ACOUSTIC STUDIO

New high school for Schofields and Tallawong

Noise and Vibration Impact Assessment for Review of Environmental Factors

29 January 2025

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Disclaimer

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Contents

Appendices

Executive Summary

Acoustic Studio has been engaged by NSW Department of Education to prepare a Noise and Vibration Impact Assessment for the Review of Environmental Factors submission associated with the proposed New High School for Schofields and Tallawong.

Construction Noise and Vibration

Construction for the project will 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.

Outside of Standard Hours works are proposed for:

- Saturday - 1:00pm – 5:00pm

The assessment has determined that construction noise and vibration that is likely to result from the proposed activity is a low to medium risk based on the assessment undertaken at this planning stage.

Further development of the construction strategy will be required as the design progresses; however, the risks are anticipated to remain low to medium and will require appropriate management and planning to minimise noise and vibration impact to surrounding receivers.

Construction noise and vibration mitigation measures to be incorporated are provided below.

Construction Noise

Construction noise impacts are predicted to generally be above Noise Management Levels but within the Highly Affected Noise Level except when works are carried out centrally within the site with respect to the noise sensitive receivers.

A Construction Noise and Vibration Management Plan 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:

- **Communication and scheduling** (duration and respite periods) coordinated.
- **Alternative construction methodology or equipment** such as electric tower cranes.
- **Noise Barriers or Screening**.
- For **construction traffic** - planning of access routes, staging and management of arrivals.
- 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.

Detailed project specific mitigation measures which consider the various project stages and respective affected receivers are provided in Section 6.5.3.

Construction Vibration

The impact of vibration will need to be confirmed and quantified further as part of the Construction Noise and Vibration Management Plan 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.

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):

- **Workshops** may need to keep doors and windows closed when carrying out noisy activities.
- **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.
- **Hall doors and windows** will need to be **kept closed during out of hours use** for noisy activities (including amplified music).
- **Building Services**
  - As a mitigation measure, during the detailed design phase, further assessment and 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.
  - The centralised plant will require acoustic screening / louvres plus ducted discharge to some areas.
  - In duct attenuation will be allowed for equipment terminating at the façade.
  - Acoustic louvres will be provided for dust extraction fans supplying wood and metal workshops.
  - Enclosures and attenuators will be provided to the Fire Pump Room.
- **Deliveries and loading dock** carried out between 7:00:am and 6:00pm.

External Noise Intrusion

Based on the measured noise levels and strategic location of buildings, 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 identified developments in the vicinity of the new high school project 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 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 high 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 NSW Nosie Policy for Industry).

Evaluation of Environmental Impacts

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed activity, it is determined that:

- Potential noise and vibration impacts are low to medium risk and require mitigation measures / management and planning of construction noise and vibration plus noise mitigation measures to control operational noise. This will ensure the project will not have significant or adverse effects on the locality, community and environment.
- Potential impacts can be appropriately mitigated or managed through recommended measures to ensure that there is minimal effect on the locality, community.
- The activity is not considered to be a significant impact.

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) for the construction and operation of the new Schofields - Tallawong High School (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 (T&I SEPP) 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 3.37A 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 school.
- Establish the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Quantify the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- 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	NSW DECC *Interim Construction Noise Guideline*, 2009	Section 5.1.1, 6.5
	Construction vibration	NSW DECC *Assessing Vibration: a Technical Guideline*, 2006	Section 5.1.3, 9.1
Operational Noise Emission	Playground Noise	AAAC *Guideline for Child Centre Acoustic Assessment*, 2013	Section 5.2.4, 7.3.7
	Internal School Activity Noise	NSW EPA *Noise Policy for Industry*, 2017	Section 5.2, 7.3.1
	Public Address Systems		Section 5.2, 7.3.6
	Out of Hours Use (Hall)		Section 5.2, 7.3.3
	Building Services		Section 5.2.1, 7.3.8
	Loading and Waste Collection		Section 5.2, 7.3.9
	Traffic On Site		Section 5.2, 7.3.9
	Traffic Off Site	NSW EPA *Road Noise Policy*, 2011	Section 5.2.3, 7.3.10
External Noise Intrusion	Road	NSW DoP *Development Near Rail Corridors and Busy Roads – Interim guideline*, 2008	Section 5.3.2, 8.1.1
	Rail		Section 5.3.2, 8.1.2
	Aircraft	AS 2021:2015 *Acoustics—Aircraft noise intrusion— Building siting and construction*	Section 5.3.2, 8.1.3

1.2 Site Description

The site is known as 201 Guntawong Road, Tallawong, NSW, 2762 (the site), and is legally described as part of Lot 1 in Deposited Plan 1283186. The site is located at the corner of Guntawong Road and Clarke Street, Tallawong and is approximately 4 hectares in area. The site has an approximately 100-metre-long frontage to Guntawong Road along its northern boundary. Nirmal Street provides a partial frontage along the eastern boundary of the site with plans to extend Nirmal Street to provide a future connection to Guntawong Road.

The site is predominantly cleared land and consists of grassland with several patches of remnant native vegetation particularly within the northern portion of the site. As a result of precinct wide rezonings, the surrounding locality is currently transitioning from a semi-rural residential area to a highly urbanised area with new low to medium density residential development with supporting services. The site is located approximately 1.5km to the north west of Tallawong Metro Station and is also serviced by an existing bus stop along Guntawong Road.

Figure 1 below provides and aerial image of the site.

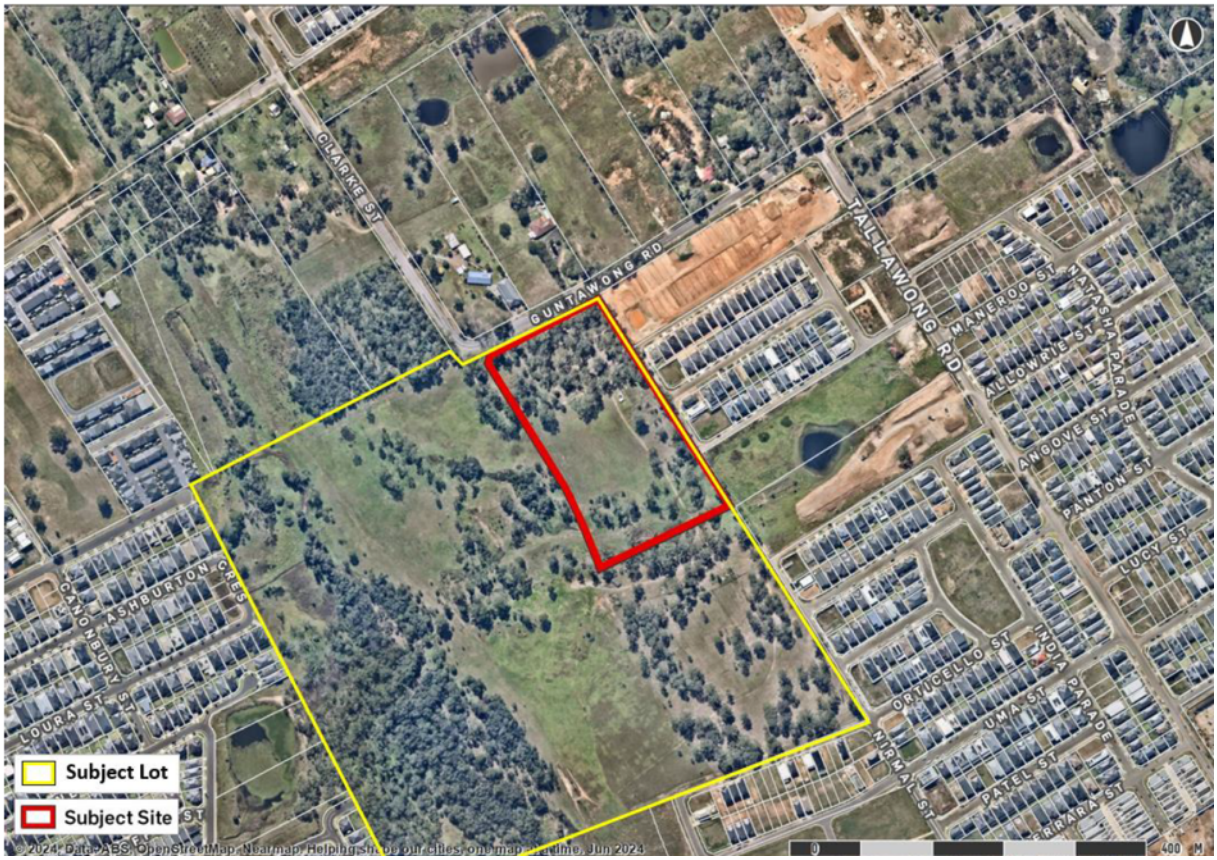


Figure 1 Aerial Photograph of Site *(Source: Urbis 2024)*

The proposed site and land uses that will surround the site are shown in Figure 2.

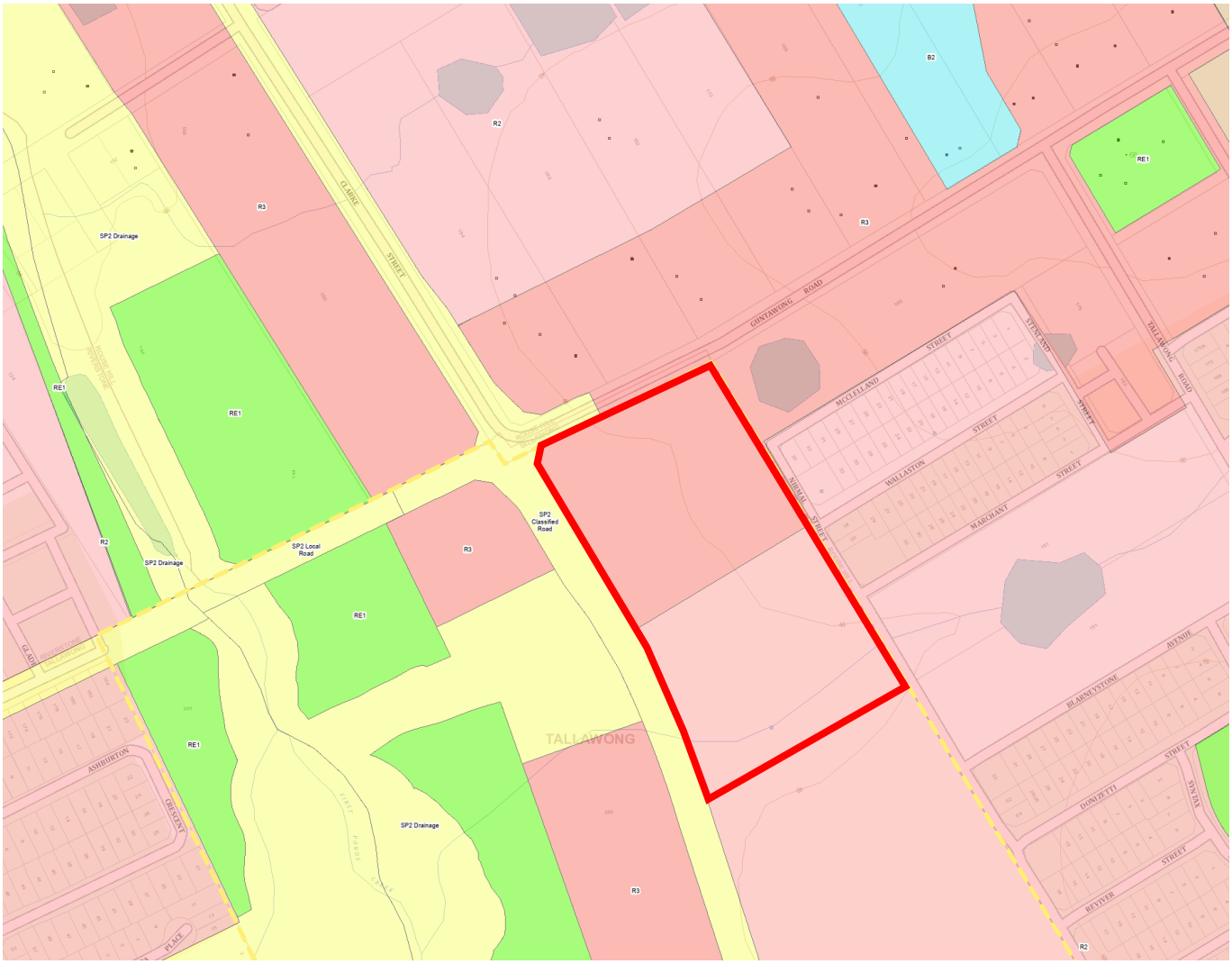


Figure 2 Activity Site (RED border) and Neighbouring Land Uses *(Source: NSW Planning Portal Spatial Viewer)*

1.3 Proposed Activity Description

The proposed activity is for the construction and operation of a new high school known as Schofields - Tallawong High School. The new high school will accommodate up to 1,000 students. The school will provide 49 permanent teaching spaces (PTS), and 3 support teaching spaces (STS) across three buildings.

The buildings will be three-storey in height and will include teaching spaces, specialist learning hubs, a library, administrative areas and a staff hub. Additional core facilities are also proposed including a standalone school hall, a carpark, a pick up and drop off zone along Nirmal Street, two sports courts and a sports field.

Specifically, the proposal involves the following:

- Three learning hubs (three-storeys in height) accommodating 49 general teaching spaces and 3 support learning units (SLUs).
- Other core facilities including amenities, library, staff hub and administrative areas.
- Standalone school hall.
- Separate carpark and pick up and drop off zone.
- Open play space including two sports courts and a sports field.
- Public domain works.

The proposed site access arrangements are as follows:

- Main pedestrian entrance to be located off Nirmal Street.
- Pick up and drop off zone proposed along Nirmal Street.
- Onsite parking access via Nirmal Street.

Figure 3 provides an extract of the proposed site plan.

Figure 3 Proposed site plan *(Source: djrd)*

1.4 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 (CNVMP) shall be prepared by the contractor with consideration of the Interim Construction Noise Guideline (ICNG). 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. Including advance notice and communication with residential receivers for noisy activities and establish a hotline complaints management.	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 dB reduction (where line-of sight is broken) to 10 dB reduction	Reduce noise impact
CM-04	Section 6.5 - Alternative construction methodology and equipment	Implement quieter 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 6.7.1 - 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 6.1 - 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. This can include pre-condition surveys on sensitive structures within 50m of the site.	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	Section 7.3.2 - Workshops	Doors and windows may need to be kept closed during out of hours use for noisy activities	To achieve project PNTL and minimise noise impact to surrounding neighbours
D/O - 02	Section 7.3.3 – Evening Hall Use	Doors and windows will need to be kept closed during out of hours use for noisy activities (including amplified music).	To achieve project PNTL and minimise noise impact to surrounding neighbours
D/O - 03	Section 7.3.4 – Cleaning during nighttime hours	Where cleaning activities occur between 5:30-7:00am, the following should apply: Ensure windows and doors are closed to limit noise emissions. Air conditioning is not to be operated. Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.	To achieve project PNTL and minimise noise impact to surrounding neighbours
D/O - 04	7.3.6 - 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 - 05	Section 7.3.8 – Building Services	During the detailed design phase, further assessment and 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.	To ensure plant selections and treatment are provided to achieve project PNTL and minimise noise impact to surrounding neighbours
D/O - 06	Section 7.3.8 - Core Plant Acoustic Treatment	The centralised plant will require acoustic screening / louvres plus ducted discharge to some areas. In duct attenuation will be allowed for equipment terminating at the façade. Acoustic louvres will be provided for dust extraction fans supplying wood and metal workshops	To achieve project PNTL and minimise noise impact to surrounding neighbours

Mitigation Number / Name	Aspect / Section	Mitigation Measure	Reason for Mitigation Measure
D/O - 07	Section 7.3.9 Deliveries and loading dock	To be carried out between 7:00am and 6:00pm	To achieve project PNTL and minimise noise impact to surrounding neighbours plus avoid sleep disturbance
D/O - 07	Section 7.3.5 Operational Noise Management Plant	An Operational Noise and Vibration Management Plan should be prepared	To manage ongoing operational noise from the school.

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 Schofields - Tallawong High School 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:

- Blacktown City Council Growth Centre Precincts Development Control Plan 2010 – Schedule 8 Riverstone East Precinct.
- 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.
- Association of Australasian Acoustical Consultants (AAAC) *Guideline for Child Centre Acoustic Assessment* 2013.
- Australian Standard AS 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.
- Australian Standard AS 2021:2015 *Acoustics – Aircraft noise intrusion - building siting and construction*.
- Australian Standard AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites*.
- Australian Standard AS 1055:2018 *Acoustics – Description and Measurement of Environment Noise*.
- Australian Standard AS 2670.2-1990 *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)*.
- 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).
- NSW 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

The reasonably most affected residential noise sensitive receivers to the site are as follows:

- Residential properties fronting the project site to the east along **Nirmal Street**.
- Residential properties fronting the project site to the north along **Guntawong Road**.

Figure 4 Activity Site and Neighbouring Land Uses (existing plus future)

4.2 Noise Monitoring Locations

Unattended long-term noise monitoring

Unattended long-term monitoring was carried out at two locations shown in Figure 4.

- Logger 1 – at 18 Nirmal Street.
- Logger 2 – at 194 Guntawong Road.

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.

Short-term attended Measurements

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

These attended monitoring locations are shown in Figure 5.

4.3 Methodology

Andre Almeida 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 – Wednesday 18 September 2024 to Wednesday 2 October 2024.
- Logger L2 – Wednesday 18 September 2024 to Tuesday 1 October 2024.

Unattended monitoring was carried out with the following equipment

- Logger L1- Svantek (Serial Number 69721).
- Logger L2 - Svantek (Serial Number 98077)

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:

- Wednesday 18 September 2024, between 11:00 am and 12:30 pm.
- Friday 4 October 2024 between 11:00 am and 12:00 pm.

Attended short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number: 3010373). 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 5. 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.

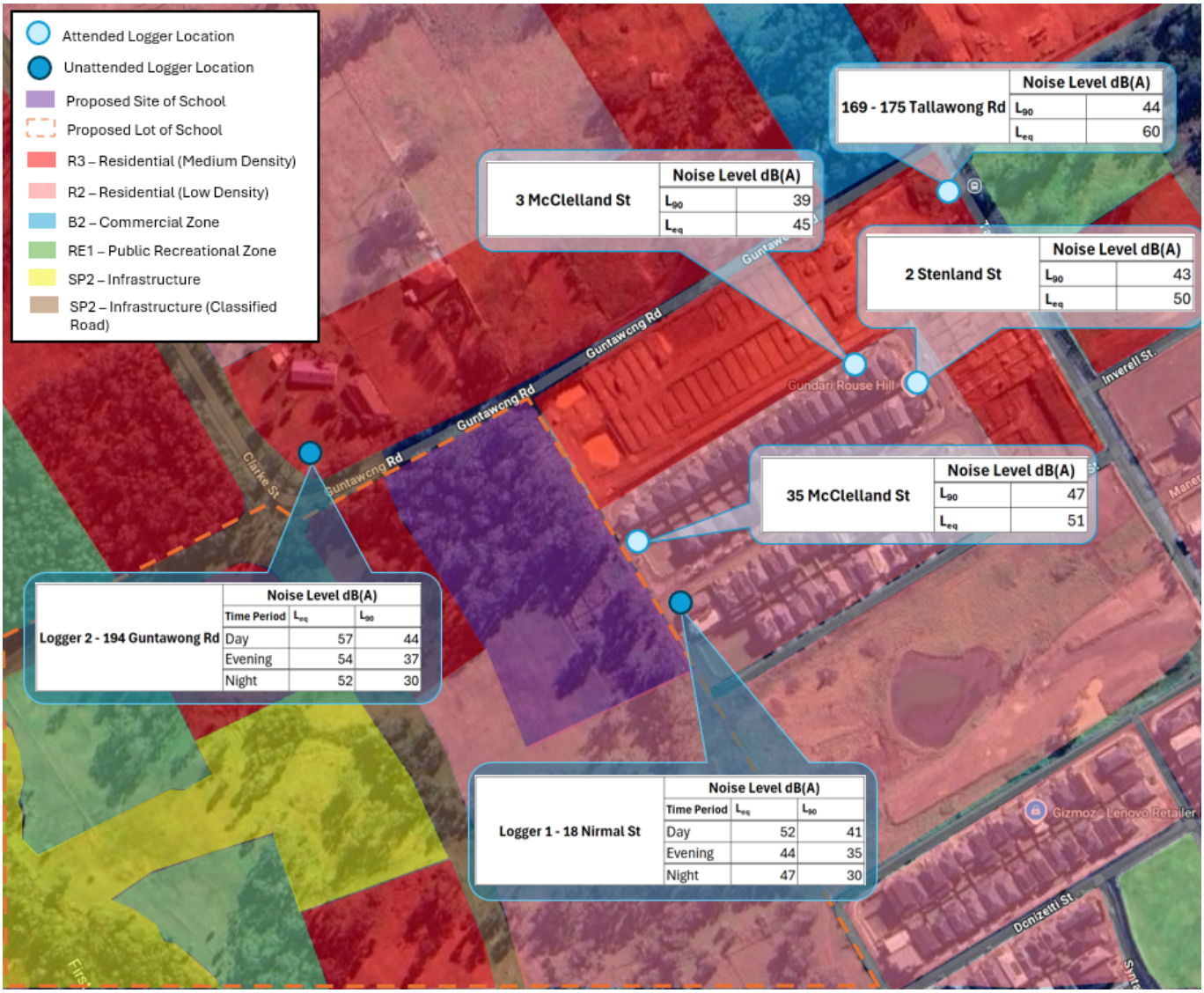


Figure 5 Noise Survey Results for the Project Site and Surrounds

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 school site:

- **Logger 1** (Referred to as **East and West**) – used to establish noise targets for existing and future residential noise sensitive receivers adjacent to the project site that are less affected by noise from Guntawong Rd. situated;
  - To the **east** of the project site adjacent to Nirmal St
  - To the **west** and **southwest** of the project site
- **Logger 2** Referred to as (**North**) - used to establish criteria at existing and future residential noise sensitive receivers adjacent to the site, situated to the **north**, **northeast** and **northwest** along Guntawong Rd.

