ACOUSTIC STUDIO

Sutherland Public School – Hall Upgrade

Noise and Vibration Impact Assessment for Review of Environmental Factors

14 February 2025

Address Unit 27, 43-53 Bridge Road,
Stanmore NSW 2048 Australia

Phone +61 2 9557 6421

Email mail@acousticstudio.com.au

Contact for this report
[Contact Name]
[name@acousticstudio.com.au]

Document Information

Project & Number	Sutherland Public School – Hall Upgrade	SVM 3589
Title	Noise and Vibration Impact Assessment for Review of Environmental Factors	
Reference	20250214 SVM3589.0003.Rep.REF_v3.docx	
Client	NSW Department of Education	

Organisation	Circulation	Delivered via
RPS Consulting	Tom Short	Email / SharePoint
RPS Consulting	Ted Kvasnicka	Email / SharePoint
BKA Architecture	Ashwin Kuruvilla	Email / SharePoint
Steensen Varming	Alan Sharkey	Email / SharePoint
Project Team	Project Team	SharePoint

Revision History

Revision	Date	Description	Prepared by	Reviewed by
Draft	29/11/2024	Draft REF Issue	VM / LL	AC
1	17/12/2024	REF Issue	LL	AC
2	19/12/2024	Updated with town planner comments	LL	AC
3	14/02/2025	Updated with SINSW Statutory Planner comments	LL	AC

Association of Australasian
Acoustical Consultants

Contents

Appendices

Acronyms

Initialism	Definition
ACS	Acoustic Studio
CNVMP	Construction Noise and Vibration Management Plan
COLA	Covered Outdoor Learning Area
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation
DECC	NSW Department of Environment and Climate Change
DoE	NSW Department of Education
DPHI	Department of Planning, Housing and Infrastructure
EFSG	Engineering Facilities Standards and Guidelines
ICNG	Interim Construction Noise Guideline (NSW EPA, 2009)
LEP	Local Environment Plan
NMLs	Noise Management Levels
NPI	Noise Policy for Industry (NSW EPA, 2017)
NVIA	Noise and Vibration Impact Assessment
PA	Public Adress Systems
POEO	NSW Protection of the Environmental Operations
REF	Review of Environmental Factors
RBL	Rating Background Level
RNP	Road Noise Policy
SPS	Sutherland Public School
SEPP TI	State Environmental Planning Policy (Transport and Infrastructure)

Executive Summary

Acoustic Studio (ACS) has been engaged by NSW Department of Education (DoE) to prepare a Noise and Vibration Impact Assessment for the Review of Environmental Factors submission associated with the proposed new school hall and COLA at Sutherland Public School (SPS).

The site currently accommodates the SPS which is located at 38-54 Eton Street, Sutherland, NSW 2232. The proposed school hall is to be located within Lot 6, 7 and 8 DP 802.

Construction Noise and Vibration

Construction for the project should be carried out during recommended standard constructions hours outlined in the Interim Construction Noise Guideline, as follows:

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

It has determined that construction noise and vibration that is likely to result from the proposed activities is a medium risk based on the assessment undertaken at this planning stage, as follows:

- **Noise** - There will be times / situations when works and activities are likely to be above Noise Management Levels and, in some cases, be above the Highly Affected Noise Levels (particularly if excavators with hammers and piling machines are used during earthworks and early structure works). All reasonable and feasible mitigation measures should be applied to reduce noise impact.
- **Vibration** - There is potential for human perception vibration impacts on nearby same school existing buildings. For the nearest sensitive residential receiver, vibration is expected to be low risk, with the nearest residential receiver at more than 30m.

Further development of the construction strategy will be required as the design progresses; however, the risks are anticipated to remain and will require appropriate management and planning to minimise noise and vibration impact to surrounding receivers. As such, the key mitigation measures for construction noise and vibration impacts management are in Table 2 in Section 1.5.

Operational Noise

Operational noise from the activity is capable of meeting the relevant noise criteria set out in this Noise and Vibration Impact Assessment, provided the following noise mitigation measures are implemented as part of the final design (or alternative solutions to achieve the Project Noise Trigger Levels for the project are provided):

- **hall doors and windows** can be **kept open during school hours and out of hours use up to 10pm** for noisy activities (including amplified music if noise levels inside the hall are limited to 80dBLAeq,30minutes).
- **Building Services**
  - In duct attenuation will be allowed for equipment terminating at the façade.
- **Public Address (PA) Systems** should be limited to 7am to 6pm and incorporate good practice design and set at the lowest level practical whilst still achieving intelligibility requirements.

External Noise Intrusion

Based on the measured noise levels and strategic location of openings in the hall building, no additional acoustic treatment to the façade (above a minimum / standard design) is required to control external noise intrusion and achieve the relevant internal noise levels for the project.

Cumulative Noise Impact

Cumulative Construction Noise

The Contractor for the project will need to collaborate with proponents of other developments and construction works in the vicinity of the new school project (if identified) to minimise cumulative impacts of noise and vibration and be captured in the Construction Noise and Vibration Management Plan to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered. and managed against Noise Management Levels / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites (if identified) and respite periods.
- Coordination of traffic routes to minimise impact.
- Coordination of community consultation.

Cumulative Operational Noise

The Project Noise Trigger Levels have been established using the approach in the Noise Policy for Industry (NPI) which considers a noise sensitive receiver that is affected by up to 3 to 4 individual noise sources. Therefore, achieving the PNTLs for the new hall will ensure that cumulative noise impact (in conjunction with other sites) is appropriately controlled (assuming that all other sites have been designed in accordance with the requirements of the NSW NPI).

1 Introduction

This Noise and Vibration Impact Assessment (NVIA) has been prepared by Acoustic Studio to support a Review of Environmental Factors (REF) for the Department of Education (DoE) as the proponent for the construction and operation of the new school hall at Sutherland Public School (SPS) (the activity).

The purpose of the REF is to assess the potential environmental impacts of the activity prescribed by State Environmental Planning Policy (Transport and Infrastructure) 2021 (SEPP TI) as "development permitted without consent" on land carried out by or on behalf of a public authority under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The activity is to be undertaken pursuant to Chapter 3, Part 3.4, Section 3.37 of the T&I SEPP.

This document has been prepared in accordance with the Guidelines for Division 5.1 assessments (the Guidelines) by the Department of Planning, Housing and Infrastructure (DPHI). The purpose of this report is to:

- Identify noise sensitive receivers that will potentially be affected by the operation and construction of the new school hall.
- Quantify the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- Establish the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Provide a quantitative assessment of main noise and vibration generating sources associated with construction.
- Provide a quantitative assessment of the main sources of operational noise including building services and traffic.
- Provide a quantitative assessment of external noise intrusion / noise impacts on the proposed activity.
- Assessing whether the relevant criteria can be achieved and, where applicable, recommending measures to minimise and mitigate potential impacts.

1.1 REF Acoustic Considerations

The following table outlines the relevant acoustic considerations for REF.

Table 1 REF Acoustic Considerations

Key Acoustic Issue / Topic		Requirement / Relevant Guideline	Relevant Section of Report
Construction Noise and Vibration	Construction Noise	DECC Interim Construction Noise Guideline	Sections 5.1.1, 6, 6.5, 9.1
	Construction vibration	DEC Assessing Vibration a Technical Guideline	Sections 5.1.3, 6, 6.5, 9.1
Operational Noise Emission	Hall use (including after school hours)	Noise Policy for Industry	Sections 5.2, 7, 7.3.2, 9.2
	Noise from COLA operations as teaching area		Sections 5.2, 7, 7.3.3, 9.2
	Public Address System		Section 5.2, 7.3.4
	Building Services		Sections 5.2, 7, 7.3.5, 9.2
External Noise Intrusion	Road	Development Near Busy Roads and Rail Corridors	Sections 5.3.1, 8.2.1
	Rail		Sections 5.3.1, 8.2.2
	Aircraft	AS2107	Sections 5.3.2

1.2 Project Overview

The proposed works involve upgrades to the existing SPS. This will include:

- Demolition of existing Block J, garden bed, 4 car parking spaces and structures.
- Removal of six trees.
- Construction of a new multi-purpose school hall and COLA, including canteen/kitchenette, OOSH office, amenities, and storage.
- Relocation of existing COLA to the east of the school hall.
- Civil works as per the Civil Engineering Plan.

It is noted that the proposal retains the existing student capacity at the Sutherland Public School.

The proposed hall will sit to the western boundary of the current Sutherland Public School campus at 38-54 Eton Street, Sutherland. Figure 1 below shows the site plan of the school with proposed new hall highlighted in red.

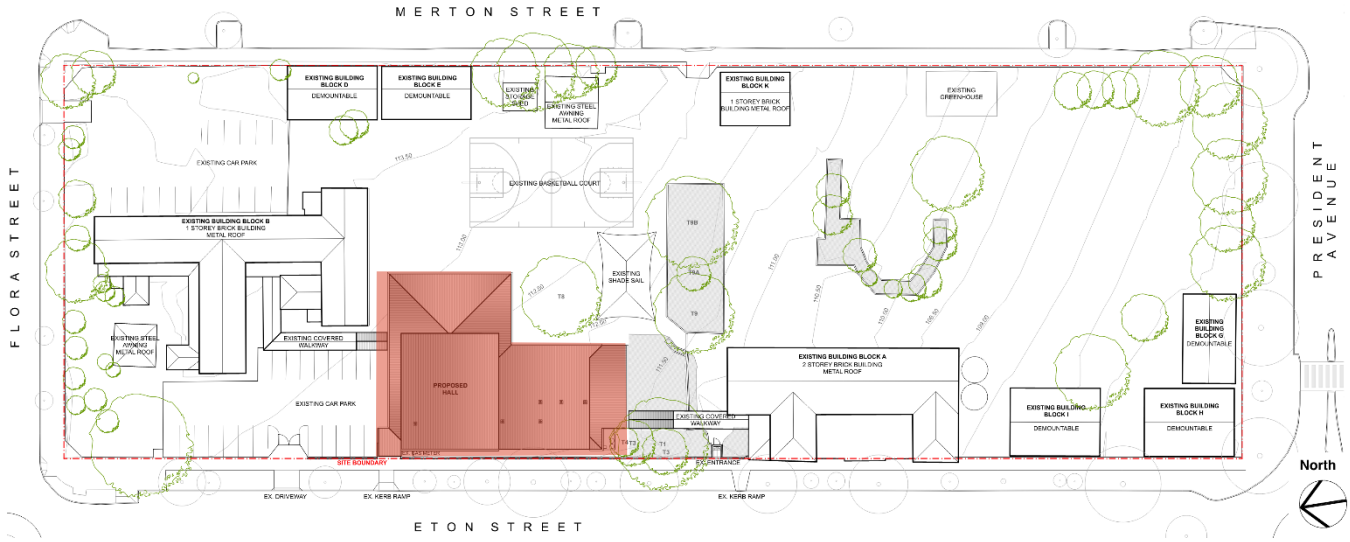


Figure 1 Site location (Source: BKA Architecture)

1.3 Proposed Activity Description

The proposed activity is for the construction and operation of a new hall, and adjacent Covered Outdoor Learning Area (COLA), within the existing SPS campus.

The hall will be used during school hours for:

- Student assemblies.
- Student performances.
- Indoor sports.
- Teaching activities.

Outside school hours, the Hall will be used for:

- OSHC.
- Occasional school events.
  Note: SINSW has confirmed that the sole purpose of this facility is as a primary school hall, that will be used for school related activities only. At the opening of the new hall there are no planned community groups uses. In any case, the hall will not operate past 10pm (i.e. no night-time use).

Figure 2 below shows the plan of the proposed hall and COLA.

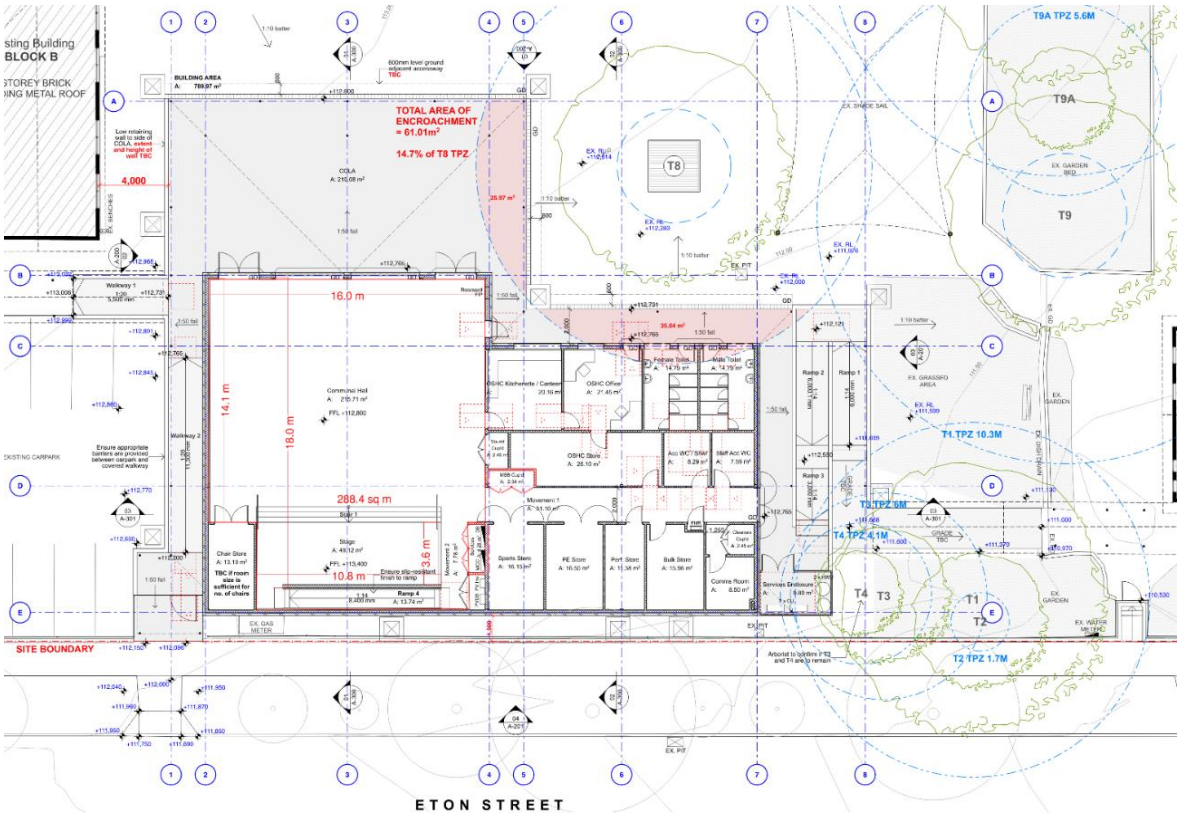


Figure 2 SPS proposed hall plan (Source: BKA Architecture)

The operational hours of the new Hall are as follows:

- During school hours: 9am to 3pm.
- Out of School Hours Care (OSHC): 7 to 9am and 3 to 6pm.
- Occasional after school hours use (e.g. presentations, parent teacher sessions): up to 10pm.

It is noted that the new facilities cleaning hours and car parking operations will follow the existing arrangements already in place for the school (before and after OSHC). Hence, no additional future impacts from hall cleaning activities or car parking arrangements are anticipated and are not further assessed in this report.

1.4 Noise and Vibration Assessment Scope

The scope of the noise and vibration assessment is limited to noise impacts associated only with the new hall to include:

- Construction noise and Vibration associated with the new hall works.
- Operational noise associated with new hall and COLA.

Assessment of existing school operations (i.e. all operations other than those associated with the new hall and its construction) are excluded from this assessment report.

1.5 Mitigation Measures

Table 2 Project Mitigation Measures Summary Table

Mitigation Number / Name	Aspect / Section	Mitigation Measure	Reason for Mitigation Measure
Construction Management – Section 6			
CM-01	Section 6.5 - Preparation of a CNVMP	A Construction Noise and Vibration Management Plan shall be prepared by the contractor. Implementation of all reasonable and feasible mitigation measures for all works.	To ensure that any adverse noise impacts to surrounding noise sensitive receivers are minimised
CM-02	Section 6.5 - Scheduling and respite periods	Coordinate duration and respite periods	Reduce noise impact
CM-03	Section 6.5 - Noise barriers and screening	Noise barriers or screening to provide shielding of noise to achieve a 5-10 dB reduction	Reduce noise impact
CM-04	Section 6.5 - Alternative construction methodology and equipment	Implement quitter methodology or equipment	Reduce noise impact
CM-05	Section 6.5 - Construction Traffic	Planning of access routes, staging and management of arrivals	Reduce noise impact
CM-06	Section 6.7 - Noise monitoring	Include an allowance for attended monitoring (half day) at the commencement of the first round of noise intensive works, including Excavation / Earthworks and Substructure	This will be used to quantify predictions, inform improvements and updates to the management plan and determine if further or longer-term monitoring is required.
CM-07	Section 6.7 - Vibration survey	It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment	To determine whether the existence of significant vibration levels justifies a more detailed investigation.

Mitigation Number / Name	Aspect / Section	Mitigation Measure	Reason for Mitigation Measure
Design and Operation – Section 7			
D/O - 01	7.3.4 - Public Address Systems	Operation should be limited to 7am to 6pm and incorporate good practice design and set at the lowest level practical whilst still achieving intelligibility requirements	To achieve project PNTL and minimise noise impact to surrounding neighbours
D/O - 02	Section 7.3.5 - Plant Acoustic Treatment - Fans	In duct attenuation will be allowed for equipment terminating at the façade.	To achieve project PNTL and minimise noise impact to surrounding neighbours

Part 1 – Establishing Criteria

2 Key Acoustic Considerations

The following acoustic issues are to be addressed as part of the assessment:

- **Construction Noise and Vibration**
  The impact of noise and vibration generated during construction of the SPS hall on surrounding sensitive premises (including construction noise impacts to the completed stages of the project), plus the potential cumulative effects with other surrounding activity that may be in construction at the same time.
- **Operational Noise Emissions**
  Operational 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 activity, plus the potential cumulative effects with other surrounding activity.
- **External Noise Intrusion**
  From external noise sources including rail, road traffic and aircraft noise.

3 Relevant Standards and Guidelines

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

- Sutherland Shire Council Development Control Plan (DCP) and Local Environment Plan (LEP), 2015
- NSW EPA Noise Policy for Industry (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 2107:2000 “Acoustics – Recommended design sound levels and reverberation times for building interiors”.
- Australian Standard AS 2021:2000 “Acoustics – Aircraft noise intrusion - building siting and construction”.
- 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.
- Australian Standard “AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)” 1990.
- British Standards Institution “BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)” 1992.
- German Standard DIN 4150-3:1999 “Structural vibration Part 3: Effects of vibration on structures”.
- British Standard BS7385: Part 2: 1993 “Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration”.
- NSW Department of Education (DoE) Educational Facilities Standards and Guidelines (EFSGs).
- Department of Planning and Environment, Guidelines for Division 5.1 assessments, June 2022.

4 Noise Survey

An understanding of the site, surrounding land uses and existing noise sources is essential to provide context on the noise sensitivities around the site and to establish the relevant noise targets for the project.

The existing noise environment is quantified through noise measurement via unattended noise monitoring in accordance with the NSW Noise Policy for Industry (NPI).

4.1 Surrounding Receivers

As shown in Figure 3, the following land-uses surround the Project site:

- Residential and commercial properties fronting the project site to the west along **Eton Street**.
- Commercial properties, including a church, fronting the project site to the north along **Flora Street.**
- Residential, educational and commercial properties fronting the project site to the east along **Merton Street**.
- Residential, educational and commercial properties fronting the project site to the south along **President Avenue**.

The reasonably most-affected residential noise sensitive receivers to the site are anticipated to be:

- Residential apartment building (currently under construction) fronting the project site to the west along **Eton Street**.
- Residential and educational properties fronting the project site to the east along **Merton Street**.

