properties, which were used to confirm that the long-term monitoring is representative of the background and ambient noise levels at the nearest noise sensitive receivers.

Attended short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 3010373). The calibrations of the analysers were checked before and after the surveys and no variation in levels occurred.

Windshields were used to protect the microphones of the logger and analyser. Weather conditions were wet and windy during the first period, and generally calm and dry during the attended noise surveys. The captured data which was affected by weather was excluded and not used for the analysis in the following sections.

Isaac Bradbury of Acoustic Studio Pty Ltd carried out the surveys.

3.2 Noise Monitoring Locations

The loggers were located at the proposed site at the following locations:

- Location L1 – on the eastern border of the NNPS site, at the nearest, reasonably most-affected residential receiver

The unattended long-term noise monitoring location is shown in Figure 4.
The detailed results of the unattended long-term noise monitoring at the logger location is shown in Appendix A.

This location was chosen as it:

- Was a secure place to leave the noise loggers unattended, and
- Was judged to provide representative of background and ambient noise levels at the reasonably most-affected noise sensitive receivers (both adjacent to the school and across Garden St / Pittwater Road). This was confirmed with comparison against attended measurements at Garden Street and Darius Avenue.

3.3 Unattended Long-term Monitoring Results

3.3.1 Background and Ambient Noise

The logged data shows the background and ambient noise levels representative of the area. The recorded background noise levels have been used to establish noise targets for noise emitted from the construction and operation of the new building.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{90}. The Rating Background Noise Level (RBL) provides a single figure that represents the background noise level over the entire monitoring period for assessment purposes. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The background sound levels have been established in general accordance with the methodology described in the NSW Noise Policy for Industry (NPI), i.e. the 10th percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period. These background noise levels are shown in Table 1 below, together with the L_{Aeq} ambient noise levels measured for each period.

Logging Period	Background Noise Levels (RBL), dB(A)			Leq Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Period 1	41	43	36	56	55	48
Period 2	42	40	32	55	49	47

Table 1: Long-term background and ambient noise levels

Based on our observations during the site inspections, both ambient and background noise levels around the Project Site are generally dominated by local and distant traffic noise plus general suburban hum around the site.

3.4 Short-term Monitoring Results

Six (6) short-term noise monitoring locations were chosen as representative of the site and surrounds as follows:

- **Location A –** Logger location (NNPS Residential boundary).
- **Location B –** NNPS Carpark Entrance.
- **Location C –** 14 Oak Street.
- **Location D –** Western boundary of NNPS, near Northern Beaches Indoor Sports Centre.
- **Location E** – Corner Garden Street and The Crescent.
- **Location F** – 23 Darius Avenue.

A summary of the measured values of the short-term background and ambient noise monitoring around the existing site is provided in Table 2.

The attended measurements were taken for a period which accurately captured the noise environment / profile which was being measured (between 2-15 minutes).

Location	Time (May 2nd, 2022)	Descriptor	Measured sound level, dB re 20 µPa									
			Overall dB(A)	Octave band centre frequency[1], Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
A	Between 1:30-2pm	L_{eq}	55	58	54	47	44	46	51	50	45	35
		L_{90}	50	54	48	41	39	42	45	44	40	30
	Between 2-2:30pm	L_{eq}	46	56	53	44	40	40	41	38	38	31
		L_{90}	41	54	47	39	37	37	38	35	31	25
B	Between 1:30-2pm	L_{eq}	53	57	56	51	43	43	47	47	47	41
		L_{90}	49	54	51	43	39	40	45	43	38	29
C	Between 1:30-2pm	L_{eq}	55	59	59	52	48	49	51	48	42	36
		L_{90}	46	55	53	46	40	40	43	39	31	22
	Between 1:30-2pm	L_{eq}	57	61	60	52	50	50	53	51	43	35
		L_{90}	43	55	52	45	39	38	40	36	29	21
D	Between 2-2:30pm	L_{eq}	46	60	60	51	40	40	41	38	38	31
		L_{90}	42	57	54	45	36	37	37	33	28	21
E	Between 2-2:30pm	L_{eq}	69	67	69	64	64	64	67	61	53	47
		L_{90}	55	60	59	54	51	49	52	48	40	31
F	Between 2-2:30pm	L_{eq}	46	58	54	48	42	43	41	38	37	33
		L_{90}	41	53	48	42	37	36	37	32	24	19

Table 2: Summary of short-term traffic, background and ambient noise levels

4 The Key Acoustic Considerations

The following acoustic considerations are to be addressed as part of the assessment:
External Noise Emissions - Noise emissions from the Project will need to be managed to limit environmental noise impacts on nearby buildings resulting from the operation of the proposed development. In particular, this applies to:

- Building services and plant - The impact of mechanical noise generated by any new mechanical plant and services.
- Operational noise – associated with noisy activities, including new buildings.

External Noise Emissions associated with the Operation - Noise emissions from the Project are to be managed to limit environmental noise impacts on sensitive receivers resulting from the operation of the proposed development.

External Noise Intrusion – From external noise sources including plant and equipment and road traffic.

Construction Noise and Vibration - The impact of noise and vibration generated during the construction stages of the Project on surrounding noise and vibration sensitive premises.

- The development will contribute to an increase in noise and vibration to the surrounding environment during construction. Typically, this will result from a combination of intermittent and continuous noise from construction and excavation equipment, construction traffic and plant commonly used on construction sites.
- Design noise and vibration targets have been set for the Project and construction noise impacts have been anticipated from standard construction procedures.
- The noise and vibration targets and expected impacts are reported in Section 4 and Section 8 of this report. Where the noise and vibration impacts are predicted to be above the NMLs, then all reasonable and feasible noise and vibration mitigation measures must be considered as detailed in Section 8.5.

The engaged Contractor would be required to prepare a Construction Environmental Management Plant (CEMP) based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

The CEMP is to provide the following:

- A quantitative construction noise and vibration assessment, which includes:
    - Identifying noise and vibration sensitive receivers potentially affected by the proposed works.
    - Reference the appropriate construction noise and vibration criteria outlined in Section 1.1 of this report.
    - Identifying noise and vibration sources associated with the proposed works.
    - Providing an assessment of noise and vibration generated by the proposed works against the relevant management levels.
    - Determining the likely need for noise and vibration mitigation and management measures.
- A control strategy for construction noise and vibration mitigation to best minimise potential impacts through implementation of reasonable and feasible measures.
- Noise and vibration monitoring as required, using monitors equipped with alert/notification systems to ensure works are carried out in accordance with the applicable Guidelines and Standards.

5 Project Noise and Vibration Targets

5.1 Relevant Standards and Guidelines

The following acoustic standards and guidelines have been considered in establishing noise and vibration criteria and assessment for this project.

- Pittwater Local Environmental Plan (LEP) 2014.
- Pittwater 21 Development Control Plan (DCP).
- NSW EPA Noise Policy for Industry (NSW NPI) 2017.
- NSW EPA Road Noise Policy (RNP) 2011.
- NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline" (ICNG) 2009.
- NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline" (AVTG) 2006.
- NSW Department of Planning "Development Near Rail Corridors and Busy Roads – Interim Guideline" 2008.
- NSW Protection of the Environmental Operations (POEO) Act 1997.
- Australian Standard "AS 2436 : Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites" 2010.
- Australian Standard "AS 1055 : Acoustics – Description and Measurement of Environment Noise" 1997.
- NSW School Infrastructure "Educational Facilities Standards and Guidelines".
- State Environmental Planning Policy (Transport and Infrastructure), 2021 ('SEPP')

5.2 Operational Noise Emissions

5.2.1 NSW Education Educational Facilities Services Guidelines (EFSGs)

Section DG11 (acoustics) of the EFSGs outlines the following:

Noise emission considerations include:

- *Noise emission from school activity (e.g.: music performance, sporting activity)*
- *Noise emission from a mechanical services (such as air conditioning unit or fan)*

The extent to which noise emission will have to be considered and the extent of acoustic treatment required will depend upon:

- *Whether noisy activities take place in a room or space*
- *Whether the room or space is naturally ventilated and therefore windows and/or doors are expected to be open when noisy activities are taking place*
- *Room facade construction and orientation of 'acoustically weak' facades relative to noise-sensitive receivers*
- *Distance to noise-sensitive receivers*
- *Whether mandatory noise emission criteria are required to be satisfied at nearby boundaries and land uses.*

The above considerations are discussed in the next sections against the relevant noise guidelines.

Noise sources with a recognised guideline and assessment method:

- Plant and Equipment from internal and external sources: NSW NPI (refer Section 5.2.1)
- Vehicles on site: NSW NPI (refer Section 5.2.1)
- Vehicles on public roads: NSW RNP (refer Section **Error! Reference source not f ound.**)

Noise sources with no specific guideline and assessment method (however, we consider the following best practice approach appropriate):

- Noise from school activities from internal building areas or outdoor COLA:
    - In alignment with the Intrusiveness criterion from NSW NPI (refer Section 5.2.1)
- Communal out of hours usage of school facilities
    - In alignment with the Intrusiveness criterion from NSW NPI (refer Section 5.2.1)
    - In alignment with the requirements of the POEO act & NSW Local Government Checklist (refer Section 5.2.5)

5.2.2 Pittwater Local Environmental Plan (LEP), 2011 and Pittwater 21 Development Control Plan (DCP)

There is currently a new Development Control Plan (DCP) in preparation for the Northern Beaches council.

The former Pittwater 21 DCP, which is the most recent and relevant DCP which applies to the suburb of Narrabeen states the following in relation to acoustic controls (in addition to requiring general compliance with the NSW Protection of the Environmental Operations (POEO) Act 1997):

"Part C5.21 – Plant, Equipment Boxes and Lift Over-run
Controls
Where provided, plant and equipment boxes and lift over-runs are to be integrated internally into the design fabric of the built form of the building.

Locate and design all noise generating equipment such as mechanical plant rooms, mechanical equipment, air conditioning units, mechanical ventilation from car parks, driveway entry shutters, garbage collection areas or similar to protect the acoustic privacy of workers, residents and neighbours… "

5.2.3 NSW EPA Noise Policy for Industry (NPI), 2017

The NSW NPI provides guidance on the methodology for determining project-specific noise trigger levels or targets for external noise emissions from plant associated with a development.

The criteria have two components:

- Intrusiveness Noise Level – controlling intrusive noise impacts in the short term for residences.
- Amenity Noise Level (ANL) – maintaining noise level amenity for particular land uses for residences and other land uses.

Applying the more stringent of the two criteria provides the Project Noise Trigger Level (PNTL).

The NSW NPI considers the following when establishing the criteria:

- The existing Ambient (L_{eq}) and Background noise levels (L_{90}) that surround the site.
- The time of day that the noise generating development will be in operation, defined by the following:
    - Day (7am to 6pm).
    - Evening (6pm to 10pm).
    - Night (10pm to 7am).
- The type of receivers.
- The type of area that the development site and its nearest receivers are located. The NSW NPI provides recommended noise levels for specific receiver types and the type of area they are located within.

- The type of noise source and its characteristics. The NSW NPI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

Further guidance on establishing the criteria can be found in the NSW NPI.

Noise Impacts on the Surrounding Community

Based on the measured noise levels detailed in Section 3 and in accordance with the methodology outlined in the NSW NPI (further described in Appendix B), Table 3 details the corresponding targets of allowable noise emission from external plant and equipment at the nearest receiver boundaries from the School.

NOTE: Achieving the noise targets below will ensure the requirements of Pittwater Council DCP are also satisfied.

Receiver (External)	Period	Project Noise Trigger Level (PNTL) $L_{eq(15min)}$ dB(A)
Residential	Day	46
	Evening	43
	Night	37
Industrial	When in use	68
Commercial	When in use	63
Active Recreation	When in use	53
Passive Recreation	When in use	48

Table 3: NSW NPI Project Noise Trigger Levels for external noise emissions from proposed development

5.2.4 Sleep Disturbance (Residential Receivers)

Noise sources with the potential for sleep disturbance are likely to occur during night-time (10pm to 7am) operational and construction works activities.

The NSW NPI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq,15min}$ and/or L_{AFmax} noise levels at the receiver that are considered applicable to the SSDA. It suggests Sleep Disturbance Screening Criteria of:

- Event $L_{Aeq,15min}$ 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or
- Event L_{AFmax} 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.

If the $L_{Aeq,15min}$ noise level above background is less than 5 dB and/or maximum noise emergence above background is less than 15 dB, then the noise is considered unlikely to cause sleep disturbance. If the screening test level is exceeded, then further assessment of sleep disturbance effects is warranted.

The Sleep Disturbance Screening Criteria are presented in Table 4.

Residential Receiver Location	Period	Sleep Disturbance Screening Criteria	
		$L_{Aeq,15min}$ dBA	L_{AFmax}, dBA
All	Night (10pm to 7am)	40	52

Table 4: Sleep Disturbance Screening Criteria

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,(15\ minute)}$ by more than 5 dB(A) and 15 dB(A) respectively are screening criteria for the purpose of assessing potential impacts from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance Screening Criteria is exceeded, the detailed analysis is to cover the extent to which the noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the RNP.

Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10pm and 7am);
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

A further consideration for sleep awakening is whether the environmental noise has changed. Section 5.3 "Response to a Change in Noise Level" of the RNP states:

"While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. […] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB(A) in maximum noise levels."
Section 5.4 of the RNP, "Sleep Disturbance", states that:
"From the research on sleep disturbance to date it can be concluded that:

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

The internal noise levels provided in the RNP are related to potential sleep awakening. Typically noise impact assessments consider the worst-case scenario, including when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB(A) attenuation from outside to inside through the open window. This situation is considered likely during warmer seasons. When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB(A).

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests (extract from RNP Section 5.4 above) that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these

events occur no more than twice in one night.

Residential Receiver Location	Period	Sleep Awakening Level
		L_{AFmax}, dB(A)
All	Night (10pm to 7am)	60 to 65

Table 5: Sleep Awakening Level

5.2.5 Protection of the Environment Operations Act (POEO) 1997

The Protection of the Environment Operations (POEO) Act 1997 defines "Offensive Noise" as follows:

"...

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations. ..."

Further advice on the assessment of "Offensive Noise" is provided in the Noise Guide for Local Government (NGLG), 2010, which provides a checklist (shown below), of items that may be considered:

"Offensive noise test: checklist of considerations

- *Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?*
- *Q2: Does the noise include characteristics that make it particularly irritating?*
- *Q3: Does the noise occur at times when people expect to enjoy peace and quiet?*
- *Q4: Is the noise atypical for the area?*
- *Q5: Does the noise occur often?*
- *Q6: Are a number of people affected by the noise?"*

We note that this checklist is typically used when assessing a noise complaint and is not intended as an assessment tool for planning, however is relevant for considering the impact of noise sources with no specific assessment guideline.

5.2.6 Mechanical Plant and Equipment

The design of mechanical plant and equipment shall achieve the requirements of Table 3.

5.2.7 Traffic Noise

Within the school campus (on site)

On site noise generation from car parks shall be assessed against the requirements of Table 3.

On surrounding roads (off site)

NSW Road Noise Policy (RNP)

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 6 below provides the RNP criteria for additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver - Road Type	Assessment Criteria (external[Error! Bookmark not defined.])	
	Day (7am to 10pm) $L_{eq\ (period)}$ dB(A)	Night (10pm to 7am) $L_{eq\ (period)}$ dB(A)
Residential - Local Road	55 (1 hour)	50 (1 hour)

Table 6: RNP assessment criteria for additional traffic on roads generated by land use development including construction vehicles / traffic

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that:

"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB… (in relation to existing noise levels)… represents a minor impact that is considered barely perceptible to the average person".