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 during Recommended Standard Hours

Location	Period		Rating Background Level (RBL), dB(A)	NML $L_{Aeq(15\ min)}$, dB(A)	
Residential (East and West)	Recommended Standard Hours	Monday to Friday 7am to 6pm	41	RBL + 10	51
		Saturday 8am to 1pm	41		51
	Outside Standard Hours	Saturday 1pm to 5pm	41	RBL + 5	46
Residential (North)	Recommended Standard Hours	Monday to Friday 7am to 6pm	44	RBL + 10	54
		Saturday 8am to 1pm	44		54
	Outside Standard Hours	Saturday 1pm to 5pm	43	RBL + 5	48

Non-Residential Receivers

NMLs for non-residential areas adjacent to the activity 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]
Places of Worship	
Passive Recreation Areas	60 dB(A) - External

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).

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

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
- School operations (classroom, workshop etc.)
- Vehicle movements within the premises

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 (East and West)	All Surrounding Receivers	Day (7am-6pm)	46
		Evening (6pm-10pm)	40
		Night (10pm-7am)	35
Residential (North)		Day (7am-6pm)	49
		Evening (6pm-10pm)	42
		Night (10pm-7am)	35
Public Recreation (Passive)		When in use	48
Public Recreation (Active)		When in use	53

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.

5.2.3 Road Traffic – On and Off Site

Roads and car parks within the school campus (on site) – NSW Noise Policy for Industry

The NPI notes that it can be used for vehicle movements within an industrial premises and/or on private roads. Therefore, on site traffic noise generation including car parks are assessed against the requirements of the NPI PNTLs in Table 5.

All other road traffic noise (off site) - NSW Road Noise Policy

The NSW Road Noise Policy (RNP) provides criteria for traffic noise from new roads or additional traffic generated on roads from new land uses and activities. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 7 provides the RNP criteria for additional traffic generated on roads from new land uses and activities (including traffic generated during the construction of that activity) in relation to the applicable receiver types surrounding the site.

Table 7 RNP assessment criteria for additional traffic on local roads generated by new land uses and activities including construction vehicles / traffic

Receiver Type	Assessment Criteria (external[2])	
	Day (7am to 10pm) L_{Aeq} (period)	Night (10pm to 7am) L_{Aeq} (period)
Residential – Local Roads	55 (1 hour)	50 (1 hour)
School Classrooms (Educational)	60 (1 hour)	-

When considering new land uses and activities and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that "In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"... [in relation to existing noise levels] ..."represents a minor impact that is considered barely perceptible to the average person".

[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 (worst-case) and 20dBA if the windows are closed or external façade is glazing. This methodology is supported by the NPI.

5.2.4 Outdoor Play Areas

There are no clearly defined criteria in Australia to assess school playground noise impacts. The AAAC Guideline for Child Centre Assessment is considered relevant as the industry best practice for school playground noise assessment.

The relevant noise assessment target for outdoor play area noise (based on the AAAC Guideline and further described in Appendix B) is provided in Table 7.

Table 8 Outdoor Play Areas Noise Assessment Target

Receiver Type	Existing Background Noise Level L90 dB(A)	Outdoor Play Noise Assessment Target Leq dB(A)
Residential 1 (East and West)	41	46 (+5 dB > 4 hrs play)
Residential 2 (North)	44	49 (+5 dB > 4 hrs play)

Further information on the AAAC Guideline for Child Centre Assessment and the process for establishing this target is provided in Appendix B.

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 9 Traffic and Rail Noise Assessment Target

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

5.3.2 Aircraft

Australian Standard 2021:2015 *Acoustics – Aircraft Noise Intrusion – Building siting and construction* (AS 2021) provides recommendations for acceptable internal noise levels within various areas of occupancy inside buildings during aircraft flyovers. The AS 2021 recommended internal (L_{Amax}) design levels for spaces within educational establishments are documented in the following table.

Table 10 AS 2021:2015 Recommended Indoor Design Sound Levels – Schools and Universities

Building Type and Activity (Schools, Universities)	Indoor Design Sound Level, dB LAmax
Libraries, study areas	50
Teaching areas, assembly areas	55
Workshops, gymnasia	75

AS 2021 also contains advice on the acceptability of building sites based on Australian Noise Exposure Forecast (ANEF) zones. The acceptability criteria states that an aircraft noise exposure level of less than 20 ANEF is considered acceptable for the building of new school buildings.

[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

At this stage information on the timing and progression of the new high school indicates that residential sites to the east of Nirmal Road could be in construction or overlap at a similar time as the school.

The Contractor for the project will need to collaborate with proponents if any developments or construction works in the vicinity of the high school is identified. Cumulative impacts of noise and vibration will be in the CNVMP as relevant, to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered and managed against NMLs / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites 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.

6.1.2 Out of Hours Construction Hours

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

- Saturday - 1:00pm to 5:00pm

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

- Internal fit-out works (once façade 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 are 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 DoE, TfNSW, Blacktown City Council, and residents to address the approvals and additional measures required for scheduling and out of hours works.

6.2 Description of Proposed Construction Activities

Table 11 Proposed Construction Activities and Equipment (note – items shaded in grey are internal works)

Activity		Key Equipment	
Site Establishment (July 2025 to September 2025)		Truck, Forklift / Hiab (mobile crane) truck / Manitou (articulating forklift) (beeping alarms) Front End / wheeled loader	Excavator 8T with bucket Semi-trailer truck Generator, diesel Concrete truck
(September 2025 to December 2026)	**Excavation / Earthworks**	Excavator 8T with bucket Excavator 8T with rock breaker Truck, forklift Skip Fill	Front End / wheeled loader (i.e CAT D4) Skid steer loader (1/2 tonne) Dump truck (tipping material)
	Staff Car Park / Waste Collection Area	Vibratory Roller Compactor Grader Excavators	Bobcats Skip Trucks Concrete Trucks Concrete Pumps
	Substructure	Bored piling rig Excavator 20T with bucket Truck, forklift Concrete vibrator	Concrete truck and pump Cement mixer Mobile crane 100T Rock breaker Drill Rig for Rock Anchors
	Structure	Tower Crane (diesel or electric) Truck, forklift and Semi-trailer truck	Mobile crane 200T Impact driver
	Façade	Tower Crane (diesel or electric) Truck, forklift	Semi-trailer truck Elevated work platforms (beeping alarms)
	Fit-out	Tower Crane (diesel or electric)	Truck, forklift Hand tools
		Hand tools Hammer drill Concrete mixer Demo saw / circular saw Angle grinder	Hammer drill Concrete mixer Demo saw Circular saw Angle grinder
	External / Public Domain Works	Excavator 8T with bucket Excavator 8T with rock breaker Truck, forklift	Concrete truck and pump Cement mixer Concrete vibrator Roller / vibrator

6.3 Noise Sensitive Receivers and Proximity to Site

Nearest sensitive receivers to the Project Site that will be potentially affected by noise and vibration are as presented below. Table 12 outlines the most critical receivers surrounding the site for each type of impact.

Table 12 Noise sensitive receivers and approximate distance to Works site

Receiver	Impact	Location	Typical Distance from Site	
			Boundary	Centre
Residential	Airborne and Vibration	East and West	20	85
Residential	Airborne	North	20	150
Public Recreation	Airborne	West	90	180
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.

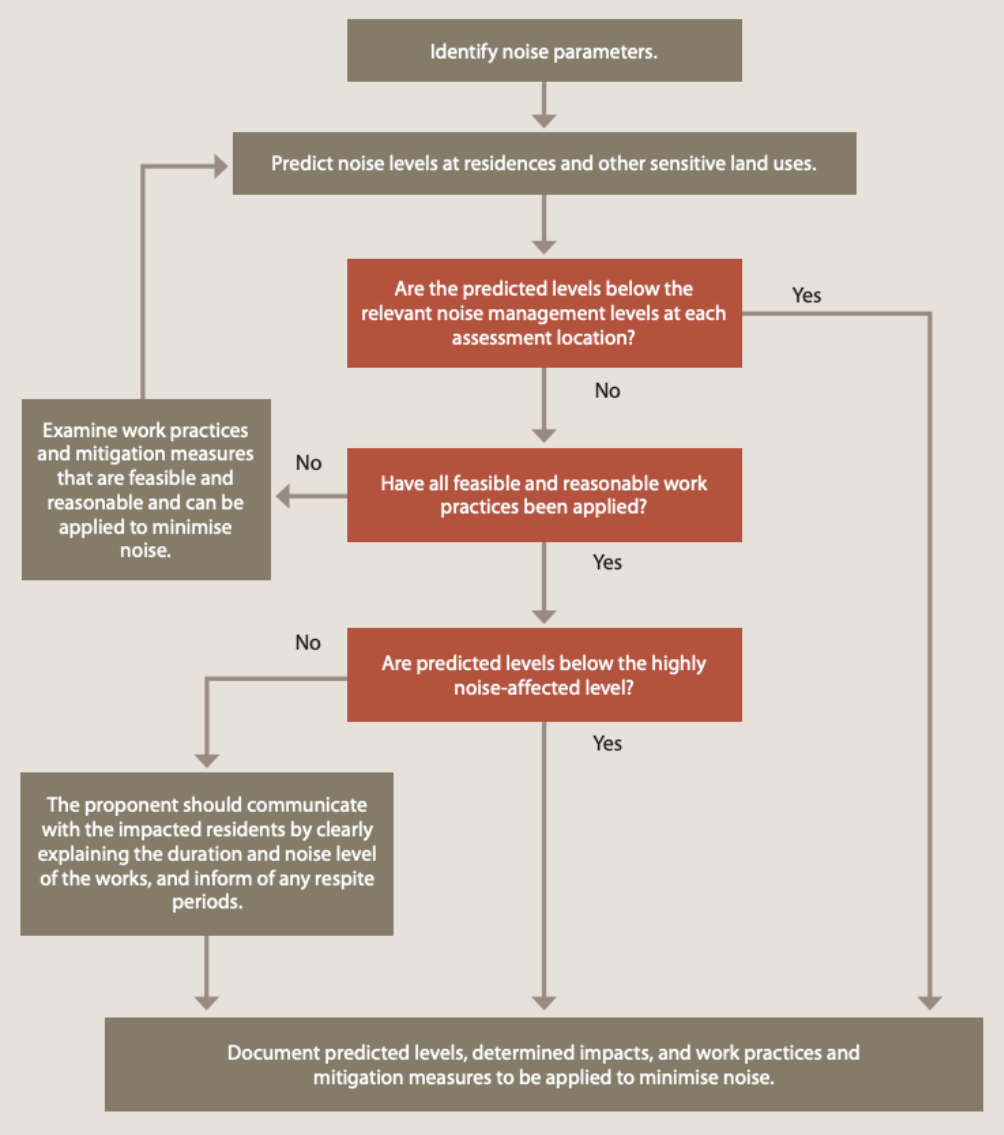


Figure 6 ICNG Construction Noise Assessment Methodology

The 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
  - Ground and building reflections.
- L_{Aeq} noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
- Predictions consider the typical distances to receivers in Table 13, 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.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment, unless otherwise stated.
- The assessment considers likely scenarios where multiple plant is used and / or activities are carried out simultaneously during construction.

6.5 Construction Noise and Vibration

6.5.1 Assessment

Airborne Construction Noise

Table 13 and Table 14 provide results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Section Table 11 operating within the boundary of the construction works site for each stage, for standard and outside standard construction hours, respectively.

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, unless a specific activity will be localised to a known particular area of the site (i.e. car park works).

These predictions assume all the plant and equipment per activity is operating continuously for a 15-minute period. In practice, much of this equipment will operate for shorter periods and much of the equipment is less noisy when used in isolation, both factors which may reduce the predicted noise level by 5-15 dB over a 15-minute period.

Table 13 STANDARD CONSTRUCTION HOURS - Construction Noise Predictions - Levels predicted to exceed the NMLs are shown in **blue**, and those predicted to exceed the "Highly Noise Affected" threshold (>75dBA) are shown in red

Location	Residential (East and West)	Residential (North)	Public Recreation	Comments
NML	51	54	60	
Construction Activities	Predicted equipment noise levels at surrounding community receivers, in Leq,15min dB(A) (Boundary – Centre)			
Site Establishment	85 – 73	85 – 68	72 – 66	Noise dominated by heavy vehicles.
Excavation / Earthworks	88 – 76	88 – 71	75 – 69	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5-10 dB quieter.
Car Park / Waste Collection	87 – 75	87 – 70	74 – 68	Noise dominated by heavy vehicles and skip trucks.
Substructure	89 - 76	89 - 71	76 - 70	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5-10 dB quieter.
Structure	85 – 72	85 – 67	72 - 66	Noise dominated by heavy vehicles and concrete pumps.
Façade	78 - 66	78 - 61	65 - 59	
Fit out	68 - 55	68 - 50	54 - 48	Assumes shielding from completed façade.
External Public Domain Works	86 - 74	86 - 69	73 - 67	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5-10 dB quieter.

Table 14 OUTSIDE STANDARD HOURS WORKS - Construction Noise Predictions - Levels predicted to exceed the NMLs are shown in **blue**, and those predicted to exceed the "Highly Noise Affected" threshold (>75dBA) are shown in red

Location	Residential (East and West)	Residential (North)	Public Recreation	Comments
NML	46	48	60	
Construction Activities	Predicted equipment noise levels at surrounding community receivers, in Leq,15min dB(A) (Boundary – Centre)			
Site Establishment	85 – 73	85 – 68	72 – 66	Noise dominated by heavy vehicles.
Excavation / Earthworks	88 – 76	88 – 71	75 – 69	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5-10 dB quieter.
Car Park / Waste Collection	87 – 75	87 – 70	74 – 68	Noise dominated by heavy vehicles and skip trucks.
Substructure	89 - 76	89 - 71	76 - 70	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5-10 dB quieter.
Structure	85 – 72	85 – 67	72 - 66	Noise dominated by heavy vehicles and concrete pumps.
Façade	78 - 66	78 - 61	65 - 59	
Fit out	68 - 55	68 - 50	54 - 48	Assumes shielding from completed façade.
External Public Domain Works	86 - 74	86 - 69	73 - 67	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5-10 dB quieter.

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.

Information provided by the Traffic Consultant SCT, contained within the Transport Access Impact Assessment, states the following:

"...

The estimated peak workforce is approximately up to 50 full-time equivalent (FTE) workers. Due to the limited public transport to the site, it is estimated that:

- *100 per cent would take private vehicle transport to the site, with a vehicle occupancy of 2.0 is assumed (typical of construction sites).*
- *Based on an estimated 50 full-time site workers, the maximum number of cars during the peak hours generated by the site is **25 light vehicles per day**.*
- *It has been assumed that approximately **10 heavy vehicles** will enter and exit the site for construction purposes throughout the day.*

*It is assumed that the **25 light vehicles** generated can **park on site** (outside of school operating hours), or on-street on the surrounding road networks. Most work will occur outside of school hours and workers would generally start earlier and end earlier than the commuter peak periods and would likely not coincide with the school or road network periods.*

Workers with heavy tools can drop them off at a work zone/loading zone before parking longer term on the recommended street. Final construction vehicle numbers are still being confirmed. At the submission of this draft, a preliminary estimate of 10 heavy vehicle truck movements is anticipated on a typical day.

The construction approach may require traffic management measures such as full/partial road closures, that will be confirmed at a later stage, will be detailed in a CTMP to be submitted to the relevant road authorities prior to obtaining Construction Certificate (CC).

Other mitigation measures would be adopted during the construction phase to ensure traffic movements have minimal impact on surrounding land uses and the community in general. These would include the following:

- *Construction workers will be discouraged from parking in residential areas. Given that Guntawong Road does not have on-street parking, this may only be required for Nirmal Street and the adjoining local roads currently under construction*
- *Truck loads would be covered during transportation off-site.*
- *Neighbouring properties would be notified of construction works and timing. Any comments would be recorded and taken into consideration when planning construction activities.*
- *All activities, including the delivery of materials, would not impede traffic flow along local roads.*
- *Materials would be delivered, and spoil removed during standard construction hours.*
- *Avoidance of idling trucks alongside sensitive receivers.*
- *Deliveries would be planned to ensure a consistent and minimal number of trucks arriving at the site at any one time.*

To manage driver conduct, the following measures are to be implemented:

- *All truck movements will be scheduled*
- *Vehicles are to enter and exit the site in a forward direction along the travel path shown on delivery maps*
- *Drivers are to always give way to pedestrians and plant.*

The RTA completed previously noted that frequent construction vehicle movements for neighbouring residential developments. To mitigate potential conflicts with other construction vehicles and general traffic, traffic controllers will be used to stop traffic on the public street(s) to allow trucks to enter or leave the site. Where possible, vehicles must enter and exit the site in a forward direction. They must wait until a suitable gap in traffic allows them to assist trucks to enter or exit the site. The Roads Act does not give any special treatment to trucks leaving a construction site, the vehicles already on the road have the right-of-way. Vehicles entering, exiting, and driving around the site will be required to always give way to pedestrians.

It is not expected that there will be other major concurrent construction activities. A further review of potential concurrent construction should occur as part of the construction traffic management plan to ensure that this remains the case or that mitigations are proposed...”

Further to the SCT’s advice 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.

Traffic Noise Predictions – Light Vehicles

Light vehicle traffic generation would be largely generated by construction worker traffic movements to and from the site. Some parking will be provided on-site, with workers to be encouraged to use public transport to access the site. As such, light vehicle traffic generation associated with construction workers will be minor (25 vehicles assuming a workforce of 50 people). Further to this, any construction worker traffic movements will generally be outside of peak periods.

As per the RNP, an increase in the traffic noise level of up to + 2dB in relation to the existing traffic noise level is considered to be a minor impact and barely perceptible to the average person.

Based on existing traffic noise level, volumes of light vehicle construction traffic are expected to be well below 2dB.

Traffic Noise Predictions – Heavy Vehicles

It is estimated that this project will involve approximately 10 on a typical day spread evenly throughout the day.

The generated heavy vehicle traffic along Guntawong is predicted to be within 55 dB(A) Leq (1 hr) on all other local roads when considering the applicable traffic noise Criteria in Table 6.

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.

General

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.

Summary of Noise Assessment Findings

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

Construction noise impacts at existing residential receivers are predicted to be generally above the NMLs, and only above Highly Noise Affected Levels when at the boundary of the 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 shown in 6.5.1, 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**.
- 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.

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

- Excavator hammer
- Vibratory roller
- Bored Piling

Table 15 High-Level Construction Vibration Assessment

Construction Activity	Vibration Impact	Likelihood
Excavator	Human Disturbance	Low Risk
	Building Damage	Low Risk
Vibratory Roller	Human Disturbance	Low to Medium 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. This can include pre-condition surveys on sensitive structures within 50m of the site.

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

It is understood that there are a number of new developments at various locations in the vicinity of the new high school that are either:

- In planning.
- Pending approval.
- Approved and may be in construction in future.
- Are currently in construction.

There is potential for cumulative construction noise and vibration impact including:

- Multiple sites under construction at the same time.
- Potential for prolonged periods of construction noise and vibration impact, where multiple developments are under construction at staggered stages (i.e. sites with start and completion dates that overlap or are in sequence).

At this stage information on the timing and progression of the new high school indicates that residential sites to the east of Nirmal road could be in construction or overlap at a similar time as the school.

The Contractor for the project will need to collaborate with proponents if any developments or construction works in the vicinity of the high school is identified. Cumulative impacts of noise and vibration will be in the CNVMP as relevant, to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered and managed against NMLs / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites 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

As per Section 6.6.2 mitigation measures should include an allowance for **attended monitoring** (half day) **at the commencement of the first round of noise intensive works**. 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 VMLs (as set out in Section 5.1.3) appropriate action is to be taken.

6.7.3 Reporting

Where noise and vibration monitoring occurs as per Sections 6.8.1 and / or 6.8.2, 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 6.8.5.

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).

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)

Building Services

- As a mitigation measure, during the detailed design phase, further assessment and 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.
- The centralised plant will require acoustic screening / louvres plus ducted discharge to some areas.
- In duct attenuation will be allowed for equipment terminating at the façade.
- Acoustic louvres will be provided for dust extraction fans supplying wood and metal workshops.
- Enclosures and attenuators will be provided to the Fire Pump Room.