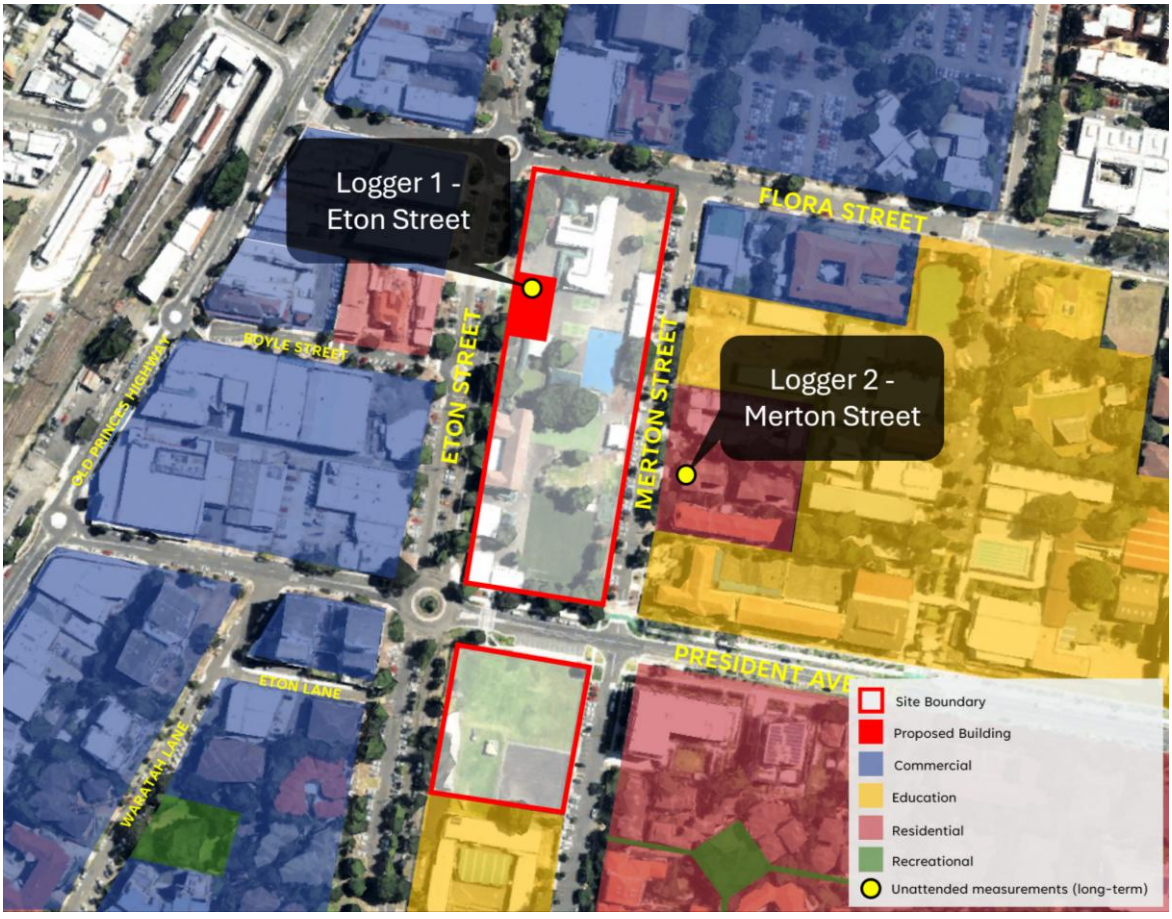


Figure 3 Activity Site and Neighbouring Land Uses – Existing and proposed (Source: Google Maps / ACS)

4.2 Noise Monitoring Locations

Unattended long-term noise monitoring

Unattended long-term monitoring was carried out at two locations shown in Figure 3.

- Logger 1 – at the school western boundary directly across 53 Eton Street.
- Logger 2 – at 20 Merton Street, to the south-east of the project site.

Both locations were considered appropriate as:

- They were accessible and secure place to leave the noise logger unattended.
- It was judged to be representative of background and ambient noise levels at the nearest, reasonably most – or potentially most – existing and future affected residences as detailed in the NPI.
- Logger 1 is representative of 53 Eton Street (future residential). As the site was under construction, it was not possible to locate the logger at its boundary. Therefore, selected location is considered the most appropriate for the project.

Short-term attended Measurements

Measurements were also carried out at locations which were selected to support the unattended noise monitoring.

These attended monitoring locations are shown in Figure 4.

4.3 Methodology

Lana Evans of Acoustic Studio Pty Ltd carried out the surveys.

4.3.1 Unattended Monitoring

Unattended long-term noise monitoring was carried out for the following periods:

- **Logger L1** – West of the project site
  - Friday 9 August 2024 to Friday 16 August
  - Tuesday 20 August 2024 to Monday 26 August 2024
- **Logger L2** – South-east of the project site
  - Friday 2 August 2024 to Thursday 8 August 2024 (on the balcony of Unit 1)
  - Tuesday 20 August 2024 to Tuesday 27 August 2024 (in the common area).
    Note: Measurements on the balcony of Unit 1 had influence of plant noise during the evening period. Additional logging was carried out in the common area in the other side of the building in the absence of plant noise. Both sets of logged data yielded similar results (i.e. plant noise in the evening did not affect the results)

Unattended monitoring was carried out with the following equipment

- Logger L1- Ngara (Serial Number 8780C9).
- Logger L2 - Ngara (Serial Number 87807B)

The noise loggers recorded LAmax, LA1, LA10, LA90, and LAeq noise parameters at 15-minute intervals continuously for the measurement period. The calibration of the loggers was checked before and after use and no significant variations were noted.

4.3.2 Attended Monitoring

Operator attended, short term monitoring was also carried out at the logger location, plus other locations surrounding the site on the following dates:

- Thursday 6 July 2024, between 10:30 am and 2:30 pm.
- Thursday 20 July 2024 between 12:00 pm and 1:00 pm.

Attended short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (1) (Serial Number: 2832406). The calibration of the analyser was checked before and after use and no significant variations were noted.

4.4 Monitoring Results

Long and short-term noise survey results are presented in Figure 4. The detailed results of the unattended long-term noise monitoring at the two logger locations are presented in Appendix A. Data measured during periods of adverse weather has been excluded.

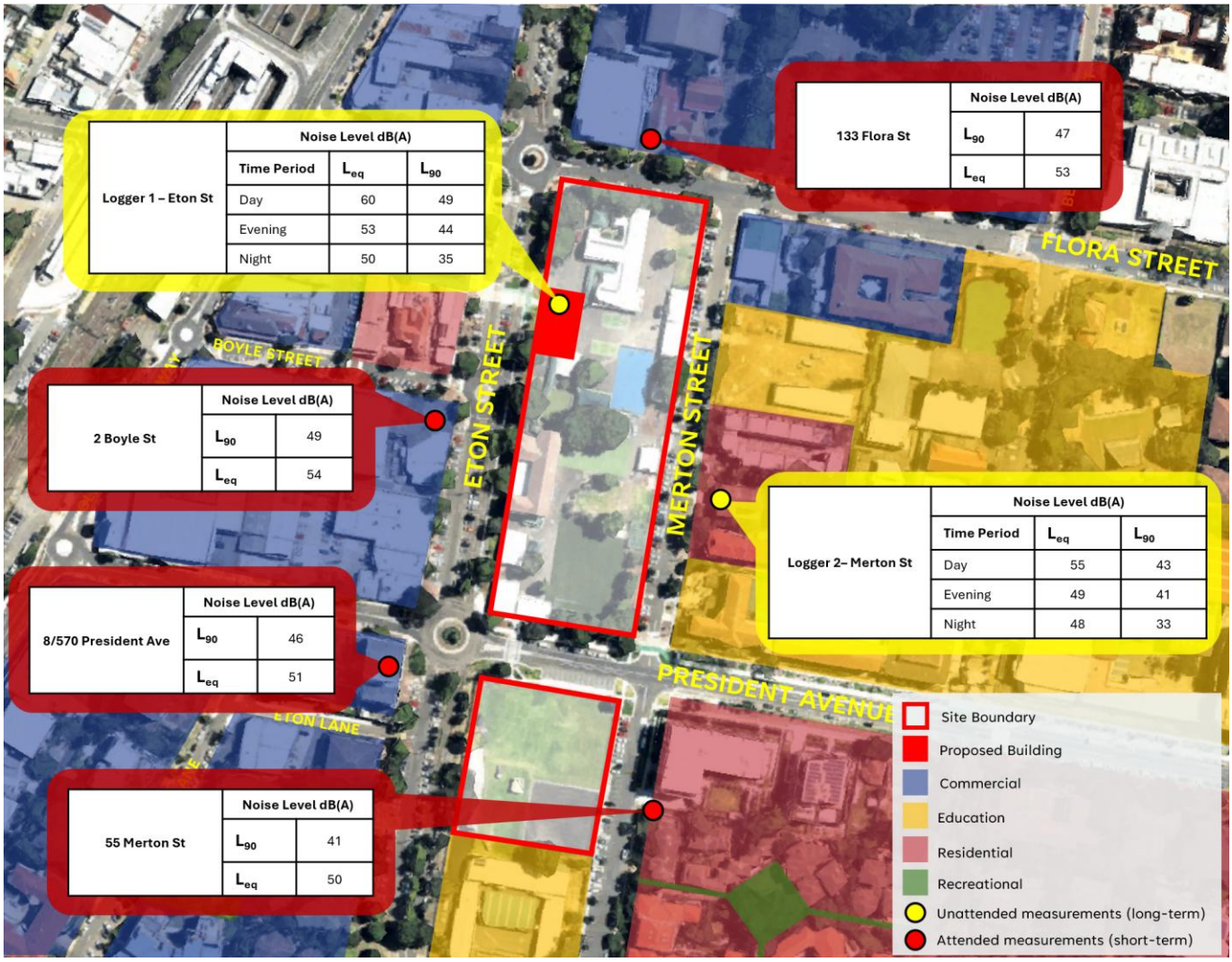


Figure 4 Noise Survey Results for the Project Site and Surrounds (Source: Google Maps / ACS)

4.4.1 Data Used for Establishing Noise Targets

The noise loggers were located to represent the reasonably most affected noise receivers near the proposed hall site:

- **Logger 1** (Referred to as **West)** – used to establish noise targets for existing commercial and future residential noise sensitive receivers (apartment building currently under construction) directly opposite to the project site in Eton Street.
- **Logger 2** (Referred to as **South-east**) - used to establish criteria at existing residential and educational noise sensitive receivers behind the site, situated along Merton Street.

5 Project Specific Noise and Vibration Criteria

The following sections outline the relevant Project Specific Noise and Vibration Targets based on the noise monitoring results and application of the relevant standards and guidelines.

5.1 Construction Noise and Vibration

5.1.1 Construction Noise

Construction Noise Management Levels (NMLs) are based on the Interim Construction Noise Guideline (ICNG) further described in **Appendix B.1**.

Residential

The project-specific construction NMLSs are shown in Table 3 based on the measured background noise levels at the site (RBL), are applicable at the property boundary. These locations represent the most affected receivers.

Table 3 Project Specific residential construction NMLs for airborne noise

Location	Period		Rating Background Level (RBL), dB(A)	NML $L_{Aeq(15\ min)}$, dB(A)	
Residential (West)	Recommended Standard Hours	Monday to Friday 7am to 6pm	49	RBL + 10	59
		Saturday 8am to 1pm	49		59
Residential (South - East)	Recommended Standard Hours	Monday to Friday 7am to 6pm	43	RBL + 10	53
		Saturday 8am to 1pm	43		53

Non-Residential Receivers

NMLs for non-residential sensitive areas adjacent to the proposed construction activities are as follows:

Table 4 Noise Management Levels for airborne noise – relevant non-residential receivers

Occupancy	Noise Management Level dB $L_{Aeq(15\ min)}$
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 65 dB(A) - External[1]
Commercial - Places of Worship (i.e. Sutherland Uniting Church)	
Other Commercial (e.g. Retail, Offices)	70 dB(A) - External

[1] External levels are based on a closed façade providing a minimum 20 dB noise reduction.

5.1.2 Construction Ground-Borne Noise

The project will be carried out during the ICNG recommended standard hours (as shown in Table 2). Assessment of ground-borne noise is only required during out-of-hours works, and therefore ground-borne noise is not considered further in the assessment.

5.1.3 Construction Vibration

Construction Vibration Management the DEC "Assessing Vibration – A Technical Guideline" (further described in Appendix B.2).

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project (based on the DEC "Assessing Vibration – A Technical Guideline", further described in Appendix B.2), 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 criteria are:

- 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, non-precision laboratories and commercial premises.

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

5.2 Operational Noise Emissions

5.2.1 NSW Noise Policy for Industry

The NSW Noise Policy for Industry (NPI) is the accepted as best practice reference guideline to assess school noise emissions including:

- Mechanical Plant
- Use of the hall and COLA

The NPI outlines the process for establishing Project Noise Trigger Levels (PNTLs). PNTLs are benchmark levels above which nose management measures are required to be considered.

PNTL and sleep disturbance screening targets are calculated based on noise monitoring data and the methodology outlined in the NPI (further described in **Appendix B.3**).

Noise Impacts on the Surrounding Community

The PNTLs are provided in Table 5.

Table 5 NSW NPI Project Noise Trigger Levels for external noise emissions from the proposed activity

Receiver		Period	PNTL dB $L_{Aeq(15\ min)}$
Residential (West)	All Surrounding Receivers	Day (7am-6pm)	54
		Evening (6pm-10pm)	48
		Night (10pm-7am)	40
Residential (South-East)		Day (7am-6pm)	48
		Evening (6pm-10pm)	46
		Night (10pm-7am)	38
School Classroom (at schools and other educational institutions outside SPS)		When in use	33 (internal) / 43 (external)[2]
Commercial Premises		When in use	63
Place of Worship		When in use	38 (internal) / 48 (external)[2]

Sleep Disturbance

The Sleep Disturbance Screening Criteria are presented in Table 6.

Table 6 Sleep Disturbance Screening Criteria

Receiver	Sleep Disturbance Screening Criteria	
	dB $L_{Aeq(15\ min)}$	**dB L_{AFmax}**
Residential (All)	40	52

5.2.2 Mechanical Plant and Equipment

The design of mechanical plant and equipment is required to target the requirements of the NPI PNTLs in Table 5.

[2] Non-residential external noise criteria are derived from internal noise criteria, assuming a transmission loss of 10dBA if windows are opened to provide natural ventilation. This methodology is supported by the NPI.

5.3 External Noise Intrusion

5.3.1 Road Traffic and Rail

The project internal noise target for traffic noise intrusion from traffic and rail sources that surround the project site are based on the Development Near Rail Corridors and Busy Roads – interim guideline, as required by Section 2.100 of the Transport and Infrastructure SEPP.

Table 7 Traffic and Rail Noise Assessment Target

Receiver Type	Noise Intrusion Assessment Criteria Max Leq(15h)(day)
Educational Institutions including childcare centres	40 (internal - Hall) / 50 (external - COLA)[3]

5.3.2 Aircraft

The site is located outside the Australian Noise Exposure Forecast (ANEF) 20 and therefore no further assessment is required.

[3] Non-residential external noise criteria are derived from internal noise criteria, assuming a transmission loss of 10dBA if windows are opened to provide natural ventilation (worst-case) and 20dBA if the windows are closed or external façade is glazing. This methodology is supported by the NPI.

Part 2 – Assessment

6 Construction Noise and Vibration Assessment

Summary of Construction Noise and Vibration Assessment

Construction Noise

The assessment has determined that construction stage impacts are a medium risk that requires management and planning to minimise noise impact.

A Construction Noise and Vibration Management Plan (CNVMP) shall be prepared by the contractor. 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.

Project specific mitigation measures shall include:

- Scheduling, Duration and Respite Periods
- Alternative construction methodology or equipment
- Noise Barriers or Screening
- Design access routes to minimise construction noise impact
- Communication
- Complaints management.

Construction Vibration

The impact of vibration will need to be confirmed and quantified further as part of the CNVMP prepared by the engaged Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

Cumulative Impacts

The Contractor for the project will need to collaborate with proponents of other developments and construction works in the vicinity of the new school project (if identified) to minimise cumulative impacts of noise and vibration and be captured in the Construction Noise and Vibration Management Plan to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered. and managed against Noise Management Levels / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites (if identified) and respite periods.
- Coordination of traffic routes to minimise impact.
- Coordination of community consultation.

6.1 Proposed Construction Hours

6.1.1 Standard Construction Hours

Proposed construction hours for the project applicable to the following assessment include Standard Construction Hours as outlined in the ICNG:

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

The proposed hours are for all construction and work on the development with the potential to generate noise greater than the Noise Management Levels, including activities in the vicinity of the site generating noise associated with preparation for the commencement of work (e.g. loading and unloading of goods, transferring of tools etc), in connection with the proposed works. Activities outside of the proposed work hours will only occur if:

- Required by the police or a public authority for the delivery of vehicles, plant or materials.
- Required in an emergency to avoid the loss of life, damage to property or to prevent environmental harm.
- The Applicant has negotiated an agreement with affected sensitive receivers and local authority.

6.1.2 Extended Construction Hours

Out-of-hours works are proposed to be undertaken during the following periods, as needed:

- Saturday - 1:00pm to 5:00pm (TBC)

Typical works proposed to be included during these hours will be limited to:

- Internal fit-out works (once building envelope is complete)
- Painting (no compressors)
- Cleaning (no power tools)
- Landscaping/gardening (no power tools)

Types of works excluded:

- Works involving earthmoving or construction equipment, power tools, vehicles or mechanical plant on site, or any other form of powered noise-generating machinery or equipment.

Extended construction hours could be proposed in order to:

- Reduce the overall construction duration, reducing the impact on affected receivers.

The proposed activities are considered be non-intrusive and are not considered within the following assessment.

If any of the works excluded above are required during extended construction hours, the contractor will need to agree upon the process with SI, TfNSW, Sutherland Shire Council, and residents to address the approvals and additional measures required for scheduling and out of hours works.

6.2 Description of Proposed Works

An approximated 12-month construction timeline is anticipated for this project, with minimal staging.

At this early stage, a Contractor has yet to been selected so there is no detailed information available about the works program. Hence, an indicative construction works summary has been developed by ACS and the Project Manager that outlines key activities in each location, with reference to ACS experience in past similar school project works. Based on this, it is anticipated that the key activities to occur for each area / stage are as shown in Table 8.

Table 8 Proposed Construction Activities and Equipment (in bold are items likely source of vibration)

Activity	Key Equipment	
Site Establishment	Truck, Forklift (beeping alarms) Hiab (mobile crane) truck / Front End / wheeled loader	Excavator 8T with bucket Semi-trailer truck Hand tools (general electric)
Demolition	Excavator 8T with bucket Excavator 8T with rock breaker **Roller (vibratory)**	Dump truck (tipping material) Bobcats
Excavation / Earthworks	Excavator 8T with bucket **Excavator 8T with rock breaker** Truck, forklift	Front End / wheeled loader (i.e. CAT D4) Skid steer loader (1/2 tonne) Dump truck (tipping material
Substructure	**Bored piling rig** Excavator 8T with bucket Truck, forklift Concrete vibrator	Concrete truck and pump Cement mixer Mobile crane
Structure	Tower Crane (diesel or electric) Truck, forklift and Semi-trailer truck	Mobile crane Hand tools
Façade	Tower Crane (diesel or electric) Truck, forklift Hand tools	Semi-trailer truck Elevated work platforms (beeping alarms)
Fit-out (internal works)	Hand tools (general electric) Hammer drill	Circular saw Angle grinder
External / Public Domain Works	Excavator 8T with bucket Truck, forklift Concrete truck and pump	Cement mixer Concrete vibrator **Roller (vibratory)**

6.3 Noise Sensitive Receivers

Nearest sensitive receivers to the Project Site that will be potentially most-affected by construction noise and vibration are as presented below. Table 9 outlines the most critical receivers surrounding the site for each type of impact.

Table 9 Construction Noise sensitive receivers and approximate distance to Works site

Receiver	Impact	Location	Typical Distance to Sensitive Receiver	
			From Construction Site Boundary	From Construction Site Centre
Residential West – 53 Eton St	Airborne and Vibration	West	35	45
Residential East – 16 Merton St	Airborne	South-East	55	75
Classrooms – St Patricks Catholic Primary	Airborne	East	80	100
Place of Worship – Sutherland Uniting Church	Airborne	East	80	100
Commercial on Eton St (directly across the site)	Airborne	West	35	45
Note: Construction noise prediction distances apply to the receiver boundary (as per ICNG)				

6.4 Assessment Methodology

The assessment methodology follows the ICNG process identified below.