5.2.8 Playground Noise

The project will not include any changes or additions to play area spaces, and school bell times will remain as existing. Therefore, a detailed assessment of play area noise is not included for this assessment.

5.3 External Noise Intrusion

5.3.1 General

Pittwater Local Environmental Plan (LEP), 2011 and Pittwater 21 Development Control Plan (DCP)

Pittwater LEP and DCP documentation does not provide objective noise control measures for external noise intrusion to an educational facility. Therefore, objective assessment targets are based on other relevant guidelines outlined in the following sections.

NSW Department of Education – Educational Facilities and Standards Guidelines (EFSGs) DG11 - Acoustics

The NSW DEC EFSGs DG11 guideline (found at https://efsg.det.nsw.edu.au) provides internal noise levels that should be achieved within educational facilities which are generally consistent with the recommended satisfactory design sound levels from Australian Standard AS 2107:2016.

The DEC requires that recommended internal noise levels in DG11 be achieved in all relevant spaces within the proposed development. Therefore, the criteria outlined in DG11 have been adopted for this project.

5.3.2 Traffic Noise to Buildings

State Environment Planning Policy (Planning and Infrastructure), 2021

Clause 2.120 of the SEPP 2021 outlines requirements related to the assessment of noise impact from non-road developments that are adjacent to road corridors with traffic volumes of more than 20,000 vehicles.

Objective criteria for internal noise levels that must be achieved are provided for residential development only.

In the absence of objective criteria for the educational facilities, reference is made to NSW Department of Planning (DoP), *Development Near Busy Roads and Rail Corridors – Interim Guideline* and Australian Standard AS2107, which recommend internal design noise levels within occupied spaces and are detailed below.

NSW DoP, Development Near Busy Roads and Rail Corridors

For airborne noise from road traffic, the NSW DoP Interim Guideline sets an internal noise target of 40 dB(A)[1] for educational institutions.

[1] Airborne noise is from traffic is calculated as $L_{eq\ 15\ hr}$ Day and $L_{eq\ 9\ hr}$ night.

5.3.3 Traffic Noise to Outdoor Areas

When considering outdoor areas of a school where it is affected by external noise, the following guidelines are relevant.

NSW EPA Road Noise Policy (RNP)
The RNP provides assessment criteria for assessment of road impact on noise residential land uses including school playground areas as follows:

- Open space (active land use) – External $L_{Aeq\ (15\ hour)}$ - 60 dB(A).
- Open space (passive land use) – External $L_{Aeq\ (15\ hour)}$ - 55 dB(A)

5.4 Construction Noise and Vibration

5.4.1 Noise Management Levels

The relevant guideline applied for the assessment of construction noise is the ICNG. This guideline provides construction NMLs for Residential, Commercial and Industrial noise receivers as follows.

Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction NMLs that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 7 outlines the methodology for determining construction NMLs at nearby residential receivers surrounding the development site based on existing background noise levels.

Time of Day	Management level $L_{Aeq\ (15\ min)}$	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 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 $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 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(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

Table 7: Residential construction Noise Management Levels for airborne noise as outlined in the ICNG

The project-specific construction Noise Management Levels are shown in Table 8 based on the measured background noise levels at the site (in Section 3 – also refer to Appendix B).

Location	Period		Rating Background Level RBL, dB(A)	Noise Management Level (External) $L_{eq\ (15\ min)}$ dB(A)
Residential	Recommended Standard Hours	Monday to Friday 7am to 6pm	42	RBL + 10 = 52
		Saturday 8am to 1pm	42	RBL + 10 = 52

Table 8: Project Specific residential construction Noise Management Levels for airborne noise

Non-Residential Receivers:

The ICNG also provides recommended construction NMLs for relevant non-residential receivers surrounding the construction site, which are as follows:

Occupancy	Management level $L_{eq\ (15\ min)}$ dB(A)
Commercial	75 dB(A) - External / 65 dB(A) - internal[2]
Active Recreation	65 dB(A)
Passive Recreation	60 dB(A)
Existing Classrooms	55 dB(A) – External / 45 dB(A) - Internal

Table 9: Non-residential Noise Management Levels for airborne noise

[2] Minimum 10 dB loss from a façade with windows sufficiently open for natural ventilation.

5.4.2 Vibration Criteria

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment
- Structural damage

Relevant management levels for each of these are detailed in the sections that follow.

Human Comfort

The DEC AVTG provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990.

This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus targets for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- **Continuous vibration** continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values.
- **Impulsive vibration** is a rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- **Intermittent vibration** can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

Examples of these vibration types are provided in Table 10 below.

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

Table 10: Examples of vibration types

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 11. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Table 11: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 12 sets out the acceptable VDV values for intermittent vibration.

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	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

Table 12: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Sensitive Equipment

Areas with sensitive equipment are likely to require a higher degree of vibration isolation than the values in Table 11 & Table 12.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 13 details the VC curves applicable to a range of highly sensitive equipment that is to be referred to and considered in conjunction with manufacturer guidelines specific to each type of equipment.

Curve	Max Value 8-80Hz	Detail Size	Equipment Types / Requirements
	Microns / sec, rms	Microns	
VC-A	50	8	Bench Microscopes < 400 x Magnification, optical and other precision balances, coordinate measuring machines and optical comparators
VC-B	25	3	Bench Microscopes > 400 x Magnification, microsurgery and neurosurgery
VC-C	12.5	1	Electron Microscopes < 30,000 x magnification, magnetic resonance imagers and microelectronics manufacturing equipment
VC-D	6	0.3	Electron Microscopes > 30,000 x magnification, mass spectrometers and cell impact equipment
VC-E	3	0.1	Un Isolated laser and optical research systems

Table 13: VC Curves for Highly Sensitive Equipment

Figure 5 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 11.

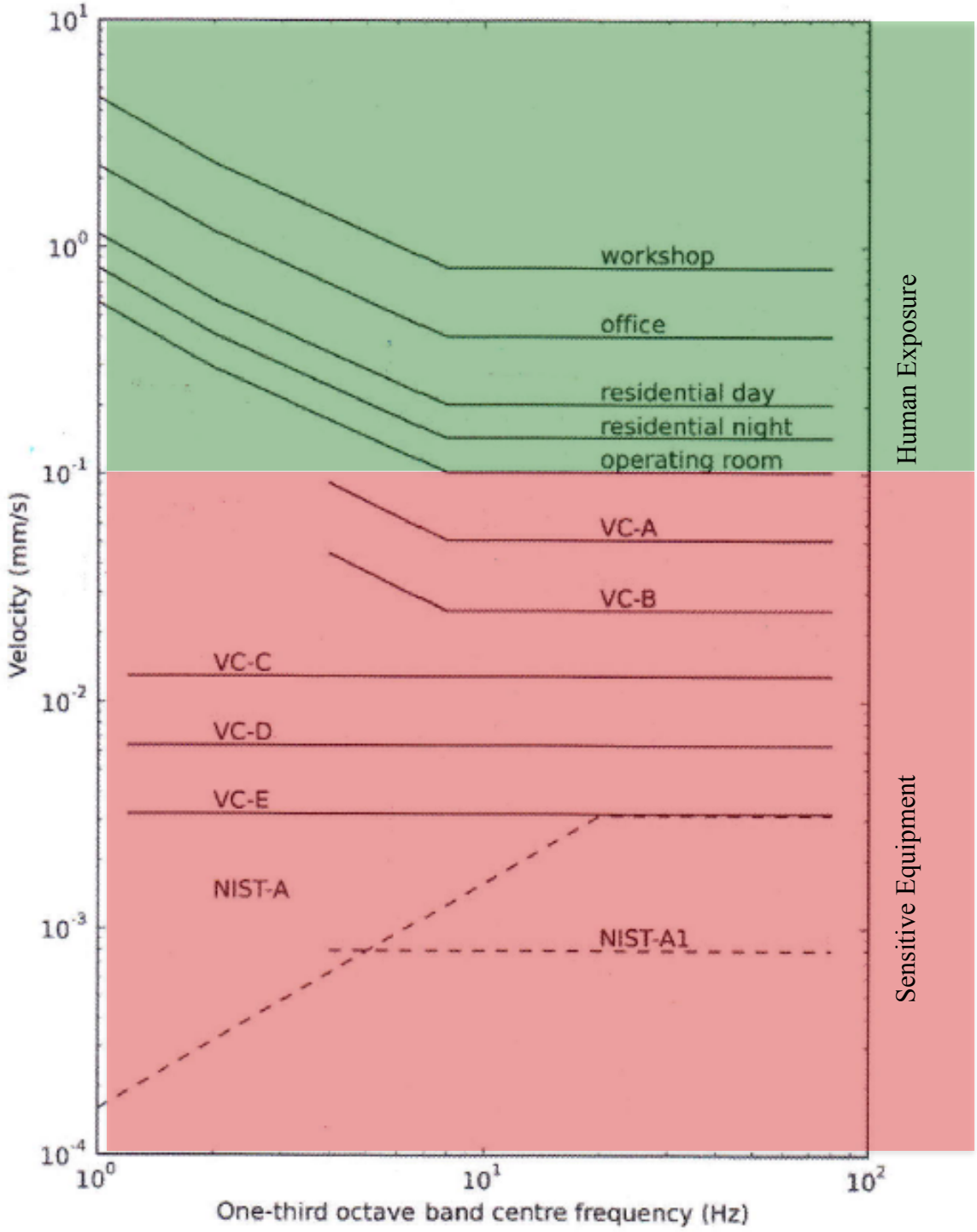


Figure 5: VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

At this stage no potentially sensitive receivers at or surrounding the site have been identified as having particularly vibration sensitive equipment.

Structural Damage

Vibration-induced damage of buildings and structures is a common concern, but it is actually rare in practice. This explains why there is limited reliable data on the threshold of vibration-induced damage in buildings and there is no directly relevant Australian Standard. There are guidelines available in a number of international standards, although these vary significantly. Criteria to prevent building damage and disruption to equipment and processes are discussed in Appendix C.

Recommendations

The criteria given in Table 11 for Human Comfort shall generally form the limiting vibration criteria for the Project.

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary vibration management levels are:

- 3 mm/s (130 dB re 10^{-6} mm/s) for buildings surrounding the Project identified as "sensitive". At this stage no structures at or surrounding the site have been identified as particularly sensitive to vibration-induced damage.
- 5 mm/s (134 dB re 10^{-6} mm/s) for residential dwellings.
- 20 mm/s (146 dB re 10^{-6} mm/s) for classrooms, and commercial premises.

These vibration management levels apply across the full frequency range of relevance (i.e. typically 1 Hz – 100Hz encountered in building construction).

6 Operational Noise and Vibration Assessment

6.1 Operating Hours

6.1.1 NNPS

Existing and future operations will be as follows:

- **School hours**: 8 am to 3:30 pm
- **Class Times:**
    - 8:50 am to 10:50 am
    - 11:30 am to 1:00 pm
    - 1:50 pm to 3:00 pm
- **Administration and Office**: 8:30 am to 3:30 pm (staff are known to be on site to around 5:30pm
- **Out of School Hours Care (OSHC):** 6:45 am to 9:00 am (staff on site until 10:30 am)
- **Out of Hours Usage – New Hall –** 6 pm to 10 pm
- **Cleaners / Waste / Deliveries:** Daytime hours

6.1.2 NSHS

Existing and future operations will be as follows. Where details have not been provided, hours are anticipated to be in alignment with NNPS:

- **School hours**: 8 am to 3:30 pm
- **Administration and Office**: 8:15 am to 3:30 pm
- **Cleaners / Waste / Deliveries:** Daytime hours; cleaners from 5am to 9am, and 2pm to 6pm

6.2 Operational Noise Emissions – Mechanical Services

Plant associated with the operation of the new buildings at NNPS and NSPS, as well as new plant for the refurbished buildings will be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers with the relevant criteria in Section 0 of this report.
At this stage, plant selections and locations have not been finalised.
Acoustic Studio has carried out a preliminary review of current design strategy for key plant (including condenser units) proposals and make the following comments:

- The nearest potentially affected receivers are the residential dwellings bordering the school site to the east (Oak Street).
- The plant will be restricted to operate during normal day time hours only (7am to 6pm) unless otherwise stated below.
- The most restrictive criterion for the plant operating is 46 dB(A) during the day period (7am to 6pm) at the nearest residential receivers (unless otherwise noted below). Achieving this criterion will ensure compliance with the relevant criteria at all other receivers.
- Condenser units to supply communications rooms will be installed within the new building enclosures and operate 24 hours per day. The design will ensure that this plant achieves the night time criteria of 37 dB(A) at the nearest residential receivers.

6.2.1 NNPS

General

- Key plant is currently proposed to be located in the following areas (as shown on the Architectural DA drawings):
    - New Hall and Admin Building – A new condenser plant area at the north west corner of the building

New Buildings

Current Proposed Plant Design

- New plant areas for the Hall / Admin building - The current acoustic design has been assessed based on four (4) top discharge units selected with a sound pressure level of 67 dB(A) at 1m.

Incorporated Treatment

- Intake and discharge facing west via acoustic louvres (minimum 300mm).

6.2.2 NSHS

General

- Key plant is currently proposed to be located in the following areas (as shown on the Architectural DA drawings):
    - New 2-Storey Building Addition to Block A – New side discharge condenser units located to the north façade at level 1
    - Refurbishment of Block A
        - Comms, café and Staff Study - New condenser units located to the north east façade at level 1.

New Buildings

Current Proposed Plant Design

- New mechanical plant for the additions to block A - the current acoustic design has been assessed based on 4 side discharge units selected with a sound pressure level of between 52-57 dB(A) at 1m.

Incorporated Treatment

- No acoustic treatment required

Refurbishment areas

Current Proposed Plant Design

- Comms, café and Staff Study – 3x side discharge units selected with a sound pressure level of between 52-53 dB(A) at 1m.

Incorporated Treatment

- No acoustic treatment required for NSHS refurbishment areas.

6.2.3 Exhaust Fans

At this stage, exhaust fan selections and placements are yet to be finalised. Selections and acoustic treatments will be incorporated in the design to ensure compliance with the relevant criteria. This will include:

- Appropriate fan selections to limit noise emissions
- Pending selections, internally lined ductwork for the exhaust / discharge side of the fan

6.2.4 Cumulative Noise Impact

The assessment and design considers all existing plant and equipment that will be retained, and any new plant additions as part of the DA submission as discussed above, and the REF submission.

The recommendations provided (and detailed designs to be developed) will ensure that the noise emissions are achieved when considering the cumulative noise impact from existing and proposed plant.

During the detailed design phased, acoustic detailed design advice will be provided to the architect and services engineers to ensure that noise emissions from all plant and equipment selections are effectively controls to meet the relevant criteria at the nearest receiver boundaries.

6.3 Operational Noise Emissions - School Bells

There is no new school bell or amplified equipment proposed as part of the project. Therefore, there will be no change in noise from school bells as a result of the project.

6.4 Operational Noise – The Use

Operational noise emissions associated with the use of the Project has considered the following:

- The nearest potentially affected receivers are the residential dwellings bordering the school site to the east / north-east (Oak Street).
- The most restrictive criterion for operational noise is 46 dB(A) during the day period (7am to 6pm) at the nearest residential receivers (unless otherwise noted below). Achieving this criterion will ensure compliance with the relevant criteria at all other receivers.
- Noise emissions from new NNPS internal spaces including Hall, Staff areas, Admin and COLA
- Noise emissions from internal spaces in the new NSHS addition including movement studio and classrooms
- Relevant refurbished areas for both schools are expected to retain the same or similar noise generating activities to the existing schools, therefore are not assessed.
- No assessment of school play area noise, as this will not be changing.