Loading Dock and Waste Collection

- All loading dock activities and waste removal to be undertaken between 7:00am and 6:00pm.

Workshops

- Windows and doors closed for noisy activities

Hall (out of hours)

- Windows and doors closed for noisy activities

Cleaning

- Where **cleaning** activities occur between 5:30-7am, the following should apply:
  - Ensure windows and doors are closed to limit noise emissions.
  - Air conditioning is not to be operated.
  - Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.

An **Operational Noise and Vibration Management Plan** shall be prepared to manage ongoing operational noise from the school.

7.2 Operating Hours

The following table outlines school operation hours and provides an overview of the anticipated school activities throughout a typical school calendar year. This will be developed further based on the specific requirements of the school, but currently informs the noise assessments in the followings sections.

Table 16 Operating Hours

Activity	Hours
School Hours	Between 8:30am and 3:30pm Monday to Friday
Recess and Lunch	Between 8:30am and 3:30pm Monday to Friday (Staggered throughout the day, expected total less than 4 hours)
Administration	8:00am to 6:00pm
After Hours Use of Hall	Occasional use of Hall up to 10:00pm
Waste Collection	Proposed outside of school hours Monday to Friday
Cleaning	5:30am to 6:00pm, Monday to Friday

7.3 Operational Noise Emissions

7.3.1 Noise from Internal Classroom and Administration Areas

An assessment of noise emission from all general internal spaces has been carried out which considers the following:

- Noise Source - Noise from within internal areas within the new buildings including administration and learning areas is expected to range between 70-75 dB(A), which considers a typical worst case noisy learning activity / setting.
- Windows Open – to provide natural ventilation.
- Noise Sensitive Receivers
  - Residential - across all bordering streets, with line of sight to the façade (approx. 30m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during day and evening period – 7am to 6pm which includes school hours and after hours usage.
- Distance and screening attenuation.

The following presents the results of the assessment of the expected noise impact from internal spaces within the new building.

Table 17 Predicted noise emission levels from internal classroom usage

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Residential (east)	<40	46	Yes – See notes below
Residential (west)	<40	49	Yes – See notes below

We note the following:

- Classroom noise is predicted to achieve PNTLs with windows open.
- Noise levels will fluctuate throughout the day. This assessment considers the typical worst case. Noise levels during periods where the indoor learning areas are used for structured learning activities to be significantly lower.
- With windows closed, noise levels at the boundary will decrease significantly, and be well within the PNTL target.

7.3.2 Workshops

An assessment of noise from workshop areas, including wood and metal GLS areas, has assumed the following:

- Noise Source and levels - Noise from within internal workshop areas within the new buildings including is expected to be up to 90dB(A), which considers a typical worst case noisy learning activity / setting with power tools.
- Windows and doors **closed**
- Noise Sensitive Receivers
  - Residential
    - across Nirmal St, with line of sight to the façade (approx. 30m).
  - Compliance achieved at this location will ensure compliance is achieved at all other locations.
- Time Period – noise during
  - Day period – 7am to 6pm which includes school hours
- Distance and screening attenuation

Table 18 Predicted noise emission levels from workshops

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Residential (East)	40	46	Yes

7.3.3 Hall

School Hours (7am – 6pm)

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

- Noise Source and levels - Noise from within internal gymnasium areas is expected to be up to 75dB(A), which considers a typical learning activities, presentations, and sports and music.
- Windows open – this includes roller doors and high-level louvres for natural ventilation
- Noise Sensitive Receivers
  - Residential - across Nirmal St, with line of sight to the façade (approx. 40m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during
  - Day period – 7am to 6pm which includes school hours
- Distance and screening attenuation

Table 19 Predicted noise emission levels from school gymnasium usage during School Hours

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Residential (east)	35	46	Yes
Residential (west)	< 30	49	Yes

Evening Use (6pm – 10pm)

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

- Noise Source and levels - Noise from within internal gymnasium areas is expected to be 85-90dB(A), which considers typical after hours usages such as night school, plus presentations, performances, sports and music.
- Windows both open and closed; this includes roller doors and high-level louvres for natural ventilation
- Noise Sensitive Receivers
  - Residential
    - across Nirmal St, with line of sight to the façade (approx. 40m).
    - across Guntawong St, with shielding to the façade (approx. 180m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during
  - Evening – 6pm to 10pm, which includes after hours use.
- Distance and screening attenuation

Table 20 Predicted noise emission levels from school gymnasium usage during after hours usage

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Residential (east)	45 - 50 (windows open)	40	No – see below
	< 35 (windows closed)		Yes
Residential (north)	< 40 (windows open)	42	Yes
	< 35 (windows closed)		Yes

- Noise levels from out-of-hours usage are predicted to exceed the PNTL at Nirmal Street residents with windows and doors open for natural ventilation. Therefore, we recommend the following mitigation measures to meet the PNTL:
  - Doors and windows are to remain closed

7.3.4 Cleaning and Maintenance

Cleaning and maintenance should be limited to daytime hours where possible (7am-6pm). Where cleaning activities occur between 5:30-7am, the following should apply:

- Ensure windows and doors are closed to limit noise emissions.
- Air conditioning is not to be operated.
- Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.

7.3.5 Operational Noise and Vibration Management Plan

An Operational Noise and Vibration Management plan should be prepared in order to manage ongoing operational noise from the school.

7.3.6 Public Address Systems

There is a potential for noise levels from public address system 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).

7.3.7 Playground Noise

Outdoor play areas, including active play (sports field and court areas) and passive play (assembly and open space areas) are shown in Figure 7.

- The design of the school has located the playground areas away from boundaries facing noise sensitive receivers with shielding provided by building layouts.
- There is no clearly defined criteria for school playground noise. The AAAC Guideline for Child Centre Assessment is considered relevant as the industry best practice for school playground noise assessment.
- Predictions indicate that playground noise are within the recommended levels when applying the AAAC guidelines.

Figure 7 Play areas (in red) for the proposed activity (Source: djrd)

An assessment of playground noise level impacts on the surrounding residential receivers and adjacent public school assumes the following:

- Play activities at all passive and active areas for the high school, including a mix of active and passive play from all pupils.
- Noise levels of students playing outdoors as displayed in Table 21. These numbers have been determined by using the method adopted from the AAAC Guidelines, as well as measurements taken by Acoustic Studio of school play area noise at other schools projects, during play activities.

Table 21 Sound power levels used for the assessment of play areas

Source Type	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Active Play (per 10 children)	87	64	70	75	81	83	80	76	72	87
Passive Play (per 10 children)	81	58	64	69	75	77	74	70	66	81

The results of the assessment of noise during pay times are presented below.

Table 22 Predicted play area noise from the proposed activity

Residential Receiver	Predicted Noise Level Leq (15 min) dB(A)	Play Noise Screening Target Leq (15 min) dB(A)
Residential (East)	42	41
Residential (North)	43	44

We note the following:

- Through strategic site planning major active play areas and courts have generally been located central to the site and away from the site boundary and uses the buildings around the perimeter of the site to minimise noise impact to surrounding receivers shield much of the noise generated.
- Play noise is generally only generated for short periods per day.
- Predicted noise levels during periods of the day when using the outdoor play areas (i.e., recess and lunch - when **half** of the student faculty are in **active play** and the **other half are in passive play**) is marginally above screening noise target for the worst-case scenario assessment. Noise levels during periods where the outdoor areas are used for structured learning activities will be significantly lower.
- When considering the NSW EPA *'Noise Guide for Local Government'* offensive noise checklist:
  - Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?
    - The experienced noise from children in play areas is not loud in an absolute sense. It is also not loud compared with the existing daytime ambient noise levels in the area.
  - Q2: Does the noise include characteristics that make it particularly irritating?
    - Play areas are not considered to generate characteristics that are particularly irritating when assessed against the modifying factors in the NPI.
  - Q3: Does the noise occur at times when people expect to enjoy peace and quiet?
    - No, it occurs during daytime hours only.
  - Q4: Is the noise atypical for the area?
    - This is a new source of noise for the area, but is not atypical of a residential neighbourhood.
  - Q5: Does the noise occur often?
    - This will occur during weekdays, during limited daytime hours.
  - Q6: Are a number of people affected by the noise?

- This noise will be experienced by residences bordering the site.

Based on the above, noise from outdoor play areas is not considered offensive and no additional mitigation measures are required.

7.3.8 Building Services

General

As a mitigation measure, during the detailed design phase, further assessment and 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:

- The centralised plant will require solid acoustic screening / louvres and ducted discharge to some areas.
- **In duct attenuation** will be incorporated for equipment terminating at the façade.

At this stage, final plant selections have not been made; therefore, a detailed assessment has not been carried out. Any new items of plant will be reviewed to ensure that noise emissions meet the applicable environmental noise criteria in Section 5.2.

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.

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

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.

- Major plant areas are shown in Figure 8.
- The nearest potentially affected receivers are:
  - Residential receivers to the north (Guntawong Rd) and East (Nirmal St).
- The most restrictive criterion for the plant operating is as follows (unless otherwise noted below).
  - Day (7am to 6pm) – 46 dB(A)
  - Evening (6pm to 10pm) - 40 dB(A)
  - Night (10pm to 7am) - 35 dB(A)
  - 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.

- Out of hours use of the school facilities may require plant to be operational during the evening period (6pm-10pm).
- Comms room – a small number of separate condenser will supply communications rooms and operate 24 hours per day.

Condenser Units and Major Plant

Condenser units are proposed to be located within the activity as shown below.

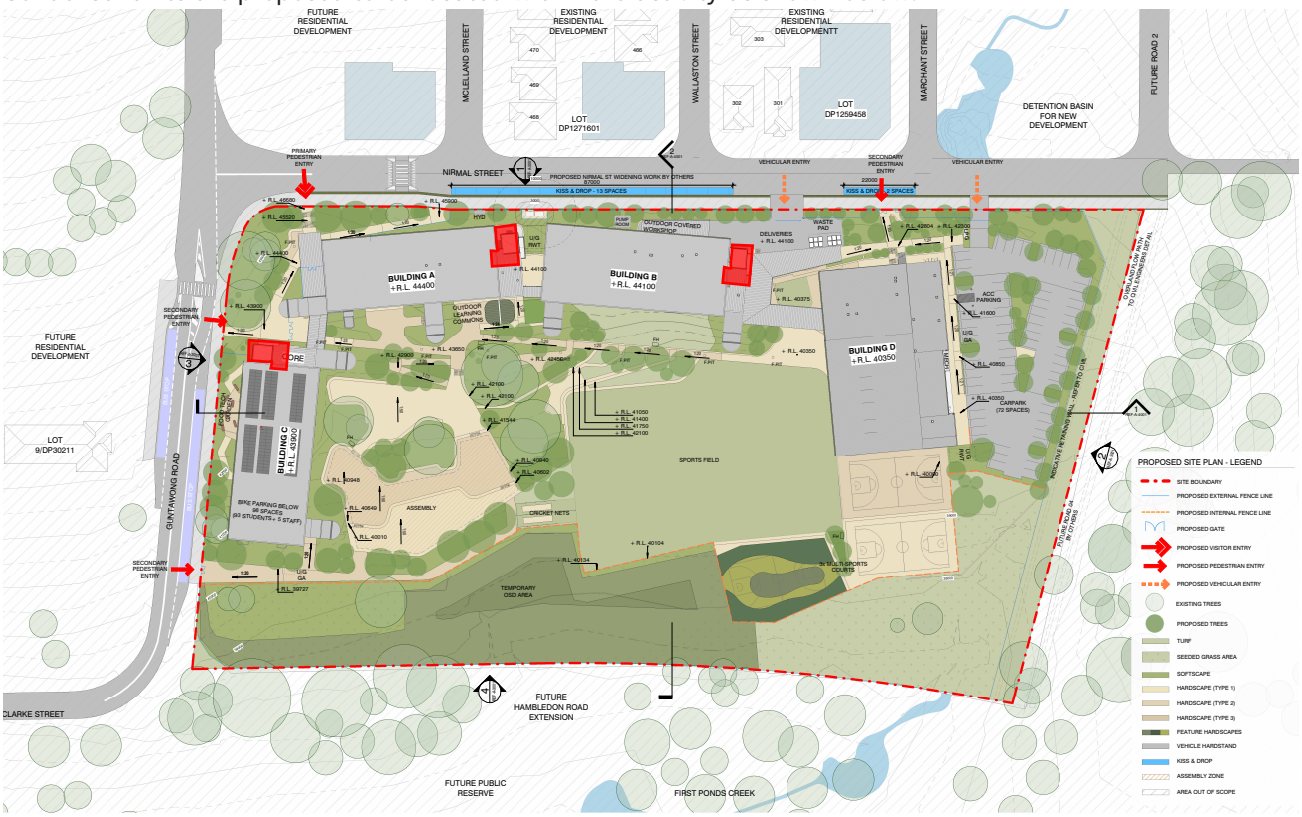


Figure 8 Major plant areas (shown in RED)

Treatment to the plant areas is to include the following:

- Incorporate solid screening / barriers or acoustics louvres extending 500m above the top of the condenser units and fans, plus ducted discharge.

Exhaust and Fresh Air Fans

Details of the selections have not yet been finalised at this stage, we note the following:

- Incorporate solid screening / barriers or acoustics louvres plus canopies and ducted discharge extending 500m above the top of the condenser units and fans.
- Internally lined ductwork for the exhaust / discharge side of the fan will be allowed for to ensure the selected fans meet the noise criteria at the boundary.
- Larger fans such as outside air and relief air fans for the gymnasium will allow for attenuators as required to ensure the selected fans meet the noise criteria at the boundary, including during evening operation.
- Dust extraction fans to be situated behind acoustic louvres in dedicated plant rooms

Dust Extraction Fans

- Dust extraction fan plant rooms will include acoustic louvres for ventilation.

Fire Pump Room

The design will include:

- Masonry wall enclosure with acoustic doors
- Attenuators and silencers to achieve 70 dB(A) @ 1m from intake and discharge

7.3.9 Traffic Noise Generation – On-Site

The following on-site traffic areas have the potential to generate noise from traffic or vehicles, and are shown in Figure 9.

- New car park
- New deliveries and waste collection area

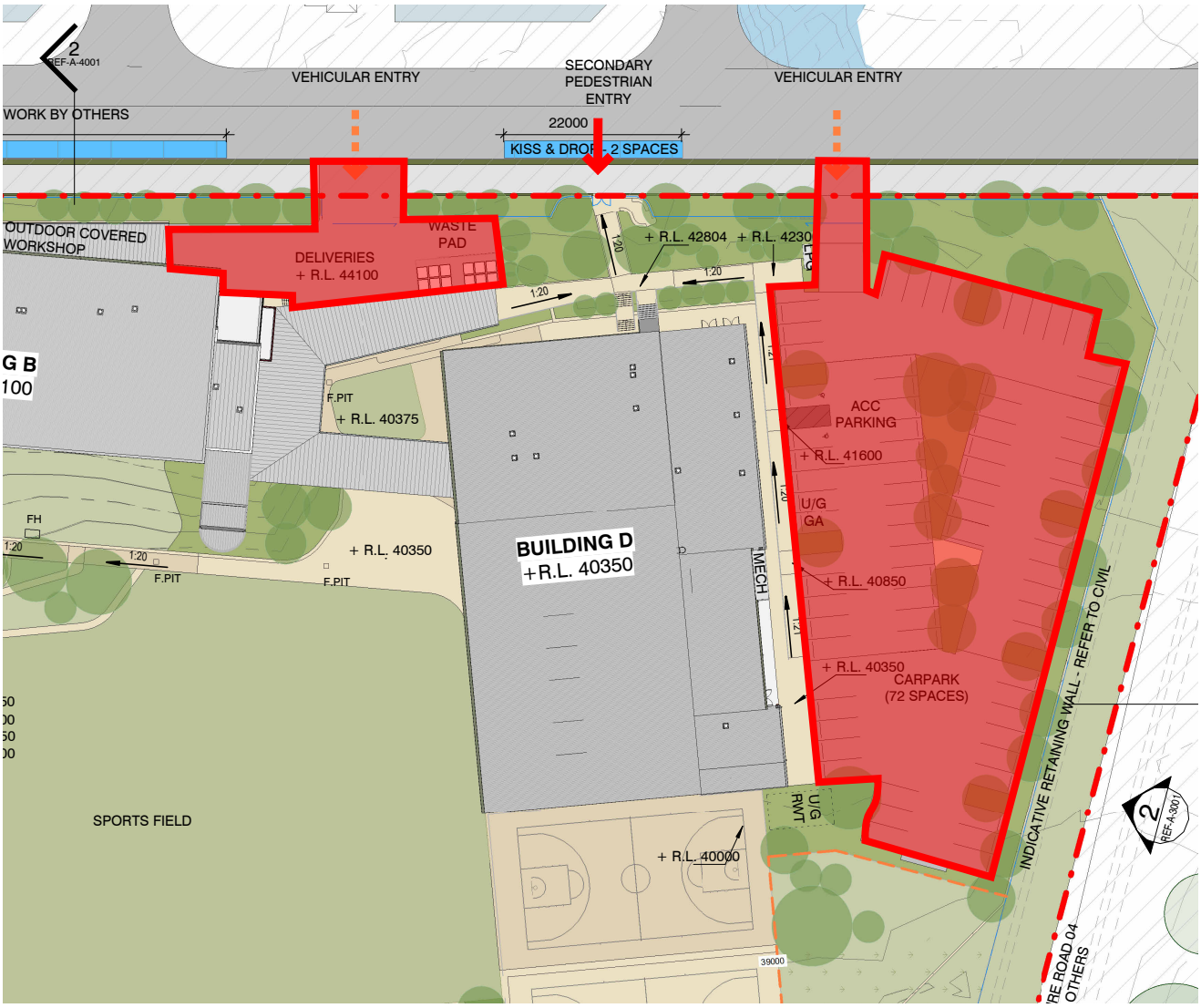


Figure 9 Car Park and Deliveries Areas (shown in RED)

Car Park

Summary

Noise emissions from the on-site car park are predicted to comply with the relevant criteria, with no further mitigation measures required.

The new car park is located to the south of the site, is proposed to include 72 spaces and will be accessed from Nirmal St, as shown in Figure 9.

Assessment of Noise Impact on Surrounding Receivers

As a worst-case scenario the car park noise assessment has considered the following, with input from the Traffic Consultant for both AM and PM peak-hour times:

Table 23 Staff Car-Park peak hour vehicle movements

Location	Vehicle Type	Peak Hour Movements (Maximum over 15-minutes)	
		AM	PM
Staff car park	LV	22	22
	HV	0	0

The predictions in the following section consider the following:

- Distance attenuation (calculated from the centre of the car park)
- Ground and building reflections
- Typical traffic noise data as presented in Appendix D.2.
- Compliance with the criteria at this location ensures compliance at all others.

The results of the car-park noise emission predictions are presented in Table 24 below:

Table 24 Car park operational noise assessment results at receiver boundary, no mitigation.

Assessment Location	Predicted Noise Level (dB(A) $L_{eq\ (15\ minute)}$) (AM/PM Peak Hour)	NPI Criteria (dB(A) $L_{eq\ (15\ minute)}$)	Complies?
Nearest Residential Receivers to the north-east, at Nirmal Road (approx. 50m)	36	46 (Day 40 (Evening)	Yes

Acoustic Studio has further considered noise impacts on surrounding receivers as follows:

- Car park will be used generally for daytime hours only, and may include controls such as gate access to limit public/after-hours usage.
- Speed limits will reduce the noise emissions from vehicles accessing/navigating the car park.

Deliveries, Loading Bays and Waste collection

The delivery, loading and waste storage area is proposed to be located to the south-east of the site near Nirmal St, with access to Nirmal St, as shown in Figure 9.

Limited information is available on deliveries.

Based on information provided by the waste consultant, waste collection will typically include:

- General Waste: 13 x 1100L bins collected 3 times weekly
- Recycling: 10 x 1100L bins collected 3 times weekly

To ensure minimal impact and to not cause sleep disturbance all delivery, loading and waste removal activities are to be undertaken between 7:00am and 6:00pm.

7.3.10 Traffic Noise Generation – Off Site

Summary

Noise impacts as a result of the additional traffic on the public roads as a result of the project operation are not expected to result in any adverse noise impacts.

The proposed project will generate additional traffic including Light Vehicles (LV), Heavy Vehicles (HV) and busses on the surrounding road network, plus kiss and ride zones.

Acoustic Studio has considered this additional traffic generation and predicted the potential noise impacts.

Traffic on Surrounding Roads

Assessment Considerations

Following a review of the traffic data provided by the traffic consultant (SCT), we note the following:

Traffic Periods

- Predicted AM peak vehicle volumes fall within 8:00-9:00 am, and within 3:00-4:00 pm for PM (which falls within the RNP day-time period of 7:00-10:00 pm)
- Traffic generated as a result of the project operation will be minimal outside of these times.

Road Classification

All nearby roads presented are considered local roads, and assessed as $L_{eq\ (1\ Hour)\ (External)}$

Traffic Data

The predicted worst-case traffic volumes (busiest 1-hour AM and PM periods) on streets surrounding the project are presented in Table 25.