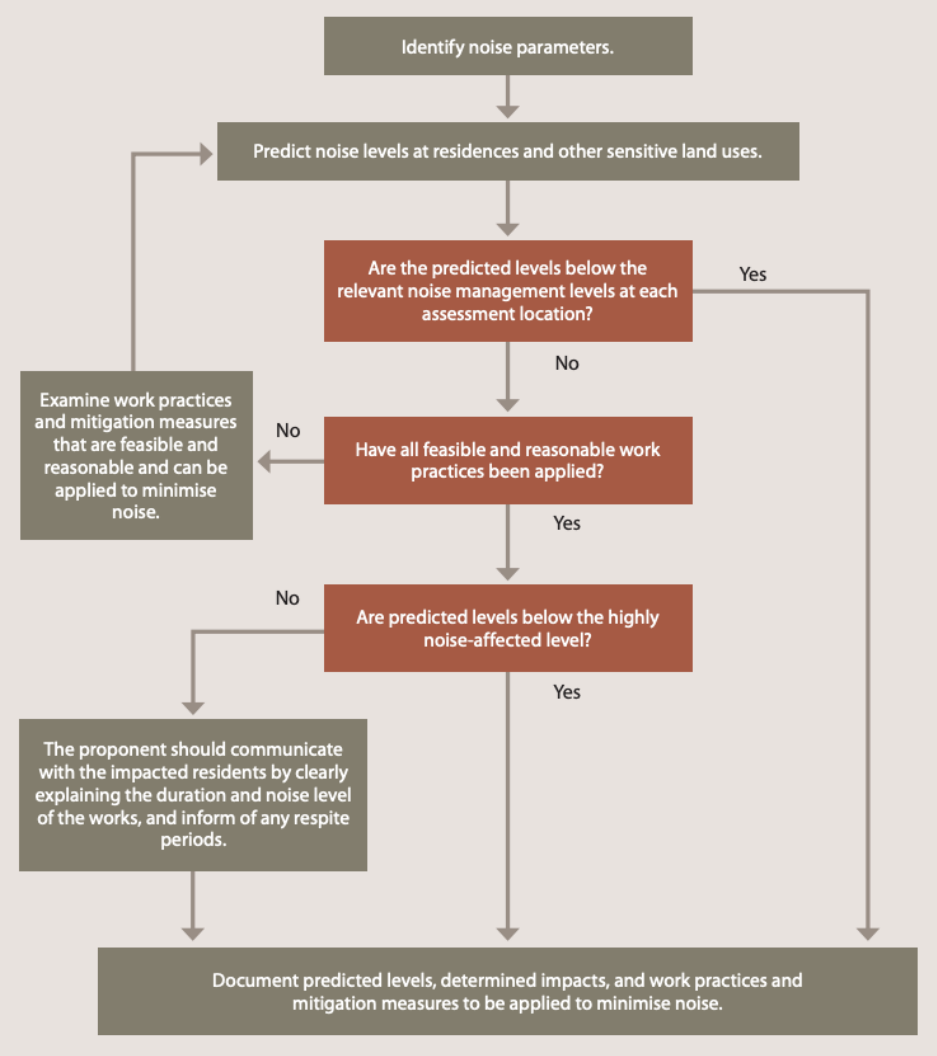


Figure 5 ICNG Construction Noise Assessment Methodology (Source: ICGN, 2009)

This assessment has considered the following:

- Typical activities as detailed in Section 6.2.
- Noise level predictions are calculated using the noise sources and Sound Power Levels referenced for plant and equipment noise predictions are provided in Appendix D.
- Project specific Noise Management Levels at each sensitive receiver location as outlined in Section 5.1.1
- Noise level predictions consider:
  - Distance attenuation
  - Shielding of intervening structures
  - Ground and building reflections
  - Façade loss (for fit out works)
- Predictions consider the typical distances to receivers in Table 9, with a range from the nearest construction site boundary (for receivers on campus that are adjacent to the site) and the centre of construction site.
- Predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment.
- The assessment considers likely scenarios where multiple equipment / plant shown in Table 8 can be used independently or concurrently for the construction activities listed in that table.

6.5 Construction Noise and Vibration

6.5.1 Assessment

Airborne Construction Noise

Table 10 provides results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Table 8 operating at the two typical distances in Table 9 (construction site boundary and centre of the construction works site) for works each stage.

The predicted noise levels are presented as a range, based on activities being carried out at the boundary of the site (as a 'worst-case') through to activities being carried out central to the site.

Table 10 Construction Noise Predictions - Levels predicted to exceed NMLs shown in **blue**; levels predicted to exceed "Highly Noise Affected" threshold (>75dBA) shown in red

Location (external)	Residential West – Eton Street	Residential East – Merton Street	Classrooms (at schools and other educational institutions)	Place of Worship (Sutherland Uniting Church)	Commercial – Retail, offices, etc	Comments
NML (external)	59	53	65	65	70	
Construction Activities	Predicted equipment noise levels at surrounding community receivers, in Leq,15min dB(A)					
Site Establishment	64 - 78	60 - 74	57 - 71	54 - 68	64 - 78	Noise dominated by heavy vehicles.
Demolition	64 - 82	60 - 78	57 - 75	54 - 72	64 - 82	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5 dB quieter.
Excavation / Earthworks	63 – 82	59 - 78	56 - 75	53 – 72	63 – 82	
Substructure	63 - 78	59 - 74	56 - 71	53 - 68	63 - 78	Noise levels dominated by piling and concreting works. Consider schedule these works not concurrently.
Structure	64 - 76	60 - 73	57 - 69	54 - 66	64 - 76	Noise levels dominated by the use of percussive hand tools. Non-percussive tools can be considered to significantly reduce noise.
Façade	57 - 74	53 - 70	50 - 67	47 - 64	57 - 74	Noise levels dominated by crane. Electric cranes can be considered to significantly reduce noise.
Fit-out (internal works)	50 - 67	46 - 63	43 - 60	40 - 57	50 - 67	Lesser noise impacts due to most works occurring inside the new hall structure.
Landscaping Works	53 - 67	49 - 63	46 - 59	43 - 56	53 - 67	Noise levels dominated by concreting works. TBC when detailed construction program is available.

Summary of Airborne Construction Noise Assessment Findings

Construction noise impacts will be highest at the façade of nearby residential receivers on Eton Street to the east particularly during activities carried out at the boundary including demolition and excavation.

Construction noise impacts at surrounding residential receivers are predicted to be generally above the NMLs, but only above Highly Noise Affected Levels when at the boundary of the construction site.

For the majority of proposed residential receivers, noise impacts are generally above NMLs but within the Highly Affected Noise Level for the majority of the time except when works are carried out at the nearest boundary to the noise sensitive receiver.

Project Noise Mitigation Measures

For the noise sources or equipment causing exceedances in construction activities as shown in Table 10, all reasonable and feasible noise controls measures, together with construction best practices presented in Section 6 of the ICNG, will be implemented.

Project Specific Treatment

The following has been identified as project specific treatment that is considered feasible and reasonable at this planning stage for further consideration once a contractor is engaged.

- Prepare a **Construction Noise and Vibration Management Plan (CNVMP)** when the Contractor is on board that outlines actual works and considers project specific mitigation measures noise outlined below.

All Receivers

- Consider use of **electric equipment alternatives** where practical and available such as with the Tower Crane.
- Provide **notification** to residential receivers for upcoming works that are likely to be noise intensive. This may include activities **> 75dB(A) or 20 dB above NMLs**.
- Consider the scheduling and duration of high-impact activities and providing respite periods:
  - Where practical and feasible, schedule noisier activities that cannot be shielded by acoustic curtains / hoarding to occur at less sensitive periods of the day for surrounding residences (i.e. not early morning or late afternoon).
  - 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.
- Implement a **complaints hotline** for residents and surrounding receivers.
- Include an allowance for **attended monitoring** (half day) at the **commencement of the first round of noise intensive works**, including Excavation / Earthworks and Substructure. This will be used to quantify predictions, inform improvements and updates to the management plan and determine if further or longer term monitoring is required.
- **Hoarding** can be installed at the construction site boundary. This is able to achieve **5-10 dB noise reduction** for receivers at the same level (this will have a reduced or no effect for elevated receivers or elevated works), particular for activities carried out at the boundary including piling and excavation.

Construction Traffic Noise

Construction-related 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.

Traffic routes for heavy vehicles accessing the site are not available at this stage of the Project. However, it is anticipated that a traffic management plan will be prepared and the following recommendations are to be considered:

- Once a contractor is appointed, a strategy shall be developed to accommodate worker parking where possible.
- Some construction parking is to be provided on site within the construction area. Depending on the staging of works, the staff car park may become available to construction workers at some point during the works
- Local roads surrounding the site have on-street parking capacity which may also be utilised by workers. Workers are encouraged to utilise paid parking to alleviate any additional demands on the existing on-street parking spaces. Be that as it may, travelling by private vehicle is discouraged, workers are strongly encouraged to utilise alternatives such as public transport or active travel modes.
- Given the site's proximity to a range of high frequency public transport services, workers will be encouraged to use public transport to access the site. Appropriate arrangements will be made for any equipment / tool storage and drop-off requirements.
- Further to the above, once the Contractor is engaged on this project, a detailed understanding of construction traffic vehicle generation plus noise feasible and reasonable mitigation strategies will be confirmed and included in the CNVMP.

Construction Vibration

Activities that have the potential to generate ground-borne vibration during the construction works include:

- Excavator hammer
- Vibratory roller
- Bored Piling

Table 11 High-Level Construction Vibration Assessment

Construction Activity	Vibration Impact	Likelihood
Excavator	Human Disturbance	Low Risk
	Building Damage	Low Risk
Vibratory Roller	Human Disturbance	Low Risk
	Building Damage	Low Risk
Bored Piling	Human Disturbance	Low Risk
	Building Damage	Low Risk

These impacts will need to be confirmed and quantified further as part of the CNVMP prepared by the engaged Contractor.

Actual vibration levels experienced will be dependent upon:

- Site and strata characteristics.
- Specific construction equipment and methodology used.
- Exact areas where works are carried out and proximity to buildings.

A detailed assessment will be carried out when a Contractor has been engaged and the above details are confirmed.

Project Vibration Mitigation Measures

Final details of the vibration management controls required for the works would be determined when the CNVMP is prepared by the Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the assessment indicates that vibration levels might exceed the relevant criteria, then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

The Contractor will be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

6.6 Cumulative Construction Noise and Vibration Impacts

The Contractor for the project will need to collaborate with proponents of other developments and construction works in the vicinity of the new school project (if identified) to minimise cumulative impacts of noise and vibration and be captured in the Construction Noise and Vibration Management Plan to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered. and managed against Noise Management Levels / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites (if identified) and respite periods.
- Coordination of traffic routes to minimise impact.
- Coordination of community consultation.

6.7 Noise and Vibration Monitoring

6.7.1 Noise monitoring

Mitigation measures should include an allowance for **attended monitoring** (half day) **at the commencement of the first round of noise intensive works (e.g demolition)**. This will be used to quantify predictions, inform improvements and updates to the management plan and determine if further or longer-term monitoring is required.

The Contractor is to consider implementing environmental noise monitoring at the locations described below as noise intensive activities start and / or increase on site:

- Residential receivers closest to the site works being undertaken.

6.7.2 Vibration monitoring

A vibration monitoring system is to be implemented if determined to be required as part of the CNVMP and pre-commencement vibration survey. 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 the precautionary criteria (as set out in Section 5.1.3) appropriate action is to be taken.

6.7.3 Reporting

Where noise and vibration monitoring occurs, the Contractor is to prepare a noise monitoring report for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during that period. Non-compliances should be addressed as per Section 6.7.5.

6.7.4 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.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the predicted noise level, then the equipment and its position shall be noted.
- 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 Project Manager is to provide a report on the incident to the relevant stakeholders.

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

6.7.5 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.

Where a non-compliance is identified, a detailed review should be carried out to re-examine work methodologies and implementation of reasonable and feasible mitigation measures.

7 Operational Noise Assessment

7.1 Summary

Operational noise from the activity can meet the relevant noise criteria provided the following noise mitigation measures are implemented as part of the final design (or alternative solutions to achieve the PNTLs for the project are provided.

Hall operation (school hours / out of hours)

- Windows and doors can be kept open if noise level within the hall is managed to stay below 80dB(A) when amplification / speakers are in use.

Building Services

- In duct attenuation will be allowed for equipment terminating at the façade.

Public Address Systems

- To manage potential noise spill to the surrounding receivers, the following is recommended for all public address systems:
  - Limit times to daytime only (7am to 6pm)
  - Good practice design including directional speakers, facing inwards to the school away from residents, and focusing on required coverage area
  - Noise levels set and limited to the lowest level whilst still being audible and intelligible requirements for the coverage areas as defined by the EFSG section DG64 (communications)

7.2 New Hall Operating Hours

The following table outlines the new school hall (including COLA) operation hours, as presented in Section 1.2.

Table 12 New Hall (including COLA) Operating Hours Summary

Time of the Day	Activities	Hours
School Hours	• Student assemblies[1] • Student performances[1] • Indoor sports. • Teaching activities.	Between 9:00am and 3:00pm Monday to Friday
Out of School Hours Care (OSHC)	OSHC activities (e.g. arts and craft, movies screening[1])	7:00 am to 9:00 am and 3:00 to 6:00 pm Monday to Friday
After hours use (school use only)	Such as presentations[1], parent teacher sessions	Up to 10:00 pm Only occasionally
Note: 1. Amplified sound may be in use (i.e. microphones and speakers - refer)		

7.3 Operational Noise Emissions Assessment

7.3.1 Noise sensitive receivers

Nearest sensitive receivers to the Project Site that will be potentially most-affected by operational noise from the proposal are as presented below. Table 13 outlines the most critical receivers surrounding the site for each type of impact.

Table 13 Operational noise sensitive receivers and approximate distance to project site

Receiver	Location	Typical Distance to Sensitive Receiver From proposed hall / COLA boundary
Residential West – 53 Eton St	West	35
Residential East – 16 Merton St	South-East	75
Classrooms – St Patricks Catholic Primary	East	90
Place of Worship – Sutherland Uniting Church	East	85
Commercial on Eton St (directly across the site)	West	35
Note: Operational noise prediction distances apply to the receiver boundary (as per INP)		

7.3.2 Hall

Summary of hall operational noise emissions assessment

As shown in sections above, noise emissions from within the proposed hall with assumed worst-case operations (including amplified speech and music) and internal noise levels within the hall up to 80dB(A) are anticipated to comply with daytime and evening time PNTL with all windows and doors open for natural ventilation. As such, no additional noise mitigation measures are required.

School Hours and OSHC Hours (7am to 6pm – Monday to Friday)

An assessment of noise from the new hall has assumed the following:

- Noise Source and levels
  - Noise from within new school hall internal areas is expected to be up to 80dB(A), which considers worst-case (i.e. noisiest) learning activities, presentations, and sports and music, including amplified speech and music at times.
  - The assessment considers speakers within the hall to be installed on either side of the stage facing east façade (i.e. towards panel doors and COLA).
- Windows and doors open (i.e. panel doors to the east and high-level louvres to north, east and south for natural ventilation)
- Most-affected noise sensitive receivers as per Table 13, noting that compliance achieved at these locations will ensure compliance is achieved at all other locations around the proposal.
- Time Period – noise emissions during the day period, which includes school hours and OSHC
- Distance, site topography and intervening structures screening attenuation.

Table 14 Predicted noise emission levels from new Hall usage during School Hours and OSHC Hours (7am to 6pm)

Receiver	Time Period	PNTL dB $L_{Aeq(15\ min)}$	Predicted Noise Level dB $L_{Aeq(15\ min)}$	Complies?
Residential West – Eton St	Day (7am – 6pm)	**54**	45	Yes
Residential East – Merton St		**48**	46	Yes
Classrooms – St Patricks Catholic Primary	When in use	**43 (external)**	43	Yes
Place of Worship – Sutherland Uniting Church		**48 (external)**	39	Yes
Commercial – Eton St		**63**	41	Yes

After School Hours Use (6pm – 10pm)

An assessment of noise from the new hall has assumed the following:

- Noise Source and levels
  - Noise from within new school hall internal areas is expected to be up to 80dB(A), which considers a typical after hours school activities, such as parent presentations, including amplified speech and music at times.
  - The assessment considers the speakers within the hall to be and installed on either side of the stage facing east façade (i.e. towards panel doors and COLA).
- Windows and doors open (i.e. panel doors to the east and high-level louvres to north, east and south for natural ventilation)
- Most-affected noise sensitive receivers as per Table 13, noting that compliance achieved at these locations will ensure compliance is achieved at all other locations around the proposal.
- Time Period – noise emissions during the evening period up to 10pm.
- Distance, site topography and intervening structures screening attenuation.

Table 15 Predicted noise emission levels from new Hall usage during School Hours and OSHC Hours (7am to 6pm)

Receiver	Time Period	PNTL dB $L_{Aeq(15\ min)}$	Predicted Noise Level dB $L_{Aeq(15\ min)}$	Complies?
Residential West – Eton St	Day (7am – 6pm)	**48**	45	Yes
Residential East – Merton St		**46**	46	Yes
Place of Worship – Sutherland Uniting Church		**48 (external)**	39	Yes
Commercial – Eton St		**63**	41	Yes

7.3.3 COLA

School Hours and OSHC Hours (7am to 6pm – Monday to Friday)

An assessment of noise from the new hall has assumed the following:

- Noise Source and levels
  - Noise from COLA external areas expected to be up to 65dB(A), which considers worst-case (i.e. noisiest) learning activities, excluding amplified speech or music (e.g. teacher / OSHC carer projecting natural voice to a small group of students).
  - The assessment considers the speakers within the COLA area will not be in use for typical operations, are only in place for PA announcements and will face toward inner areas of the COLA (Refer to Section 7.3.4).
- Most-affected noise sensitive receivers as per Table 13, noting that compliance achieved at these locations will ensure compliance is achieved at all other locations around the proposal.
- Time Period – noise emissions during the day period, which includes school hours and OSHC
- Distance, site topography and intervening structures screening attenuation.

Table 16 Predicted noise emission levels from new Hall usage during School Hours and OSHC Hours (7am to 6pm)

Receiver	Time Period	PNTL dB $L_{Aeq(15\ min)}$	Predicted Noise Level dB $L_{Aeq(15\ min)}$	Complies?
Residential West – Eton St	Day (7am – 6pm)	**54**	< 30	Yes
Residential East – Merton St		**48**	38	Yes
Classrooms – St Patricks Catholic Primary	When in use	**43 (external)**	37	Yes
Place of Worship – Sutherland Uniting Church		**48 (external)**	< 30	Yes
Commercial – Eton St		**63**	< 30	Yes

As shown in sections above, noise emissions from the COLA area with assumed worst-case operations (excluding amplified speech or music) are anticipated to comply with daytime PNTL at all sensitive receivers. As such, no additional noise mitigation measures are required.

7.3.4 Public Address (PA) Systems

There is a potential for noise levels from public address system, if installed in the COLA area, to affect the residential receivers.

To manage potential noise spill to the surrounding receivers, we the following is recommended for all public address systems:

- Limit times to daytime only (7am to 6pm).
- Good practice design including directional speakers, facing inwards to the school away from residents, and focussing on required coverage area.
- Noise levels set and limited to the lowest level whilst still being audible and intelligible requirements for the coverage areas as defined by the EFSG section DG64 (communications).

7.3.5 Building Services

General

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

Key acoustic treatment is likely to include:

- **In duct attenuation** will be incorporated for equipment terminating at the façade.

At this stage, final plant selections have not been made; therefore, a preliminary assessment has been carried out with preliminary plant selections.

During the Detailed Design phase, acoustic detailed design advice will provide to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries as presented in in Section 5.2.

General design considerations and controls that may need to be implemented typically include, but are not limited to:

- Strategic selection and location of plant to ensure the cumulative noise contribution at the receiver boundary is achieved, and/or
- Noise control measures to be put in place to minimise noise impacts such as:
  - Noise enclosures or barriers/screening as required.
  - Acoustic louvres as required.
  - In-duct attenuation.
  - Sound absorptive panels.

Project Specific

Figure 6 shows the layout for the proposed Hall. The following outlines allowances that have been included based on the current proposals.

Actual treatments may change (and still achieve the relevant noise emissions targets) depending on final locations, orientation and equipment selections. The preliminary assessment has accounted for:

- Condenser units and fans and associated ductwork as per Steensen Varming mechanical layouts and schedules.
- The nearest potentially most-affected receiver to the proposed mechanical plant is:
  - Residential receivers in the apartment building currently under construction to the west of the site (53 Eton St).
- The most restrictive criterion for the plant operating is as per below:
  - Day (7am to 6pm) – 54 dB(A)
  - Evening (6pm to 10pm) - 48 dB(A)
  - Night (10pm to 7am) - 40 dB(A)
    Note: Criteria above corresponds to Eton St residences, which are closer to the proposed plant locations. Achieving the criterion above will ensure compliance with the relevant criteria at all other receivers.
- Plant operation hours
  - All plant unless noted below will generally be restricted to operate during normal day time hours only (7am to 6pm) unless otherwise stated below.
  - After hours use of the school facilities may require plant to be operational during the evening period (6pm-10pm).
  - Comms room – one condenser will supply communications rooms and operate 24 hours per day.