6.4.1 Noise Emissions from New NNPS Hall, Administration and Staff Areas (Daytime Use)

An assessment of noise from the Hall and associated spaces has assumed the following:

- **Noise Source -** Noise from within internal hall, administration and staff areas is expected to be up to 80dB(A), which considers a typical worst case noisy learning activity / setting from sports or music.
- **Windows open –** this includes roller doors and high-level louvres for natural ventilation
- **Residential Noise Sensitive Receivers –** to the east of the site, with line of sight to the façade. Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- **Time Period –** noise during Day period – 7am to 6pm which includes school hours.

Residential Receiver direction	Predicted Noise Level (dB(A), $L_{Aeq\ (15\text{-}minute)}$)	Hall Noise Target PNTL (dB(A), $L_{Aeq\ (15\text{-}minute)}$)	Complies?
East / North East	44	46	Yes

Table 14: Predicted noise levels from school hall usage during daytime

6.4.2 Noise emissions from New NNPS Hall – Out Of Hours

An assessment of noise from the Hall for out of hours communal use has assumed the following:

- **Noise Source -** Noise from within internal hall areas is expected to be in the order of 80-85dB(A), (considered typical worst-case for a private hire with music noise)
- **Windows Open –** this includes roller doors and high-level louvres for natural ventilation.
- **Residential Noise Sensitive Receivers –** to the east of the site, with line of sight to the façade of the hall. Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- **Time Period –** noise during Evening period – 6pm to 10pm (no later).

Residential Receiver direction	Predicted Noise Level (dB(A), $L_{Aeq\ (15\text{-}minute)}$)	Hall Noise Target (NPI Evening Intrusiveness) (dB(A), $L_{Aeq\ (15\text{-}minute)}$)	Complies?
East / North East	40-45	45	Yes

Table 15: Predicted noise levels from school hall usage during evening

An assessment of the hall noise levels affecting residential receivers shows that the criteria will be achieved with a cross/natural ventilation scheme (this includes roller doors and high-level louvres open) for typical out of hours uses for the evening period, assuming internal noise levels do not exceed 85dB $L_{Aeq,\ 15\text{-}minute}$.

6.4.3 Noise Emissions from New NNPS COLA

The proposed COLA will provide shelter to enable outdoor learning for groups.
Based on measurements and observations carried out by Acoustic Studio at and around the school, noise emissions associated with the use from the COLA is expected to result in noise emissions less than or equal to existing playground noise and / or outdoor learning carried out at the existing outdoor learning areas.
To minimise noise impact, sound absorptive finishes will be incorporated with the COLA design to limit reflections and reverberant noise build-up in the area.

6.4.4 Noise Emissions from New NSHS Addition - Movement Studio, GLS and Associated Spaces

An assessment of noise from the new NSHS addition has assumed the following:

- **Noise Source -** Noise from within movement studio, GLS and staff areas is expected to be up to 80dB(A), which considers a typical worst case noisy learning activity / setting from sports.
- **Windows open –** to provide natural ventilation
- **Residential Noise Sensitive Receivers –** to the east and west of the site, with line of sight to the façade. Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- **Time Period –** noise during Day period – 7am to 6pm which includes school hours.

Residential Receiver direction	Predicted Noise Level (dB(A), $L_{Aeq\ (15\text{-}minute)}$)	Noise Target PNTL (dB(A), $L_{Aeq\ (15\text{-}minute)}$)	Complies?
All	<40	46	Yes

Table 16: Predicted noise levels from new NSHS internal areas usage during daytime

6.4.5 Traffic Noise Generation (On Campus)

Existing car parking facilities on site are as follows:

- NNPS Existing carpark spaces - 20
- NSHS Existing carpark spaces – 20

Both NNPS and NSHS will not include any changes to car parking or vehicle access to either site, including waste removal.

Therefore, the project (once in operation) will not impact traffic noise generation on site. The staff/student numbers will remain the same post completion and there will be no change to site related traffic (i.e. no new car parking and waste collection will remain as it currently operates).

6.4.6 Traffic Noise Generation (Off Campus)

We understand that the project will result in no significant changes to road traffic or car park use - resulting in no noticeable change in noise emissions (in terms of $L_{Aeq(1hr)}$ or $L_{Aeq(Day/Evening/Night)}$).

Generally, an increase of more than 50% in traffic volumes compared with existing volumes would generate a 2 dB or more increase, which the RMS Road Noise Policy (Section 4) states is the increase in noise which is likely to become noticeable.

Therefore, given the project will result in no significant changes to road traffic or car park use, there will also be no noticeable change in road traffic noise associated with the operational phase of this project when assessed in accordance with the RMS *Road Noise Policy* Section 4.

7 External Noise Intrusion

7.1 General

Traffic noise from the adjacent Namona Street and the nearby major arterial Pittwater Road are the dominant sources of external noise affecting the existing school. Noise from new and existing mechanical plant has also been considered. We note the following.

7.1.1 Internal Spaces (NNPS and NSHS)

Based on measurements and observations carried out by Acoustic Studio at and around the school, internal noise levels of 40 dB L_{Aeq} are able to be achieved as follows:

- windows closed
- standard single glazing with a minimum performance of Rw 30-32 for new buildings.

7.1.2 COLA

The new COLA is located sufficiently away and shielded from traffic noise on Namona St. Noise levels are predicted to be within 50 dB L_{Aeq} to these areas which is considered suitable for outdoor learning.

8 Construction Noise and Vibration Assessment

8.1 Proposed Hours

Proposed construction hours for the Project are during Standard Construction Hours outlined in the ICNG as follows:

- Monday to Friday - 7:00am to 6:00pm
- Saturday - 8:00am to 1:00pm
- Sunday and Public Holidays – No works.

Note that the duration for each stage would be confirmed by the Contractor once appointed.

8.2 Description of Proposed Works

An indicative construction works program has been developed by the Project Manager that outlines the key activities in each particular location. Detailed construction works program will be finalised by the contractor.

It is anticipated that the key activities to occur for each area / stage are as follows.

8.2.1 NNPS

- New Build (Admin, Staff, COLA and Hall building)

8.2.2 NSHS

- New Addition / extension to Block A (Admin, Staff, COLA and Hall)
- Refurbishment of Block A spaces

8.2.3 Key activities and equipment

Activity	Key Equipment
Site Establishment	Truck, Forklift Hiab (mobile crane) truck Front end / Wheeled loader Generator, diesel
Excavation / Earthworks	Excavator, 8T with bucket Excavator with rock breaker Truck, Forklift Front end / Wheeled loader Skidsteer loader (½ tonne) Dump Truck (tipping material) Skip Fill
Substructure	Bored Piling Rig Truck, Forklift

Activity	Key Equipment
	Concrete Vibrator
	Concrete pump
	Cement Mixer
Structural / concreting	Truck, Forklift
	Hiab (mobile crane) truck
	Mobile crane
	Generator, diesel
	Electric Hand Tools
	Scissor Lift
	Cement Mixer
	Concrete Vibrator
	Concrete pump
Building Envelope	Truck, Forklift
	Electric Hand Tools
	Scissor Lift
	Hiab (mobile crane) truck
	Skip Fill
	Angle Grinder
Fitout & finishes	Electric Hand Tools
	Scissor Lift
	Mobile crane
	Truck, Forklift
	Welder
	Generator, diesel
External works / landscaping	Electric Hand Tools
	Bobcat / Forklift
	Skidsteer loader (½ tonne)
Demobilisation	Truck, Forklift
	Electric Hand Tools
	Front end / Wheeled loader
	Mobile crane

Table 17: Typical key construction activities and equipment for both NNPS and NSHS

8.3 Construction Noise

The following sections outline the preliminary assessment carried out for construction noise emissions.

8.3.1 Noise Sources

The key noise sources for the activities occurring during construction works and the associated equipment sound power levels are listed in Table 18. These values are based on Acoustic Studio's database and the relevant Australian and International Standards including AS2436:2010 and BS5228-1:2009.

Noise Source / Plant	Sound Power Level, $L_{eq,T}$ dB(A)	Sound Pressure Level, $L_{eq,T}$ dB(A), at 10m
Dump Truck (tipping material)	117	89 (+5dB penalty – tonal reversing alarm)
Truck, Forklift *(vibration source)*	107	79 (+5dB penalty – tonal reversing alarm)
Tipper / Bin lift Truck	111	83 (+5dB penalty – tonal reversing alarm)
Hiab (mobile crane) truck	113	85 (+5dB penalty – tonal reversing alarm)
Bobcat / Forklift	110	82 (+5dB penalty – tonal reversing alarm)
Front end / Wheeled loader	111	83 (+5dB penalty – tonal reversing alarm)
Skidsteer loader (½ tonne) *(vibration source)*	104	76 (+5dB penalty – tonal reversing alarm)
Excavator with rock breaker *(vibration source)*	116	88 (+5dB penalty)
Excavator, 8T with bucket *(vibration source)*	105	77
Vibratory roller *(vibration source)*	108	80
Asphalt Paver *(vibration source)*	108	80
Asphalt Rotomill (scabbler)	111	83
Concrete Pump	110	82
Cement Mixer	109	81
Concrete Placing Boom	105	77
Concrete Vibrator	104	76
Jump Form	102	74
Generator, 4 stroke portable petrol	103	75
Generator, diesel	113	85
Air compressor	107	79
Compactor *(vibration source)*	113	85
Angle grinder	101	73
Concrete Saw, handheld	115	87 (+5dB penalty)
Demolition saw	119	91 (+5dB penalty)
Circular saw	112	84 (+5dB penalty)
Jack Hammer *(vibration source)*	121	93 (+5dB penalty)
Hammer / percussive drill *(vibration source)*	112	84 (+5dB penalty)
Rattle gun	113	85 (+5dB penalty)
Electric drill	91	63
Electric hand tools	102	74
Welder	105	77
Tower crane	105	77
Mobile crane	106	78
Skip Fill	117	89
Bored Piling Rig	110	82
Scissor lift	98	70

Table 18: Typical mid-point sound power and pressure levels of plant typical to proposed construction. These sound level values do not include the 5 dB penalty noted for some types of work. The 5 dB penalty is added to the predicted sound level at the receiver.

Potential sources of vibration and ground-borne noise during the Project works include:

- Excavation and concrete hammering.
- Piling Works.

Vibration and ground-borne noise impacts are likely to be highest during demolition and excavation, when equipment such as hammer attachments are used. Where practical, the contractor should aim to implement alternative low noise and vibration methods.

8.3.2 Sensitive receivers

Nearest sensitive receivers to the Project Site that will be potentially affected by noise and vibration are surrounding residential, industrial, commercial and recreation areas as presented in Section 2, as well as existing on-site classrooms.

Table 19 and 21 outlines the most critical receivers surrounding the sites for each type of impact.

Receiver	Impact	Location	Typical Worst-Case Distance from construction site (m)
Residential	Airborne + Vibration	North / North East	80m
Commercial	Airborne	West and South	30m
Existing Classrooms	Airborne	North West	20m

Table 19: Noise sensitive receivers and approximate distance to project construction works site for NNPS

Receiver	Impact	Location	Typical Worst-Case Distance from construction site (m)
Residential	Airborne + Vibration	North / North East	160m
Commercial	Airborne	West and South	120m
Existing Classrooms	Airborne	North West	20m

Table 20: Noise sensitive receivers and approximate distance to project construction works site for NSHS

8.3.3 Construction Noise Assessment Methodology

A preliminary assessment of the likely noise impacts of the proposed works on the most-affected receivers surrounding the site has been carried out.
The assessment has considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 8.2.
- Project specific Noise Management Levels at each sensitive receiver location as outlined in Section 5.4.1.
- Noise level predictions are calculated using the noise data provided in Table 18. Where multiple plant types exist (such as trucks) typical worst-case levels are applied.
- Noise level predictions consider:

    - Distance attenuation (nearest position on site to receiver)
    - Shielding
    - Ground and building reflections
- The noise level predictions are based on assumptions that represent the worst-case scenario.
- L_{Aeq} noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
- Predictions consider the typical worst-case distances in Table 19.
- The predictions consider individual tasks and associated equipment from the nearest construction site boundary.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment, unless otherwise stated.

8.3.4 Assessment Results

Construction Noise

Table 21 presents the results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Section 8.3.1 operating within the boundary of the construction works site.

The following predictions assume:

- Activity source sound power level assumes noise at any individual receiver is dominated by the noisiest item of equipment at any one time.
- Outside to inside attenuation of classrooms is assumed to be 10 dB (with windows open). A further reduction of 10dB can be assumed for windows closed.
- Standard daytime hours of work

Activity	Activity Source Level (SWL)	Receiver	NML (dBA)	Worst Case Sound Levels (dBA)	Exceedance (dBA)	Comments
Site Establishment	113	East Residential	52	67	15	Primary contributors to predicted exceedance are generator, crane and loaders
	113	Commercial - NBISC	75	75	0	
	113	Existing Classrooms	55	79	24	
Excavation / Earthworks	117	East Residential	52	71	19	Primary contributors to predicted exceedance are Skip fill and Excavator/rock breaker
	117	Commercial - NBISC	75	79	4	
	117	Existing Classrooms	55	83	28	
Substructure	110	East Residential	52	64	12	Primary contributors to predicted exceedance are Concrete pump and cement mixer
	110	Commercial - NBISC	75	72	n/a	
	110	Existing Classrooms	55	76	21	
Structural / Concreting	113	East Residential	52	67	15	Primary contributors to predicted exceedance are crane truck, diesel generator and concrete pump
	113	Commercial - NBISC	75	75	0	
	113	Existing Classrooms	55	79	24	
Building Envelope	117	East Residential	52	71	19	Primary contributors to predicted exceedance are crane truck and skip fill
	117	Commercial - NBISC	75	79	4	
	117	Existing Classrooms	55	83	28	
Fitout & Finishes	113	East Residential	52	67	15	Primary contributors to predicted exceedance are diesel generators and trucks
	113	Commercial - NBISC	75	75	0	
	113	Existing Classrooms	55	79	24	
External works / landscaping	110	East Residential	52	64	12	Primary contributors to predicted exceedance are bobcat/forklift
	110	Commercial - NBISC	75	72	n/a	
	110	Existing Classrooms	55	76	21	
Demobilisation	111	East Residential	52	65	13	Primary contributors to predicted exceedance are front end loader and trucks
	111	Commercial - NBISC	75	73	n/a	
	111	Existing Classrooms	55	77	22	

Table 21: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations for work at NNPS – Levels predicted to exceed the NMLs are in red

Activity	Activity Source Level (SWL)	Receiver	NML (dBA)	Worst Case Sound Levels (dBA)	Exceedance (dBA)	Comments
Site Establishment	113	East Residential	52	61	9	Primary contributors to predicted exceedance are generator, crane and loaders
	113	Commercial - NBISC	75	63	n/a	
	113	Existing Classrooms	55	79	24	
Excavation / Earthworks	117	East Residential	52	69	17	Primary contributors to predicted exceedance are Skip fill and Excavator/rock breaker
	117	Commercial - NBISC	75	71	n/a	
	117	Existing Classrooms	55	87	32	
Substructure	110	East Residential	52	65	13	Primary contributors to predicted exceedance are Concrete pump and cement mixer
	110	Commercial - NBISC	75	67	n/a	
	110	Existing Classrooms	55	83	28	
Structural / Concreting	113	East Residential	52	58	6	Primary contributors to predicted exceedance are crane truck, diesel generator and concrete pump
	113	Commercial - NBISC	75	60	n/a	
	113	Existing Classrooms	55	76	21	
Building Envelope	117	East Residential	52	61	9	Primary contributors to predicted exceedance are crane truck and skip fill
	117	Commercial - NBISC	75	63	n/a	
	117	Existing Classrooms	55	79	24	
Fitout & Finishes	113	East Residential	52	65	13	Primary contributors to predicted exceedance are diesel generators and trucks
	113	Commercial - NBISC	75	67	n/a	
	113	Existing Classrooms	55	83	28	
External works / landscaping	110	East Residential	52	61	9	Primary contributors to predicted exceedance are bobcat/forklift
	110	Commercial - NBISC	75	63	n/a	
	110	Existing Classrooms	55	79	24	
Demobilisation	111	East Residential	52	58	6	Primary contributors to predicted exceedance are front end loader and trucks
	111	Commercial - NBISC	75	60	n/a	
	111	Existing Classrooms	55	76	21	

Table 22: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations for work at NSHS – Levels predicted to exceed the NMLs are in red

8.3.5 Construction Traffic Noise

As identified throughout Section 8, noise from construction-related works at the site is expected to be a primary contributor to noise impacts on nearby noise-sensitive receivers.