Table 25 Traffic Movements on roads surrounding the project

Peak-hour vehicle movements									
Location	Type	Existing Background		Future estimate 'no activity' on road movements (2040)		Activity vehicle generation		Activity vehicle generation + all other on-road traffic	
		AM	PM	AM	PM	AM	PM	AM	PM
Guntawong Rd / Clark St (Immediately west of the intersection with Tallawong Rd)	LV	1057	709	1311	876	165	165	1476	1041
	HV	12	21	15	26	0	0	15	26
Nirmal St	LV	10	7	12	9	165	165	177	174
	HV	0	0	0	0	0	0	0	0
Wallaston St	LV	21	15	26	19	0	0	26	19
	HV	0	0	0	0	0	0	0	0
Marchant St at intersection with Tallawong Rd	LV	31	22	29	24	165	165	194	189
	HV	0	0	0	0	0	0	0	0
Tallawong Road Immediately south of Guntawong Road	LV	517	407	644	508	165	165	809	673
	HV	10	15	12	19	0	0	12	19

Assessment

Based on the numbers provided in Table 25, we make the following notes based on the increase of traffic generated as a result of the project on local roads:

Table 26 Traffic noise assessment – local roads

Road	Road Traffic Noise Impacts (Local Roads)					
	Existing Traffic Noise Levels $L_{eq\ (1\ Hour)}$ dB(A)		Predicted Traffic Noise Levels 2040 with Activity $L_{eq\ (1\ Hour)}$ dB(A)		RNP Criteria Residential Local Roads – $L_{eq\ (1\ Hour)}$ dB(A)	Complies?
	am	pm	am	pm	Day (7am-10pm)	
Guntawong Rd / Clark St (Immediately west of the intersection with Tallawong Rd)	See Notes Below				55	See Notes below
Nirmal St	40-45	40-45	55-60	55-60	55	
Wallaston St	45-50	45-50	55-60	55-60	55	
Marchant St at intersection with Tallawong Rd	45-50	45-50	55-60	55-60	55	
Tallawong Road Immediately south of Guntawong Road	See Notes Below				55	

We make the following comments:

- Noise from existing Guntawong Rd and Tallawong Rd traffic is already measured to be above the RNP criteria. The expected increase is predicted to be less than 2dB in relation to the existing traffic noise level and is considered to be a minor impact and barely perceptible to the average person.
- Noise levels from traffic generated by the operation of the project are generally predicted to be marginally above the relevant RNP noise criteria (which may be up to 5dB as a worst-case) for **residential properties** on **local roads** during the **peak periods (drop off and pick up times)**.
- With respect to the above, we make the following comments
  - The RNP provides examples of strategies to mitigate noise from traffic-generating developments on existing roads, including the following, where considered reasonable including:
    - Location of private access roads
    - Regulating times of use
    - Noise barriers
    - Property treatment
  - The kiss and drop has been located away from Guntawong Road to reduce congestion and maintain safety around the school.
  - A difference of 5dB would be a clearly noticeable change, however the prediction of up to 5 dB above the traffic noise criteria is a worst case prediction that would only occur during the typical 8:00am to 9:00am and 3:00pm to 4:00pm peak drop off and pickup times. This is also during the Daytime (7am to 6pm) at the busiest and least sensitive times of the day.
  - All other times outside of peak times are expected to experience similar noise levels to existing conditions.
  - Engineering controls such as noise barriers are not considered practical to implement on a local residential street when considering access requirements (driveways) and other impacts such as visual amenity.

- Property treatment is generally considered as a last resort. We understand other guidelines exist where 65 dB(A) $_{\text{Leq 15 hour}}$ is referenced as a trigger to identify when a receiver qualifies for consideration of noise mitigation.
- Predictions include the 2040 no-activity traffic increase projections for the area, which captures the worst-case assessment.
- Further detail of mitigation measures are provided in the Transport and Accessibility Impact Assessment report prepared by STC.
- The design and activity phase will be used to inform and implement feasible and reasonable noise mitigation measures.

Kiss and Ride Zones

The kiss & ride areas and traffic volumes for this project are displayed in Figure 10 and Table 25.

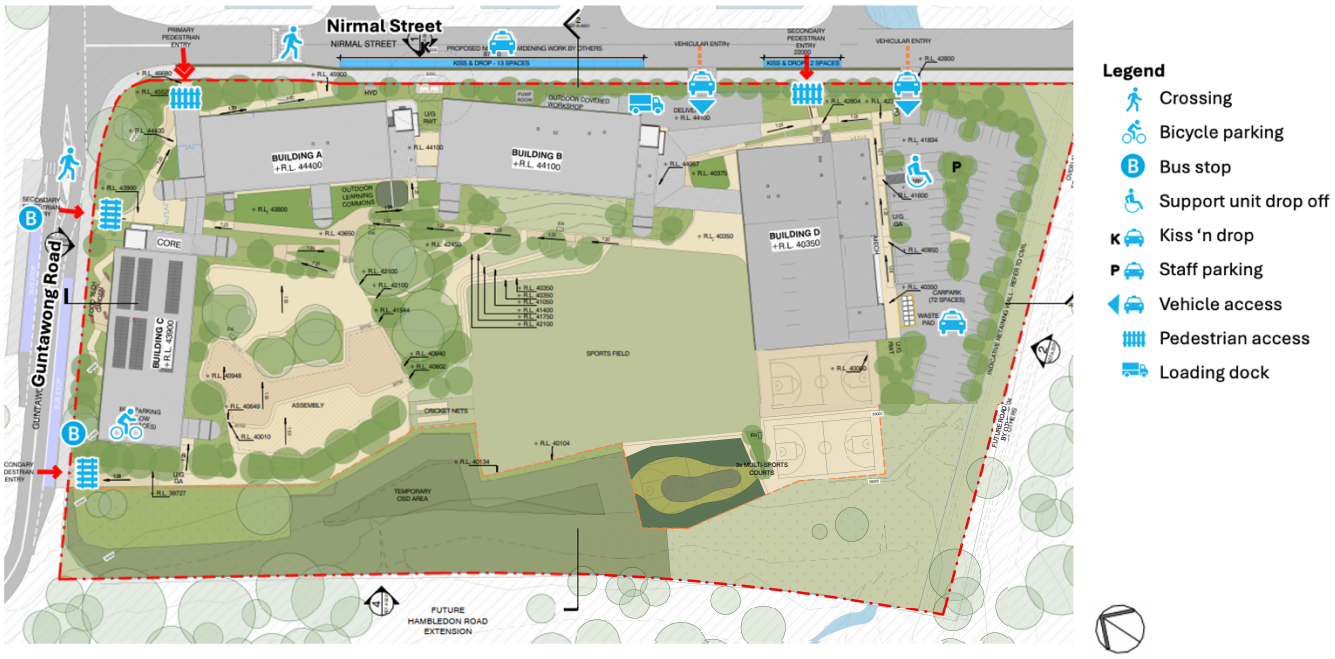


Figure 10 Kiss and Ride Zone(s) – Nirmal St (source: STC)

Table 27 Kiss and Ride traffic movements – peak hour

Location		Peak Hour Movements	
		AM	PM
Nirmal St	LV	165	165
	HV	0	0

These numbers represent the number of vehicles accessing the kiss and ride areas, and are included in the total traffic volumes as displayed in Table 25.

Noise levels generated by kiss & ride area access considers the following:

- Kiss and Ride usage will generally be limited to the morning and afternoon peak hours (in alignment with vehicle peak hours i.e. 8:30-9:30am and 3:00 to 4:00pm), which are captured within the off-site vehicle movements assessment.
- Distance attenuation to the nearest residential receivers (approx. 15m).
- Noise sources considered as per Appendix D.2 specifically vehicles accelerating, engines starting, doors closing, plus people talking. This assessment does not include traffic moving at constant speed (which is considered in Table 26)

The results of the kiss & ride areas noise assessment are presented below:

Table 28 Kiss & Ride Noise Assessment

Assessment Location	Predicted Noise Level (dB(A) $L_{eq\ (1\ Hour)}$)	RNP Criteria, (Day 7am-10pm) dB(A)	Complies?
Residential receivers, Nirmal Road	40	55 (Residents on Local Roads – $L_{eq\ (1\ Hour)}$	Yes

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

Summary of External Noise Intrusion Impacts

Road Traffic noise is the main external noise source with potential to impact on the activity.

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.

8.1 External Noise Sources

8.1.1 Road Traffic

Road Traffic noise are identified as the main noise sources with potential to impact on the site. Measured noise levels at the school boundary are shown in Table 29.

Table 29 Traffic Noise Levels at School Boundary

Receiver Type	Measured Noise Level Day (7am to 10pm) L_{Aeq} (period)
Gunatawong Road Boundary	68 (1 hour) dB(A)

Based on the noise levels in Table 29, internal noise level criteria in Section 5.3 will be achieved with windows closed with standard façade and window construction described in Section 8.2. Therefore, no additional acoustic treatment is required.

8.1.2 Rail Noise

The nearest rail line is more than 1km from the site. Therefore, no noise controls are required for rail noise and will not need to be considered further in the design.

8.1.3 Aircraft Noise

Aircraft noise impacts on the proposed site have been considered.

AS2021:2015 suggests relevant internal noise level targets to be considered (as per Section 5.3.2), and furthermore, it suggests assessment is not necessary for buildings situated:

a) Within **15 km** of an **international** airport, major domestic airport, or major military aerodrome.
b) Within **10 km** of a **domestic** airport with regular scheduled public transport services.
c) Within **5 km** of any **other** type of aerodrome for which an ANEF chart is available.

The closest airports to the project site include :

- Future **Western Sydney Airport (WSI) (International)**
  - The project site lies approximately 21 km to the west of the WSI. ANEF zones are not yet finalised and published for the relevant Western Sydney Airport, however the proposed project lies outside of the Australian Noise Exposure Concept (ANEC) contours which are a precursor to the ANEF for new airports.
  - Analysis of the WSI *Environmental Impact Statement* and the WSI *Airport Aircraft Overflight Noise Tool* show that this location falls outside of the selected noise contours for WSI, but state that for this specific project location *'... you may still see and hear aircraft flying to and from WSI at a noise level of around 42 decibels.'*
  - The project site is more than 15km from this airport (as per point 'a)' above)

Based on the above, whilst aircraft noise may be audible from flyovers from each of these airports, the project does not require a detailed aircraft noise assessment, and relevant internal noise levels are predicted to be achieved with windows open and no further upgrades to the standard building facade.

8.2 Noise Intrusion to Internal Areas - Façade Acoustic Treatments

Internal noise levels in all occupied spaces are able to be achieved with windows and doors closed and the following minimum façade performances which are achieved by the proposed design without any additional acoustic treatment:

- Glazing - Rw 30-32
- External Walls - Rw 40-45.
- Roof - Rw 30-35.

Windows and doors are not required to be closed at all times, but have the ability to do so to limit noise intrusion when required.

Mechanical ventilation (fresh air) is provided to all occupied spaces to ensure compliance with windows and doors closed.

8.3 Noise Intrusion to External Areas - Impact to Playground

The impact from traffic noise has been considered in the strategic location of major active and passive play areas, and orientation of buildings.

External noise impacts from traffic on open space for passive and active use areas of the schools have been predicted to be within the recommended RNP criteria of 60dB LAeq(15hour) (active), and 55 dB LAeq(15hour) (passive).

9 Summary of Assessment and Mitigation Measures

This NVIA has been carried out to determine the potential noise impact and considerations for the proposed high school.

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 of this NVIA 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. Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse vibration impacts to surrounding residential, commercial, and recreational receivers are minimised.

Cumulative Impacts

At this stage information on the timing and progression of the new high school indicates that residential sites to the east of Nirmal road could be in construction or overlap with a similar time as the school.

The Contractor for the project will need to collaborate with proponents if any developments or construction works in the vicinity of the high school is identified. Cumulative impacts of noise and vibration will be in the CNVMP as relevant, to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered and managed against NMLs / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites 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.

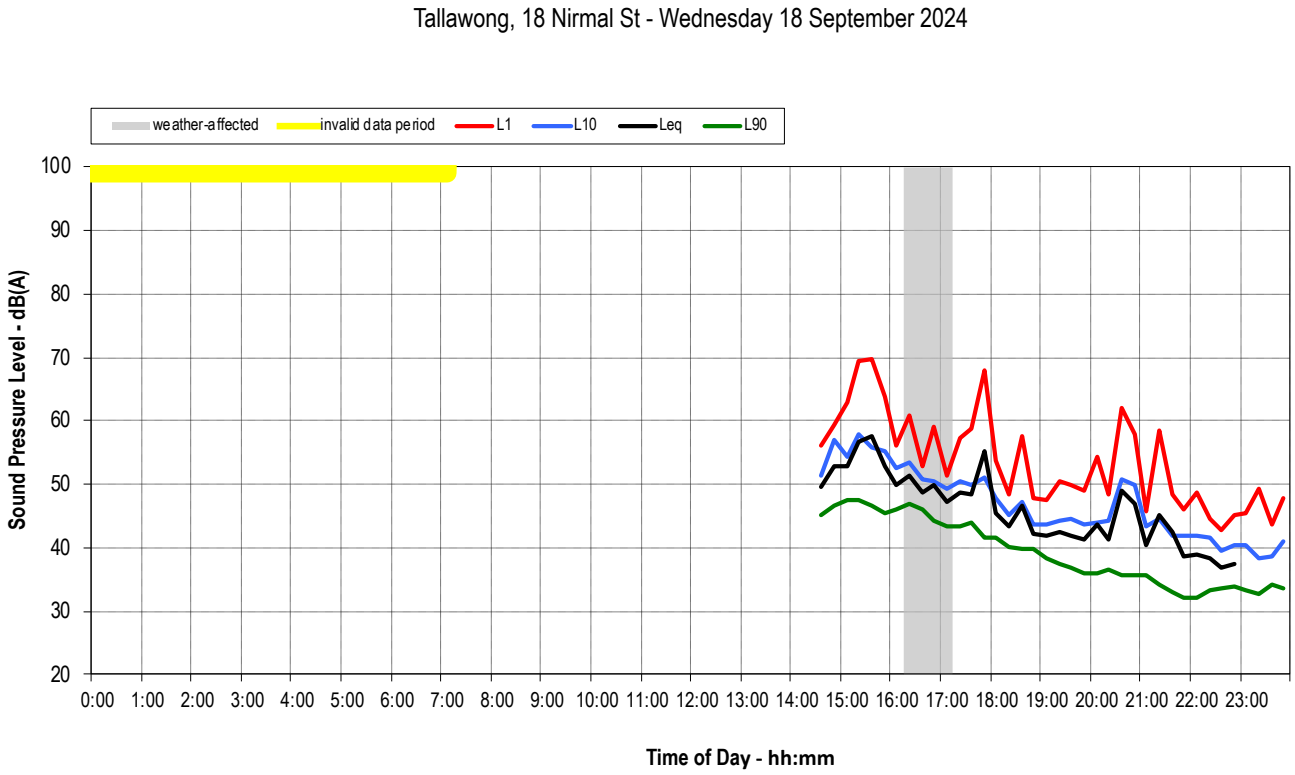
9.2 Operational Noise

Operational noise from the activity is capable of meeting the relevant noise criteria set out in this NVIA, provided noise mitigation measures 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 mitigations measures (where applicable) are provided below:

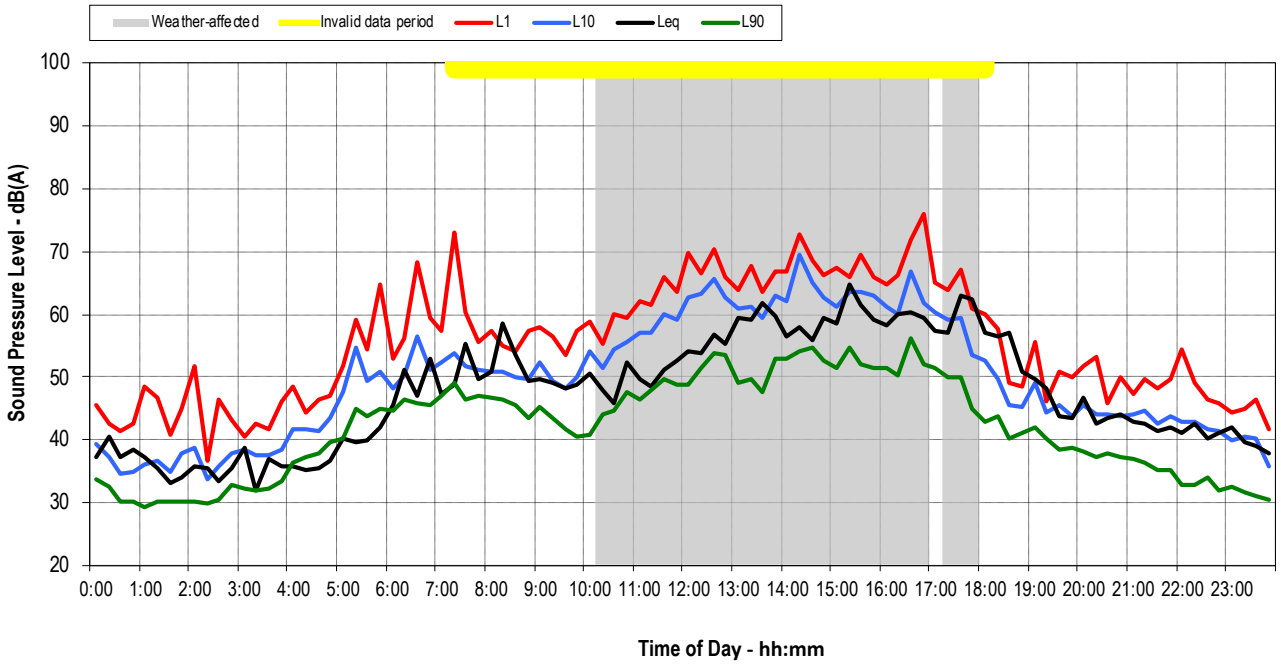
- **General classroom noise** with windows open is predicted to meet the relevant criteria at the receiver boundaries no mitigation measures.
- **Workshops** – Workshops will require windows and doors to be closed for noisy activities.
- **Public Address Systems** should be limited to 7am to 6pm and incorporate good practice design and set at the lowest level practical whilst still achieving intelligibility requirements.
- **Hall operations** during school hours are predicted to meet the relevant criteria with no mitigation measures**. Doors and windows** will need to **be kept closed during out of hours use**. Mechanical fresh air will be provided to ensure adequate ventilation.
- Where **cleaning** activities occur between 5:30-7am, the following should apply:
  - Ensure windows and doors are closed to limit noise emissions.
  - Air conditioning is not to be operated.
  - Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.
- **Playground noise** is generally able to meet the relevant targets during limited daytime hours with no further mitigation measures. Where the noise levels exceed the noise targets, they are not considered offensive, and deemed acceptable.
- **Basketball courts** and **playing field** use are predicted to meet the relevant receiver criteria with no further mitigation.
- **Building Services**
  - Rooftop condenser plant areas will require acoustic screening / louvres
  - In-duct attenuation will be allowed for equipment terminating at the façade.
- **Traffic noise** as a result of the project from both on and off-site sources is predicted to meet the relevant criteria with no mitigation measures required. This includes:
  - Traffic on surrounding roads (off site)
  - Staff Car Park (on Site).
  - Waste collection: is to be carried out between 7am and 6pm.