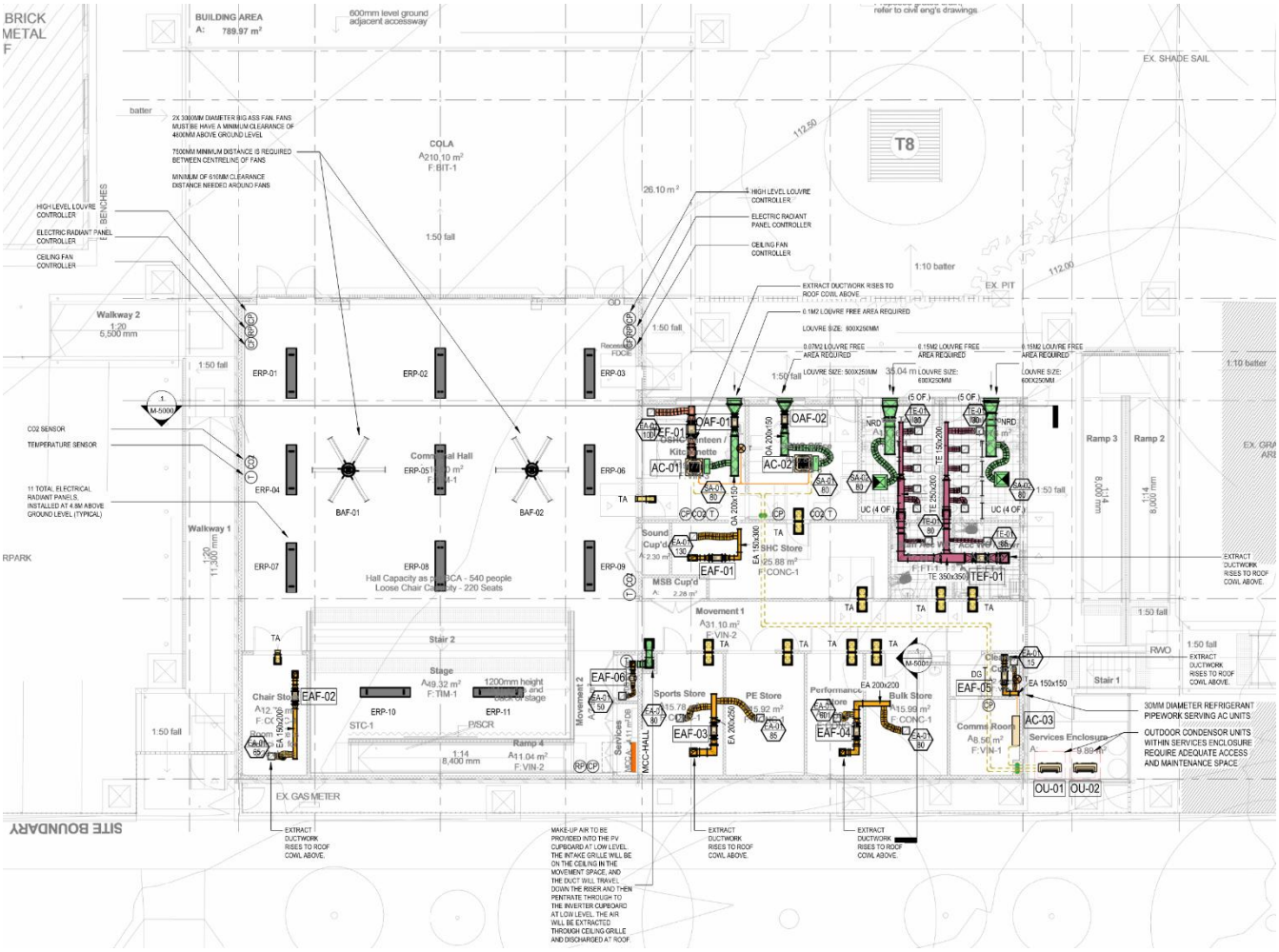


Figure 6 Schematic Design (SD) mechanical layout for the proposed Hall (Source: Steensen Varming)

7.3.6 Sleep disturbance

The hall is not expected to operate past 10pm and the only items of plant to be operative 24/7 is the condenser unit catering for the comms room. Hence, sleep disturbance is not an issue for the proposal and it is not assessed herein.

7.4 Cumulative Operational Noise Impact

On-site

The amenity noise has been established in accordance with the NPI. The standard approach of deriving the project amenity considers a noise sensitive receiver being impacted by the cumulative noise emissions of no more than three to four individual industrial noise sources.

This approach applies to this project and is appropriate when considering adjacent developments contributing to noise emissions.

Therefore, achieving the PNTLs for the new school will ensure that cumulative noise impact (in conjunction with other sites) is appropriately controlled (assuming that all other sites have been designed in accordance with the requirements of the NPI).

8 External Noise Intrusion

8.1 Summary

Road Traffic noise is the main external noise sources with potential to impact on the development.

An assessment of Rail noise is not required for this project.

An assessment of Aircraft noise is not required for this project.

No additional acoustic treatment to the façade is required in order to control external noise intrusion and achieve the relevant internal noise levels for the school.

The impact from traffic noise has been considered for active and passive outdoor play areas. Strategic location and orientation of buildings provide shielding from surrounding roads to ensure appropriate noise levels are achieved in these areas.

8.2 External Noise Sources – Noise Intrusion to Internal Areas

8.2.1 Road Traffic

Road Traffic noise is identified as the main noise sources with potential to impact on the site. Measured noise levels at the school boundary are shown in Table 17.

Table 17 Traffic Noise Levels at School Boundary

Receiver Type	Measured Noise Level Day (7am to 10pm) L_{Aeq} (15hr)
Proposed Hall – Eton Street Boundary	61 LAeq(15hr) dB(A)

An assessment has been conducted of existing traffic noise impacts on the proposal and the following is concluded:

- Target internal noise levels in proposed hall occupied spaces, 40dB(A)as per Table 7, are able to be achieved with windows and doors open or closed considering the following minimum façade performances in the proposed design without any additional acoustic treatment:
  - Glazing / Louvres- Rw 32
  - External Walls - Rw 40-45.
  - Roof - Rw 20-25.
- Target external noise levels in proposed COLA, 50dB(A)as per Table 7, are able to be achieved with the current site layout, as the COLA is well shielded from traffic noise in Eton St via the proposed hall building intervening structure.

Based on the above predicted traffic noise levels, internal (Hall) and external (COLA) traffic noise criteria in Table 7 will be achieved with windows and doors open and closed with standard façade and window construction as currently included in the design. Therefore, no additional acoustic treatment is required to the building envelope.

8.2.2 Rail Noise

The nearest rail line is more than 150m from the site. Therefore, no noise controls are required for rail noise and will not need to be considered further in the design.

9 Mitigation Measures

A NVIA has been carried out to determine the potential noise impact and considerations for the proposed SPS new hall.

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 mitigation measures recommendations within this NVIA report are as follows:

9.1 Construction Noise and Vibration

Construction Noise

The assessment has determined that construction stage impacts are a medium risk that requires management and planning to minimise noise impact.

A Construction Noise and Vibration Management Plan (CNVMP) shall be prepared by the contractor. 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.

Where reasonable and feasible, the control measures listed below will be implemented:

- **Avoid** the use of **reversing beeping alarms** or provide for alternative systems, such as broadband reversing alarms, particularly during any early morning period.
- **Construct barriers and hoardings** around smaller specific areas and / or loud or noisy plant where reasonable and feasible which can provide 5-10 dB reduction depending on the situation. Noting that in some instances (larger excavation equipment) barriers will have limited or reduced benefit.
- **Schedule work (particularly noisy activities)** during the least sensitive times of the day (not early morning or late afternoon).
- **Designate, design and maintain access routes** to the site to minimise noise impacts, with coordination between other construction sites to minimise cumulative construction traffic noise impact.
- **Communication** - Inform affected residential and educational receivers about the timing and duration of planned works (i.e. letter drops).
- **Complaints management** shall be addressed as noted in Section 6.7.4
- Implementation of **all reasonable and feasible mitigation** measures for all works will ensure that any adverse noise impacts to surrounding residential and educational receivers are minimised when NMLs cannot be met due to safety or space constraints.

Construction Vibration

Final details of the vibration management controls required for the works would be determined when the CNVMP is prepared by the Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the assessment indicates that vibration levels might exceed the relevant criteria, then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

The Contractor will be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

Cumulative Impacts

The Contractor for the project will need to collaborate with proponents of other developments and construction works in the vicinity of the new school project (if identified) to minimise cumulative impacts of noise and vibration and be captured in the Construction Noise and Vibration Management Plan to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered. and managed against Noise Management Levels / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites (if identified) and respite periods.
- Coordination of traffic routes to minimise impact.
- Coordination of community consultation.

Construction Traffic Noise

Whilst construction traffic noise is predicted to achieve the relevant criteria, the following will be implemented as best practice:

- Access routes should be limited to main roads or the most direct route on local residential streets. Cumulative impact will also need to be considered and may include splitting traffic across multiple routes to limit extended periods of traffic noise impact.
- 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.

9.2 Operational Noise

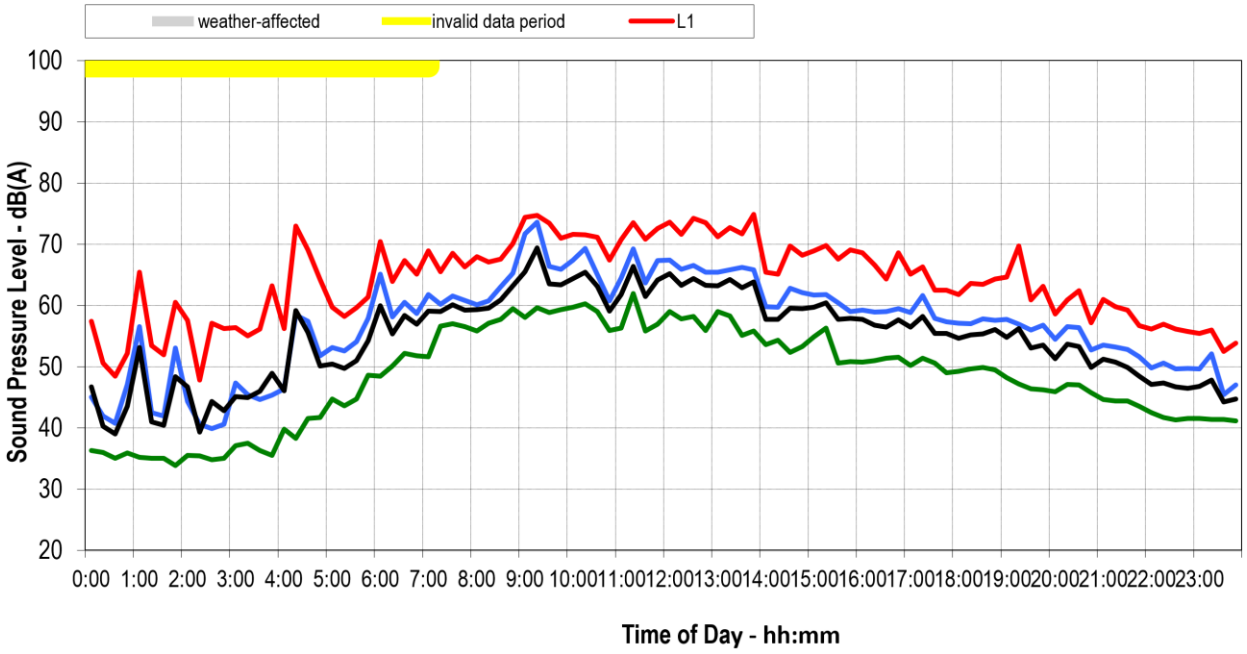
Operational noise from the activity is capable of meeting the relevant noise criteria set out in this NVIA, provided current SD design proposals for the project are implemented as part of the final design (or alternative solutions to achieve the (PNTLs) for the project are provided).

A summary of the findings and recommendations are provided below:

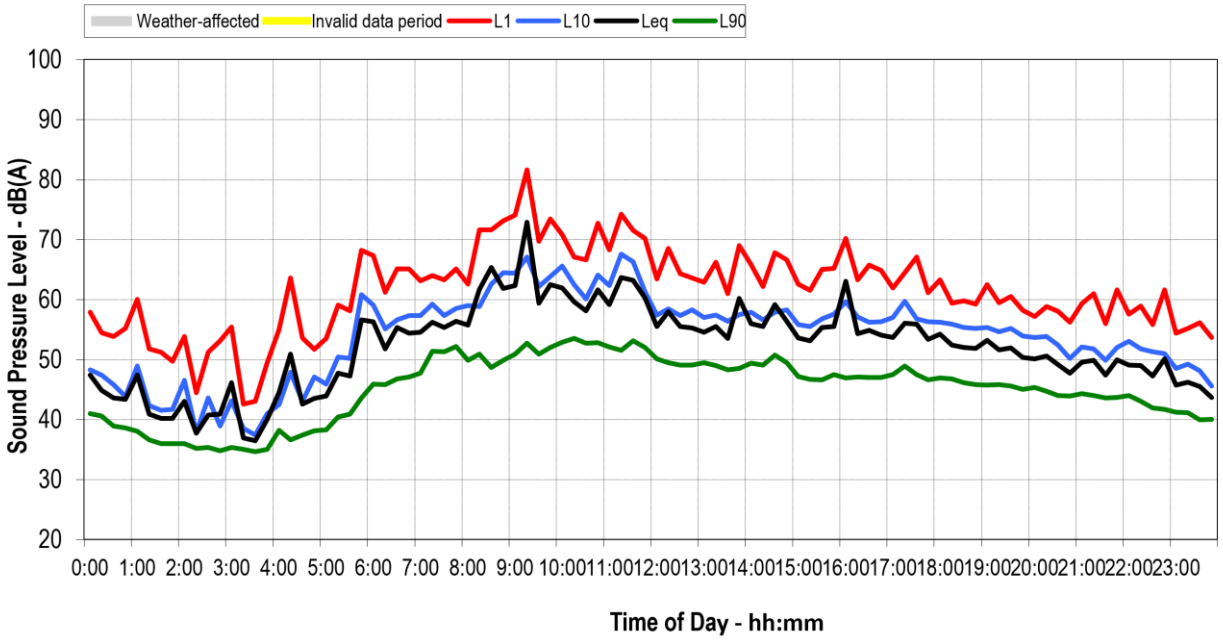
- **Hall operations, including COLA** no additional noise mitigation required (if internal noise levels in Hall are below 80dB(A) including amplified music/speech).
- **Building Services**
  - In-duct attenuation will be allowed for equipment terminating at the façade (already included in the SD design).
- **Public Address Systems** should be limited to 7am to 6pm and incorporate good practice design and set at the lowest level practical whilst still achieving intelligibility requirements.

Appendix A Noise Logger Data

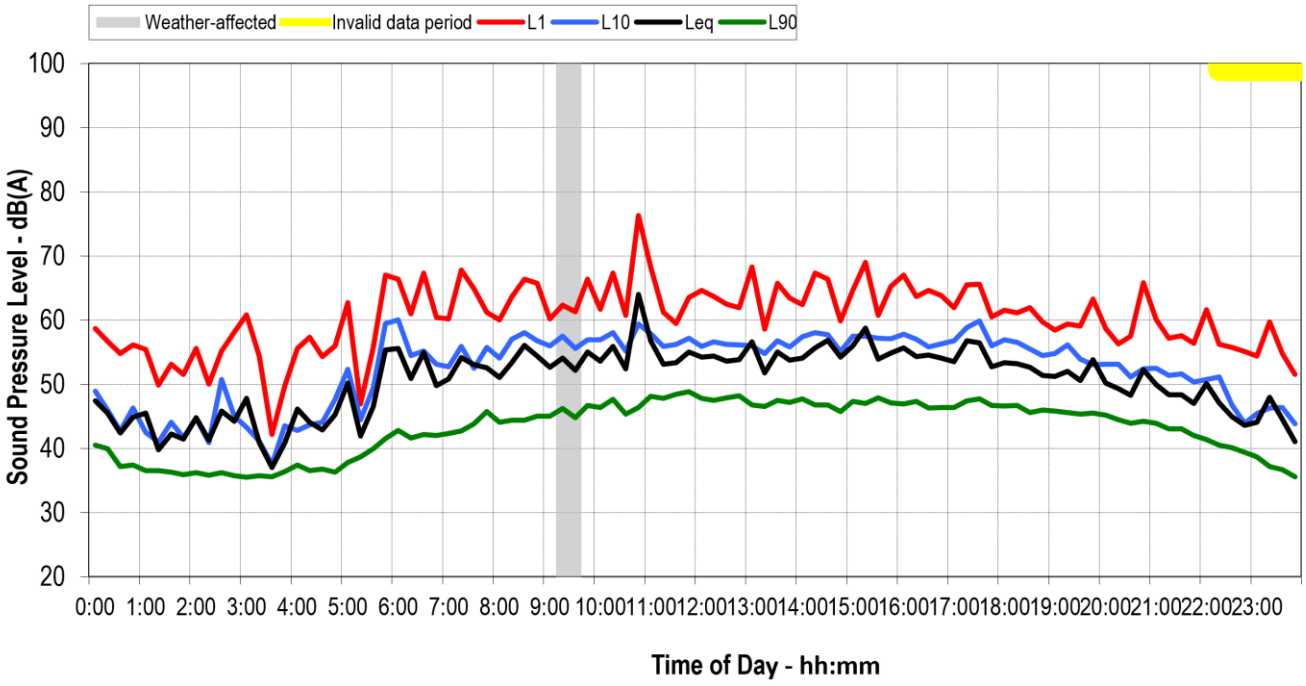
Logger 1 - Eton St, Sutherland PS Hall - Friday 09 August 2024



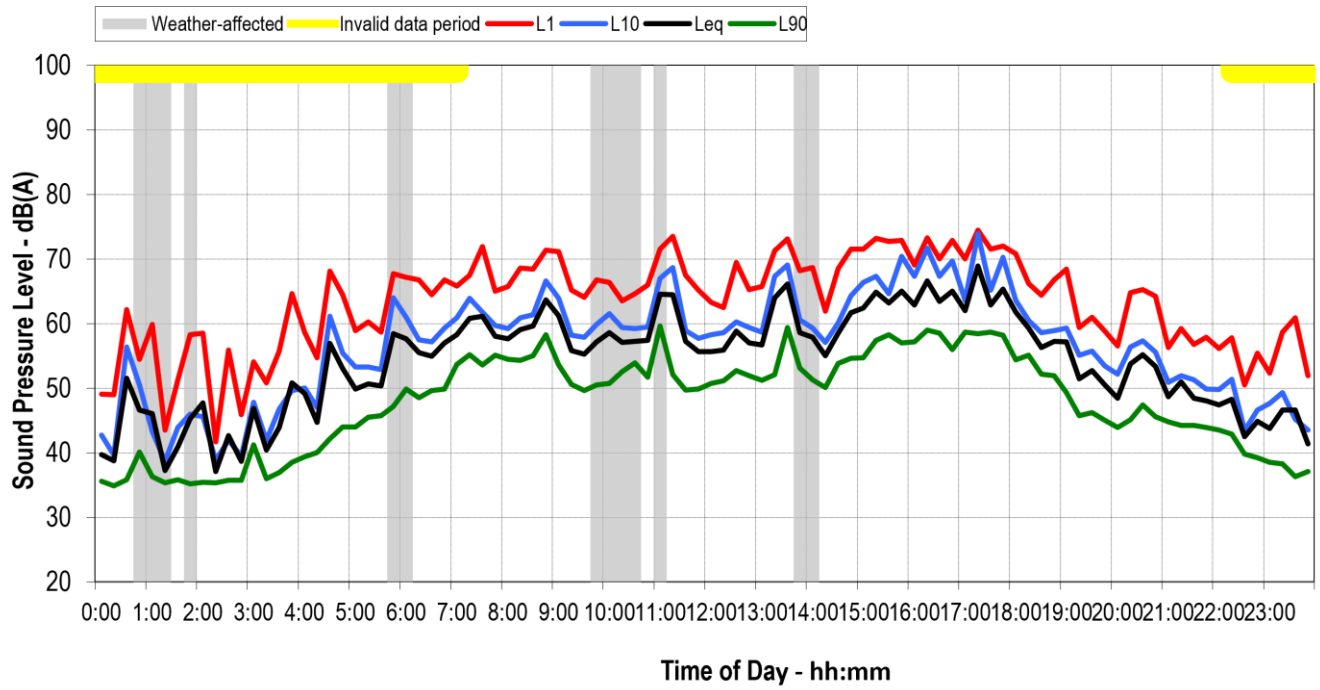
Logger 1 - Eton St, Sutherland PS Hall - Saturday 10 August 2024