Construction-related general road traffic is a temporary noise source but one which requires assessment and management, particularly for heavy vehicles accessing the site.

Truck arrivals to, and departures from, site should be scheduled to occur outside the busiest traffic periods, but where possible should also avoid noise-sensitive time periods.

Separately from the noise impacts quantified in Section 8, potential noise impacts from general construction traffic needs to be considered.

The temporary additional traffic increase due to construction will be minimal, totalling far less than 50% additional vehicles to the existing traffic. The increases in road traffic due to construction will result in below the 2 dB increase considered to be noticeable from the RNP.

However, it is also important to recognise that heavy vehicles associated with construction can generate maximum noise levels which are higher than general car traffic, and can lead to greater disturbance than cars.

Access routes should be limited to main roads and avoid local residential streets. Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided.

These noise avoidance driver behaviours may need to be enforced through observation and monitoring, and all contractors and subcontractors are to be made aware of the need for noise-considerate driver behaviour when travelling to and from the work site.

Noise from construction traffic should be dealt with by appropriate management measures that minimise noise impact. This includes:

- Staging and managing arrival of trucks to avoid queueing and idling on public streets;
- Arriving at and departing from the site via designated routes that avoid or minimise the use of local roads;
- Minimising reversing to minimise the use of movement alarms (“reversing beepers”) and / or incorporating quacker alarms;
- Minimise the use of engine braking and to avoid noise actions such as slamming doors, loud radios, shouting or the use of truck horns for signalling.

Minimising construction traffic noise will be further addressed in the Construction Traffic Management Plan.

8.3.6 Summary of Noise Assessment Findings and Discussion of Noise Controls During Construction

Based on the results from the high-level assessment based on the indicative works, we make the following comments:

- Construction works noise impacts will be greatest at residential receivers adjacent to the school to the east. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs due to the proximity to the nearest affected receivers but generally within the "Highly Noise Affected" noise levels. The worst-case noise impacts are for excavators with hammers with noise levels predicted to be above the NMLs by up to 32 dB (to classrooms with windows open).
- Where NMLs are exceeded, mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - Schedule noisy activities to less sensitive times of the day for each nominated receiver (i.e. daytime hours).
    - Hoarding that may already be included as part of the site works can reduce noise levels by 5 to 10 dB.
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
    - The predictions for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and hammers, and the proximity to on campus sensitive receivers (some of which are within 20m).
    - Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when NMLs cannot be met due to safety or space constraints.

It is important to recognise that the actual noise levels generated during the construction works are likely to vary considerably depending on many factors including:

- Number of items of plant and equipment operating simultaneously.
- Location of equipment on the site – relative to the noise-sensitive receivers.
- Shielding of noise provided by structures and hoardings on and around the site.
- Reflections provided by existing structures on and around the site.
- Meteorological conditions.

When construction and excavation works are likely to exceed stated criteria at nearest sensitive receivers, particularly when works occur in the areas closer to the nominated receiver, all feasible and reasonable noise control measures are to be considered.
If, during construction works, an item of equipment exceeds either the NML at any location or the maximum recommended equipment noise levels, the following noise control measures, together with construction best practices presented in Section 8.5 shall be considered to minimise the noise impacts on the neighbourhood:

- Consider implementing equipment-specific temporary screening for noisy equipment, or other noise control measures recommended in Appendix E of AS2436. This is most likely to apply to noisier items such as jackhammers.
- For large work areas, solid screening or hoarding as part of the worksite perimeters would be beneficial.
- Locate specific activities such as carpentry areas (use of circular saws etc) to internal spaces or where shielding is provided by existing structures or temporary screening.
- Managing the arrival of trucks and heavy vehicles on site at any given time (through scheduling deliveries at different times).
- Unnecessary idling of vehicles and equipment is to be avoided.
- Traffic routes are to be prepared to minimise the noise impact on the community (such as entry and exit point at different locations on the site and access via separate roads where practical).
- When loading and unloading trucks, adopt best practice noise management strategies to avoid materials being dropped from a height.
- Adopt quieter methodologies. For example, where possible, use concrete sawing and removal of sections as opposed to jackhammering.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc), not specifically identified in this assessment, incorporates silencing/shielding equipment as required to meet the noise criteria.

Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when Noise Management Levels cannot be met due to safety or space constraints.
It is recommended that a comprehensive CEMP is prepared further to this assessment. The engaged Contractor would be required to prepare a comprehensive CEMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

8.4 Construction Vibration

When considering the vibration impact associated with construction works, the following is to be taken into account.

- The type of vibration generating equipment.
- Geotechnical characteristics of the site.
- The layout of the site, including the location of static sources of vibration.
- Techniques used in construction to minimise generated vibration levels.
- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

8.4.1 Summary of Vibration Assessment and Discussion of Vibration Controls During Construction

A detailed vibration assessment has not been carried out at this stage, as actual vibration levels experienced will be dependent upon:

- Site and strata characteristics
- Specific construction equipment used
- Vibration requirements of sensitive equipment
- Activities that have the potential to generate ground-borne vibration during the construction works include:
    - Excavator hammer
    - Vibratory roller
    - Jackhammer
    - Piling
- Based on the scope of works and typical equipment required, there is potential for human perception vibration impacts on nearby NNPS and NSHS buildings and there is requirement to review works processes during detailed works planning to ensure that minor cosmetic impacts to structures are avoided. The significance of these impacts will need to be determined as part of the CEMP prepared by the Contractor.

Final details of the vibration management controls required for the works would be determined when the CEMP is prepared by the Contractor.
On campus buildings present the most stringent vibration criteria, particularly given their proximity to the Project Site. Controlling vibration at these receivers will also ensure that vibration criteria at all other receivers will also be satisfied.
The Contractor would be required to prepare a final CEMP based on their proposed plant, equipment and construction methodology.

8.5 Control elements

8.5.1 Noise

As a general rule, prevention is to be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.
It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise mitigation/minimisation. Providing treatments at the affected residences or other sensitive land uses is to be only considered as a last resort. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
    - Use quieter methods.
    - Use quieter equipment.
    - Operate plant in a quiet and effective manner.
    - Where appropriate, limit the operating noise of equipment.
    - Maintain equipment regularly.
    - Where appropriate, obtain acoustic test certificates for equipment.
- On-site noise management
    - Strategically locate equipment and plant.
    - Avoid the use of tonal reversing alarms or provide for alternative systems (such as broadband reversing alarms).
    - Maximise shielding in the form of existing structures or temporary barriers.
    - Schedule the construction of barriers and structures so they can be used as early as possible.
    - Brief Project staff and workers on the noise sensitivity of the neighbours to the site, particularly the residents nearby. The staff and workers need to be mindful of the noise from their discussions and colour of the language, particularly in sensitive periods, for example, during the pre-start times or "toolbox talk" as they gather to commence for work in the morning.
- Consultation, notification and complaints handling
    - Provide information to neighbours before and during construction.
    - Maintain good communication between the community and Project staff.
    - Have a documented complaints process and keep register of any complaints.
    - Give complaints a fair hearing and provide for a quick response.
    - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
    - Schedule activities to minimise noise impacts.

- Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
- Keep truck drivers informed of designated routes, parking locations and delivery hours.

8.5.2 Vibration

At this stage, we anticipate that there is potential for construction works to result in some structural and human perception vibration impacts – particularly from the use of excavators with hammers near existing buildings.
Vibration management controls required for the works would be determined when the CEMP is prepared by the Contractor.
All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on-site.
The following considerations shall be taken into account:

- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

8.5.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks are to be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue).

8.5.4 Additional Noise and Vibration Control Measures

All practical means should be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.
If, during construction, an item of equipment exceeds either the NML at any location or the maximum recommended equipment noise levels, the following noise control measures, together with construction best practices presented in Section 8.5.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Modifications to construction equipment used:
  - Avoid the use of large excavators – use the smallest size practicable;
  - Avoid the use of vibratory rollers – switch off vibration mode, or use the smallest size practicable if vibration must be employed;
  - Avoid the use of tracked vehicles on site, where practicable, particularly large tracked excavators and cranes – use vehicles with tyres.
- Modifications to methods of construction:

    - Saw cutting can be considered for rock removal rather than conventional rock hammering techniques to limit vibration when close to vibration sensitive locations.

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, residential receivers are likely to be more sensitive to noise before 9 am than the other receivers.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix E of AS2436.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc) not specifically identified in this assessment incorporates silencing/shielding equipment as required to meet the noise criteria.
- Minimise noise from workers as discussed in Section 8.5.1.

Implementation of all reasonable and feasible mitigation measures for all construction works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

8.6 Noise and vibration monitoring

8.6.1 Noise monitoring

The Contractor is to consider implementing environmental noise monitoring at the reasonably most affected residential noise receivers from the construction works (adjacent to NNPS school at Oak Street).

8.6.2 Vibration monitoring

A vibration monitoring system is to be implemented if required. This system would monitor vibration levels when there is potential for them to change. This could happen in various situations, such as, changes in equipment and activities or changes to work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding VMLs appropriate action is to be taken.

8.6.3 Communication and complaints

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.
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.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is occurring outside normal working hours, the activity is to be immediately stopped. Where stopping the activity would create a safety issue the activity may be permitted to continue only as long as is necessary to make the area safe. The activity is to then cease.
Any activity that is directed to cease due to excessive noise is not to recommence until the Project Manager is satisfied that the noise and vibration target requirements can be met and has given permission to recommence the activity.
The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.
The Contractor is to provide a 24-hour telephone contact number and this number is to be prominently displayed on the site.

8.7 Non-compliances

Non-compliance reports can be used as appropriate to deal with failures to meet the construction noise and vibration management and control requirements.

9 Discussion and Recommendations

A noise and vibration assessment report has been produced to determine the potential noise impacts and considerations for proposed refurbishment and upgrades at Narrabeen Education Precinct.
The existing noise environment has been established based on long-term and short-term monitoring data.
Appropriate criteria for both noise and vibration have been established based on relevant guidelines and standards. A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

Construction Noise

- Proposed construction hours are as follows:
    - Monday to Friday - 7:00am to 6:00pm
    - Saturday - 8:00am to 1:00pm
    - Sunday and Public Holidays – No works.
- Based on the results from the high-level assessment based on the indicative works, we make the following comments:
    - Construction works noise impacts will be greatest at existing classroom receivers adjacent to the construction sites. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs due to the proximity to the nearest affected receivers but generally within the "Highly Noise Affected" noise levels. The worst-case noise impacts are for excavators with hammers with noise levels predicted to be above the NMLs by up to 32 dB.
- Where NMLs are exceeded, mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - Schedule noisy activities to less sensitive times of the day for each nominated receiver (i.e. daytime hours).
    - Hoarding that may already be included as part of the site works can reduce noise levels by 5 to 10 dB.
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
    - The predictions for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and hammers, and the proximity to on campus sensitive receivers (some of which are within 20m).
    - Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when NMLs cannot be met due to safety or space constraints.

Construction Vibration

- Based on the scope of works and typical equipment required, there is potential for human perception vibration impacts on nearby NNPS and NSHS buildings and

there is requirement to review works processes during detailed works planning to ensure that minor cosmetic impacts to structures are avoided. The significance of these impacts will need to be determined as part of the CEMP prepared by the Contractor.

- The Contractor determine whether the existence of significant vibration levels justifies a more detailed investigation.

Construction Environmental Management Plan

- A CEMP shall be prepared further to this assessment by the engaged Contractor.

Operational Noise - Mechanical Plant

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 0 of this report.
Recommendations are provided for noise controls to key plant. During the detailed design stage, the acoustic consultant shall provide detailed design advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Operational Noise - The Use

Noise emissions have been considered from the following areas:

- Noise emissions from new internal spaces including Administration and Classrooms in the new NNPS building
- Noise emissions from the new hall building for NNPS
- Noise emissions from the Covered Outdoor Learning Area (COLA) to be included as part of the new hall/admin building for NNPS.
- Noise emissions from new internal spaces including movement studio and Classrooms in the new NNPS addition

Noise from the above areas are not expected to generate any additional impact above the existing noise emissions from the school and therefore is not expected to have adverse noise impact on noise sensitive receivers surrounding the site.

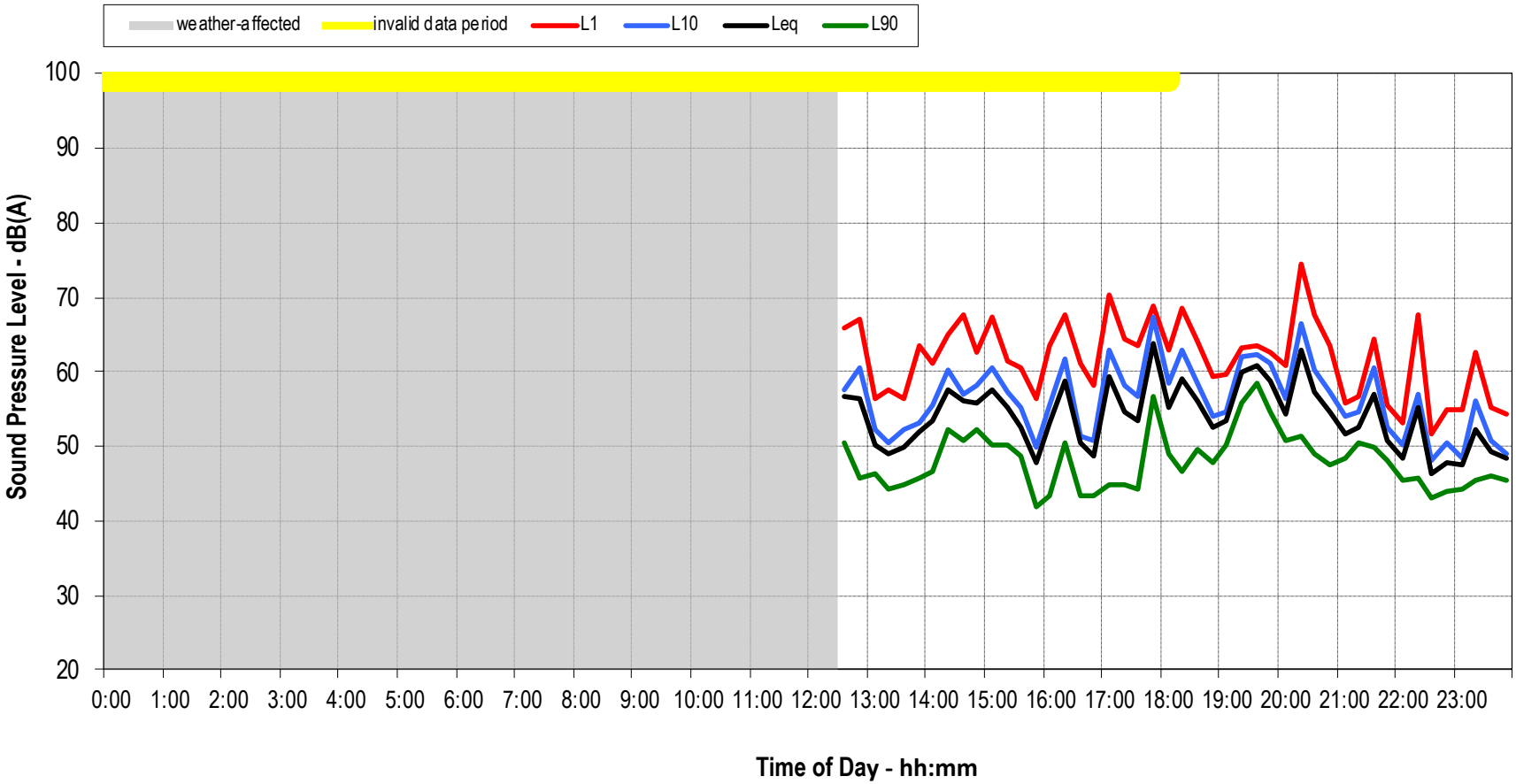
Operational Noise – Outside Hours

Use of the new NNPS school hall will occur during the daytime, and evening periods (6pm to 10pm). Noise emissions from the hall are expected to comply with the relevant criteria at the nearest residential boundary for the daytime and evening periods, assuming that the internal noise level (with windows/louvres open) does not exceed 85dB $L_{Aeq,\ 15\text{-minute}}$.