Appendix A Noise Logger Data

A.1 Logger 1 (18 Nirmal St)



Tallawong, 18 Nirmal St - Thursday 19 September 2024



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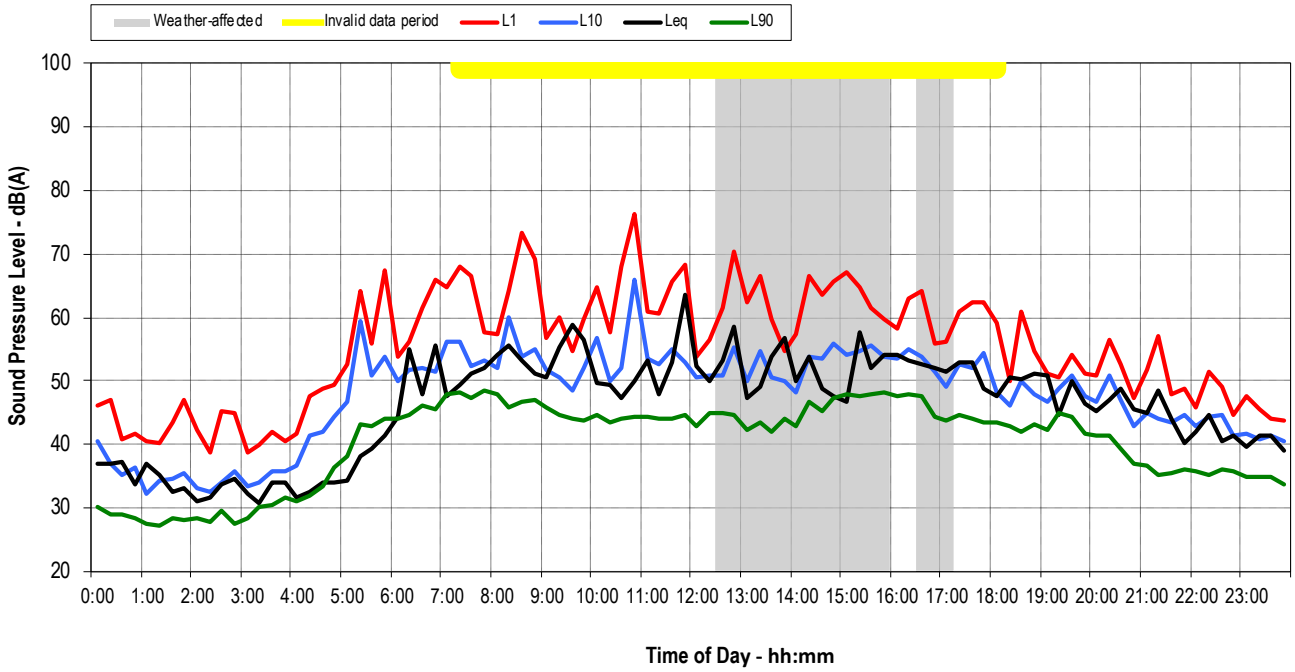

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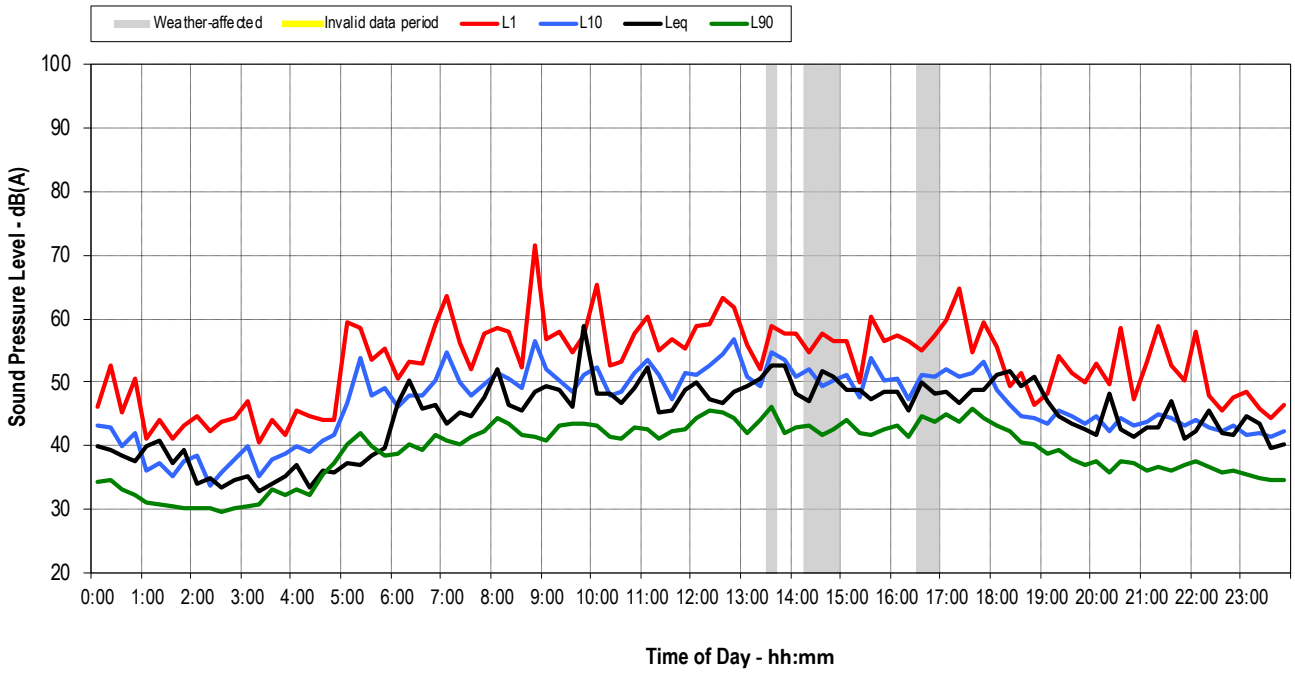
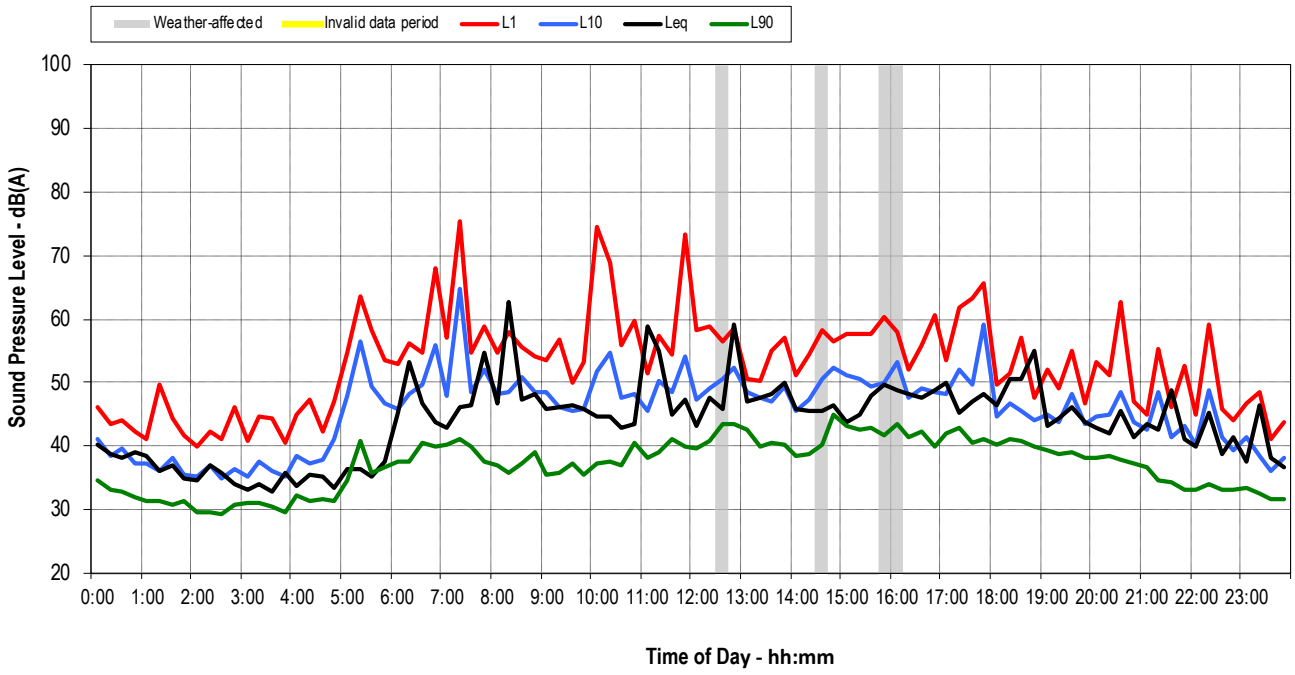
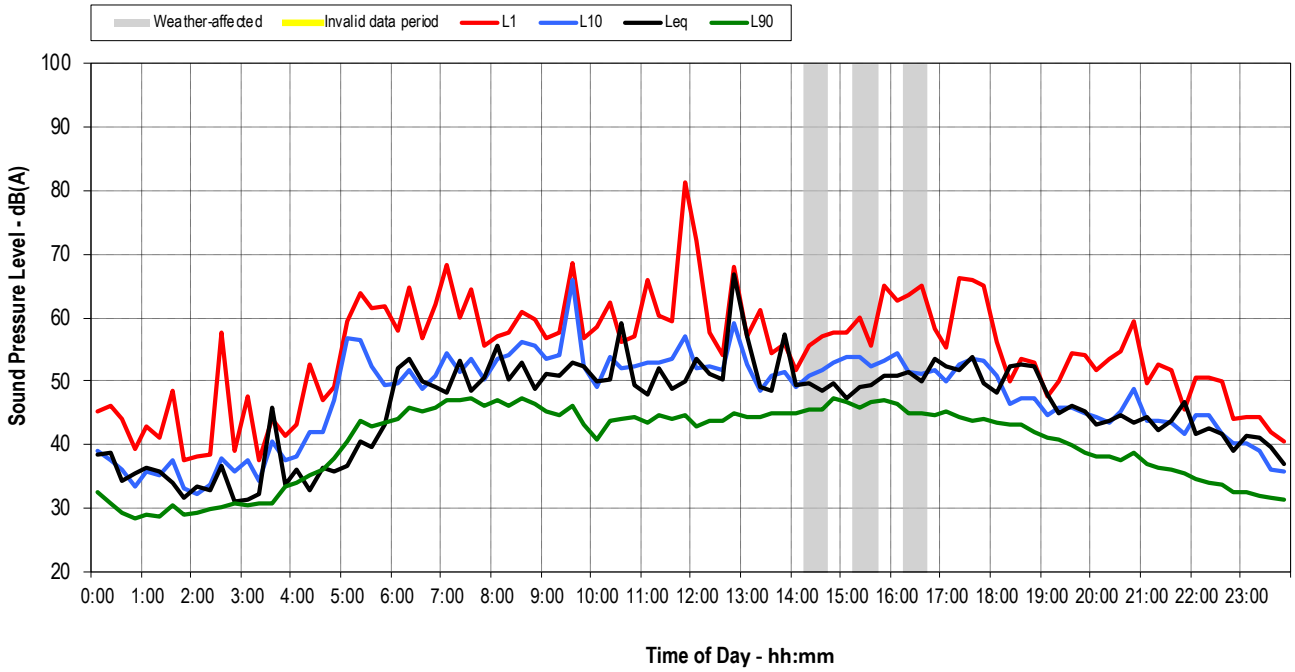


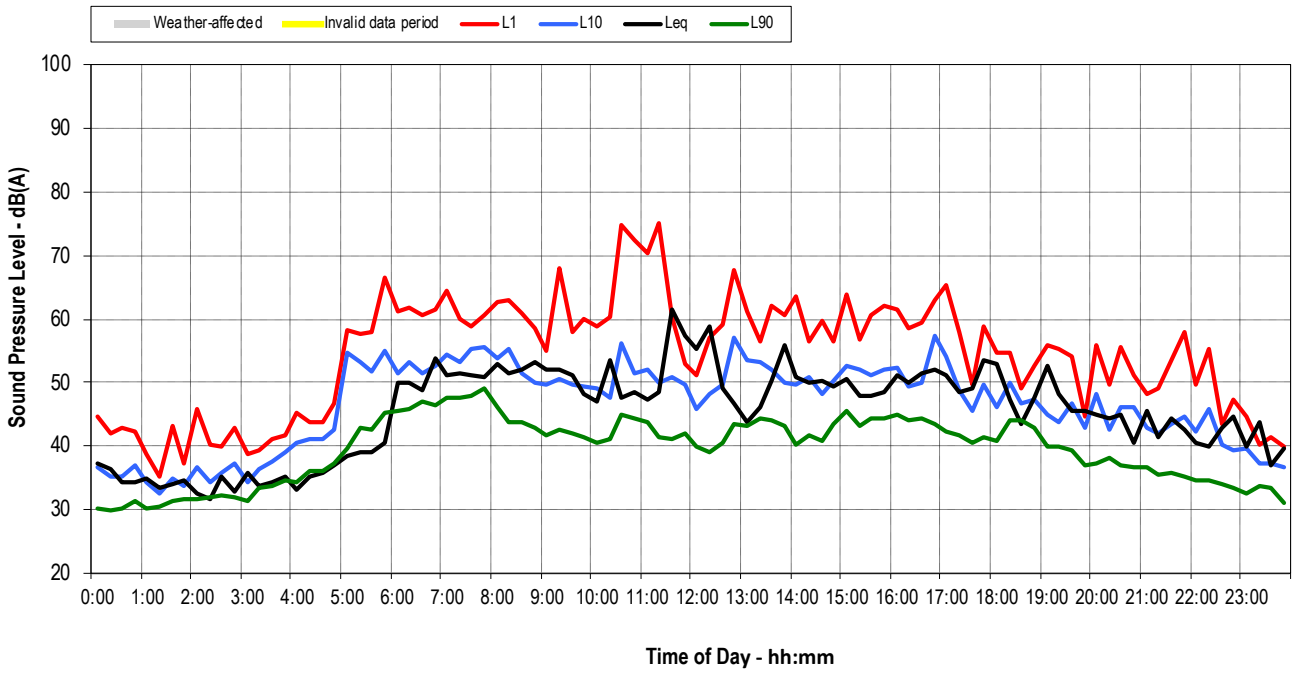
Tallawong, 18 Nirmal St - Sunday 22 September 2024



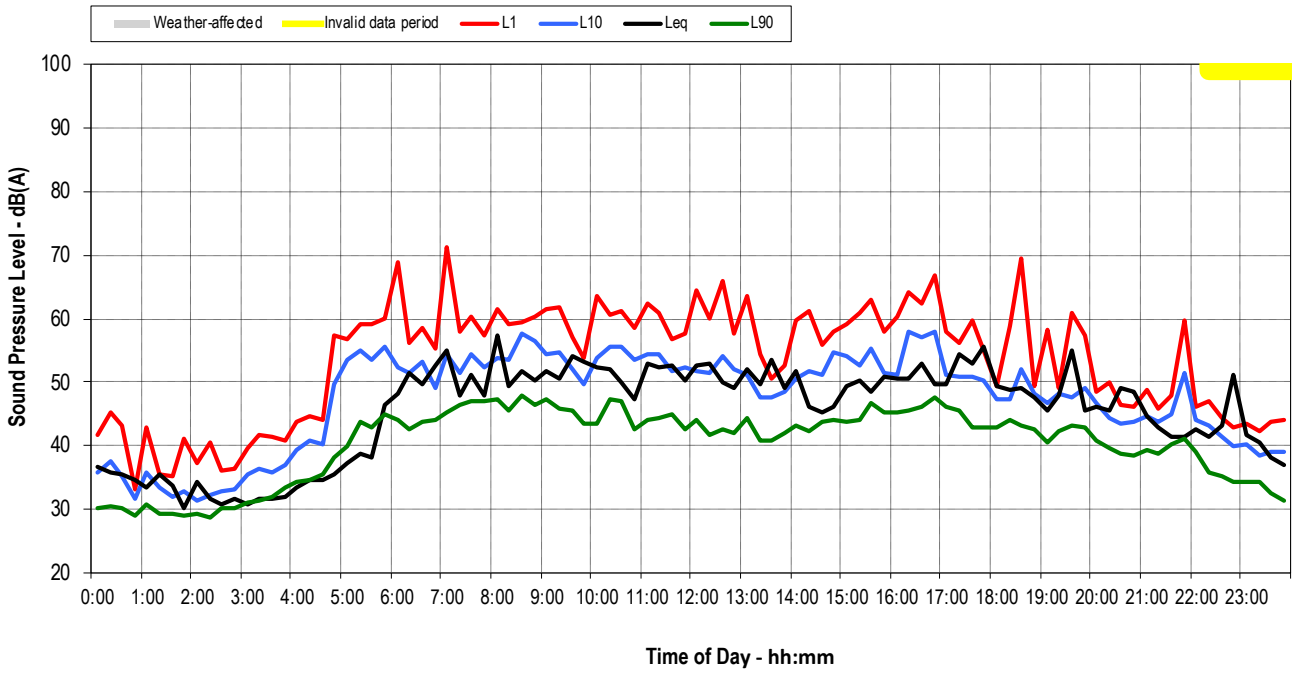
Tallawong, 18 Nirmal St - Monday 23 September 2024



Tallawong, 18 Nirmal St - Tuesday 24 September 2024



Tallawong, 18 Nirmal St - Wednesday 25 September 2024



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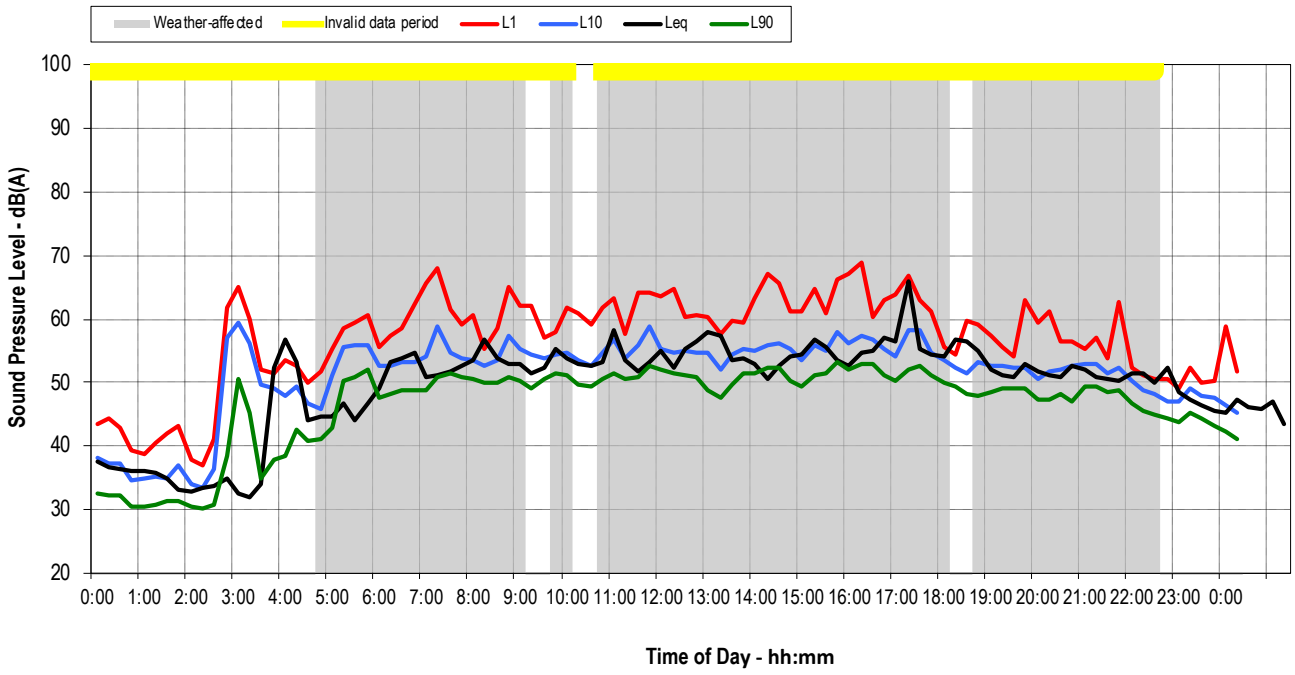

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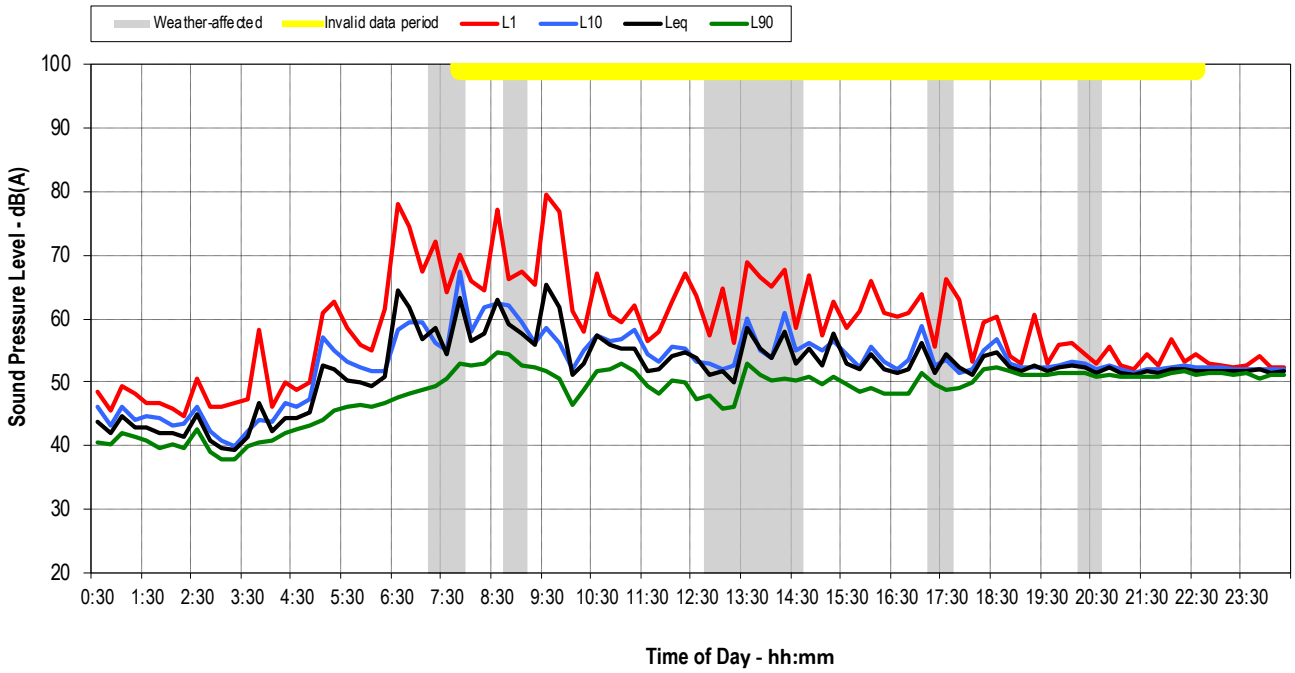