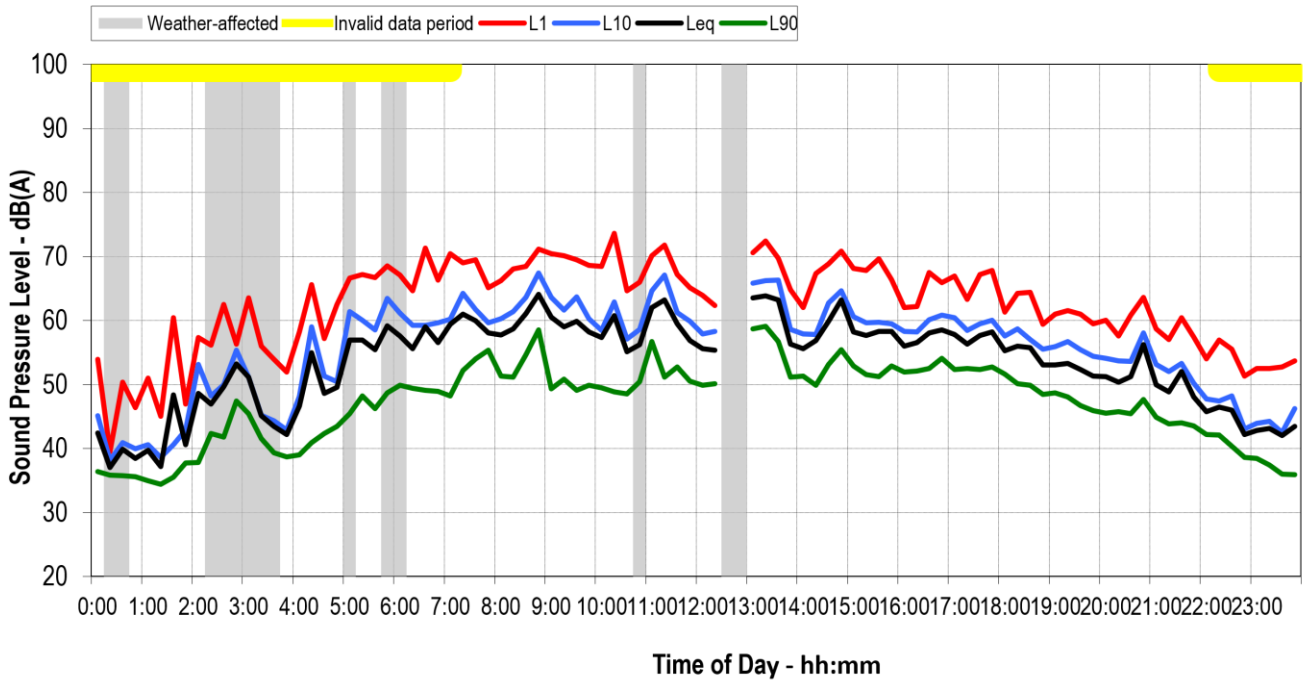
Logger 1 - Eton St, Sutherland PS Hall - Sunday 11 August 2024



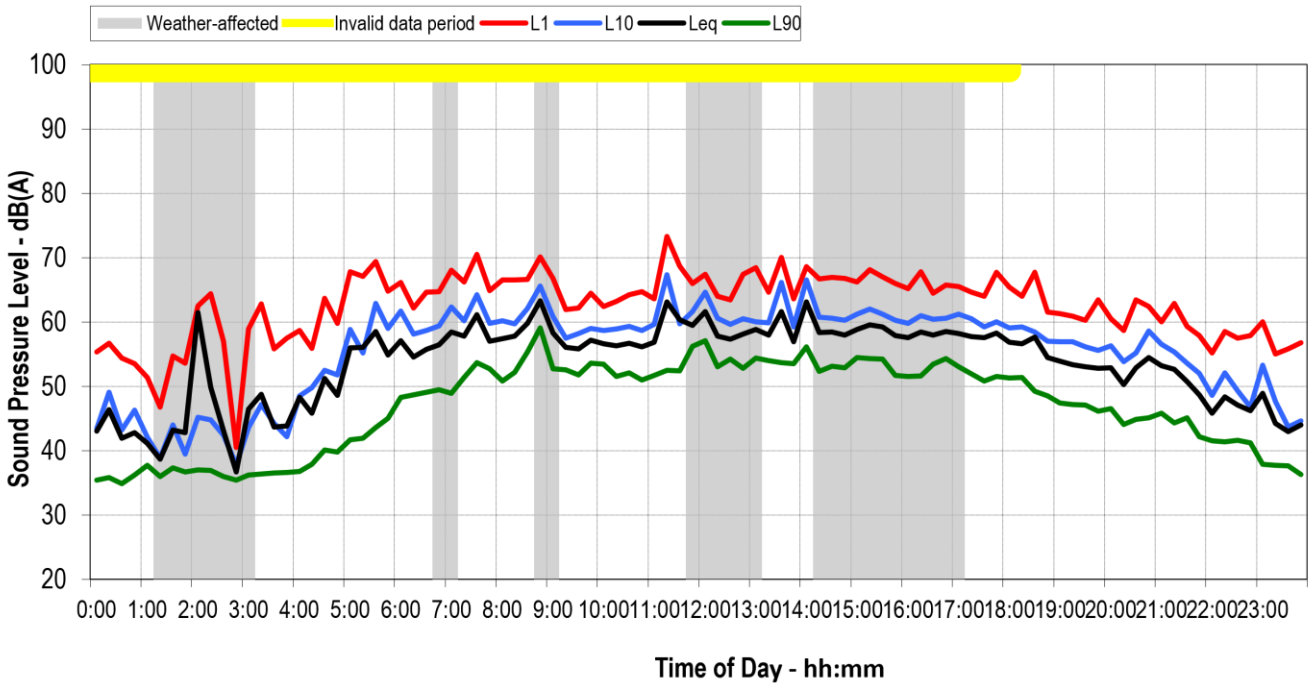
Logger 1 - Eton St, Sutherland PS Hall - Monday 12 August 2024



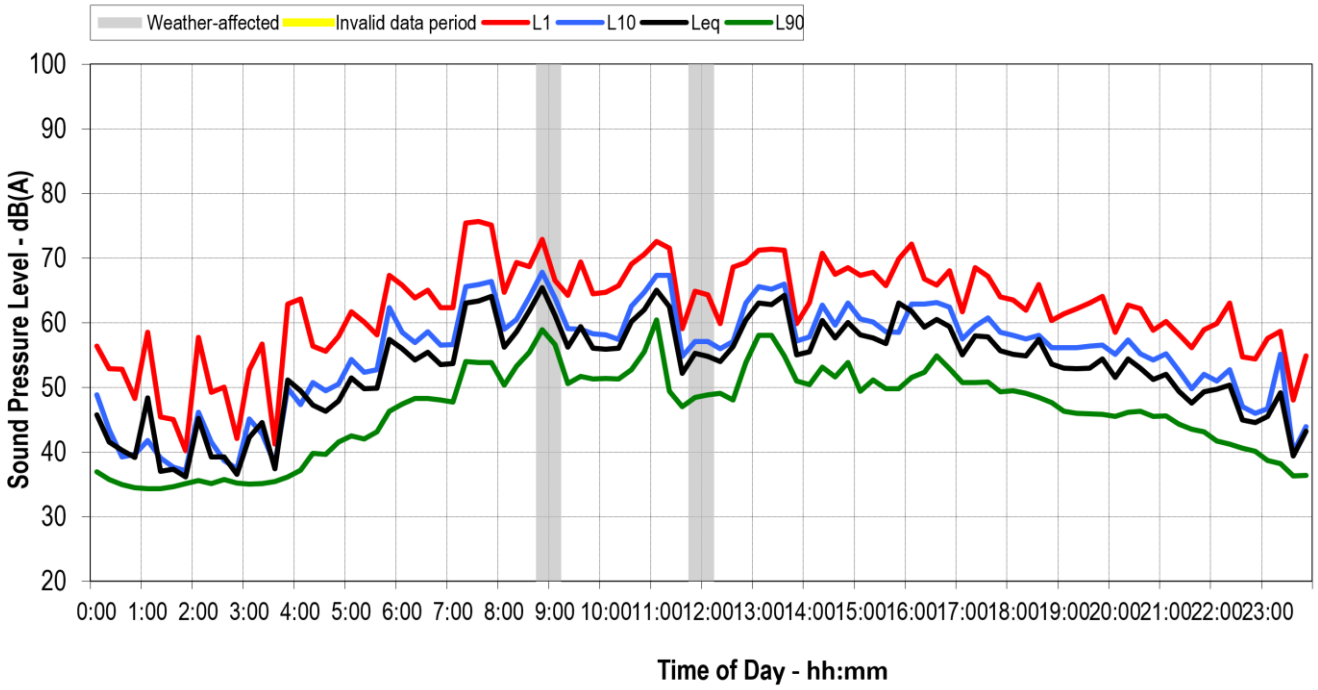
Logger 1 - Eton St, Sutherland PS Hall - Tuesday 13 August 2024



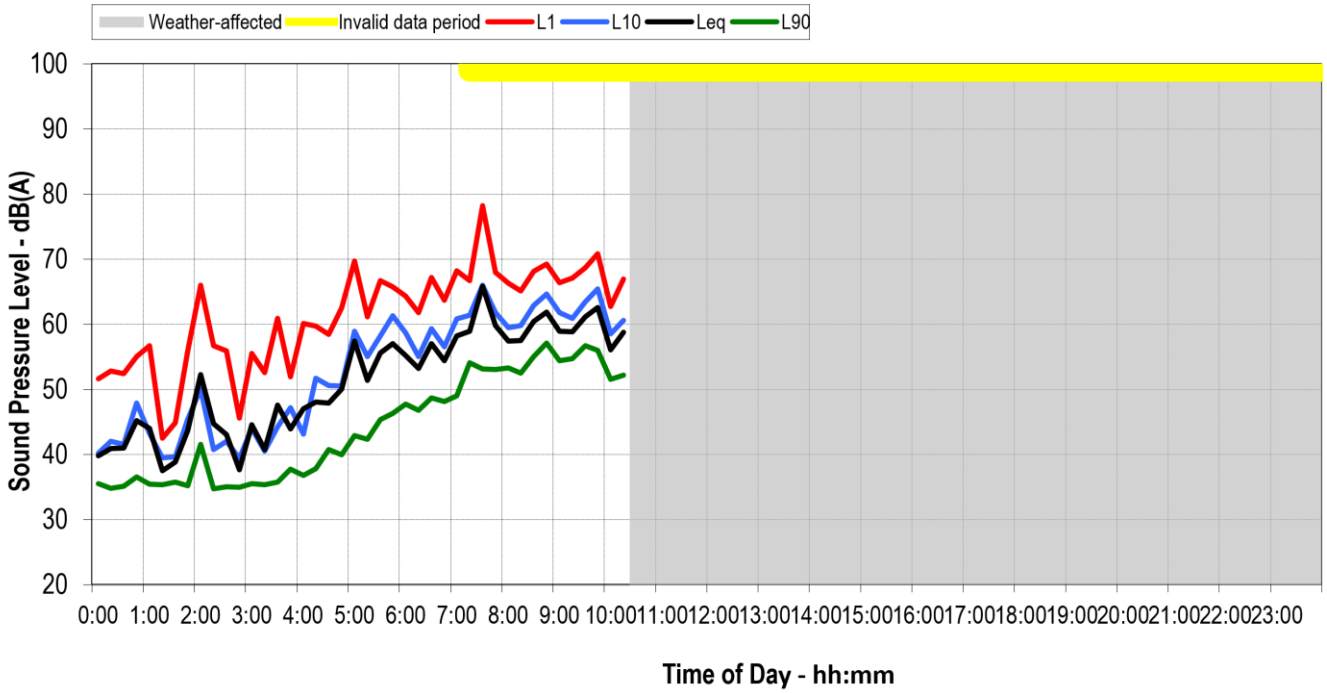
Logger 1 - Eton St, Sutherland PS Hall - Wednesday 14 August 2024



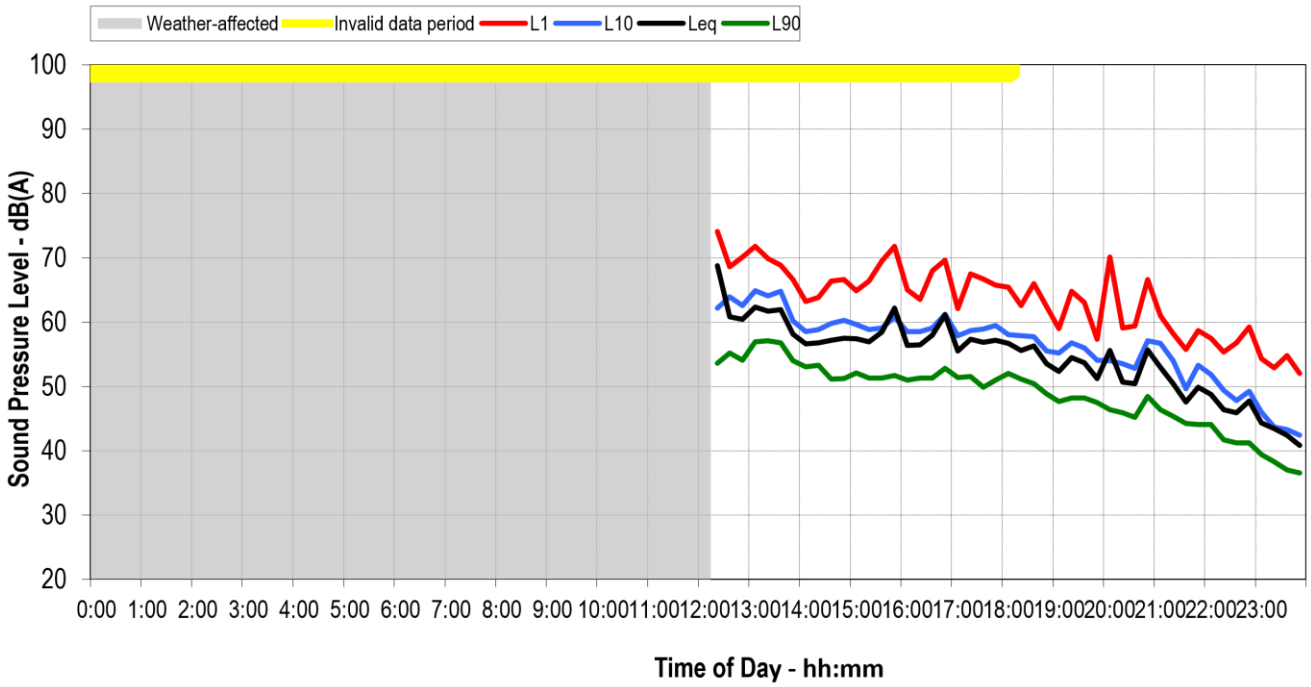
Logger 1 - Eton St, Sutherland PS Hall - Thursday 15 August 2024



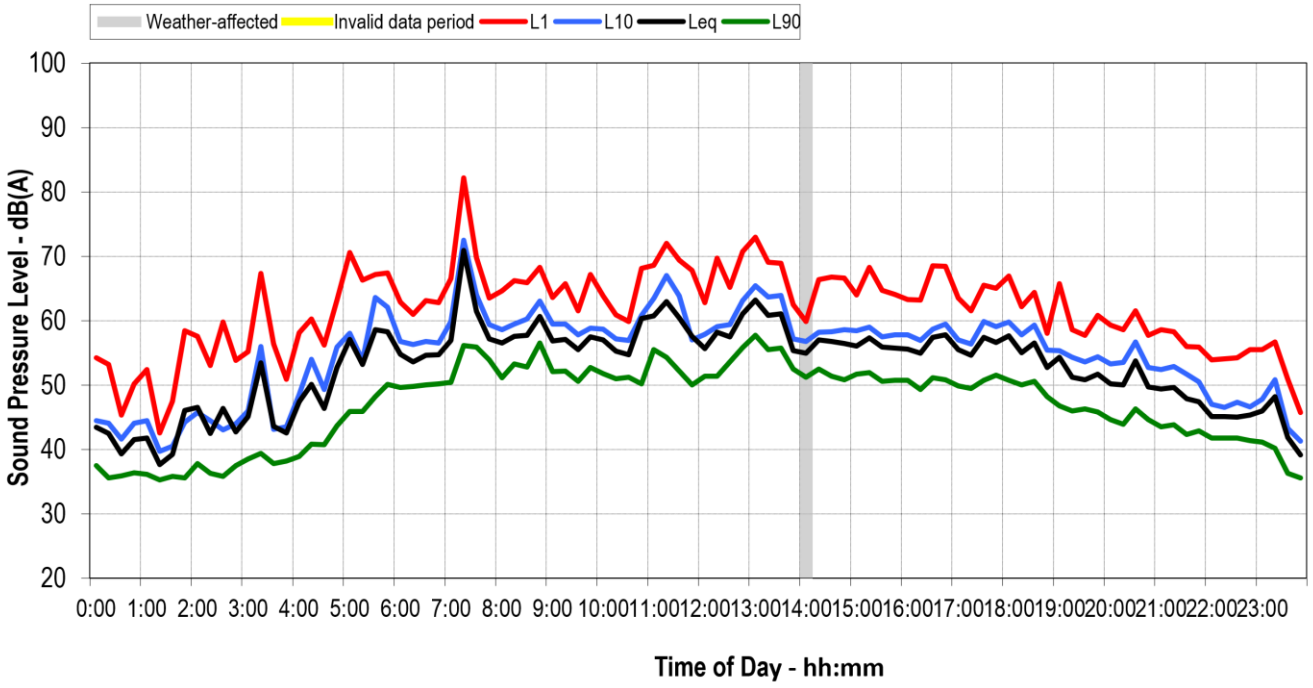
Logger 1 - Eton St, Sutherland PS Hall - Friday 16 August 2024



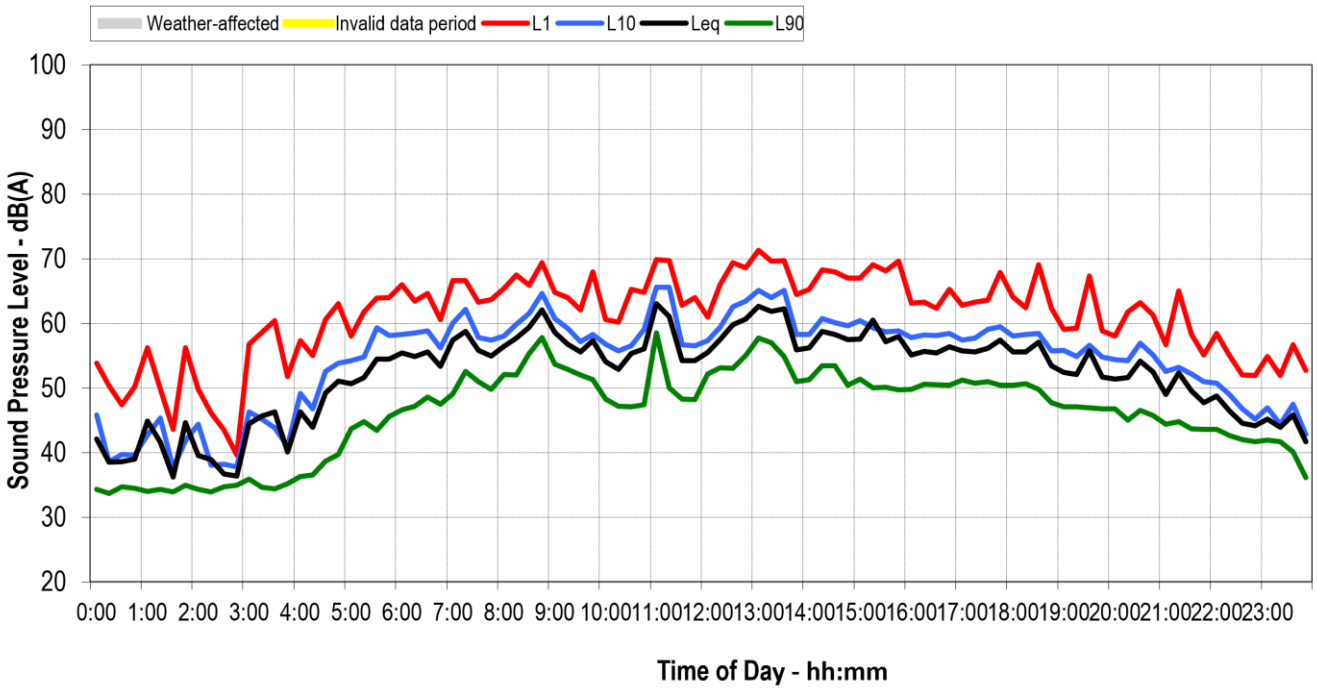
Logger 1 - Eton St, Sutherland PS Hall - Tuesday 20 August 2024