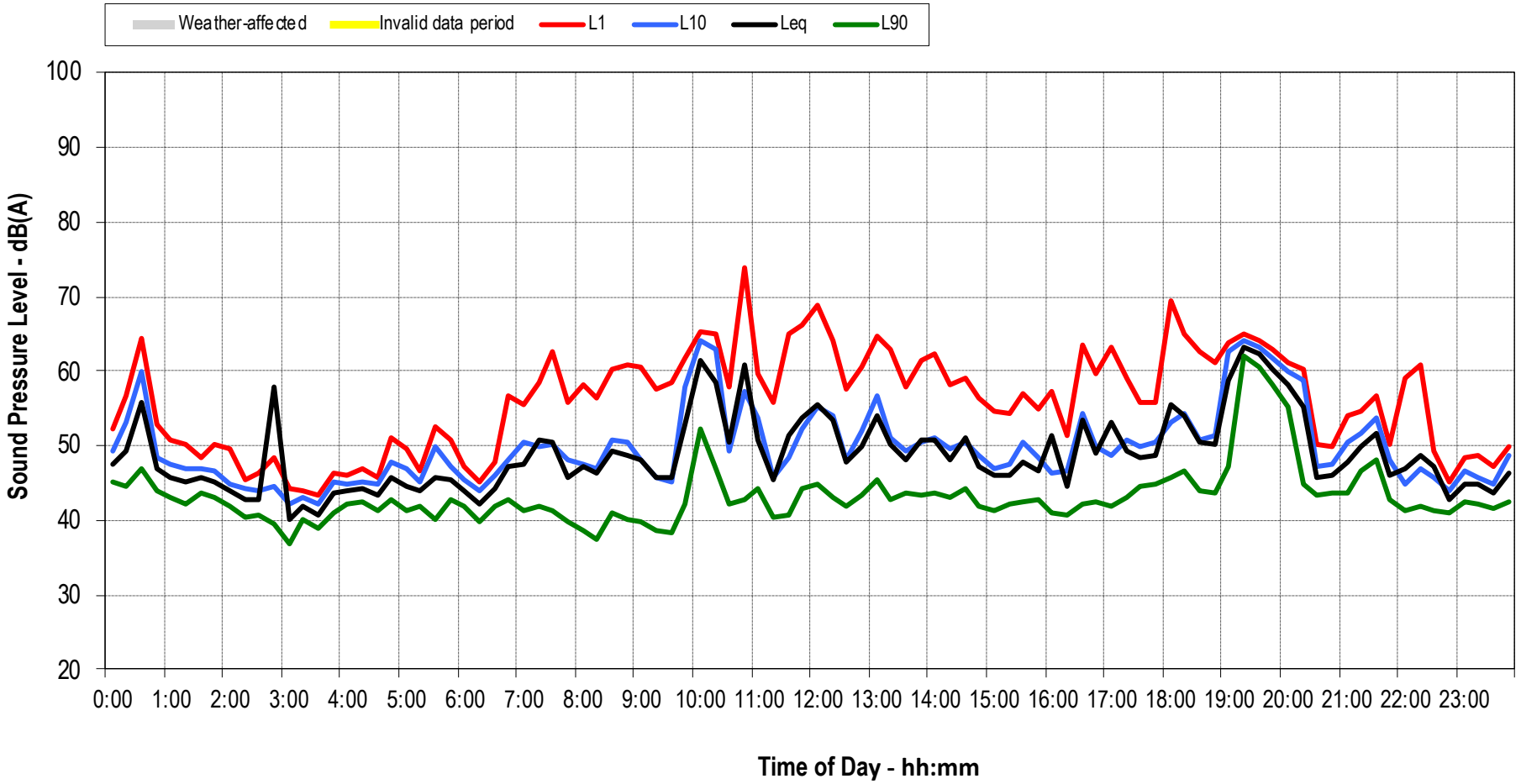
Appendix A – Ambient Noise Monitoring Data

Period 1

Narrabeen Education Precinct - Friday 08 April 2022



Narrabeen Education Precinct - Saturday 09 April 2022



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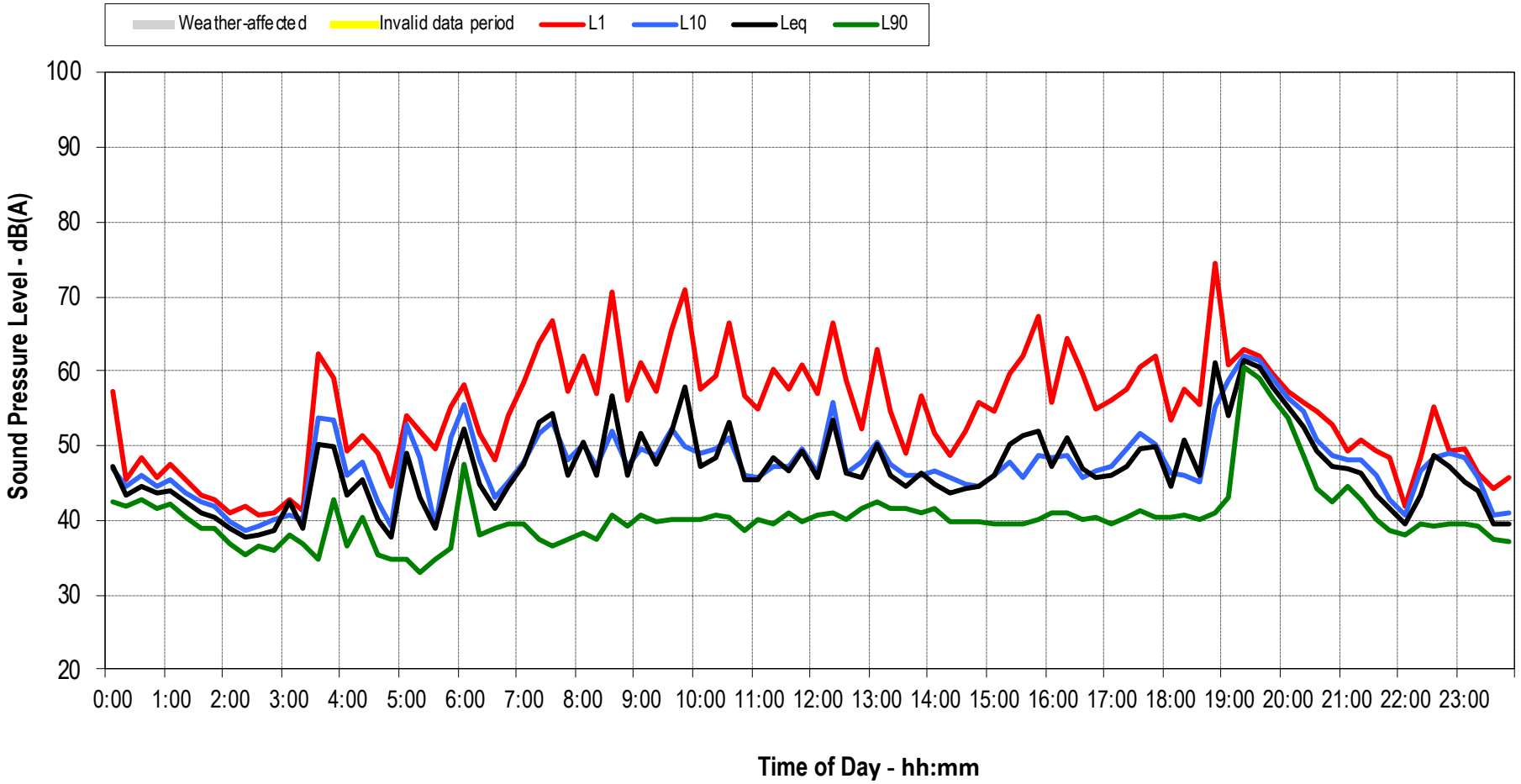
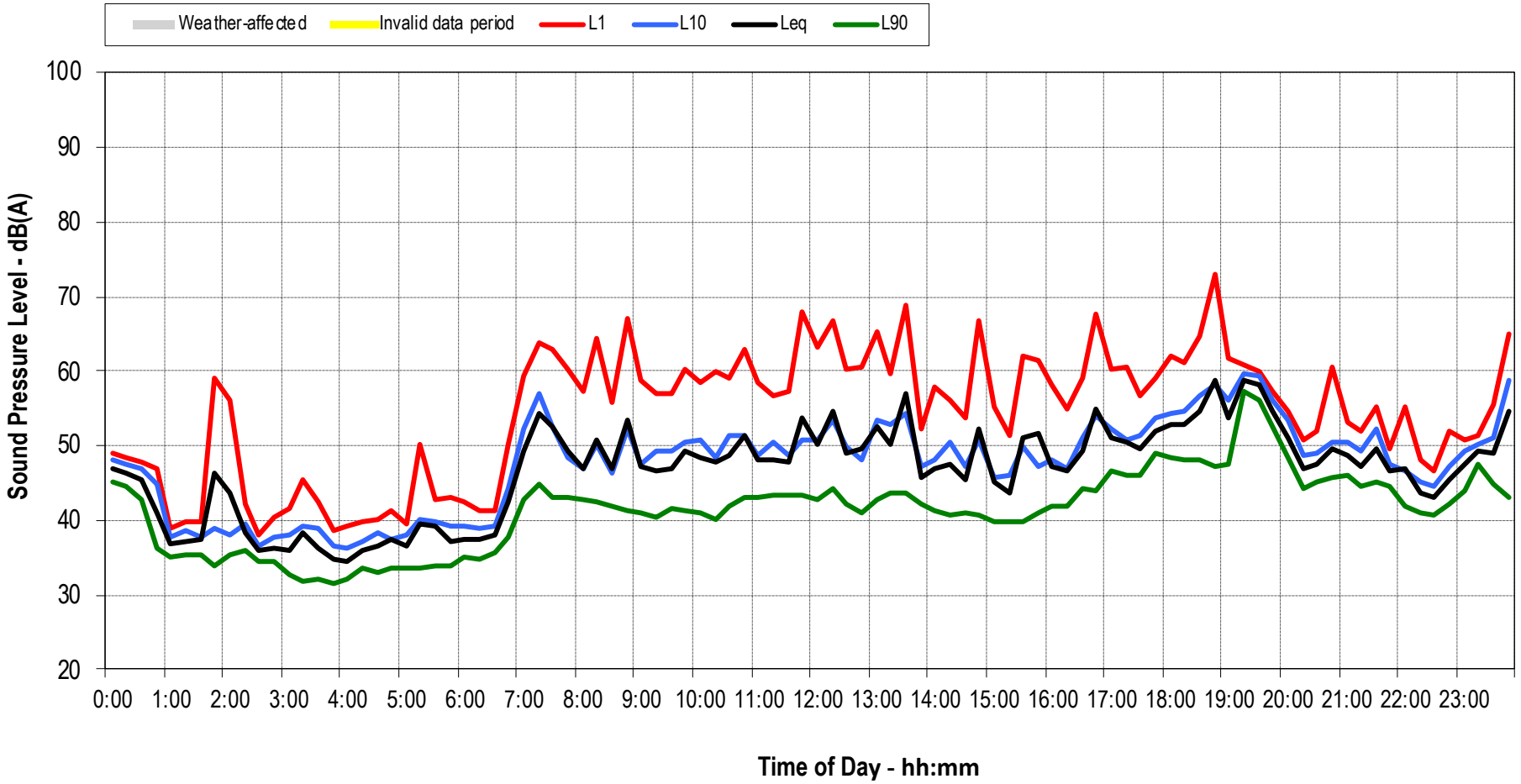


Narrabeen Education Precinct - Monday 11 April 2022



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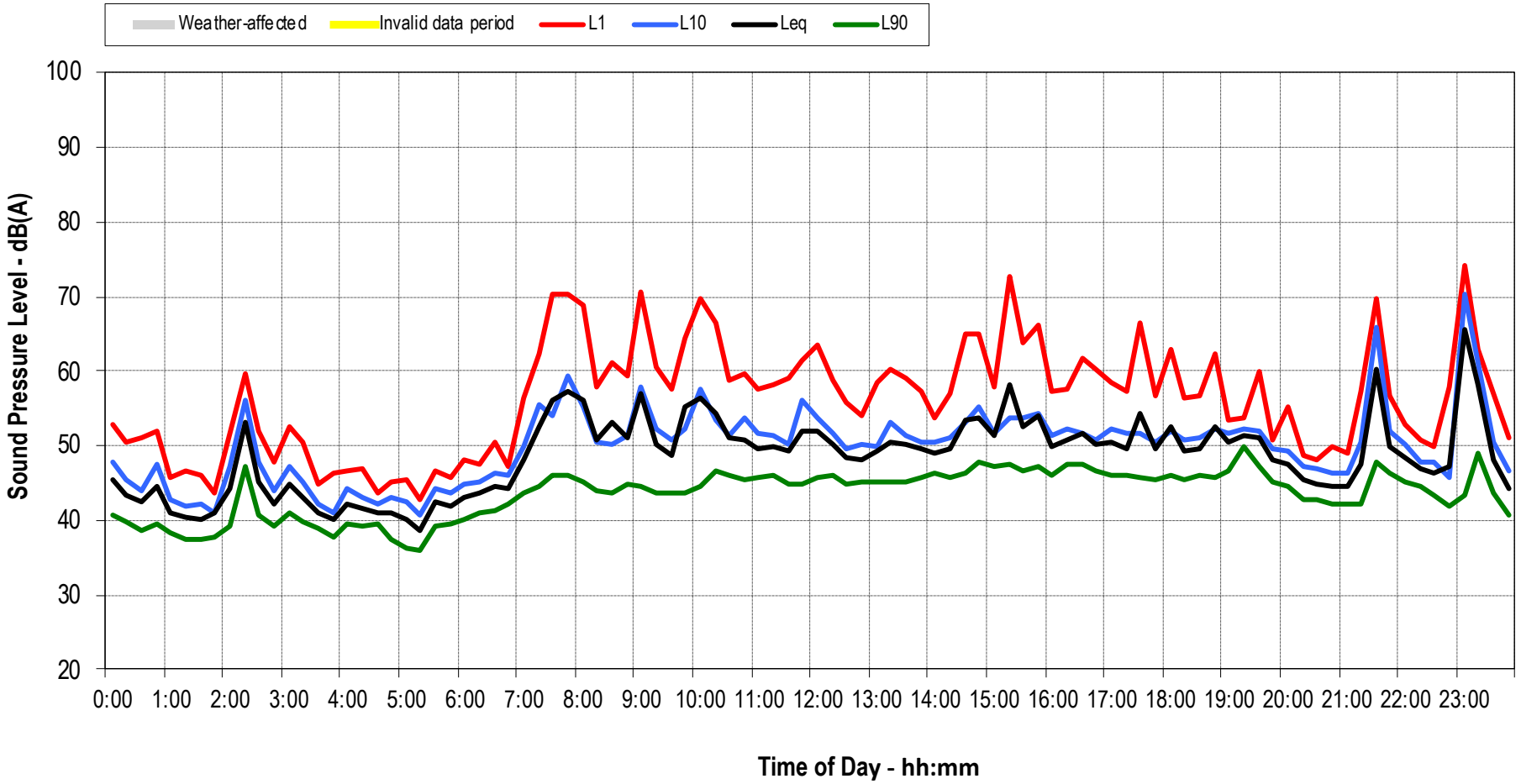