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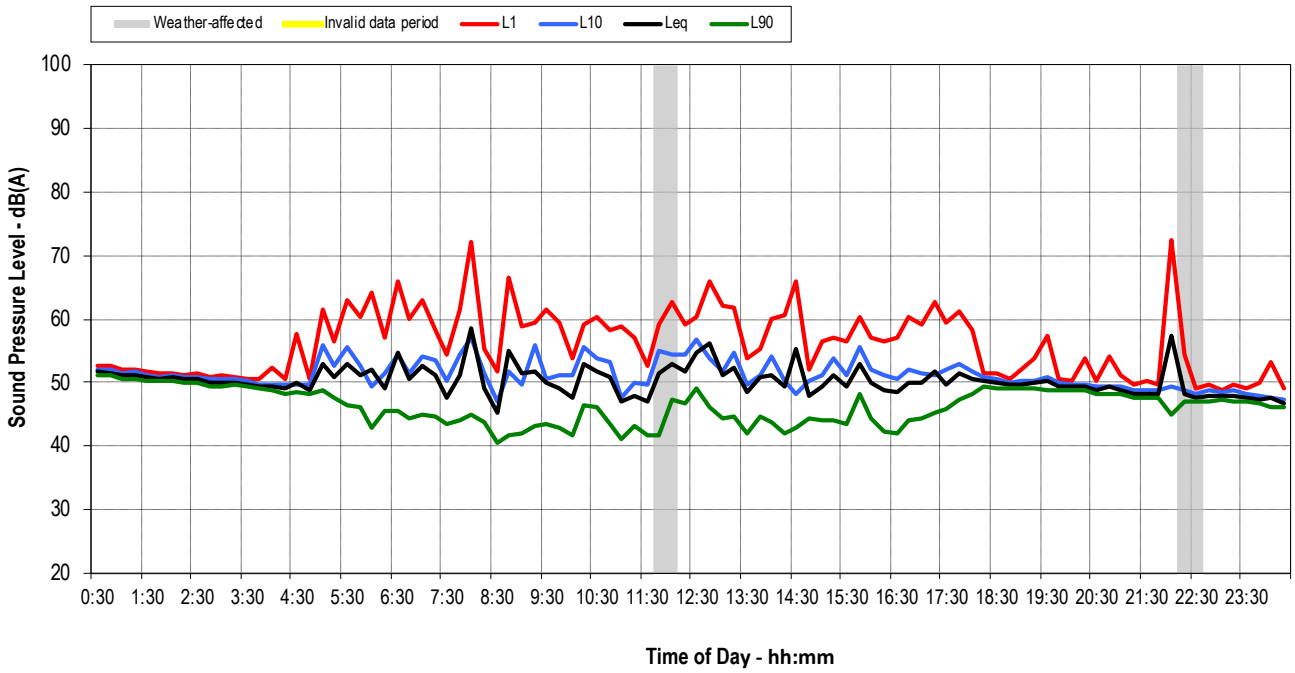

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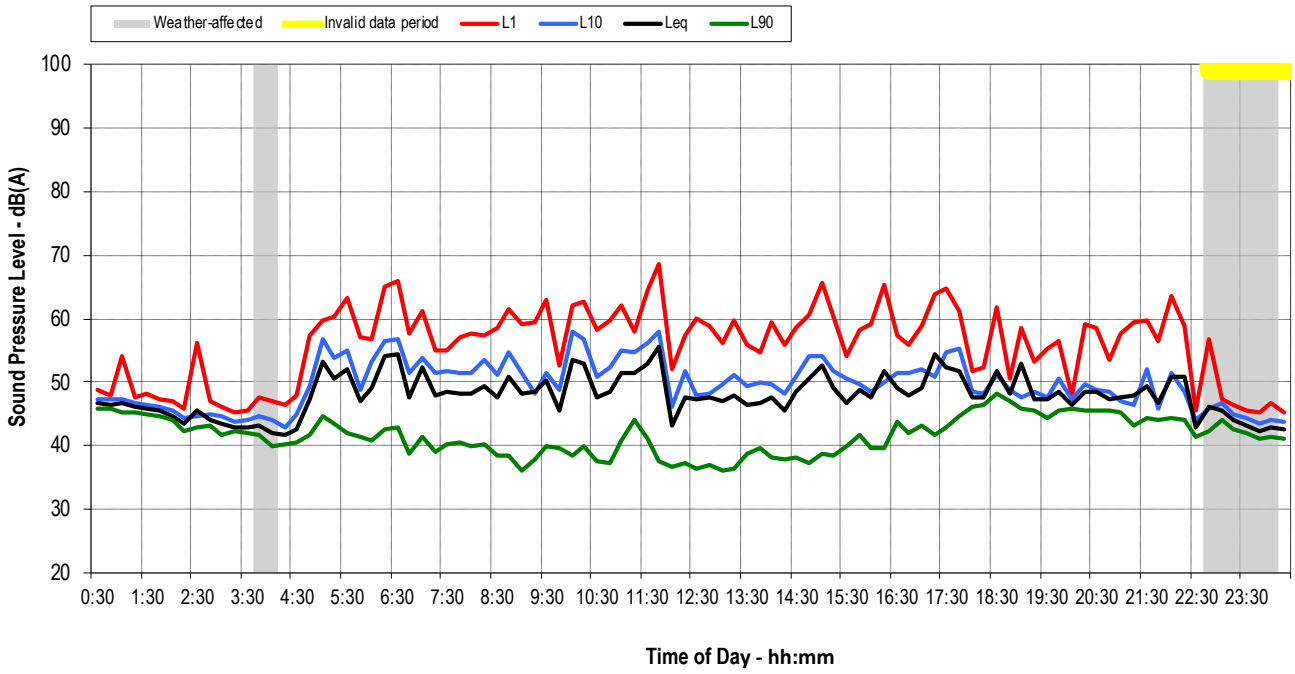

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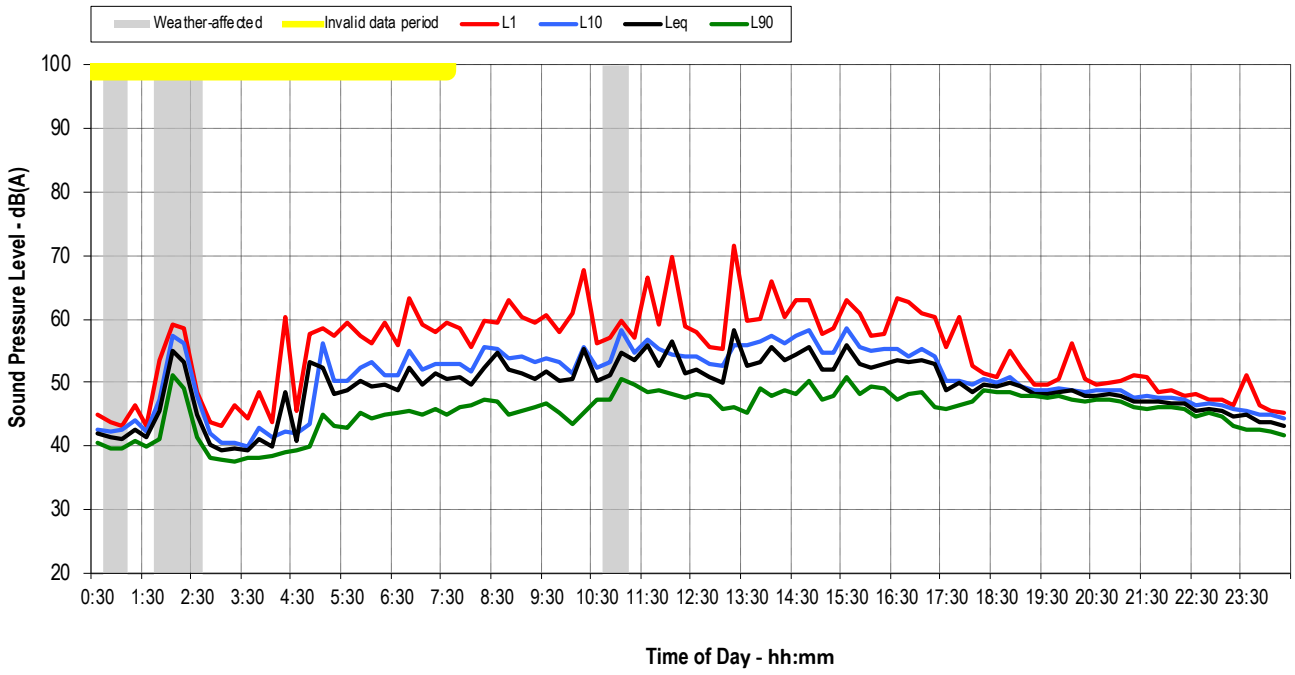
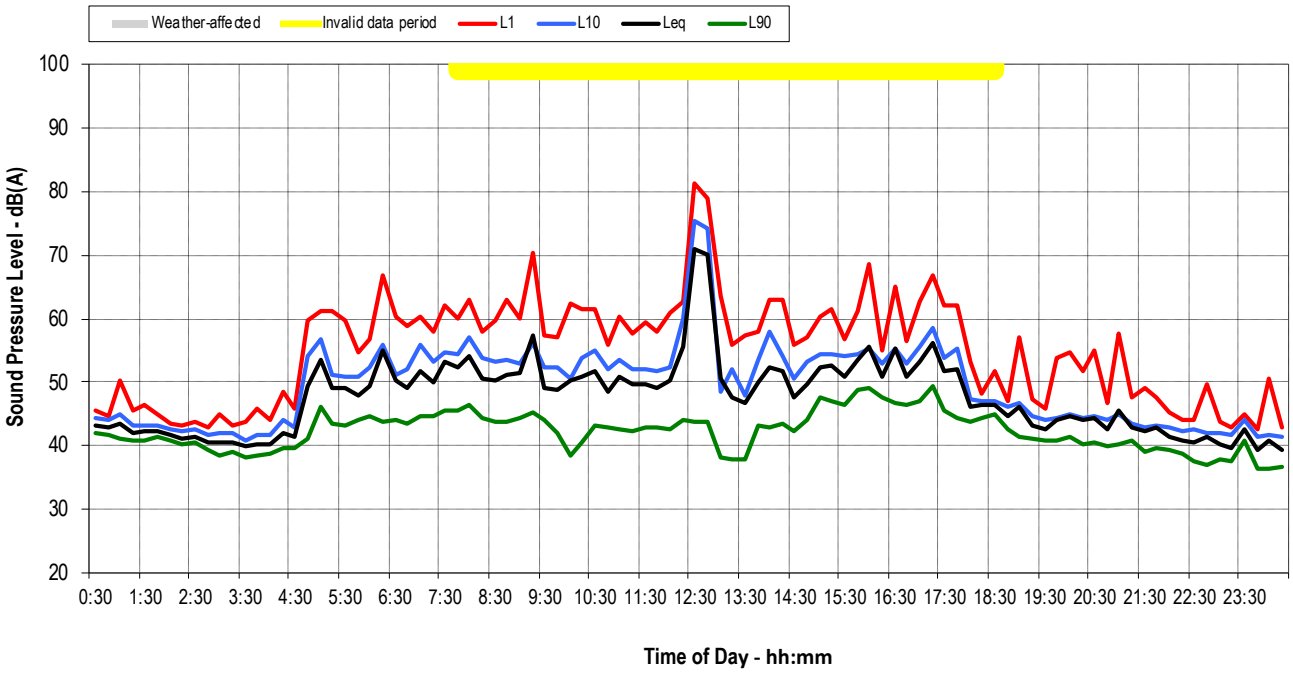


Tallawong, 18 Nirmal St - Tuesday 01 October 2024



A.2 Logger 2 (194 Guntawong Rd)

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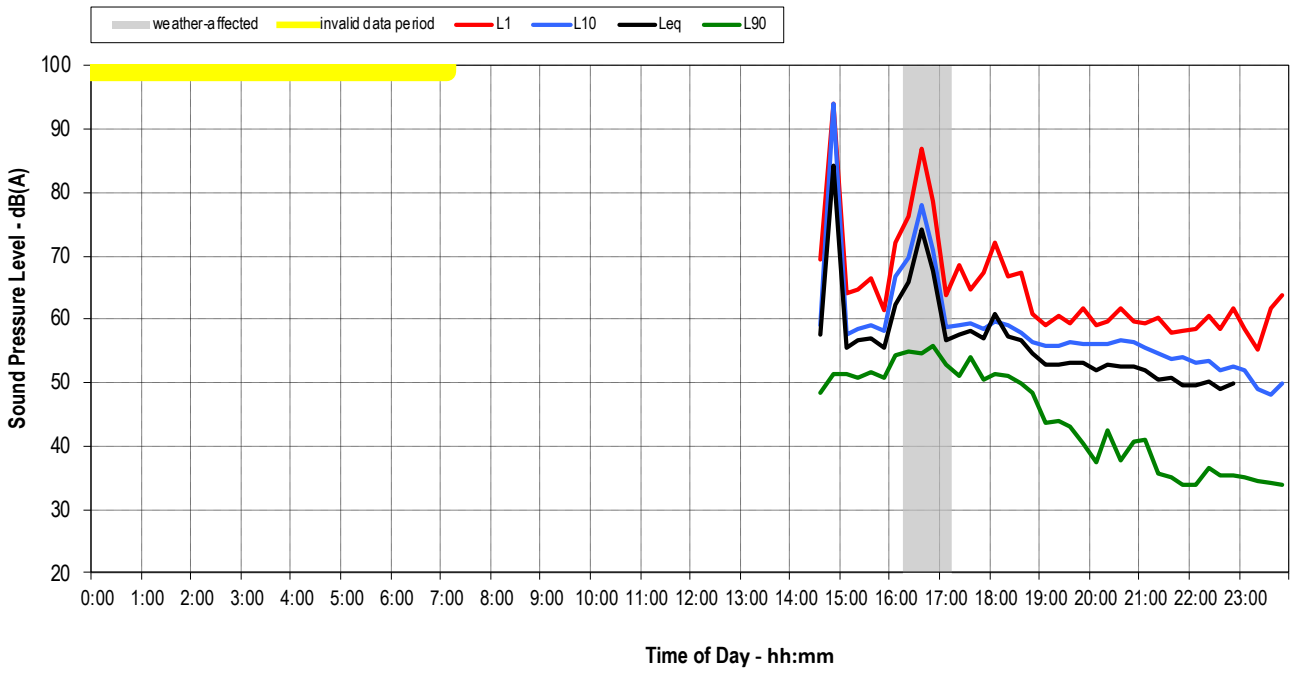
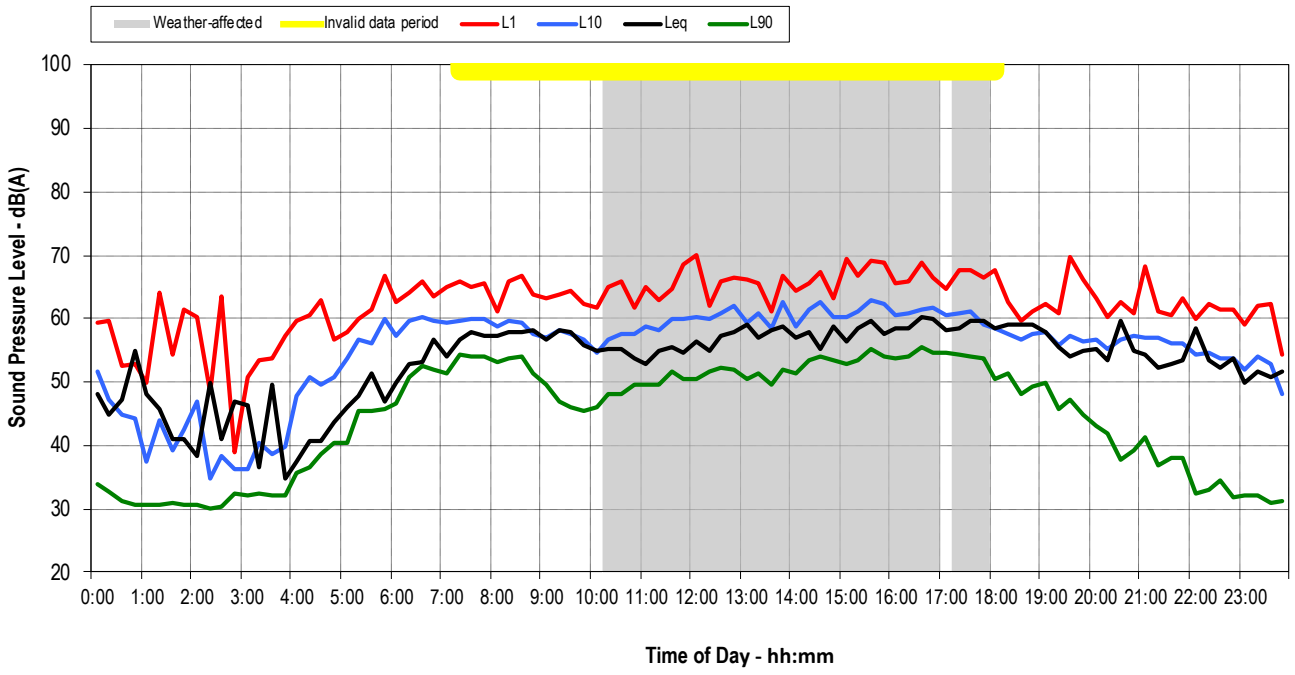


Tallawong, 194 Guntawong Rd - Thursday 19 September 2024



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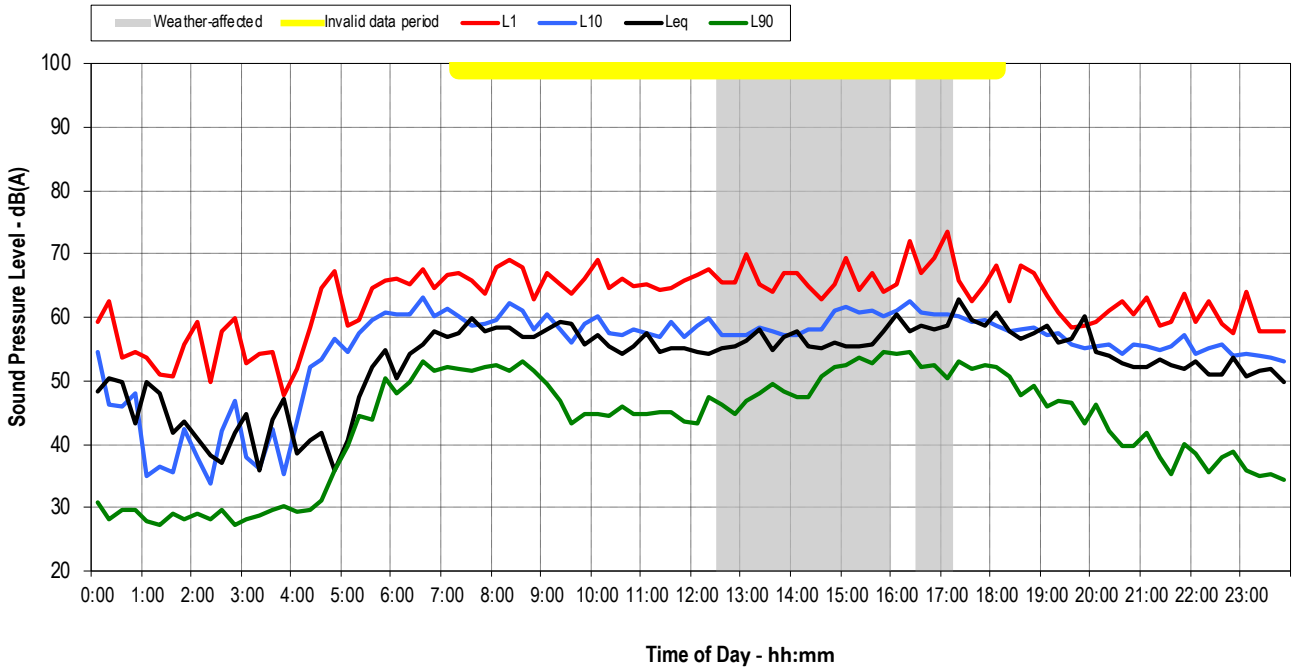