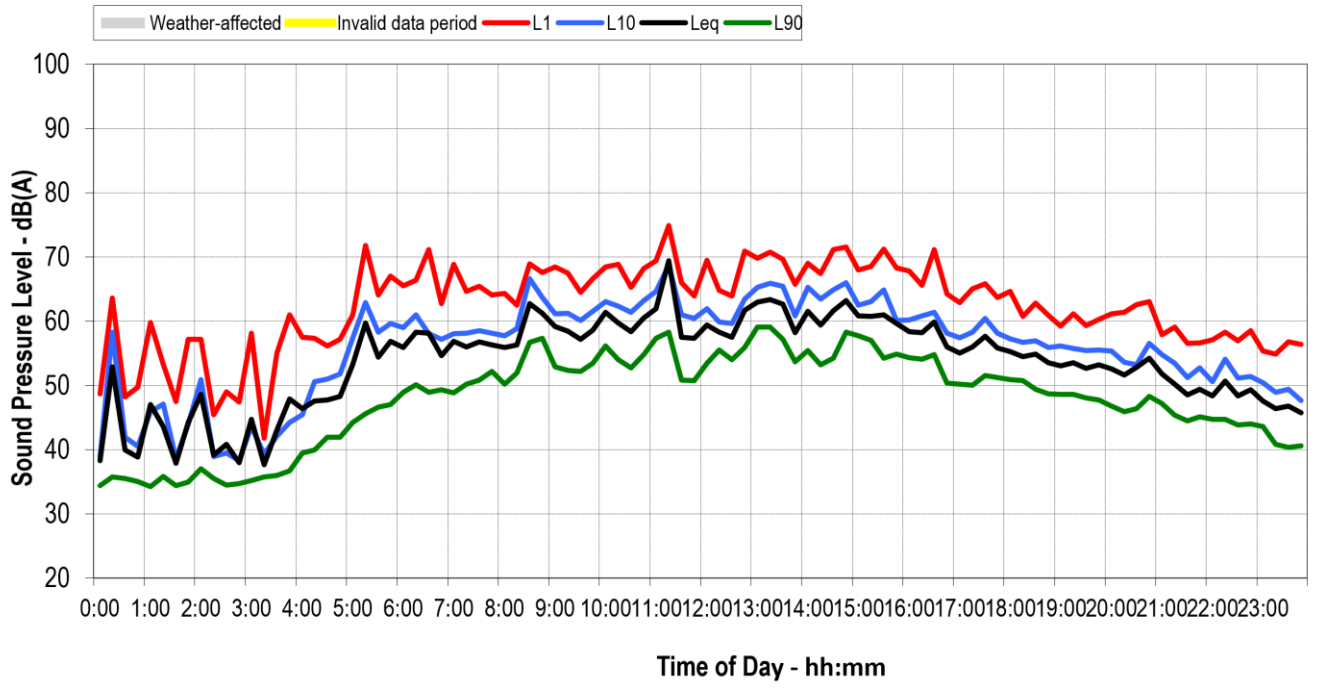
Logger 1 - Eton St, Sutherland PS Hall - Wednesday 21 August 2024



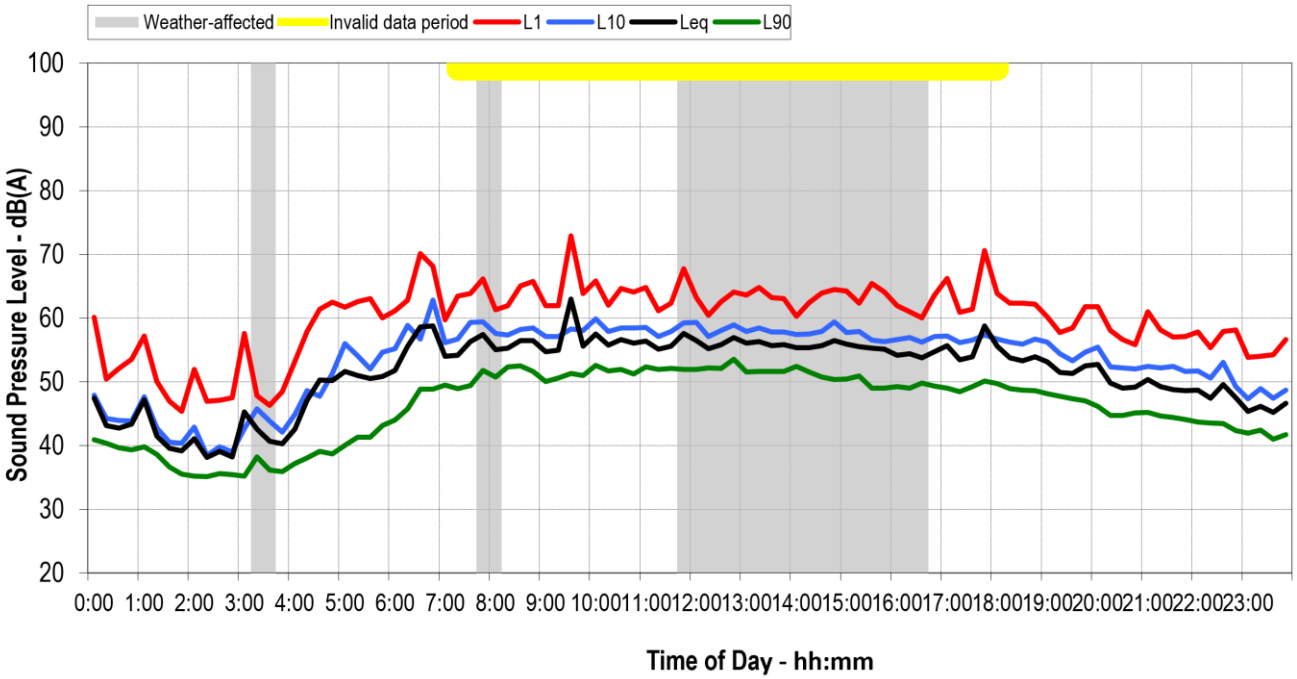
Logger 1 - Eton St, Sutherland PS Hall - Thursday 22 August 2024



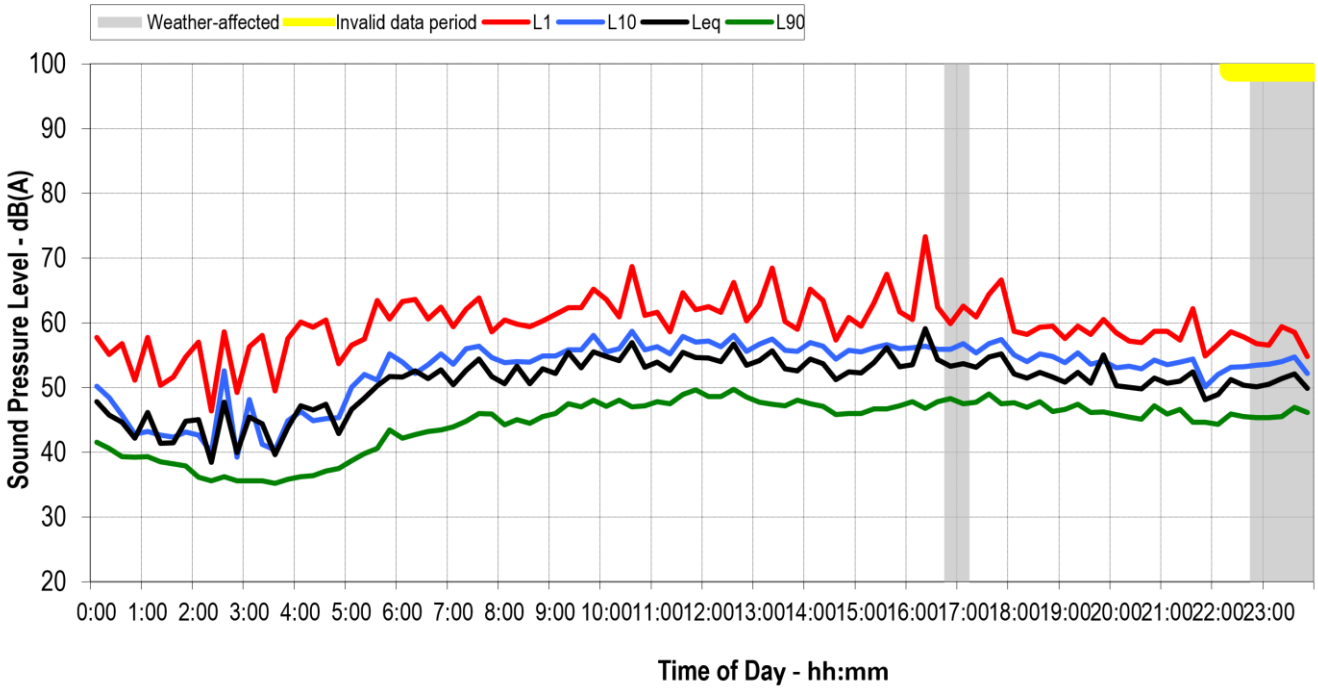
Logger 1 - Eton St, Sutherland PS Hall - Friday 23 August 2024



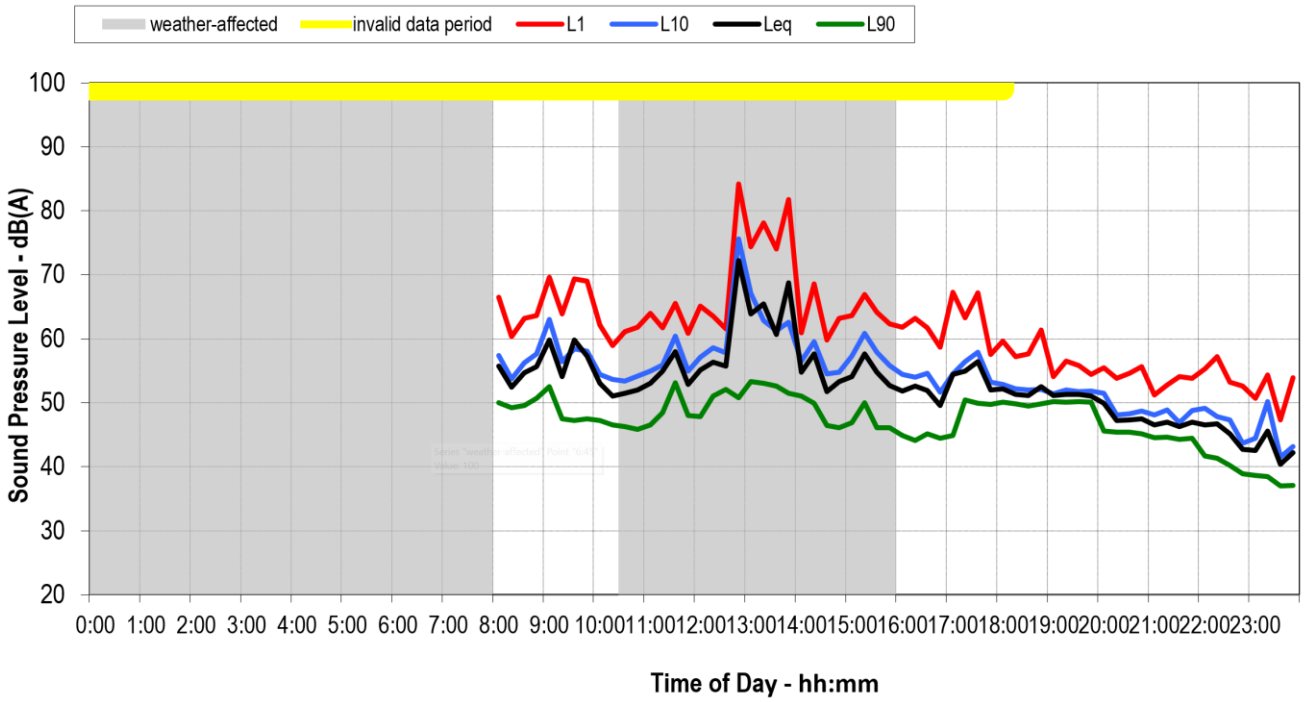
Logger 1 - Eton St, Sutherland PS Hall - Saturday 24 August 2024



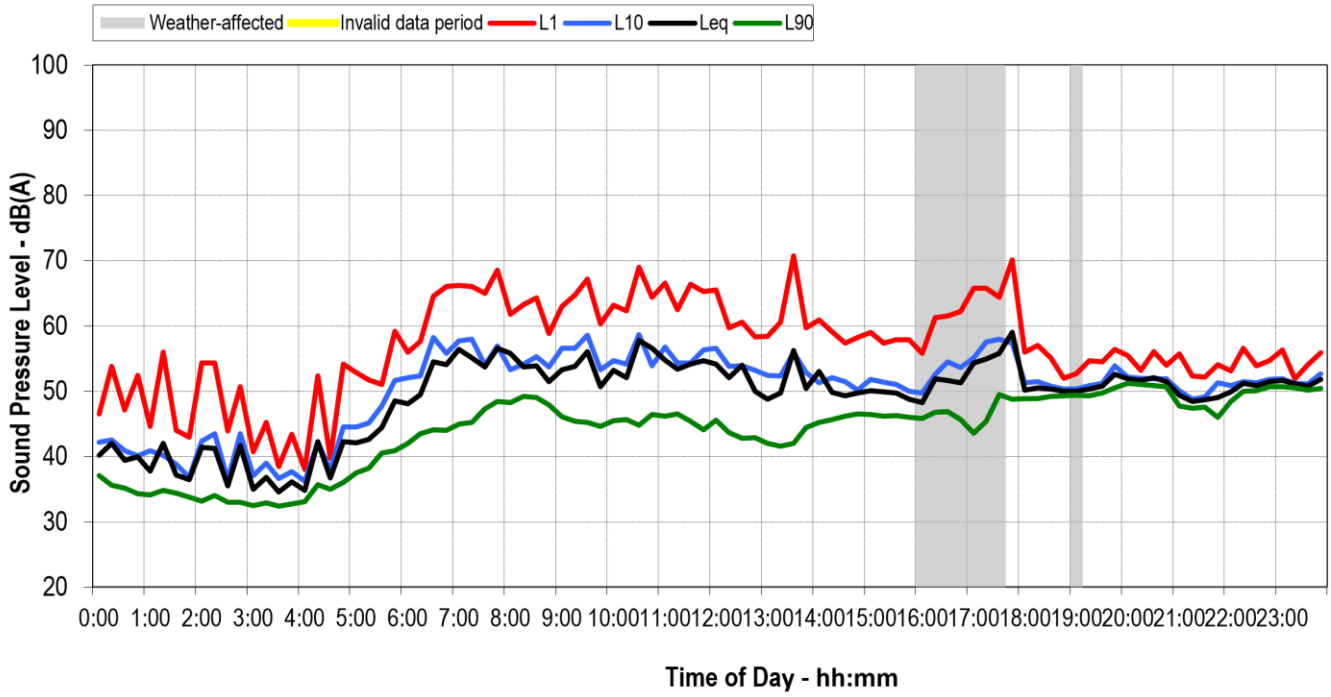
Logger 1 - Eton St, Sutherland PS Hall - Sunday 25 August 2024



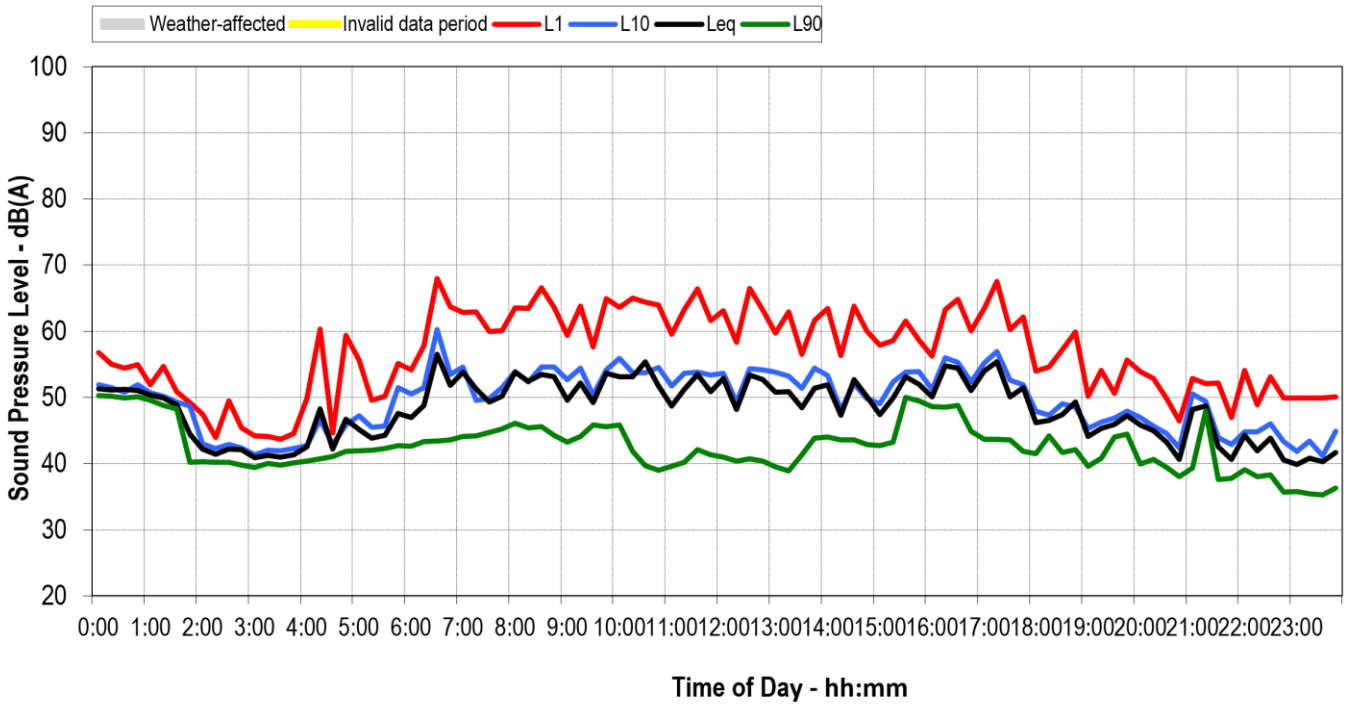
Logger 2 Merton St, Sutherland PS Hall - Friday 02 August 2024



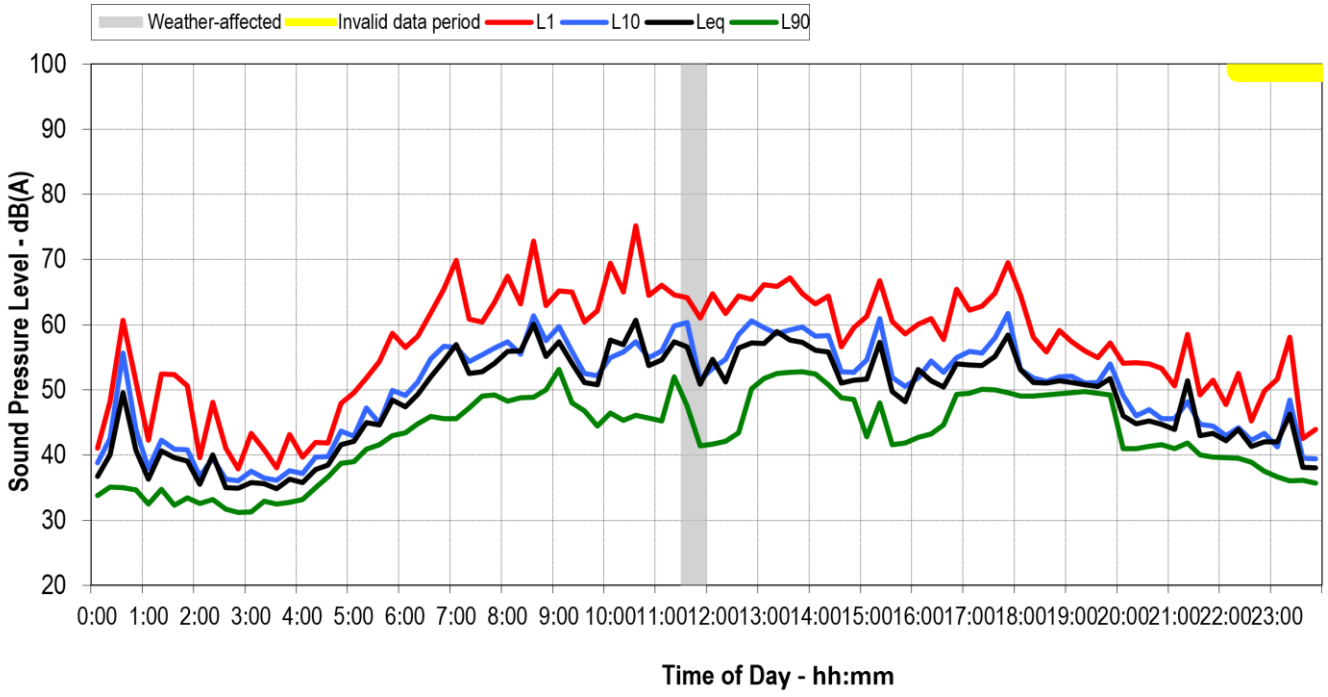
Logger 2 Merton St, Sutherland PS Hall - Saturday 03 August 2024