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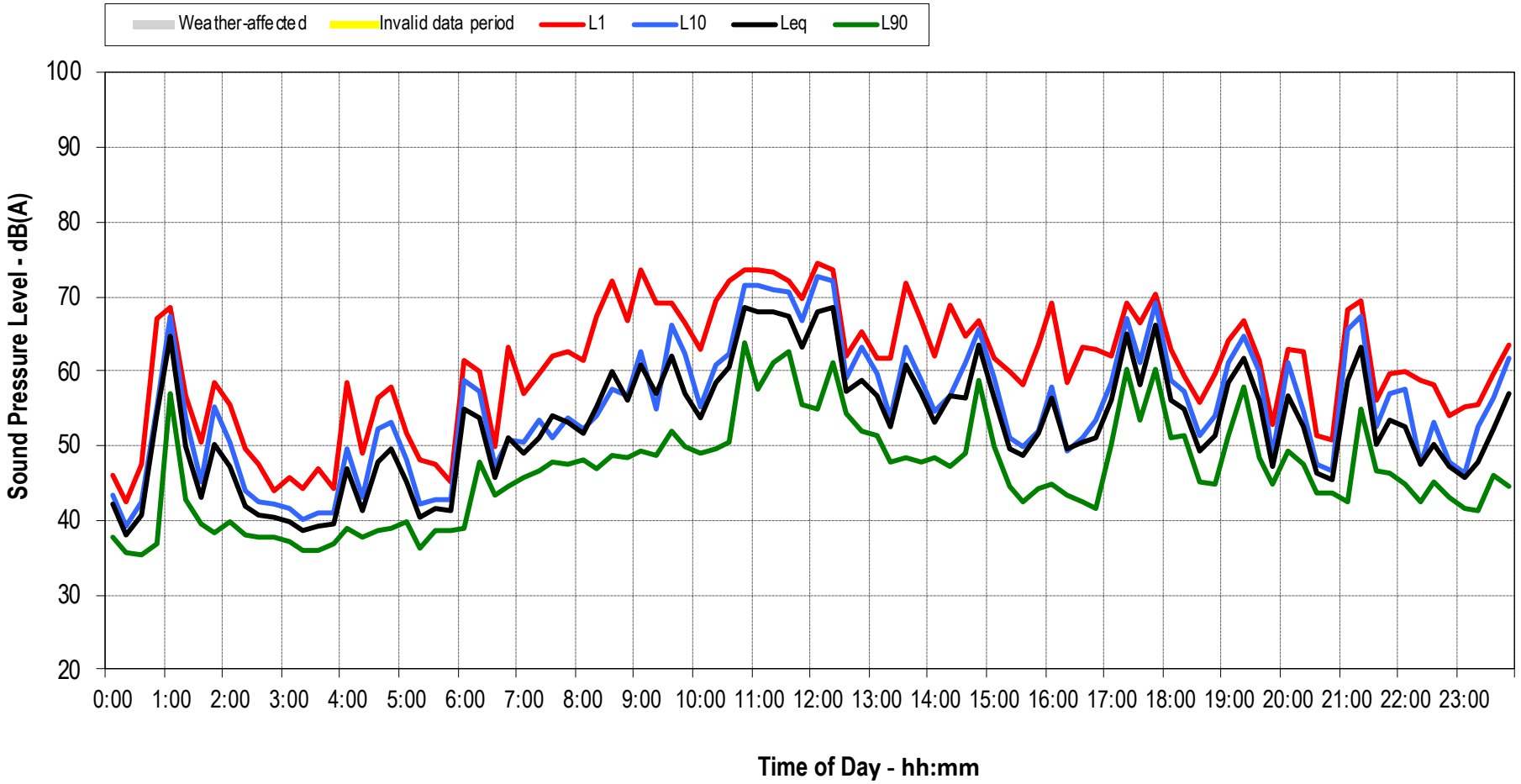

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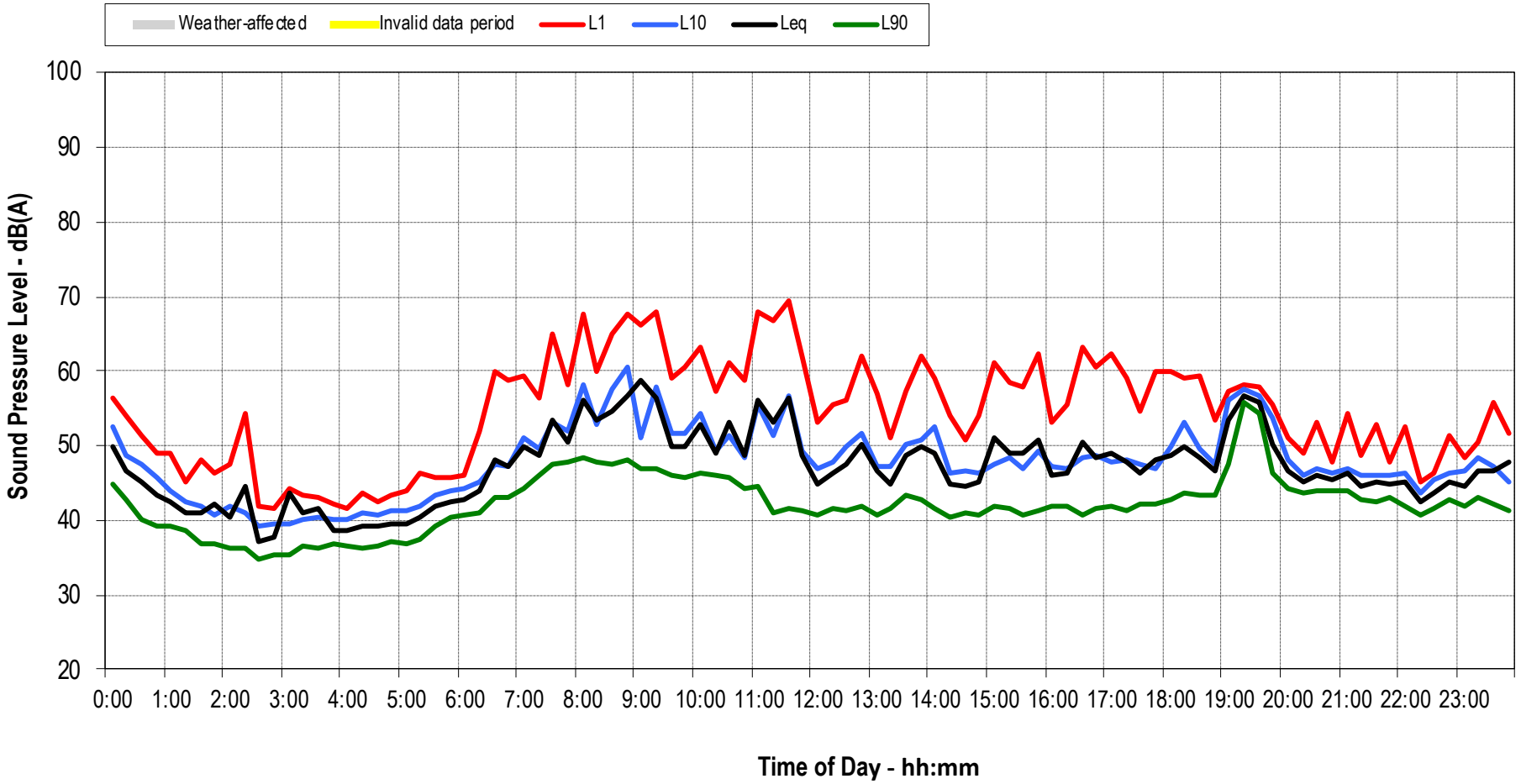

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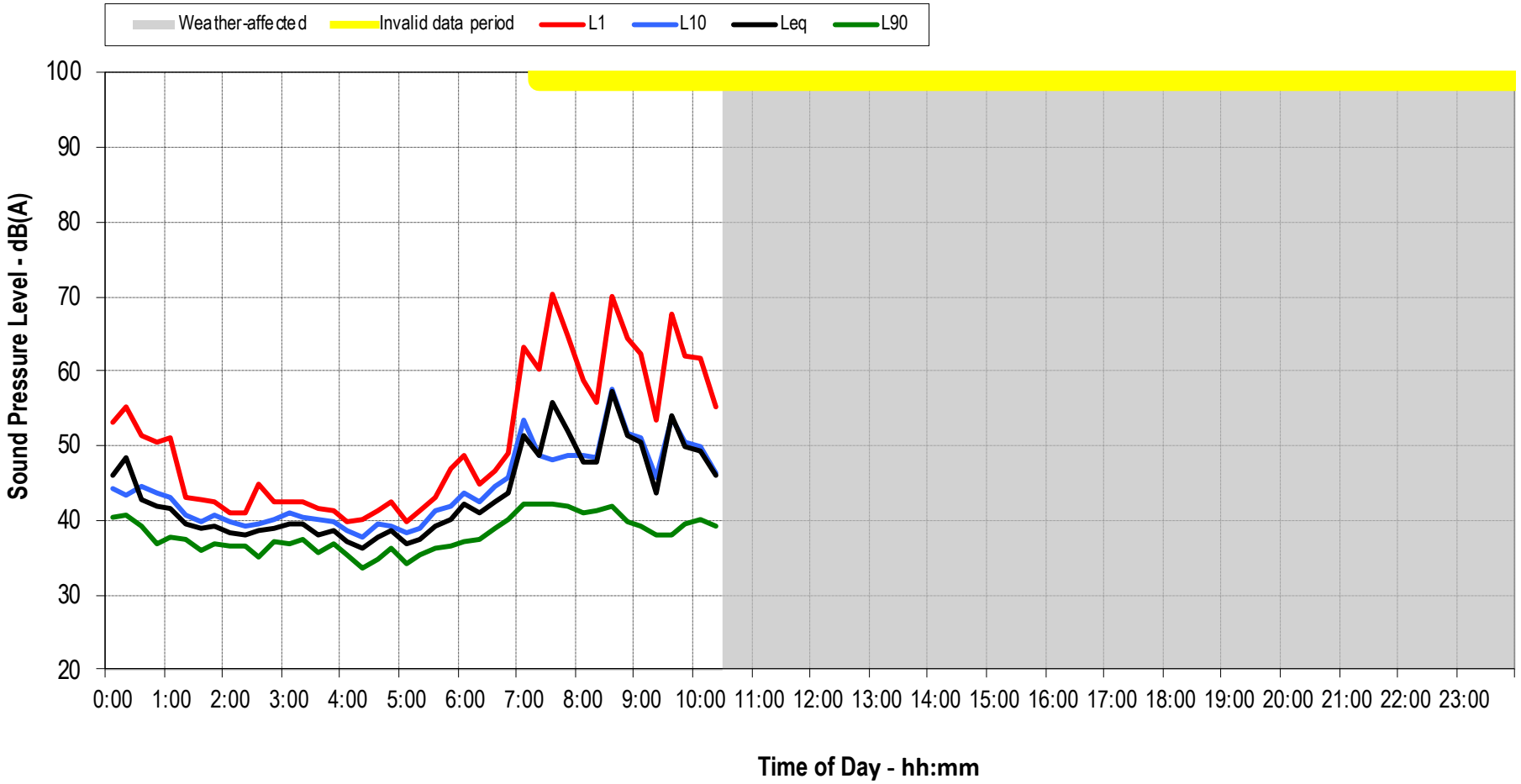