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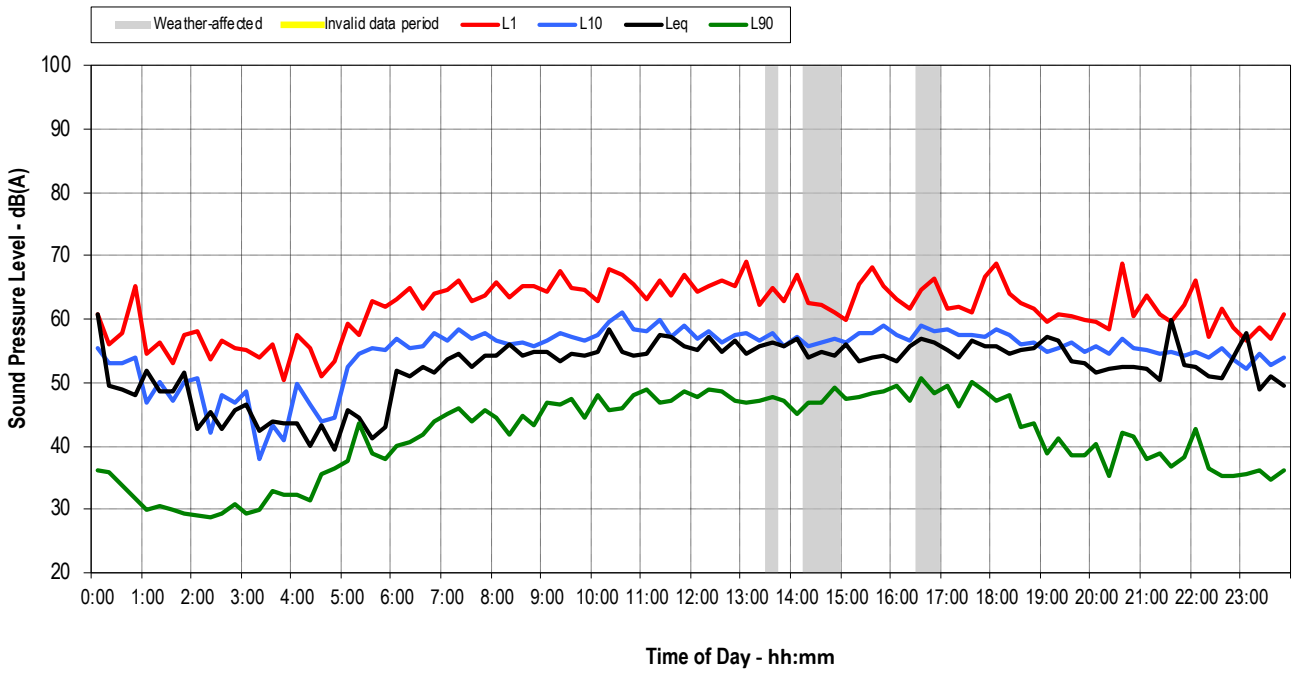
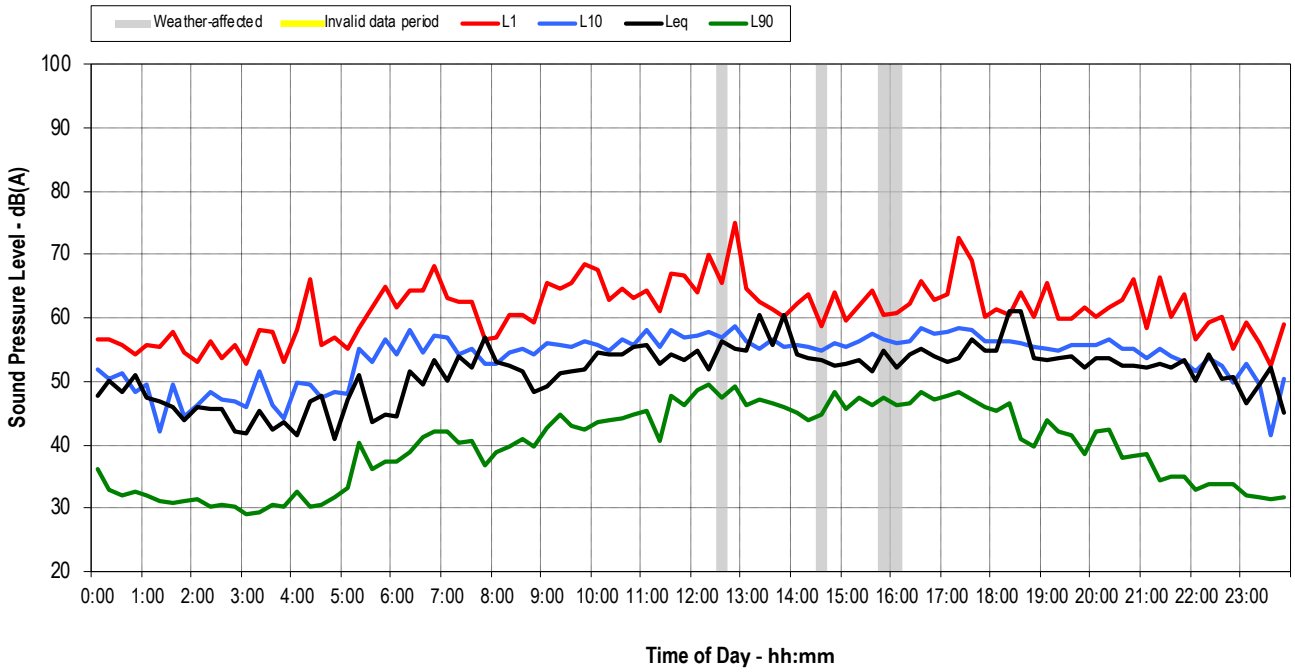


Tallawong, 194 Guntawong Rd - Sunday 22 September 2024



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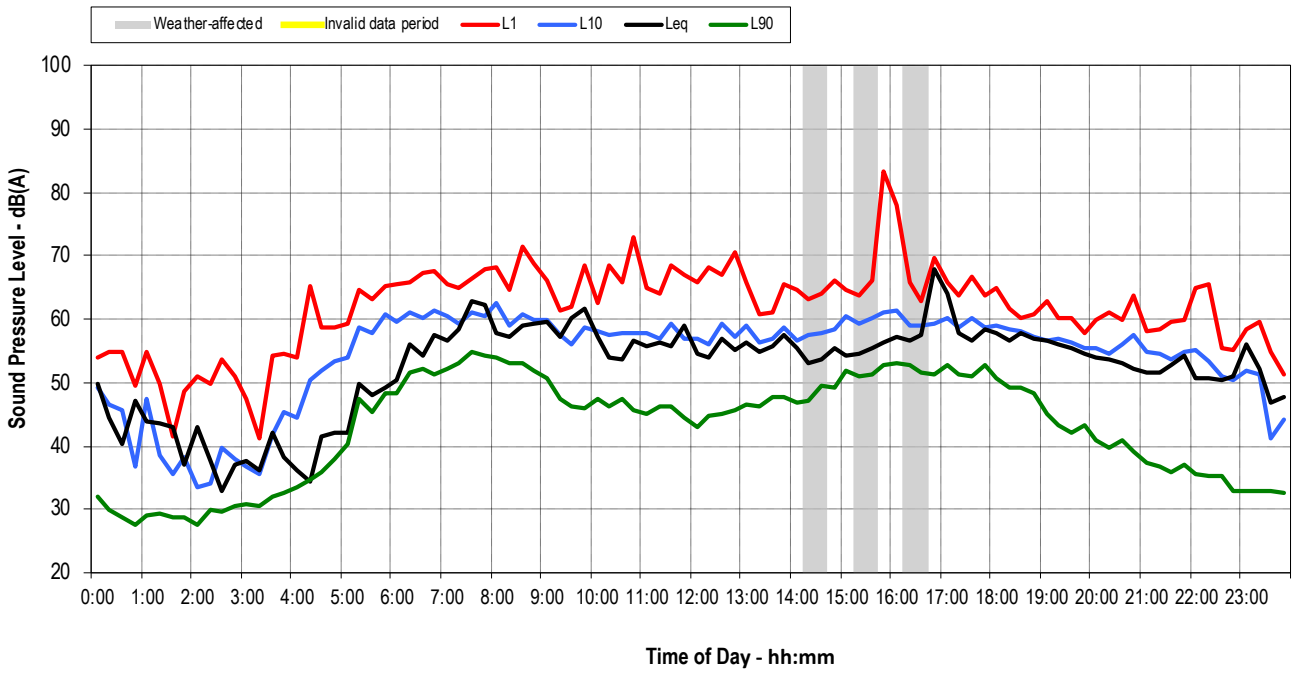
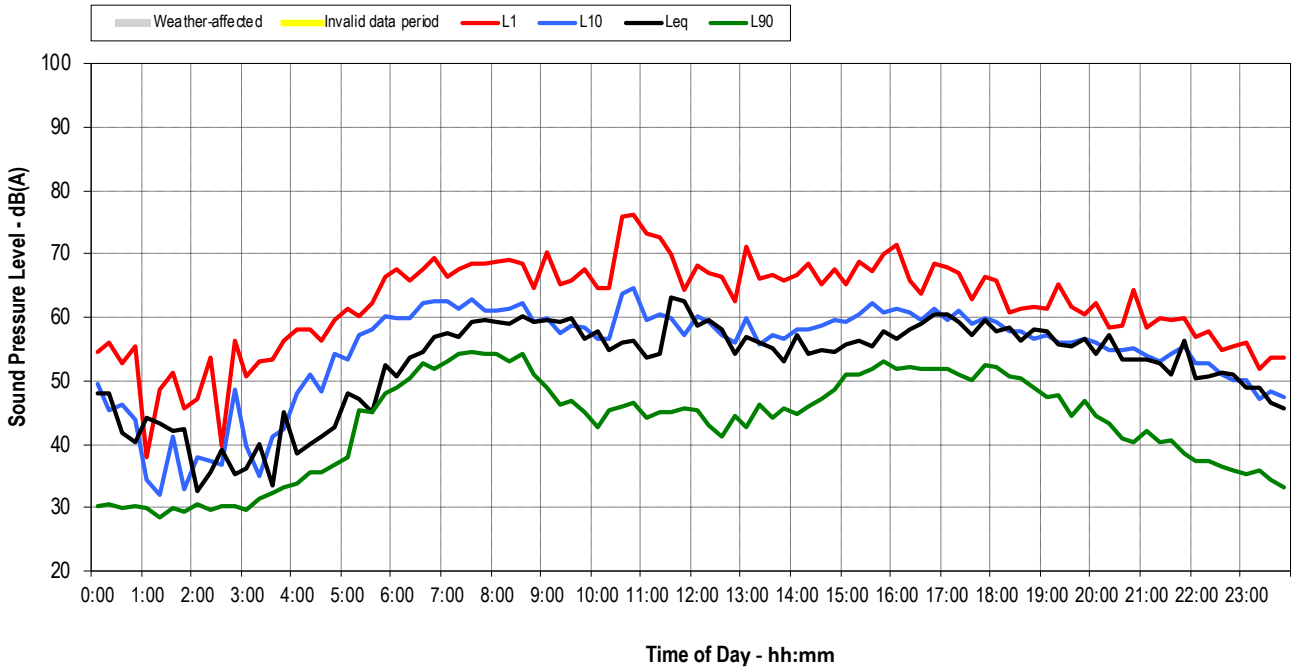
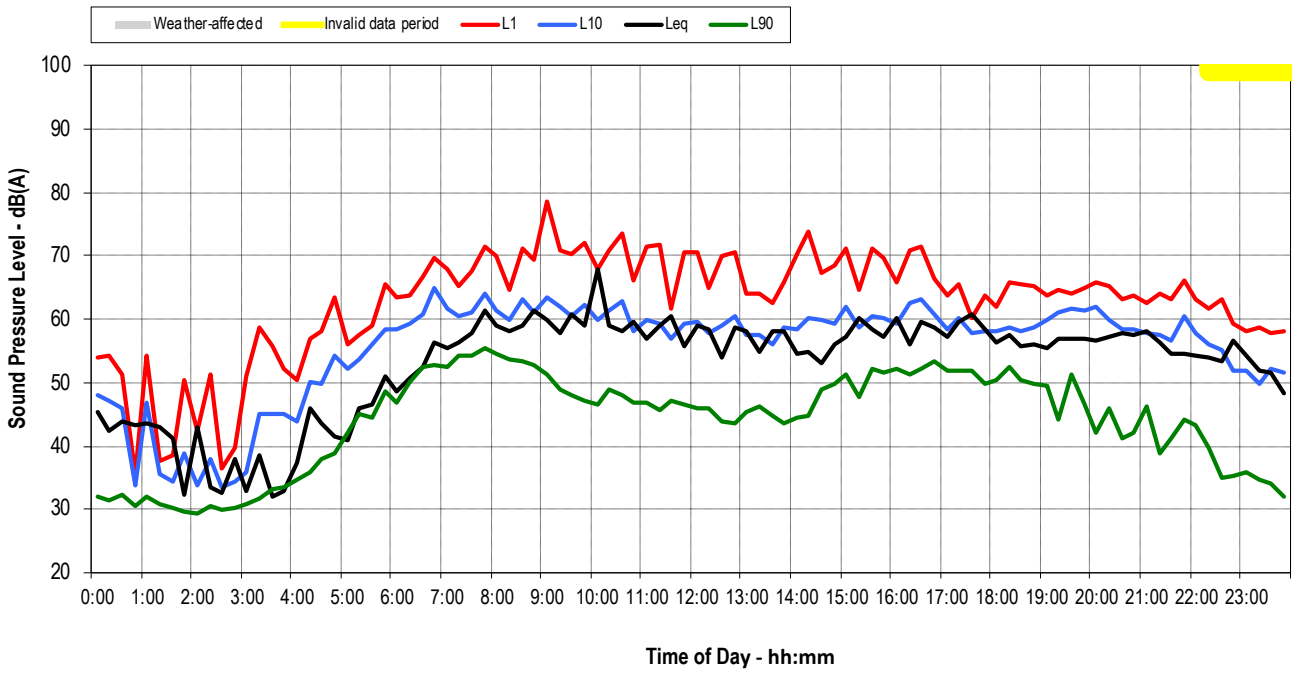


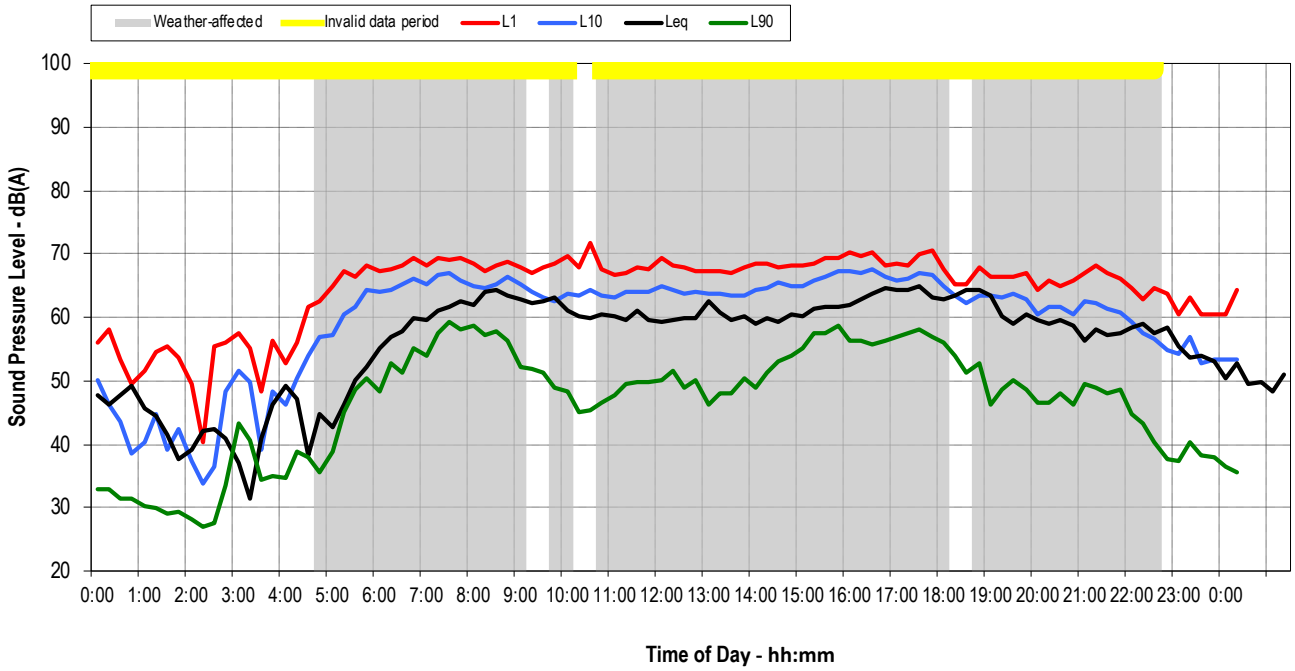
Tallawong, 194 Guntawong Rd - Tuesday 24 September 2024



Tallawong, 194 Guntawong Rd - Wednesday 25 September 2024



Tallawong, 194 Guntawong Rd - Thursday 26 September 2024



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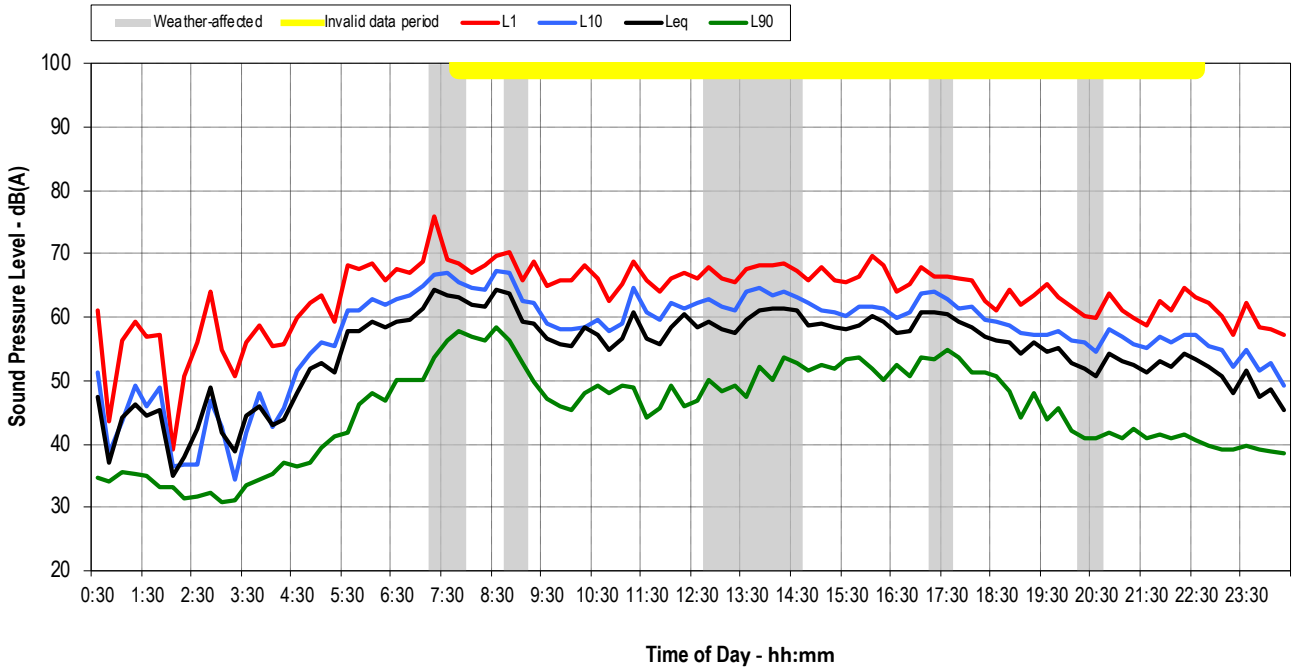