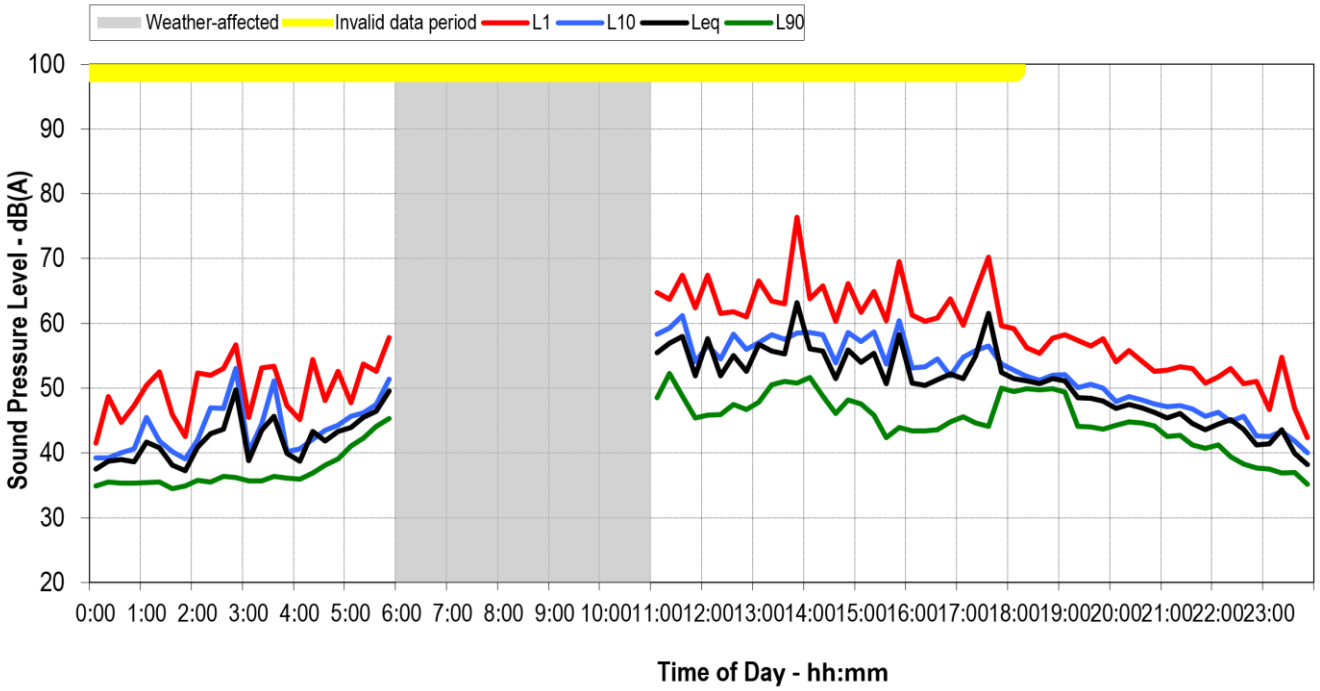
Logger 2 Merton St, Sutherland PS Hall - Sunday 04 August 2024



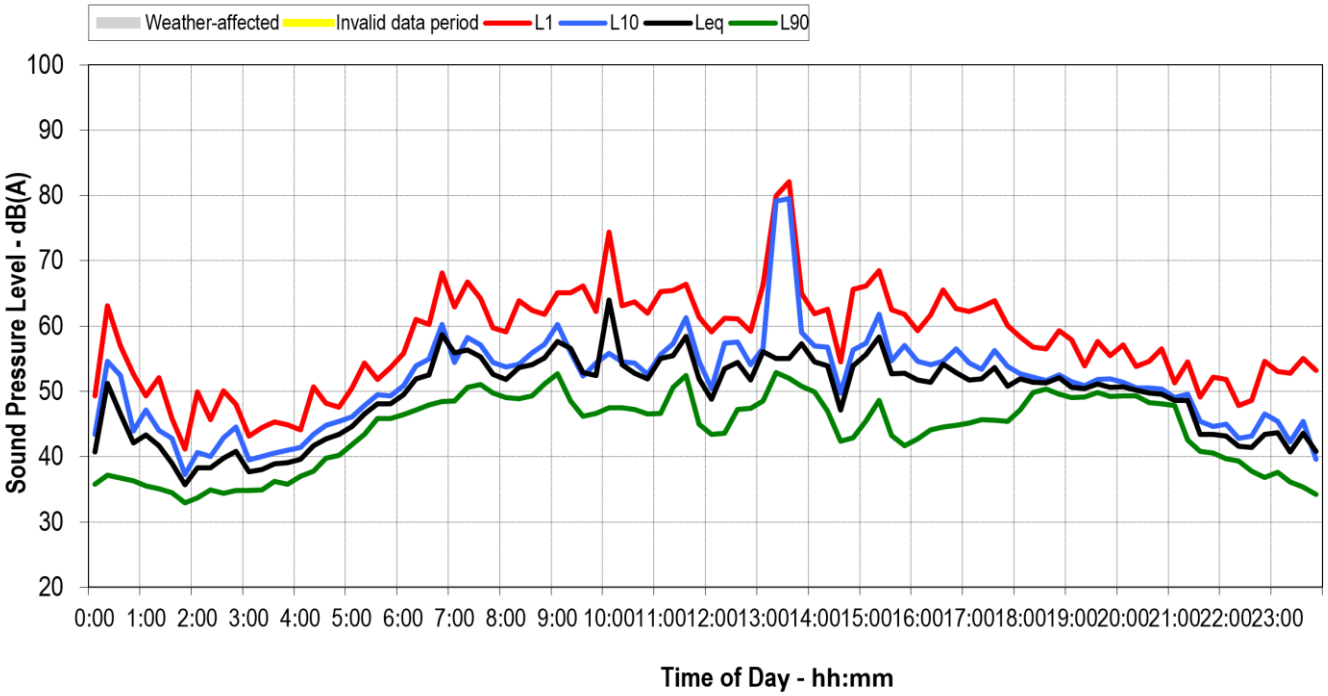
Logger 2 Merton St, Sutherland PS Hall - Monday 05 August 2024



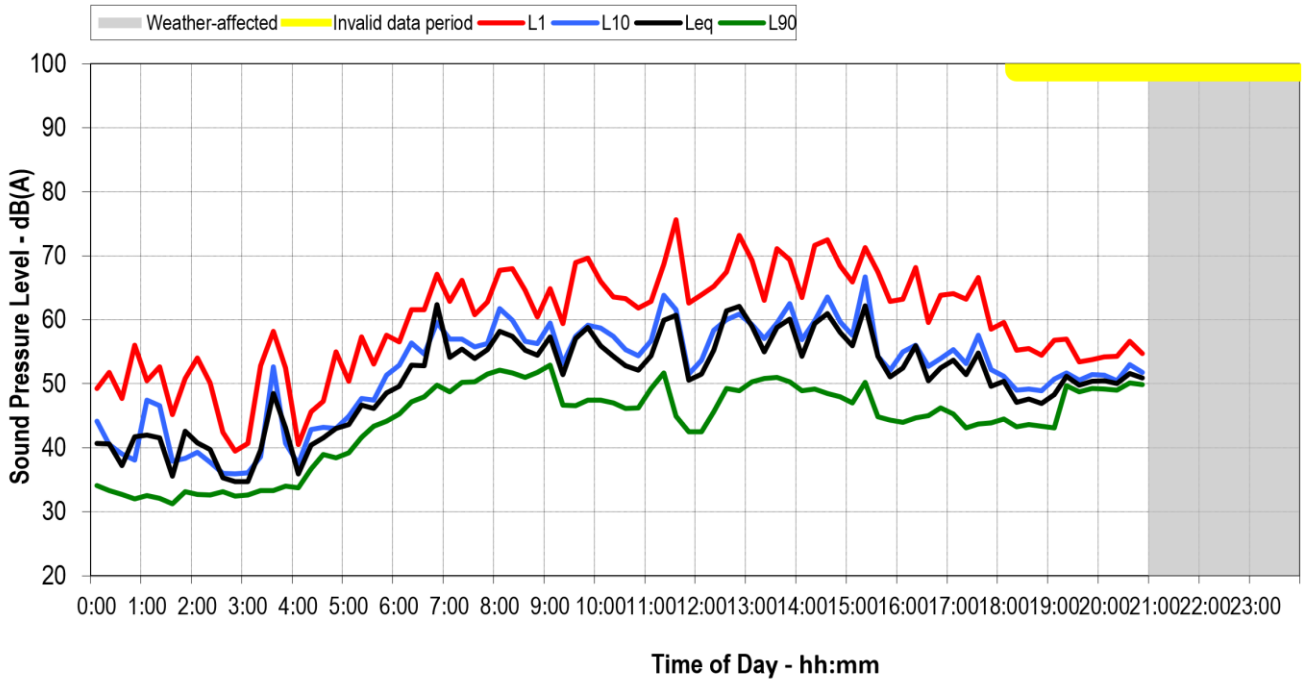
Logger 2 Merton St, Sutherland PS Hall - Tuesday 06 August 2024



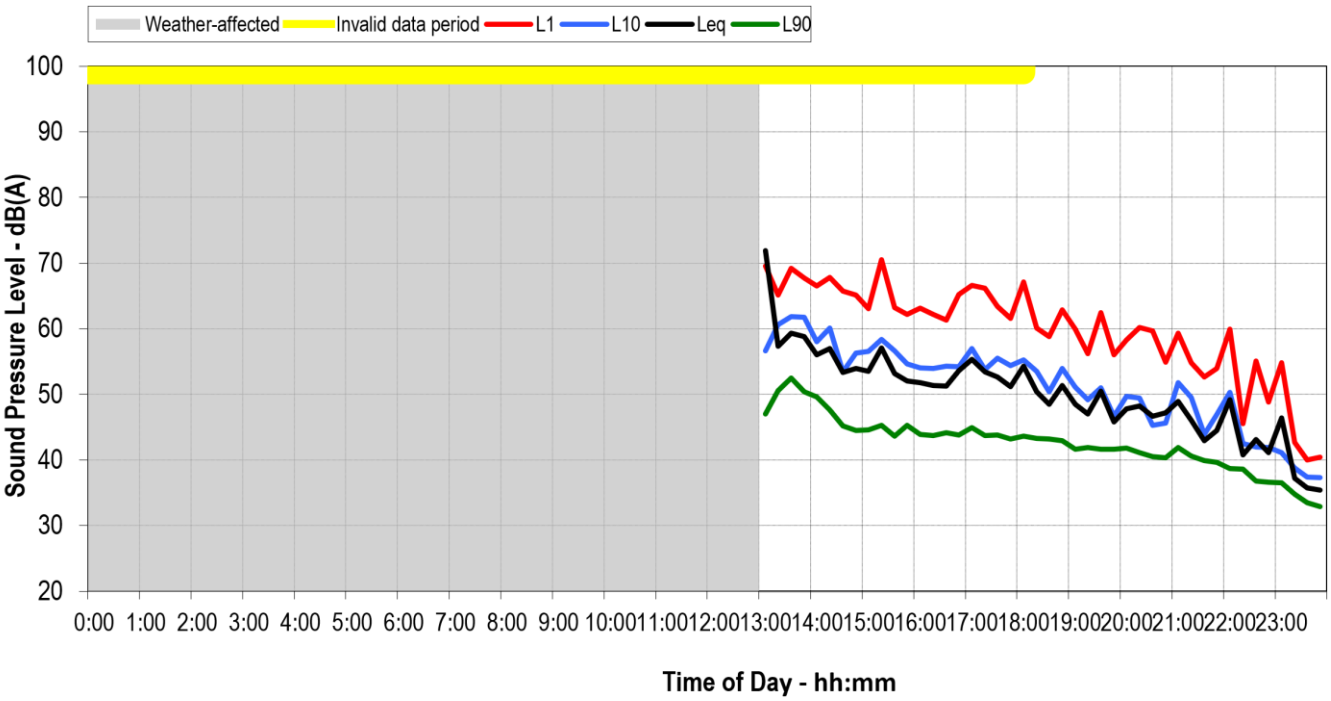
Logger 2 Merton St, Sutherland PS Hall - Wednesday 07 August 2024



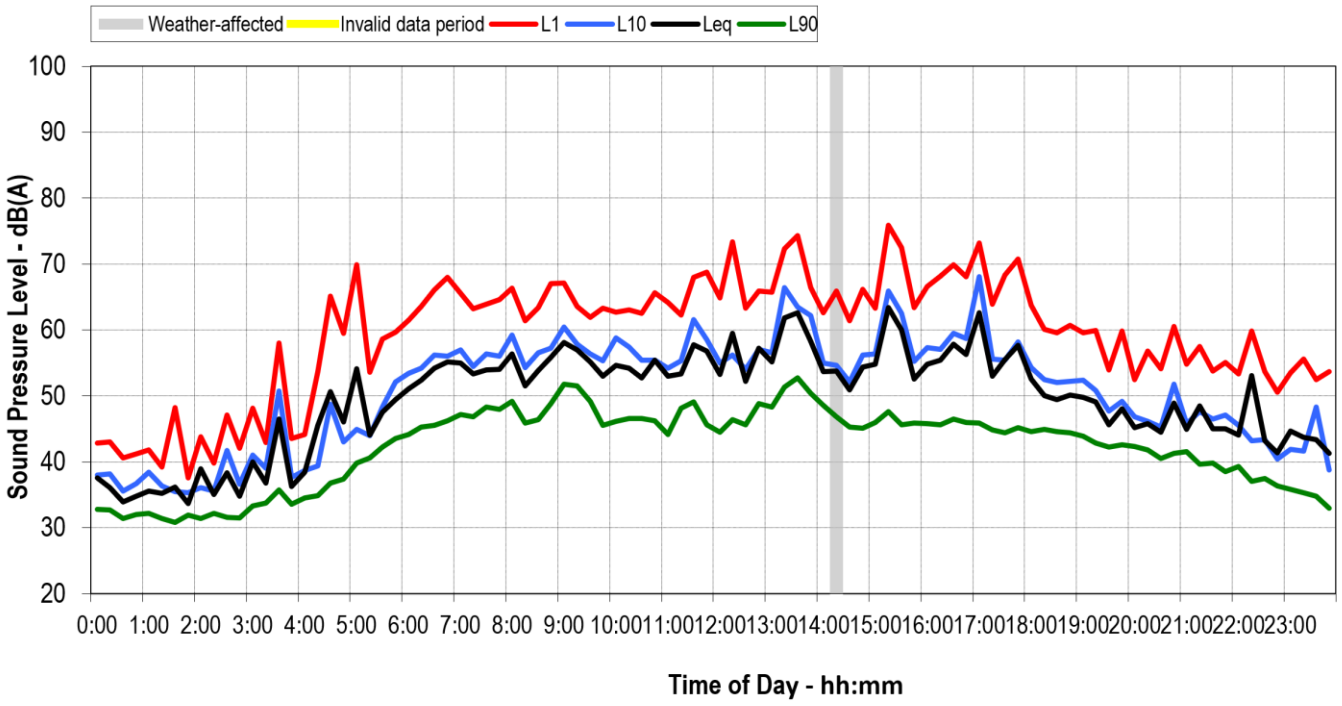
Logger 2 Merton St, Sutherland PS Hall - Thursday 08 August 2024



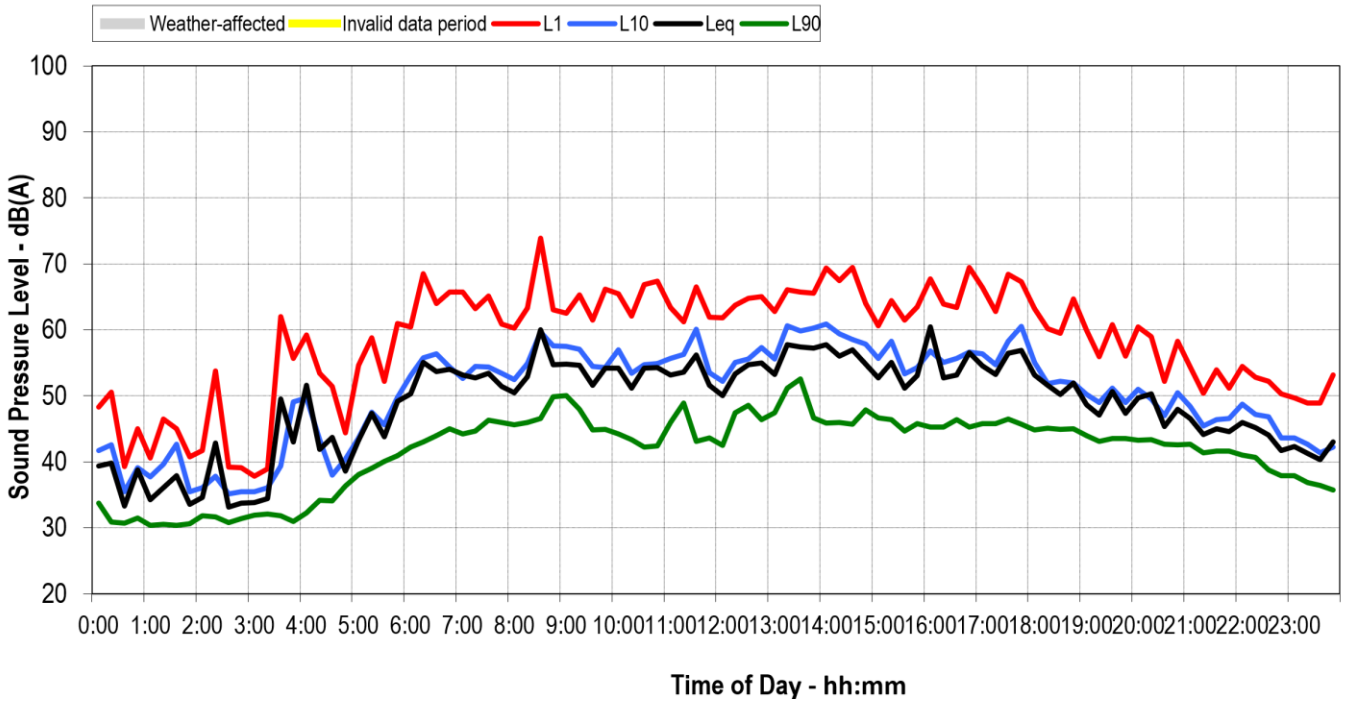
Logger 2 Merton St, Sutherland PS Hall - Tuesday 20 August 2024



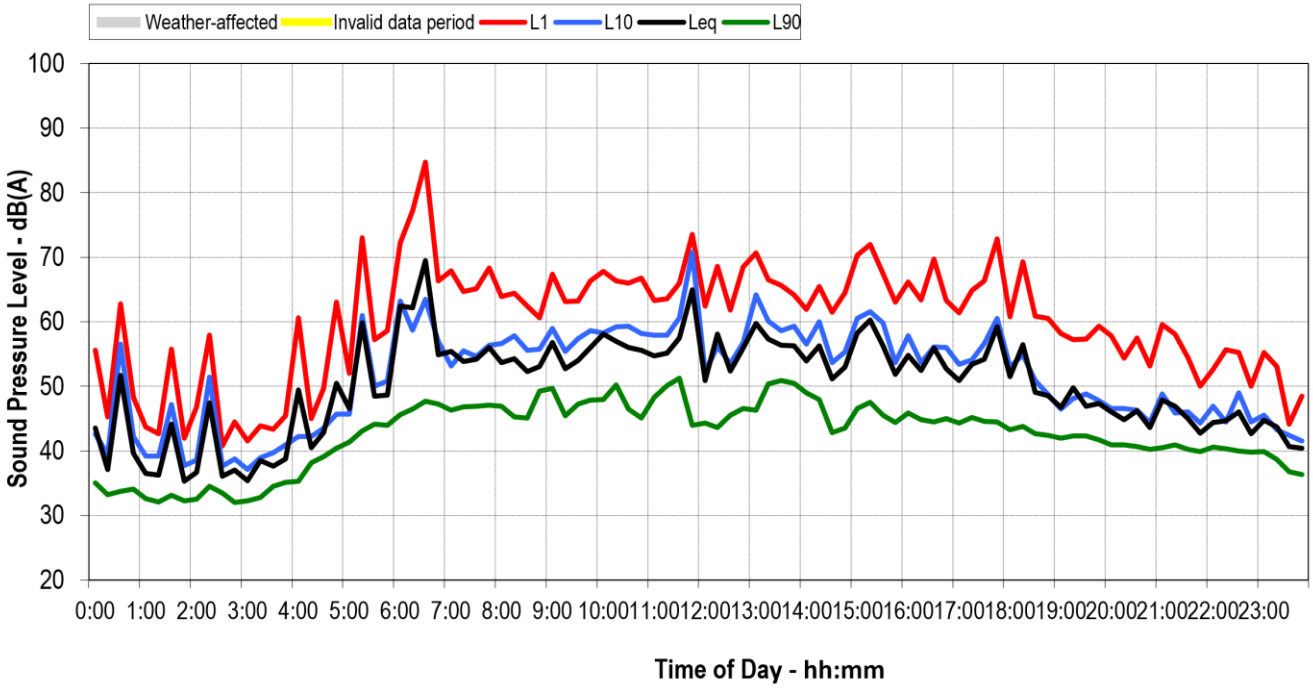
Logger 2 Merton St, Sutherland PS Hall - Wednesday 21 August 2024