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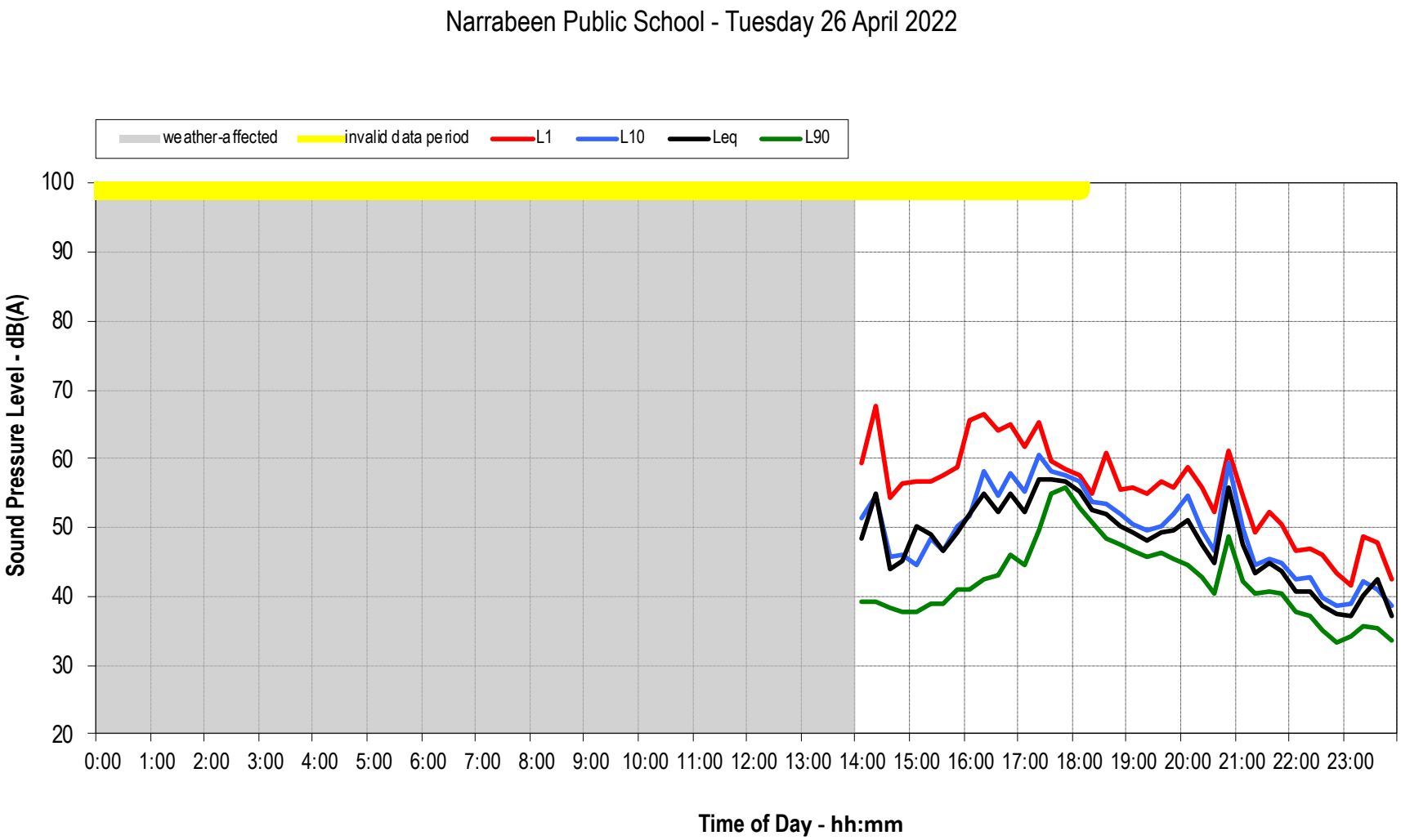
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weather-affected
invalid data period
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L10
Leq
L90
Sound Pressure Level - dB(A)
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70
60
50
40
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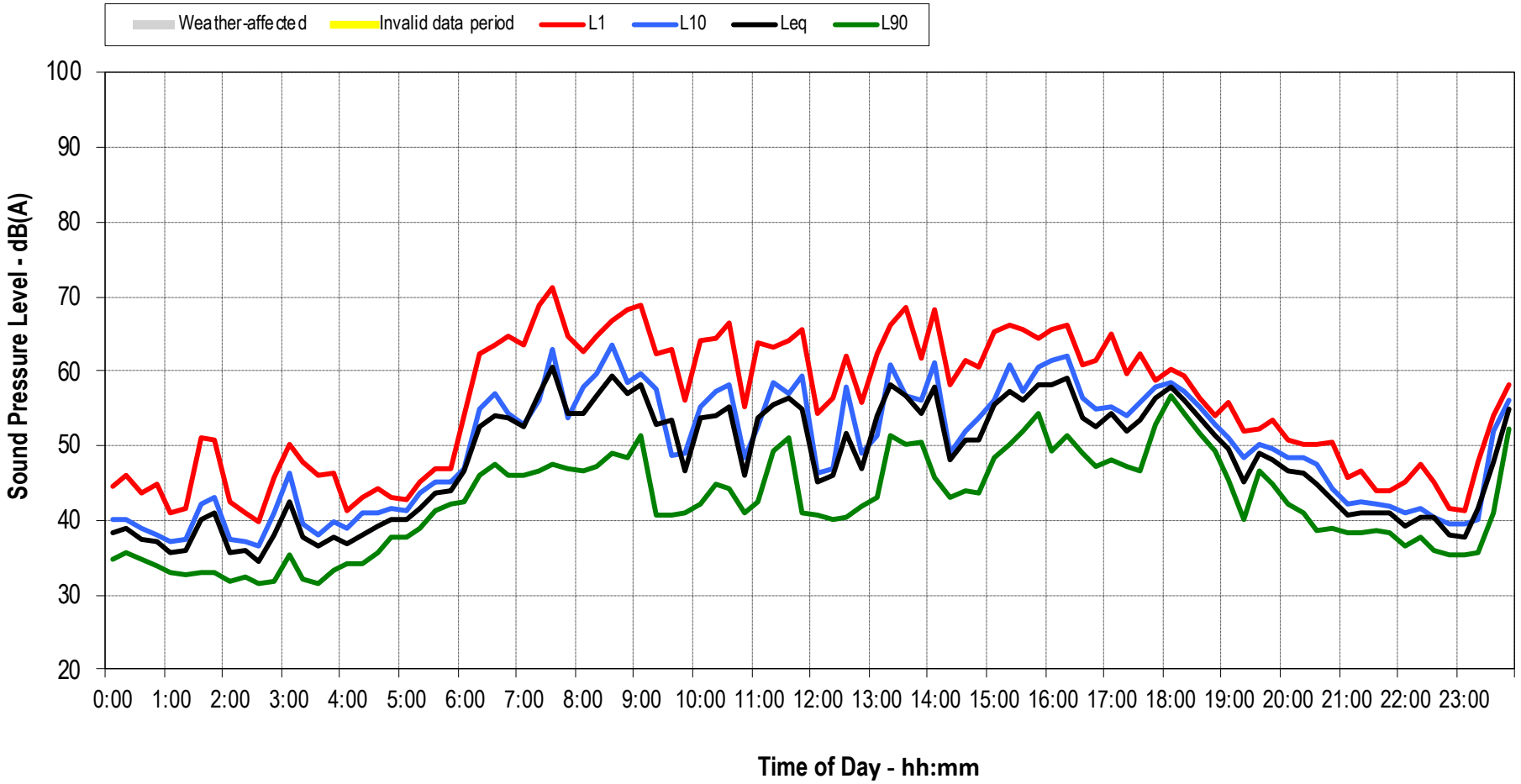

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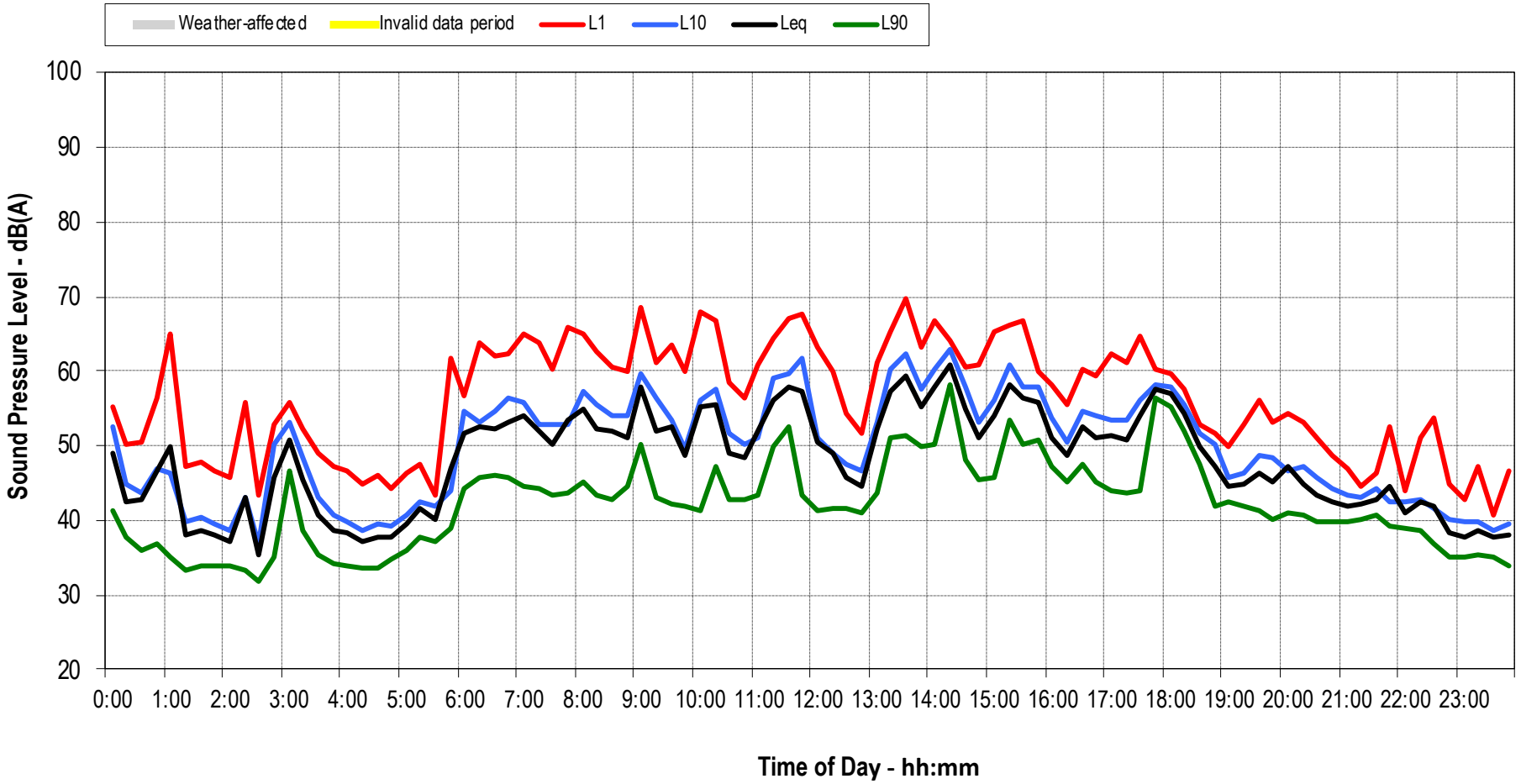

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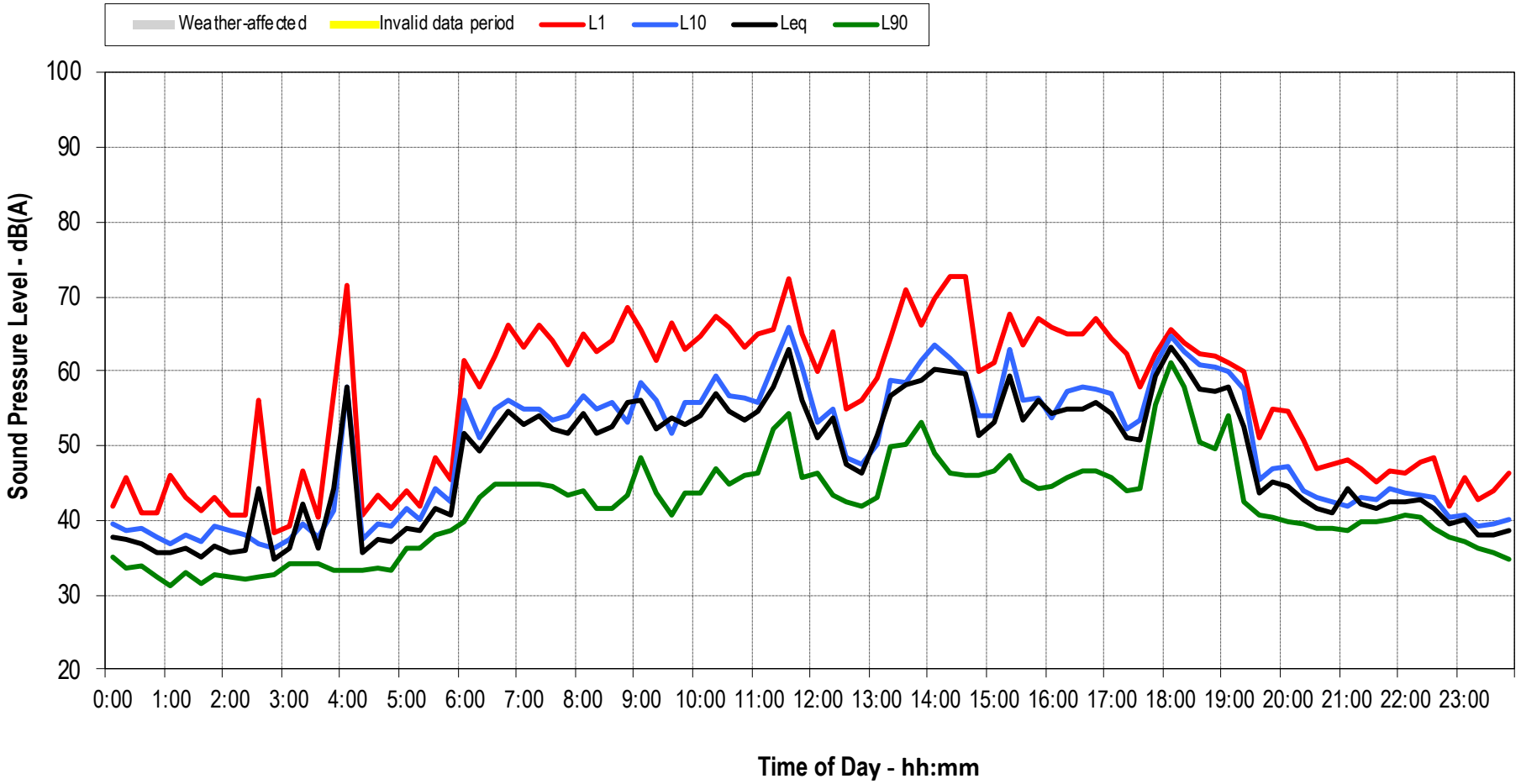

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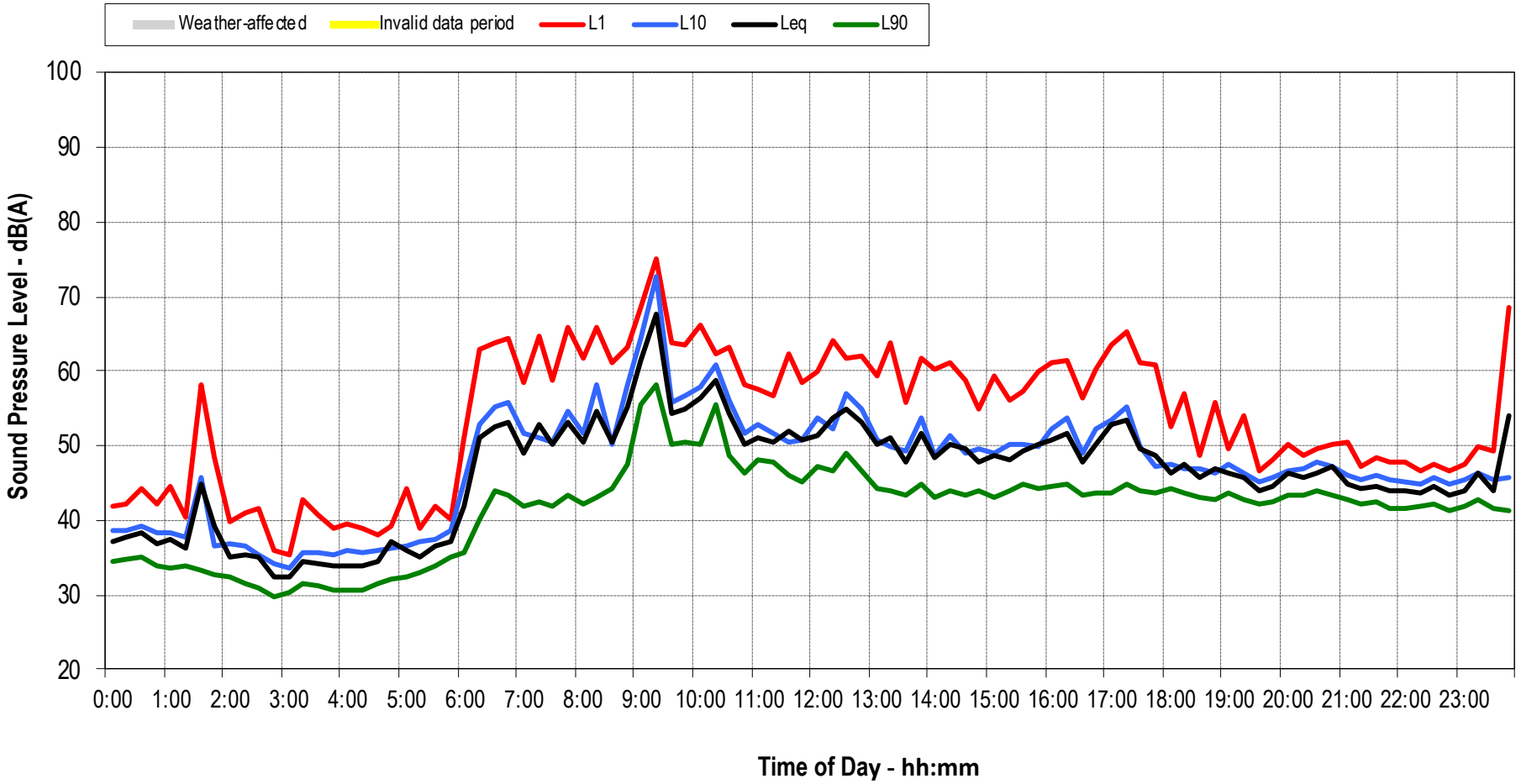