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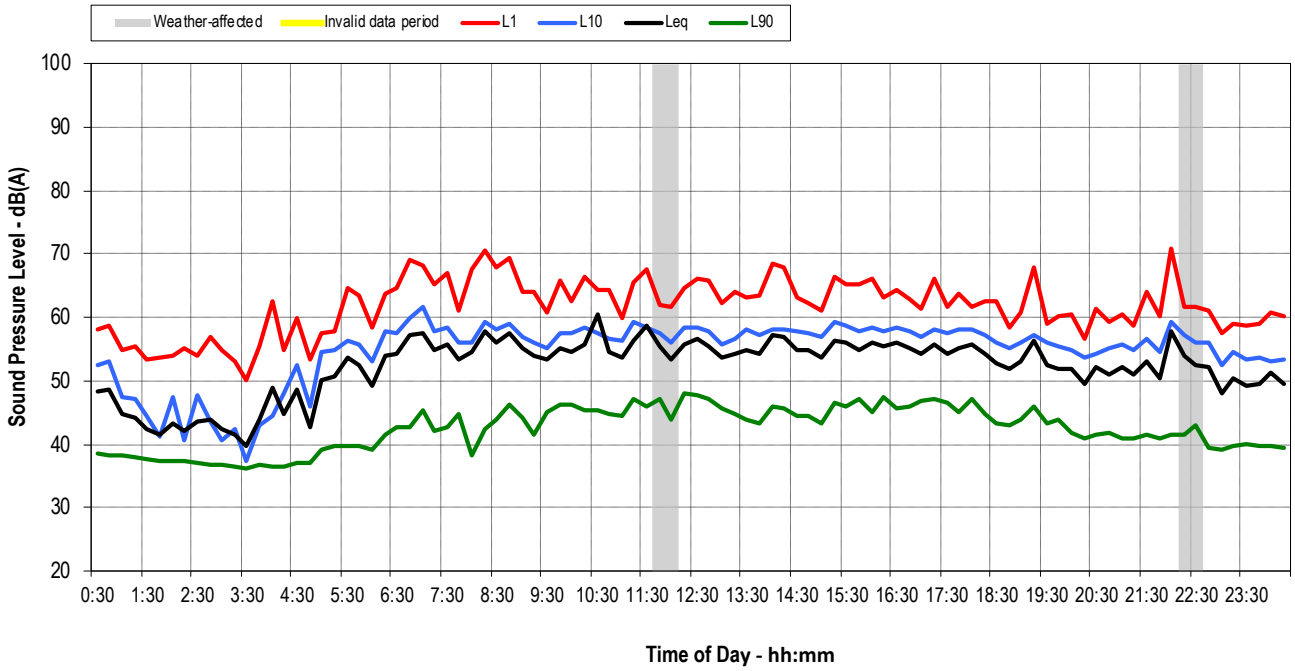
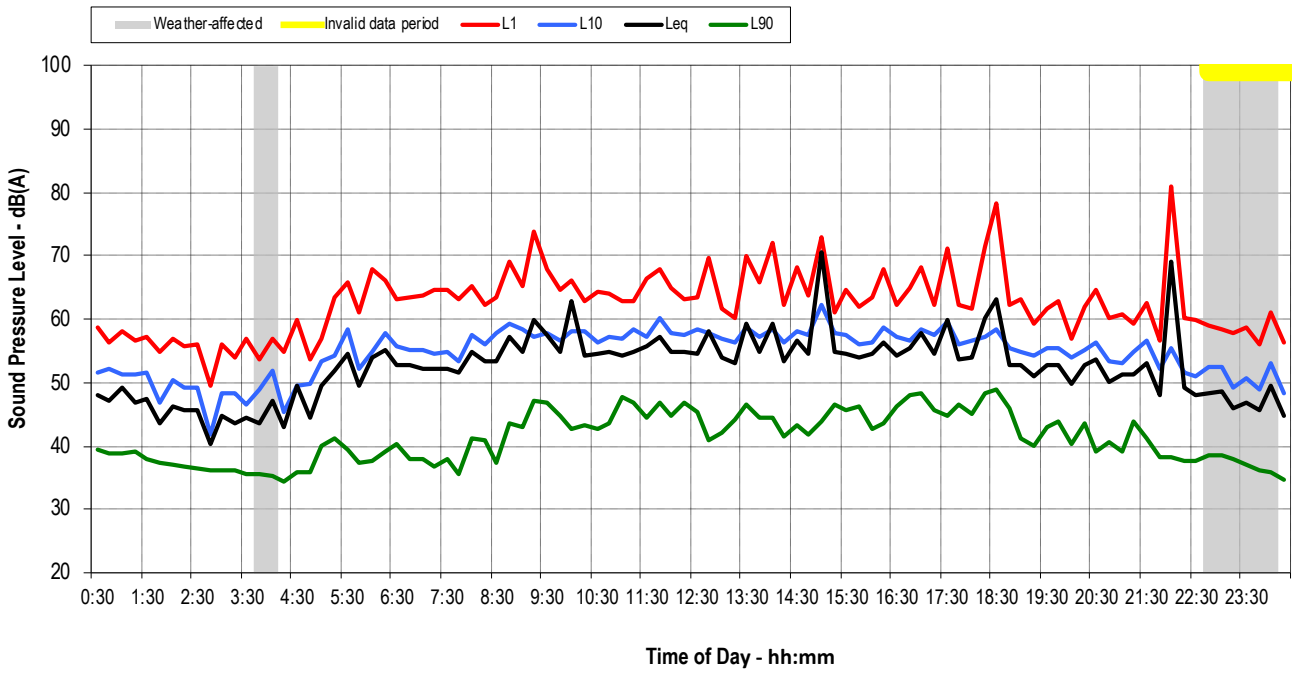
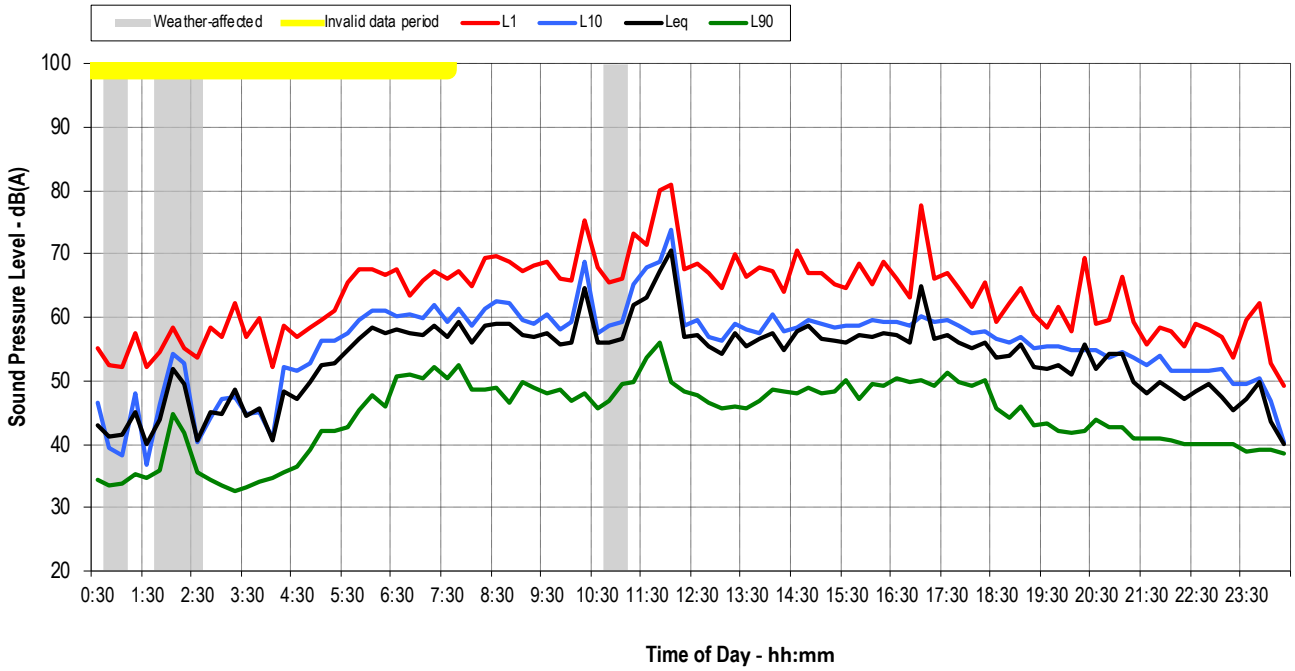


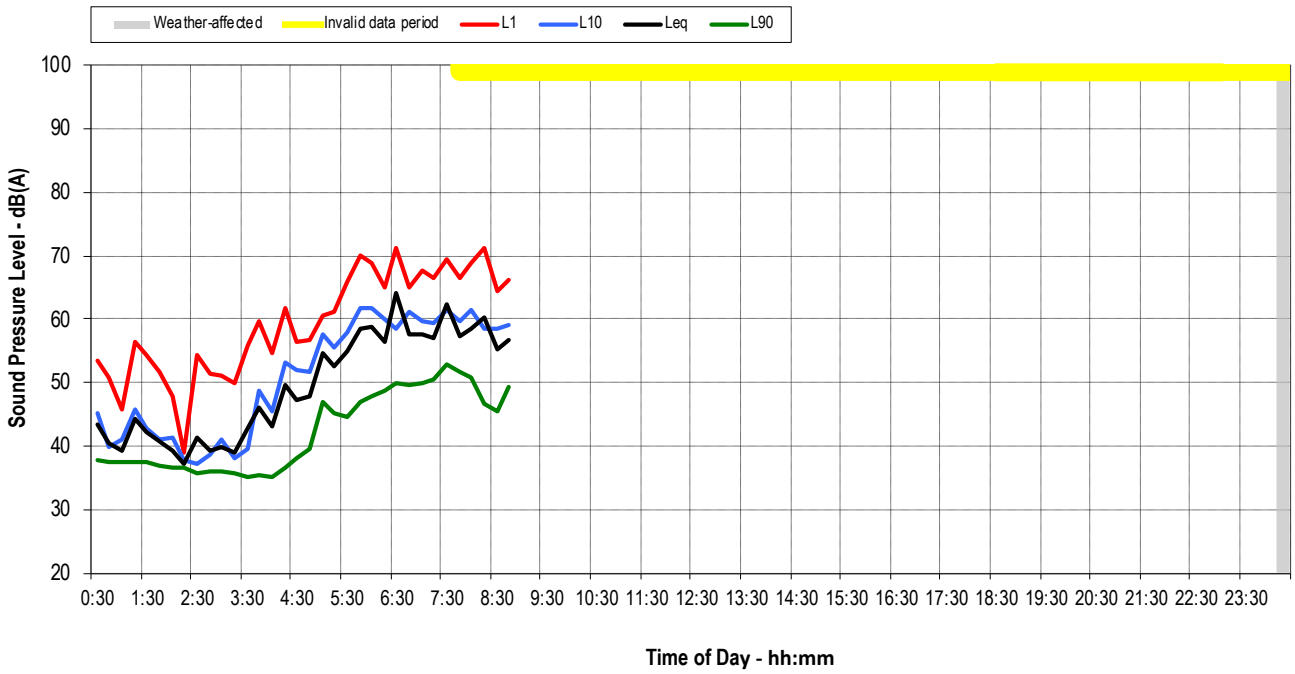
Tallawong, 194 Guntawong Rd - Sunday 29 September 2024



Tallawong, 194 Guntawong Rd - Monday 30 September 2024



Tallawong, 194 Guntawong Rd - Tuesday 01 October 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 30 outlines the methodology for determining construction Noise Management Levels at nearby residential receivers surrounding the activity site based on existing background noise levels.

Table 30 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.

Table 31 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 32 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 33. 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 33 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 34 sets out the acceptable VDV values for intermittent vibration.

Table 34 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 32 & Table 34.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 35 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 35 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 11 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 35:

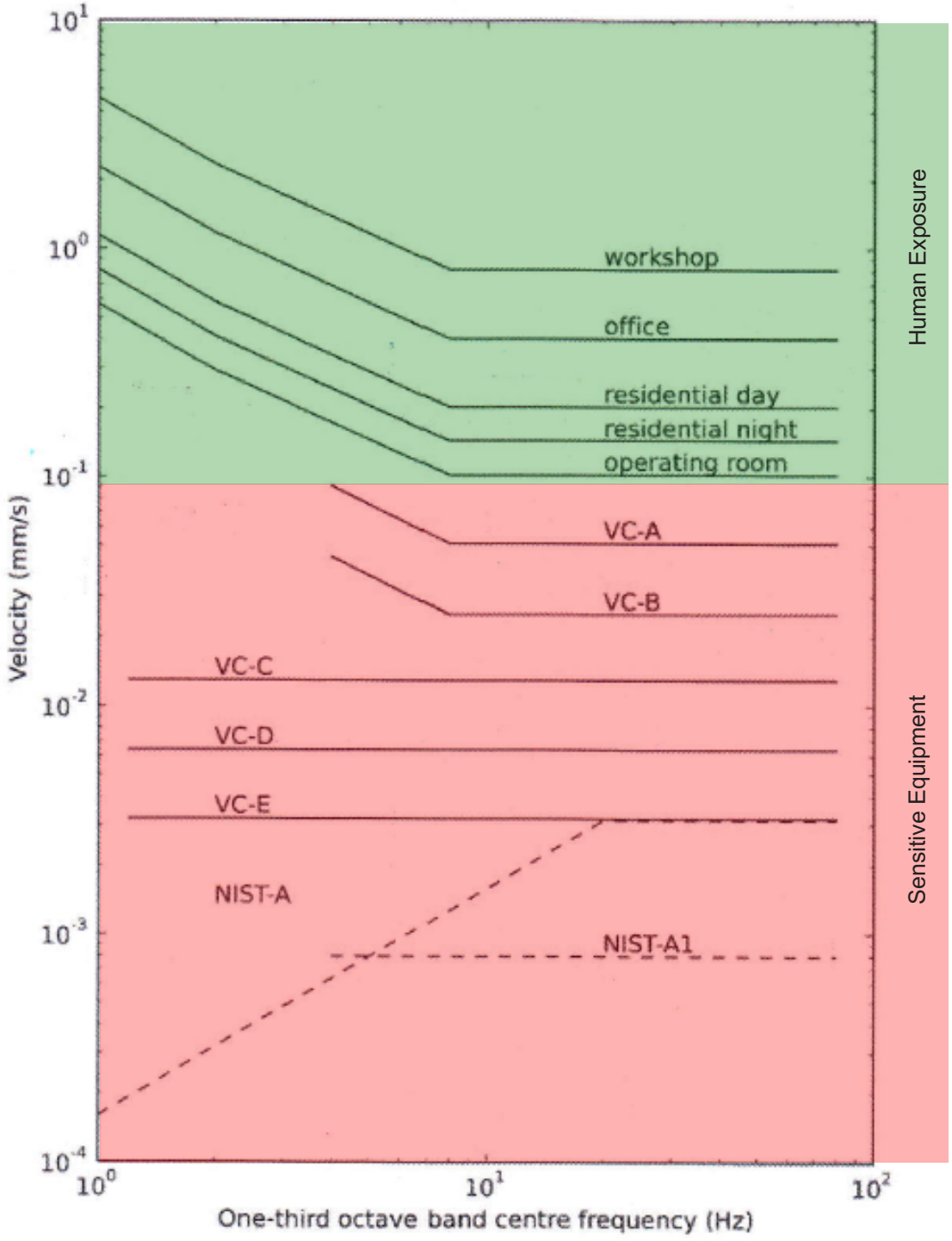


Figure 11 VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

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 36 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 36 *are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of* Table 36 *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 37 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 38 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

Table 38 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 39.

Table 39 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 – Nirmal Street	41	35	30	52	44	47
Logger 2 Guntawong Road	44	37	30	57	54	52

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 RBLs at Logger 1 – Nirmal Street presented below for each period.

- Day Intrusiveness criterion of 41 + 5 = 46 dB(A)
- Evening Intrusiveness criterion of 35 + 5 = 40 dB(A)
- Night Intrusiveness criterion of 30 + 5 = 35 dB(A)

Similarly, the intrusiveness noise level has been determined from the RBLs at Logger 2 – Guntawong Roa presented below for each period.

- Day Intrusiveness criterion of 44 + 5 = 49 dB(A)
- Evening Intrusiveness criterion of 37 + 5 = 42 dB(A)
- Night Intrusiveness criterion of 30 + 5 = 35 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 new activity 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 new activity 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 40 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	Day	60
	Evening	50
	Night	45
Passive Recreation Area	When in use	50
Active Recreation Area	When in use	55

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 a new industrial activity, 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 new activities 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 activity 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 new activity 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 new activity 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 new activity.

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 41 Calculation of Project ANLs

Receiver - External	Time of Day	Recommended ANL	Adjustment	Calculated Project ANL[4]
Residential (East and West)	Day	55	-5 (eq2) + 3	53
	Evening	45	-5 (eq2) + 3	43
	Night	40	-5 (eq2) + 3	38
Residential (North)	Day	55	-5 (eq2) + 3	53
	Evening	45	-5 (eq2) + 3	43
	Night	40	-5 (eq2) + 3	38
School classroom	When in use	45	-5 (eq2) + 3	43
Passive Recreation Area	When in use	50	-5 (eq2) + 3	48
Active Recreation Area	When in use	55	-5 (eq2) + 3	53

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 42 below (PNTLs shown shaded).

Table 42 Project Noise Trigger Levels

Receiver - External	Time of Day	Intrusiveness	Amenity	Project PNTL
Logger Residential 1 (East and West / Nirmal St)	Day	46	53	51
	Evening	40	43	48
	Night	35	38	43
Logger Residential 2 (North / Guntawong Rd)	Day	49	53	53
	Evening	42	43	48
	Night	35	38	42
School Classroom	When in use	-	43	43
Passive Recreation Area	When in use	-	48	48
Active Recreation Area	When in use	-	53	53

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 and construction works activities.

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

[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).

- 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 43 Sleep Awakening Level

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

B.5 Playground Noise

There is no clearly defined criteria for school playground noise. The following guidelines for outdoor play areas in childcare centres are considered relevant as the industry best practice for school playground noise assessment.

Association of Australasian Acoustical Consultants Guidelines for Child Care Acoustic Assessment

The AAAC Guideline for Child Care Centre Acoustic Assessment states the following:

"... 3.2 Criteria – Residential Receptors

3.2.1. Outdoor Play Area

The noise impact from children at play in a child care centre differs from the domestic situation in that it is a business carried out for commercial gain, the number of children can be far greater than in a domestic situation and the age range of the children at the centre does not significantly vary over time as it would in a domestic situation. However, the noise from children is vastly different, in both character and duration, from industrial, commercial or even domestic machine noise. The sound from children at play, in some circumstances, can be pleasant, with noise emission generally only audible during the times the children play outside. Night time, weekend or public holiday activity is not typical and child care centres have considerable social and community benefit.

***Base Criteria** – With the development of child care centres in residential areas, the background noise level within these areas can at certain times, be low. Thus, a base criterion of a contributed $L_{eq,15min}$ 45 dB(A) for the assessment of outdoor play is recommended in locations where the background noise level is less than 40 dB(A).*

***Background Greater Than 40 dB(A)** – The contributed $L_{eq,15min}$ noise level emitted from an outdoor play and internal activity areas shall not exceed the background noise level by more than 5 or 10 dB at the assessment location, depending on the usage of the outdoor play area. AAAC members regard that a total time limit of approximately 2 hours outdoor play per morning and afternoon period should allow an emergence above the background of 10 dB (i.e., background +10 dB if outdoor play is limited to 2 hours in the morning and 2 hours in the afternoon).*

***Up to 4 hours (total) per day** – If outdoor play is limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed $L_{eq,15\text{-}minute}$ noise level emitted from the outdoor play shall not exceed the background noise level by more than 10 dB at the assessment location.*

***More than 4 hours (total) per day** – If outdoor play is not limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed $L_{eq,15\text{-}minute}$ noise level emitted from the outdoor play area shall not exceed the background noise level by more than 5 dB at the assessment location.*

The assessment location is defined as the most affected point on or within any residential receiver property boundary. Examples of this location may be:

- 1.5 m above ground level;
- On a balcony at 1.5 m above floor level;
- Outside a window on the ground or higher floors..."

B.6 Road Traffic Noise

Car parks within the school campus (on site)

The NPI notes that it can be used for vehicle movements within an industrial premises and/or on private roads. Therefore, assessment of car parks and roads within the school campus are assessed against the requirements of the NSW NPI.

All other road traffic noise - NSW Road Noise Policy

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from a new land use activity. The relevant criteria are as per construction traffic noise criteria outlined in Section 5.4.

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

Table 44 below provides the RNP criteria for additional traffic generated on roads from a new land use activity in relation to the applicable receiver types surrounding the site.

Table 44 RNP assessment criteria for additional traffic on roads generated by new land use activity, including assessment of construction vehicles / traffic noise

Receiver - Road Type	Assessment Criteria (external)	
	Day (7am to 10pm) $L_{eq\ (period)}$ dB(A)	Night (10pm to 7am) $L_{eq\ (period)}$ dB(A)
Residential - new freeway/arterial/sub-arterial road	55 (15 hour)	50 (9 hour)
Residential - existing freeway/arterial/sub-arterial road	60 (15 hour)	55 (9 hour)
Residential - new local road	55 (1 hour)	50 (1 hour)
Residential - new off-road transitway	60 (15 hour)	50 (9 hour)

These criteria are adopted for assessment noise impacts from additional traffic on surrounding roads including construction-related traffic.

In addition to the assessment criteria outlined above, any increase in the total traffic noise level at a location due to a proposed project or traffic-generating new activity must be considered. Residences experiencing increases in total traffic noise level above 12 dB relative to the existing traffic noise level (for the applicable assessment time period) should also be considered for mitigation as described in Section 3.4 of the RNP.

For increased traffic flow on existing roads, where assessment criteria is already exceeded by existing traffic when considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational), the RNP guideline also states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"... (in relation to existing noise levels)... "represents a minor impact that is considered barely perceptible to the average person".*

Appendix C Glossary of Terms and Initialisms

C.1 Glossary

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.

C.2 Initialisms

Initialism	Definition
CNVMP	Construction Noise and Vibration Management Plan
DoE	NSW Department of Education
EFSG	Engineering Facilities Standards and Guidelines
ICNG	Interim Construction Noise Guideline (NSW EPA, 2009)
NMLs	Noise Management Levels
NPI	Noise Policy for Industry (NSW EPA, 2017)
REF	Review of Environmental Factors
RBL	Rating Background Level
SI NSW	School Infrastructure NSW

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

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

D.2 Traffic

Noise Source / Vehicle Activities	SPL at 7 metres, dB	
	$L_{Aeq,event}$	L_{AFmax}
Vehicle door closing	45-50	60-65
Vehicle engine starting	45-50	50-55
Vehicle accelerating	45-50	50-55
Vehicle moving, uniform speed	60-70	65-75
Vehicle moving, slowly	45-55	45-55
People talking	45-50	50-60
Bus / Heavy Vehicle Pass-by	65-70	77-82

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