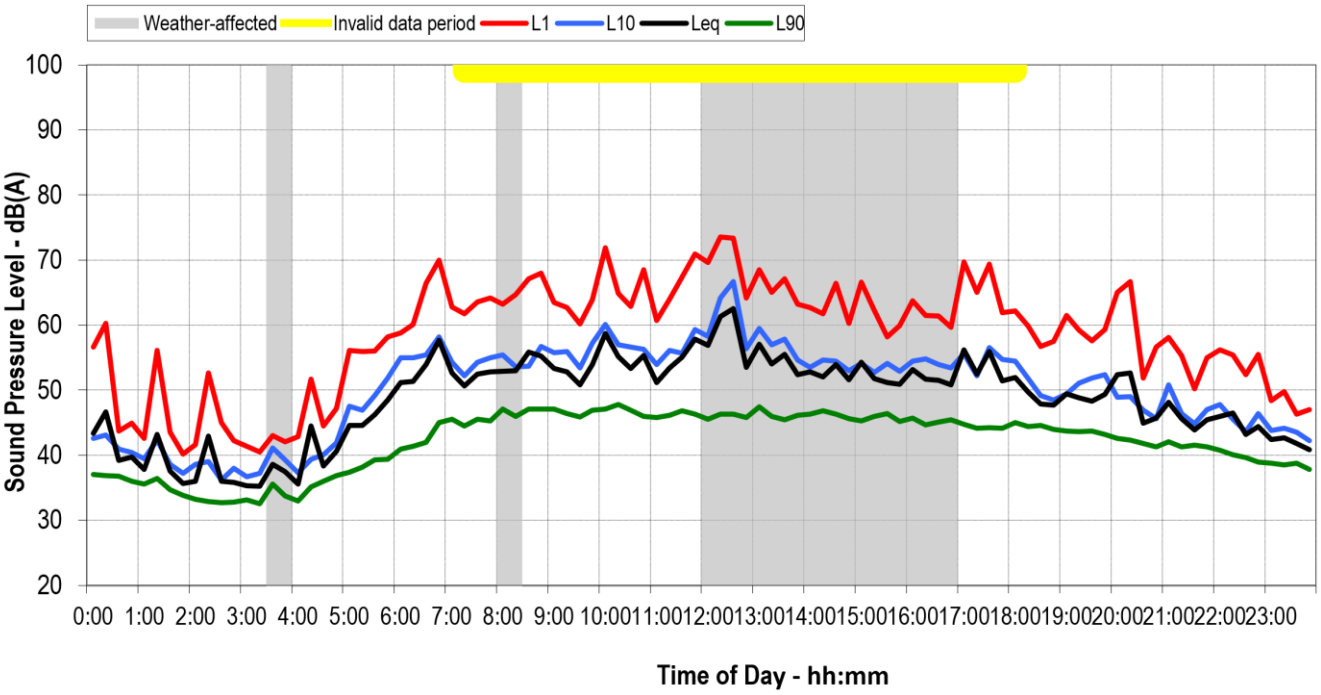
Logger 2 Merton St, Sutherland PS Hall - Thursday 22 August 2024



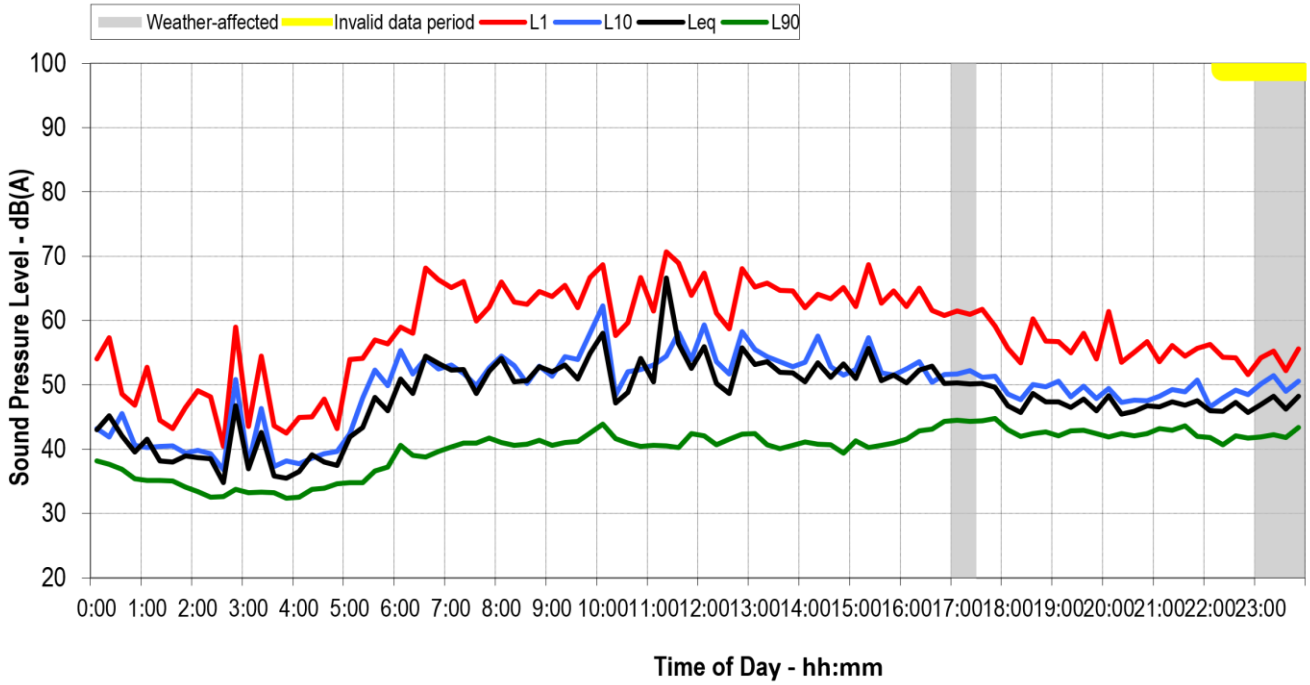
Logger 2 Merton St, Sutherland PS Hall - Friday 23 August 2024



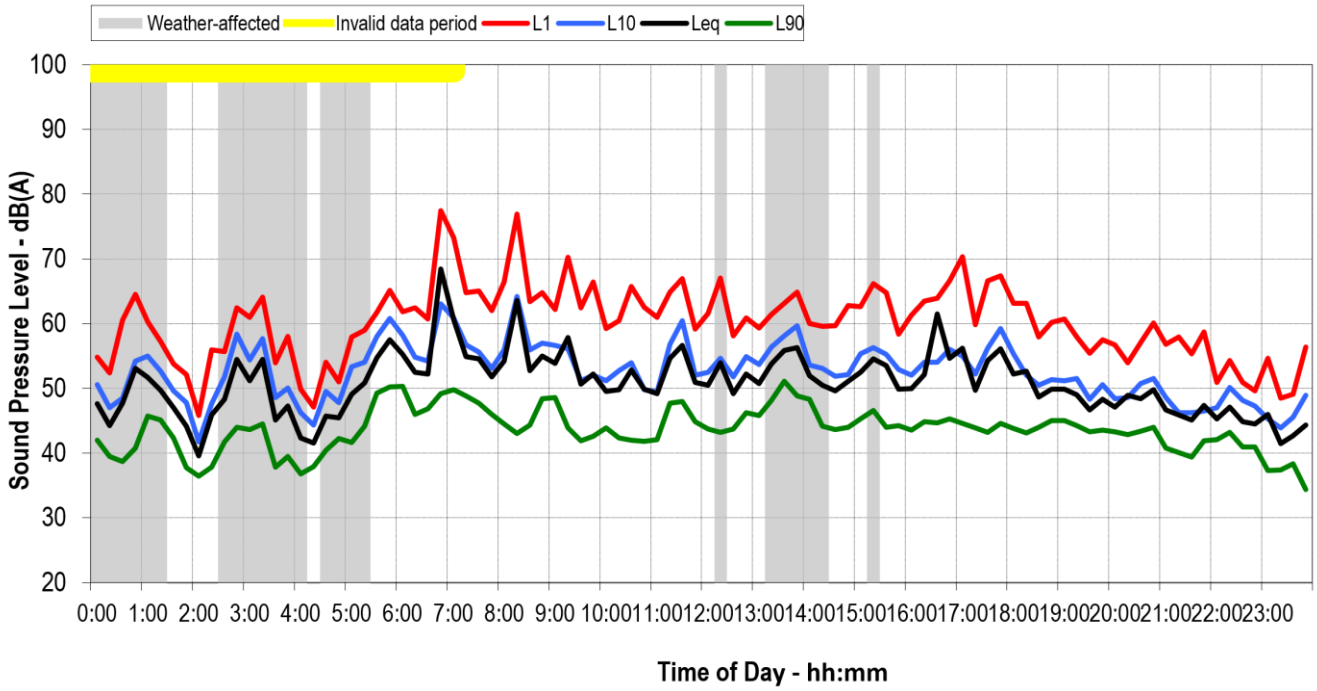
Logger 2 Merton St, Sutherland PS Hall - Saturday 24 August 2024



Logger 2 Merton St, Sutherland PS Hall - Sunday 25 August 2024



Logger 2 Merton St, Sutherland PS Hall - Monday 26 August 2024



Appendix B Summary of Guidelines Used to Establish Criteria

B.1 Construction Noise

The relevant guideline applied for the assessment of construction noise is the NSW Interim Construction Noise guideline (ICNG). This guideline provides construction Noise Management Levels 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 Noise Management Levels that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 18 outlines the methodology for determining construction Noise Management Levels at nearby residential receivers surrounding the activity site based on existing background noise levels.

Table 18 Residential construction Noise Management Levels for airborne noise as outlined in the ICNG

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.

Ground-Borne Noise

The ICNG also recommends *ground-borne* Noise Management Levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise.

The ground-borne noise levels presented below are for evening and night-time periods only, as the objective is to protect the amenity and sleep of occupants during the more sensitive time periods.

Residential construction Noise Management Levels for ground-borne noise

Time of Day	Noise Management level L_{Aeq} (15 min)
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

B.2 Construction Vibration

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 the table below.

Table 19 Examples of vibration types

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.

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 20. 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.

Table 20 Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

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

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 21 sets out the acceptable VDV values for intermittent vibration.

Table 21 Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

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

Sensitive Equipment

Areas with sensitive equipment are likely to require a higher degree of vibration isolation than the values in Table 19 & Table 21.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 22 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.

Table 22 VC Curves for Highly Sensitive Equipment

Curve	Max Value 8-80Hz Microns / sec, rms	Detail Size Microns	Equipment Types / Requirements
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

Figure 7 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 22:

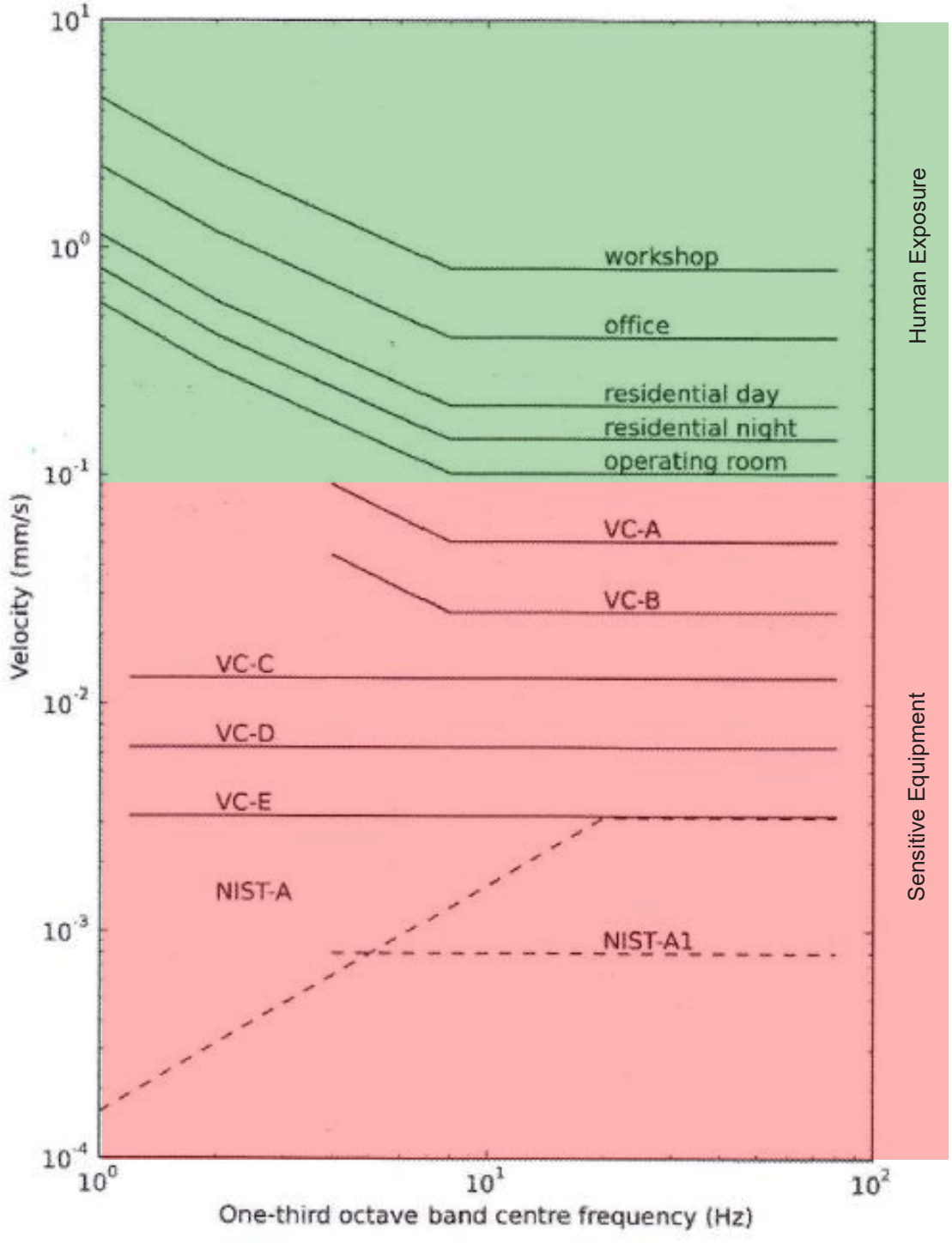


Figure 7 VC Curves (Source: Measurement and Assessment of Ground-borne Noise & Vibration, UK's Association of Noise Consultants, 2012)

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.

German Standard

The relevant German standard is *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures" (Feb 1999)*. This standard gives guidelines for short-term and steady state structural vibration.

The short-term vibration limits as follows:

Table 23 Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	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

The guidelines note that: "*provided the values given in* Table 23 *are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of* Table 23 *are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.*"

British Standard

The relevant standard is BS7385: Part 2: 1993. 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 buildings.

Table 24 Transient Vibration Guide Values for Cosmetic Damage

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

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 would 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 would be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 2006, 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 would 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.

Summary

Table 25 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

Table 25 Summary of vibration limits

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also, measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above[1]	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s[1]	For buildings particularly susceptible to vibration. Limit is for peak *resultant* particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

B.3 Operational Noise

NSW Noise Policy for Industry

The NSW NPI provides guidance on methodology for determining limiting noise criteria for external noise emissions from plant associated with a activity.

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 (Leq) and Background noise levels (L90) that surround the site.
- The time of day that the noise generating activity 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 activity 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.

Establishing NPI Criteria

The main sources of noise break-out from the site to the environment will be:

- Mechanical services plant
- Noise from playgrounds and classrooms

The environmental noise impact of the site has been assessed in accordance with the NSW EPA Noise Policy for Industry 2017 (NSW NPfI).

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 school at Carter Street, the more stringent of the intrusive and the amenity criteria sets the PNTL.

The derivation of the PNTL is provided below.

Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from LA90,15min measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPfI.

Three time periods are considered (consistent with the operating times and the time-of-day classifications in the NSW NPfI):

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

The estimated RBLs and ambient noise levels are shown below in Table 26.

Table 26 Long-term background and ambient noise levels measured around the site

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
Logger 1 – Eton Street (West)	49	44	35	60	53	50
Logger 2 - Merton Street (South-east)	43	41	33	55	49	48

The intrusiveness noise level is defined as:

- $L_{Aeq,15\ minute} \leq$ Rating Background Level + 5

The intrusiveness noise level has been determined from the RBL's at Logger 1 – Eton Sreet presented below for each period.

- Day Intrusiveness criterion of 49 + 5 = 54 dB(A)
- Evening Intrusiveness criterion of 44 + 5 = 49 dB(A)
- Night Intrusiveness criterion of 35 + 5 = 40 dB(A)

Similarly, the intrusiveness noise level has been determined from the RBL's at Logger 2 – Merton Street presented below for each period.

- Day Intrusiveness criterion of 43 + 5 = 48 dB(A)
- Evening Intrusiveness criterion of 41 + 5 = 46 dB(A)
- Night Intrusiveness criterion of 33 + 5 = 38 dB(A)

The Intrusiveness noise levels are only applied to residential receivers.

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 NPfI 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 - 5 dB(A) (Equation 2)

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

The recommended ANLs relevant to this project are specified in Table 12.

Table 27 Recommended L_{Aeq} noise levels from industrial noise sources at residential and commercial receivers

Indicative Noise Amenity Area	Period	Recommended $L_{Aeq,period}$ Noise Level (ANL)
Residential (Urban)	Day	60
	Evening	50
	Night	45
Commercial Premises	When in use	65
Place of Worship - Internal	When in use	40
School Classroom - Internal	When in use	35

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 LAeq, 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 NPfI, 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 LAeq,period(traffic) as:
  - High Traffic Project ANL = LAeq,period(traffic) - 15 dB(A) (Equation 3)

Exception B (Not Applicable to this project)– In proposed developments in major industrial clusters

The recommended amenity noise level from Table 12 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 = 10Log10(10(L – 5 dB/10)/N) dB(A) (Equation 4)

where L is the relevant recommended ANL from Table 12 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing LAeq 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 NPfI.

Project Specific Calculation

Table 28 Calculation of Project ANLs

Receiver - External	Time of Day	Recommended ANL	Adjustment	Calculated Project ANL[4]	Existing Industrial Noise Level
Residential (West)	Day	60	-5 (eq2) + 3	58	60
	Evening	50	-5 (eq2) + 3	48	53
	Night	45	-5 (eq2) + 3	43	50
Residential (South-East)	Day	60	-5 (eq2) + 3	58	55
	Evening	50	-5 (eq2) + 3	48	49
	Night	45	-5 (eq2) + 3	43	48
School classroom (Internal)	When in use	35	-5 (eq2) + 3	33	33
Commercial Premises	When in use	65	-5 (eq2) + 3	63	63
Place of Worship (Internal)	When in use	40	-5 (eq2) + 3	38	38

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 29 below (PNTLs shown shaded).

[4] The LAeq 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 LAeq,15min will be taken to be equal to the LAeq,period + 3dB(A).

Table 29 Project Noise Trigger Levels

Receiver - External	Time of Day	Intrusiveness	Amenity	Project PNTL
Logger Residential 1 (West / Eton St)	Day	54	58	54
	Evening	49	48	48
	Night	40	43	40
Logger Residential 2 (South-East / Merton St)	Day	48	58	48
	Evening	46	48	46
	Night	38	43	38
School Classroom (Internal)	When in use	-	33	33
Commercial Premises	When in use	-	63	63
Place of Worship (Internal)	When in use	-	38	38

B.4 Sleep Disturbance (Residential Receivers)

Noise sources with the potential for sleep disturbance are likely to occur during night-time (10pm to 7am) operational 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 REF. 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 $L_{Aeq,15min}$ and LAFmax not exceeding the LA90, (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.

Table 30 Sleep Awakening Level

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

Appendix C Glossary of Terms

Term	Definition
Ambient Noise Level	The ambient noise level is referred to as the equivalent continuous sound level (Leq)
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. It is noted that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.
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.
ICNG	Interim Construction Noise Guideline
L1(period)	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
L10(period)	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
L90(period)	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
LAeq(period)	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
LAmax	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.

Appendix D Noise Source Levels

D.1 Construction

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

Noise Source / Plant	Sound Power Level, $L_{eq,T}$ dB(A)	Sound Pressure Level, $L_{eq,T}$ dB(A), at 10m
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

ACOUSTIC STUDIO

Address Unit 27, 43-53 Bridge Road,
Stanmore NSW 2048 Australia

Phone +61 2 9557 6421

Email mail@acousticstudio.com.au