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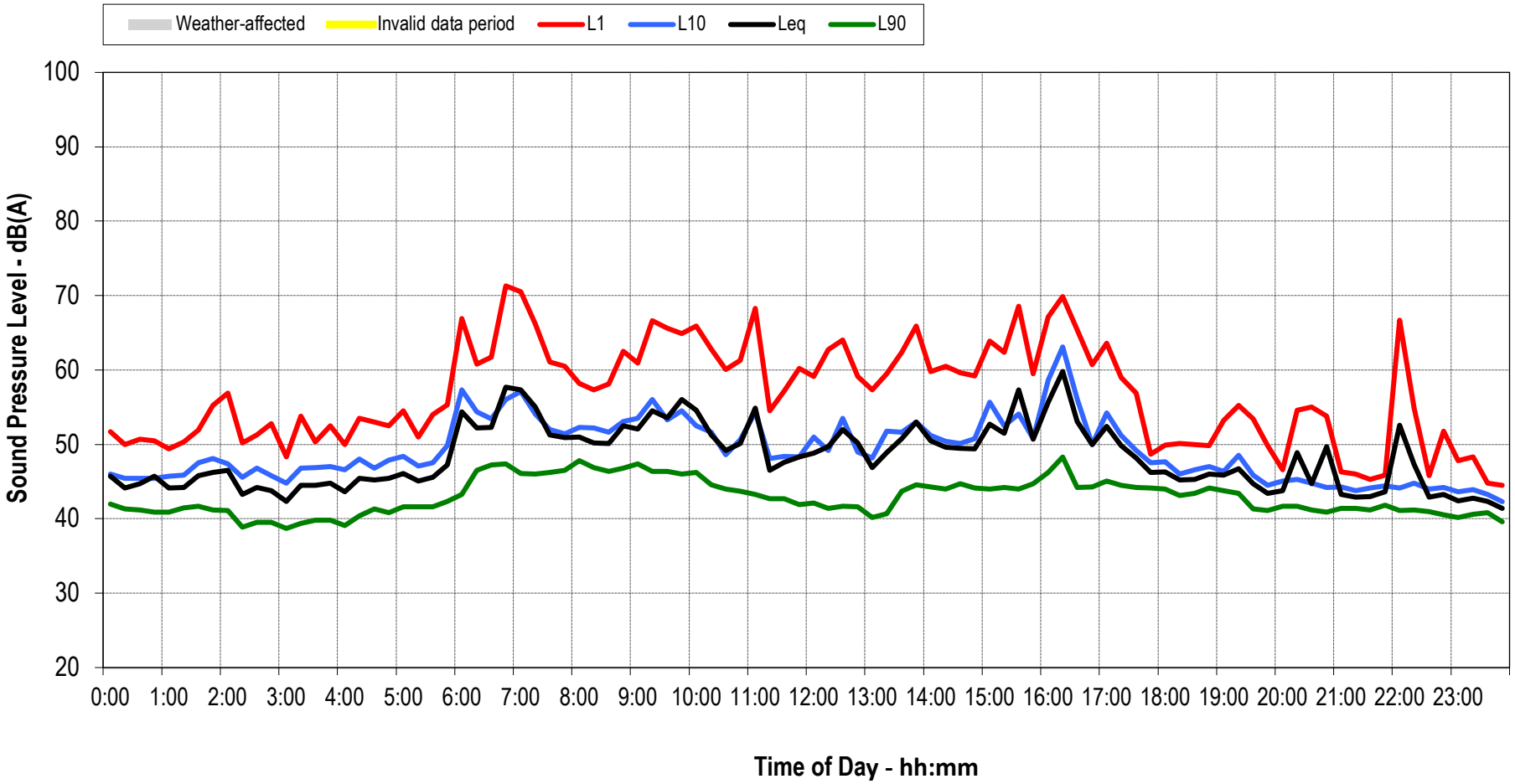

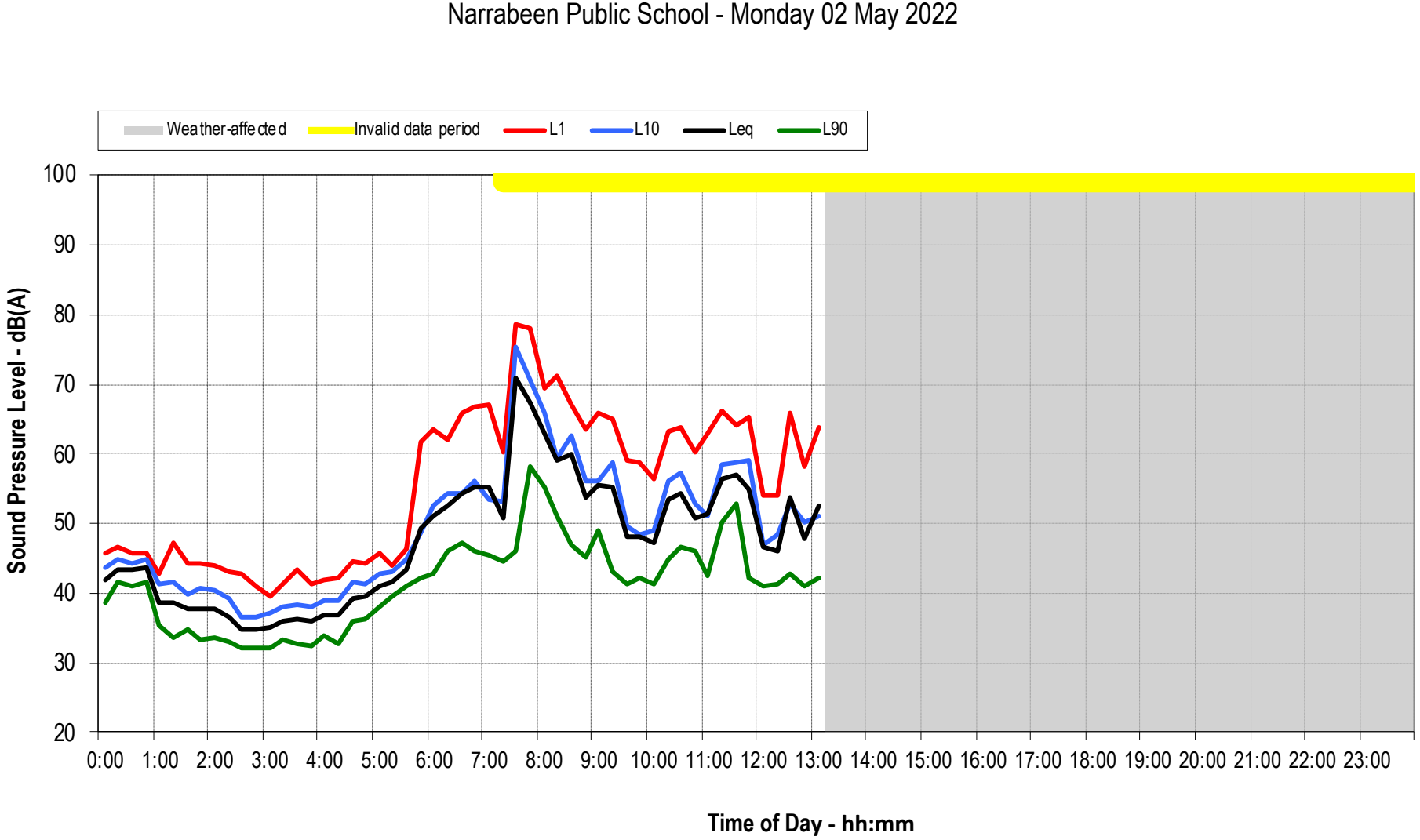
Narrabeen Public School - Monday 02 May 2022
Weather-affected
Invalid data period
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Leq
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Sound Pressure Level - dB(A)
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Appendix B – Establishing NSW NPI Criteria

The main source of noise break-out from the proposed development to the environment will be activities noise from the premises and noise from the mechanical plant.
The environmental noise impact of the site has been assessed in accordance with the NSW EPA Noise Policy for Industry 2017 (NSW NPI).
The NSW NPI sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the Project Noise Trigger Level (PNTL).

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source is not to be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria only relate to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured – if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.
The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project noise trigger level

For the new plant in ASB premises, the more stringent of the intrusive and the amenity criteria sets the PNTL.
The derivation of the PNTL is provided below.

B.1 Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPI.
Three time periods are considered (consistent with the operating times and the time-of-day classifications in the NSW NPI):

- Day - 7am to 6pm
- Evening - 6pm to 10pm
- Night - 10pm to 7am

The estimated RBLs and ambient noise levels are shown below in Table B1.

Location	L_{90} RBL Background Noise Levels, dB(A)			L_{eq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Period 1	41	43	36	56	55	48
Period 2	42	40	32	55	49	47

Table B1 : Long-term background and ambient noise levels based on NSW NPI around the site

We make the following comments with regard to the summary above:

- Data and weather observations have been reviewed during the monitoring period and affected data has been excluded when determining the PTNLs.
- Period 1 – This data for this period was collected within school holiday period
- Period 2 – This data for this period was collected within school term which would include ‘normal’ traffic and school operations.

- The lower / most stringent data collected from both periods will be used for this assessment.

B.2 Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

$L_{Aeq,15minute}$ = RBL plus 5 dB(A) (Equation 1)

The intrusiveness noise level has been determined from the RBLs presented in table B1, using the lower of the recorded values for each period as a basis for the assessment.

- Day Intrusiveness criterion of - 41 + 5 = **46 dB(A)**
- Evening Intrusiveness criterion of - 40 + 5 = **45 dB(A)**
- Night Intrusiveness criterion of - 32 + 5 = **37 dB(A)**

The Intrusiveness noise levels are only applied to residential receivers.

B.3 Determination of project amenity noise levels

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

The recommended ANL represents the objective for total industrial noise at a receiver location, whereas the project ANL represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended ANL for an area, a project ANL applies for each new source of industrial noise from an industrial development as follows:

- Project ANL = Recommended ANL minus 5 dB(A) (Equation 2)

The nearest residential receivers to the project are considered to be – as per NSW NPI Table 2.3 – in a Noise Amenity Area characterised by the NSW NPI as urban.

The recommended ANLs relevant to this project are specified in Table B3.

Receiver[3]	Time of Day	L_{Aeq}, dB(A)
		Recommended ANL
Residential (Suburban)	Day	55
	Evening	45
	Night	40
Industrial	When in use	70
Commercial	When in use	65
Active recreation	When in use	55
Passive Recreation	When in use	50

[3] The NSW NPI states, "Where internal noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with the windows opened sufficiently to provide adequate ventilation, except where means of ventilation complying with the Building Code of Australia are provided. In cases where gaining internal access for monitoring is difficult, then external noise levels 10 dB(A) above internal levels apply".

Table B3 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

The following exceptions to the above method to derive the project ANL apply:

Exception A – In areas with high traffic noise levels

The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period(traffic)}$ minus 15 dB(A). This high traffic project amenity noise level may be applied only if all the following apply:

- traffic noise is identified as the dominant noise source at the site,
- the existing traffic noise level (determined using the procedure outlined in Section A2, Fact Sheet A of NSW NPI, measuring traffic instead of industrial noise) is 10 dB or more above the recommended ANL for the area, and
- it is highly unlikely traffic noise levels will decrease in the future,

for each assessment period where these traffic noise provisions apply, the High Traffic Project ANL is to be used for industrial development, derived from the $L_{Aeq,period(traffic)}$ as:

- High Traffic Project ANL = $L_{Aeq,period(traffic)}$ minus 15 dB(A) (Equation 3)

Exception B – In proposed developments in major industrial clusters

The recommended amenity noise level from Table B3 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section B.3 can be applied. However, where a greenfield or redevelopment of an existing cluster of industry consisting of multiple new noise-generating premises is proposed, the approach for determining the project amenity noise level in Section B.3 is not applicable and the approach below is to be applied.

For the new multiple premises or redevelopment of existing clusters of industry, for each individual premise,

- Individual Project ANL = $10\text{Log}_{10}(10^{(L\ -\ 5\ dB/10)}/N)$ dB(A)(Equation 4)

where L is the relevant recommended ANL from Table B3 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing L_{Aeq} industrial noise levels are more than 5 dB lower than the relevant recommended ANL, the above equation can be modified to reflect “L” in lieu of “L – 5 dB”.

Exception C

Where the resultant project ANL is 10 dB or more lower than the existing industrial noise level. In this case the project ANL can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

Exception D

Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant ANL is assigned as the project ANL for the development. Where the project ANL applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2 of the NSW NPI.

Receiver - External	Time of Day	Recommended ANL	Adjustment	Project ANL[4]
Residential	Day	55	Equation 2	53
	Evening	45	Equation 2	43
	Night	40	Equation 2	38
Industrial	When in use	70	Equation 2	68
Commercial	When in use	65	Equation 2	63
Active Recreation	When in use	55	Equation 2	53
Passive Recreation	When in use	50	Equation 2	48

Table B4: Determination of Project Amenity Noise Levels for residential and non-residential receivers

B.4 Project noise trigger level

The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTL are shown in Table B5 below (PNTLs shown shaded).

Receiver - External	Period	Project Intrusiveness Noise Level	Project Amenity Noise Level
Residential	Day	46	53
	Evening	45	43
	Night	37	38
Industrial	When in use	-	68
Commercial	When in use	-	63
Active Recreation	When in use	-	53
Passive Recreation	When in use	-	48

Table B5 : Determination of Project Noise Trigger Levels for the site

[4] The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the Project ANL. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardize the time periods for the intrusiveness and amenity noise levels, the Policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3dB(A).

Appendix C : Building damage vibration criteria

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage. This lack of data is one of the reasons that there is variation between international standards, why the British Standards Institution (BSI) did not provide guidance before 1992 and why there are still no International Organisation for Standardisation (ISO) guidance limits.
There are however several standards that can be referred to.

German Standard

The relevant German standard is DIN 4150: Part 3: 19862. This standard gives guidelines for short-term and steady state structural vibration. For short-term vibration in buildings the following limits are given:

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

Table C1: Guideline Values of Vibration Velocity, vi, for Evaluating the Effects of Short-term Vibration

The guidelines state that:

- Experience to date has shown that, provided the values given in Table D2 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of table D2 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.

Swiss Standard

The relevant Swiss standard is SN 640 312:1978. For steady state vibration, form machines, traffic and construction in buildings the following limits are given:

Structural type	Vibration Velocity, v_i, in mm/s	
	Foundation	
	10 to 30Hz	30 to 60Hz
Commercial, Industrial including retaining walls	12	12 to 18
Foundation walls and floors in concrete or masonry. Retaining walls and ashlar construction	8	8 to 12
Foundations and basement floors concrete, with wooden beams on upper floors. Brick walls.	5	5 to 8
Particularly sensitive	3	3 to 5

Table C2: Guideline Values of Vibration Velocity, vi, for Evaluating the Effects of Steady State Vibration

British Standard

The relevant standard is BS7385: Part 2: 1993[5]. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the building:

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above

Table C3: Transient Vibration Guide Values for Cosmetic Damage

The standard states in Annex A, that:

- The age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance. It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that should be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report should be prepared both pre and post exposure, both internally and externally.

[5] British Standards 7385:1993 Part 2 "Evaluation and Measurement for vibration in Buildings. Guide to damage levels from ground-borne vibration"

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993[6], which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration should be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

[6]AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives