Resonate

Sikh Grammar School Australia

SEARs Noise and Vibration Assessment

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Document Information

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Author	Marc Schluessel Acoustic Consultant p+61 2 8355 4888 m+61 415 540 512 marc.schluessel@resonate-consultants.com	
Reviewed by	Keith Hewett	

Revision Table

Report revision	Date	Comments
0	2 May 2019	Draft for comment
A	31 May 2019	ELC outdoor play area added and minor naming convention changing
B	10 July 2019	Minor naming convention changing

Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Daytime	Between 7 am and 6 pm as defined in the INP.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound level as a doubling of loudness.
dB(A)	'A' Weighted sound level in dB.
Evening	Between 6 pm and 10 pm as defined in the INP.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
NPI	New South Wales EPA Noise Policy for Industry, 2017.
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally the boundary of a residence) is greater than 5 dB(A) above the background noise level.
L_{10}	Noise level exceeded for 10% of the measurement time. The L_{10} level is commonly referred to as the average maximum noise level.
L_{90}	Noise level exceeded for 90% of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{AE}	The sound energy level of a sound event compressed into a time period of 1 second.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum measured sound pressure level in the time period.
mm/s	Millimetres per second—units of vibration velocity.
$m/s^{1.75}$	Units of VDV.
Night-time	Between 10 pm on one day and 7 am on the following day as defined in the INP.
Noise Management Level (NML)	Construction noise management level. Where the construction noise levels are above the NML, additional consideration of feasible and reasonable noise mitigation is required.
Peak Particle Velocity (PPV)	The maximum speed of a particle in a particular component direction due to vibration during a measurement.
Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (Day/Evening/Night). For the short-term method, the RBL is simply the measured $L_{90,15min}$ noise level. For the long-term method, it is the median value of all measured background levels during the relevant assessment period.
Vibration	Refers to the oscillation of an object back and forth, normally the ground.
Vibration Dose Value (VDV)	A measure used to assess the level of vibration over a defined time period, such as a day, evening or night. Often used for the assessment of intermittent construction vibration that may rise and fall across a day.

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1 Introduction

Sikh Grammar School Australia (SGSA) wish to build a new school comprising both primary and secondary educations streams. There will also be an early learning centre on the site. As a component of the unique pedagogy of the Sikh community it is also proposed that part of the site will be used as a place of worship, a Gurdwara. There will also be a community centre - a Langar - which, at times, will be open to the broader community as part of an all-inclusive vegetarian feast that the Sikh community provide to people of all denominations.

As part of the planning process The Department of Planning and Environment has issued the project with the *Secretary's Environmental Assessment Requirements* (SEARs) for the preparation of an Environmental Impact Statement (EIS) for the development of the Sikh Grammar school and Gurdwara. Resonate Consultants has been engaged by the client c/- PMDL Architecture and Design to carry out a noise and vibration impact assessment to satisfy the SEAR's and EIS.

The SEARs state that the following are to be addressed in relation to acoustics.

> **11. Noise and Vibration**
>
> Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation, including consideration of any public address system, school bell and use of any school hall for concerts, etc. (both during and outside school hours, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.
>
> Relevant policies and guidelines:
>
> - *NSW Industrial Noise Policy* (EPA) (Updated to *NSW Noise Policy for Industry 2017*)
> - *Interim Construction Noise Guideline* (DECC)
> - *Assessing Vibration: A Technical Guideline* 2006
> - *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning 2008).

This report has been prepared to address the requirements of these standards where relevant and use additional guidance where appropriate, such as, *Association of Australian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment, October 2013*.

The purpose of this report is to identify and assess noise sources associated with the construction and operation of the schools and Gurdwara, and their impact on the local community. Currently the development site is a greenfield site, but the area around the site is identified as a place for residential development as part of the growth of Rouse Hill. The development has been split up into 10 separate stages to be completed individually over a period of approximately 20 years. Therefore, this noise impact assessment report focusses on the noise impact on future residential receivers that are proposed to be constructed adjacent to the development site on all four sides. These will likely be constructed whilst the Sikh Grammar School and Gurdwara development is being constructed and therefore, represent the nearest and most impacted noise sensitive receivers.

Where relevant criteria are predicted to be exceeded, in-principle noise mitigation or management recommendations have been made to control the noise impact. The aim of this report is to assess and demonstrate that any predicted noise impacts to the environment can in-principle, be controlled at this early planning stage. Detailed noise mitigation will be designed during the design phases of each stage of the development.

2 Project Description

2.1 Location

The Sikh Grammar School will be constructed on Lot 42 and 43 along Tallawong Road in Rouse Hill NSW. The proposed site location includes Lot 42 and 43 is presented in Figure 1. The site currently has sparsely located residential sensitive receivers adjacent, but the area is a future residential development zone and will have more residential sensitive receivers around the site in the future.

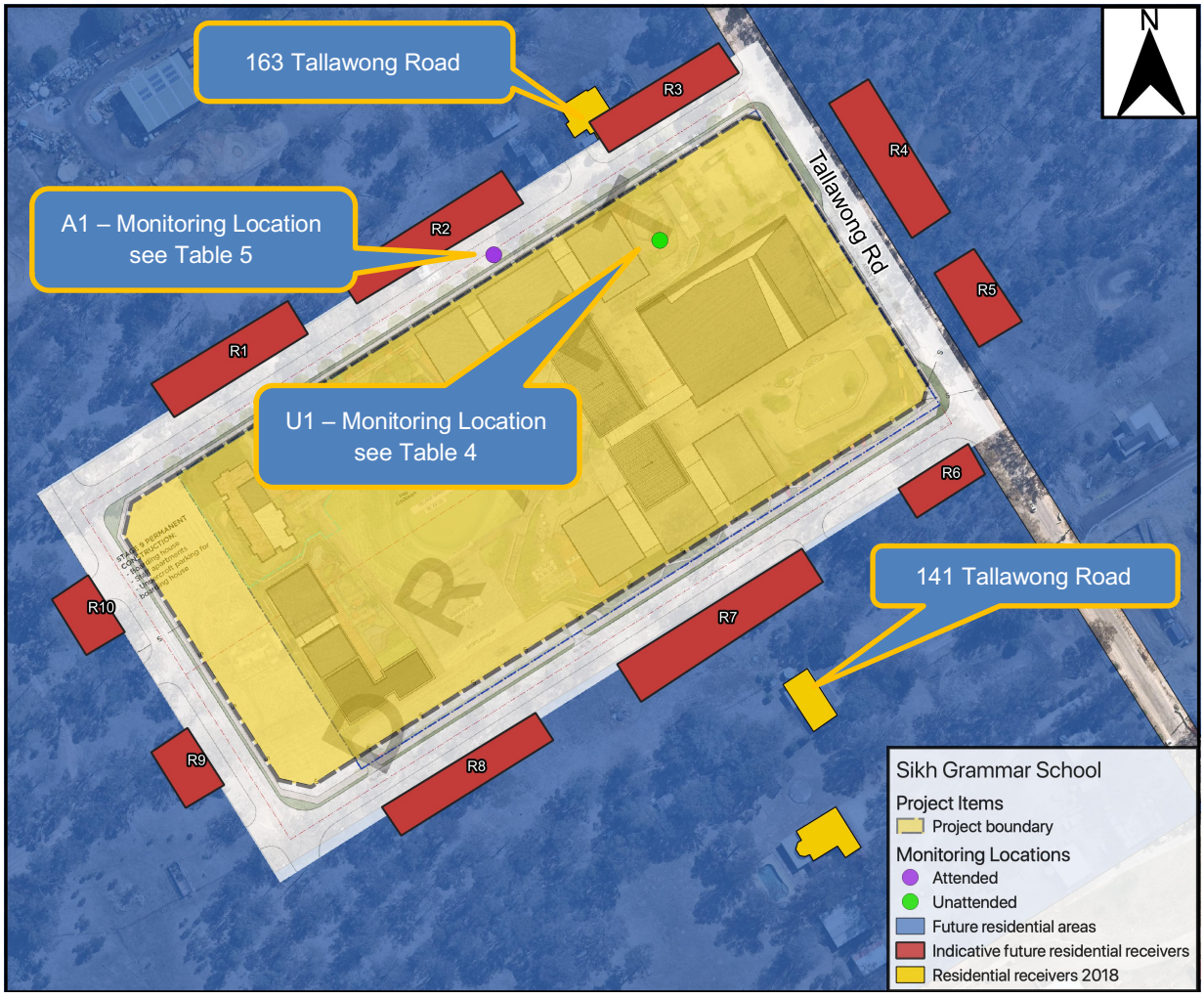


Figure 1 Sikh Grammar School site location

A number of current and future noise and vibration sensitive land uses are located in the immediate vicinity of the project site, as shown in Figure 1. Currently, the nearest identified sensitive receiver is the property at Tallawong Road 163. In the future there will be various new residential properties adjacent to the school. Therefore, ten indicative residential receivers named R1 – R10 have been nominated around the school premises.

Table 1 Noise and vibration sensitive land uses

Reference	Description
Residential land uses	
R1	Future residential development
R2	Future residential development
R3	Future residential development
R4	Future residential development
R5	Future residential development
R6	Future residential development
R7	Future residential development
R8	Future residential development
R9	Future residential development
R10	Future residential development

The currently most potentially affected sensitive receivers are either a similar distance or further away than the assessed future residential receivers R1 – R10. The current nearest residential receivers at time of writing this report are listed in Table 2.

Table 2 Noise and vibration sensitive land uses

Reference	Description
Residential land uses	
Tallawong Road 163	Residential receiver identified as nearest residential receiver and similar to R3
Tallawong Road 141	Residential receiver approximately 40 m further away from school than R7

2.2 Development Description

The development will involve 10 stages as follows:

- Stage 1
  - Relocate primary school building (temporary)
  - Multi-purpose hall (temporary)
  - On-ground parking (temporary)
  - Play space (temporary)
  - Existing house (demolition)
  - Existing on ground car park (demolition)
- Stage 2
  - K-2 play space
  - Multipurpose court and cricket nets
  - Primary School Block
  - Village green
- Stage 3A
  - Primary school block, including library and staff room on 3rd and 4th floors
  - Part civic heart construction under library building
  - Southern entry to future underground parking
  - Play space to south-west corner (Temporary)

- Stage 3B
  - Early Learning Centre (ELC)
  - ELC outdoor play area
  - ELC car park and kiss & drop
- Stage 4
  - Secondary school block with specialist science facilities
  - Part village green construction
- Stage 5
  - Secondary school block with café, TAS, Performing visual arts, library and staff room
  - Part civic heart construction
  - On-ground kiss and drop (temporary)
- Stage 6
  - Secondary school block with specialist TAS facilities and remaining homebases
  - TAS outdoor workshops
  - Services pavilion
- Stage 7
  - Multi-purpose hall and bridge link
  - Gurdwara and Langar
  - Finish civic heart construction
  - Landscaping along Tallawong Road
  - Secondary school courtyard
  - Underground car park
  - Demolition
    - Temporary parking to south east corner
    - Temporary multi-purpose hall
- Stage 8
  - Administration building
  - Final three GLA's for primary school
  - School reception and sick bay
  - Principal and support staff office
  - Demolition
    - Temporary car park to north-west corner
    - Demountable classrooms
- Stage 9
  - Boarding house
  - Staff apartments
  - Undercroft parking for boarding house

Construction Noise

At this early stage of the design process a detailed construction methodology is not available. Therefore, a typical and likely breakdown of construction phases for a building project has been used for the purposes of this assessment. The construction staging has been broadly summarised in Table 3. This assessment includes the consideration of standard hours and outside of standard hours works.

Table 3 **Anticipated typical construction activities**

Stage	Description
A) Site establishment	Bulk excavation and preparation for substructures
B) Substructure	Pilling works, followed by creation of substructures
C) Installation of temporary structures	Crane work and Power tools
D) Superstructure and façades	Creation of building superstructures and installation of building façade progressively
E) External landscaping	Landscaping works around the site precinct
F) Paving/ asphalting	Delivery of raw materials, placement of surface material
G) Demolition	Demolition with excavator and jackhammer

Operational Noise

Operational noise emission and vibration considerations for the project include:

- Mechanical services plant items.
- Other operational noise emission from the project, such as non-emergency alarms, school bells and public address systems.
- Use of the surrounding grounds by students and staff as outdoor recreation/play and teaching areas.
- On-site car park activity noise
- Use of the Gurdwara for performance/sporting events, particularly outside of regular operating hours.

3 Existing Acoustic Environment

The existing environment is located in a greenfield rural area with little noise generated from road traffic along Tallawong Road. Background noise levels are generally low with the majority driven by natural sources.

With completion of the future planned developments in the area, the environment could be considered Suburban with intermittent traffic flows and some limited commerce or industry. This change in land use from the current greenfield rural use will inevitably cause some degree of background creep of the ambient noise environment. However, with good planning the adverse effects of any rise in ambient noise level can be managed to be minor.

3.1 Unattended noise monitoring

Unattended noise monitoring was conducted to establish the existing ambient noise environment for the purpose of this noise assessment report at a location representative of the nearest sensitive receiver. Appendix A and B provide a detailed methodology and noise measurement charts for the noise survey. The resultant noise levels are summarised in Table 4.

Table 4 Unattended noise monitoring results

Location	Rating Background Level, dB(A) L_{90}[1]			Ambient noise level, dB(A) L_{eq}		
	Day 7 am—6 pm	Evening 6 pm—10 pm	Night 10 pm—7 am	Day 7 am—6 pm	Evening 6 pm—10 pm	Night 10 pm—7 am
U1 – On site	37	38	32	49	49	43

(1) The Rating Background Level is a measure of the typical minimum steady background noise level for each time of day.

3.2 Attended noise monitoring

To supplement the unattended noise monitoring results, attended monitoring was conducted at another location outside of the site. The measured noise levels over a 15-minute period are shown in Table 5, with the measurement location shown in Figure 1.

Table 5 Attended noise monitoring results

Location	Measured noise level, dB(A), 15 min				Description
	L_{max}	L_{10}	L_{eq}	L_{90}	
A1 – On site	67	52	50	47	Near the unattended logger site. Largely representative of ambient levels. Low levels of road traffic on Tallawong Road and distant construction noise audible. Construction noise controlling the higher L_{90} background during this measurement compared with the logger L_{90} over the Day time period for each day during the logging period.

4 Assessment Criteria

4.1 Construction noise

Construction noise in New South Wales is assessed using the Department of Environment & Climate Change (now Environment Protection Authority) *Interim Construction Noise Guideline* (ICNG). The ICNG is also defined as the relevant guideline for construction noise by the SEARs issued by DPE.

The ICNG aims to manage noise from construction works regulated by the EPA. It is also intended to provide guidance to other interested parties in the management of construction noise, and has therefore been adopted for this construction noise assessment.

The ICNG prescribes $L_{eq,15min}$ Noise Management Levels (NML) for sensitive receivers as part of a quantitative construction noise assessment. Where the predicted or measured construction noise level exceeds these management levels, then all feasible and reasonable work practices should be implemented to reduce construction noise, and community consultation regarding construction noise is required to be undertaken.

Residential land uses

The NMLs prescribed for residential land uses by the ICNG are presented in Table 6. The levels apply at the most exposed property boundary of the noise sensitive receiver at a height of 1.5 metres above ground level.

Other sensitive land uses

At the time of writing this report there were no other sensitive land uses identified around the school premises.

Commercial and industrial premises

At the time of writing this report there were no Commercial and industrial premises identified around the school premises.

Table 6 ICNG noise management levels for residential land uses

Time of day	Noise Management Level, $L_{eq,15\ min}$	Application notes
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	May be some community reaction to noise. • Where the predicted or measured construction noise level exceeds the noise affected level, all feasible and reasonable work practices should be applied to meet the noise affected level. • All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and duration, and provided with site contact details.
	Highly noise affected 75 dB(A)	May be strong community reaction to noise. • Where construction noise is predicted or measured to be above this level, the relevant authority may require respite periods that restrict the hours that the very noisy activities can occur. • Respite activities would be determined considering times identified by the community when they are less sensitive to noise, and if the community is prepared to accept a longer period of construction to accommodate respite periods.
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 affected noise level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the affected noise level, the proponent should negotiate with the affected community.

Noise management levels

Table 7 summarises the NMLs applicable to sensitive land uses around the project site during the construction phase. The NMLs are based on the background levels measured for the purposes of this report.

Table 7 Project specific Noise Management Levels

Land use	Noise Management Level, dB(A)			
	Standard Working Hours RBL + 10dB	Outside of Standard Working Hours RBL + 5 dB		
		Day	Evening	Night
Residential land uses	47	42	43	37

4.2 Construction vibration

Ground vibration generated by construction can have a range of effects on buildings and building occupants. The main effects are generally classified as:

- human disturbance – disturbance to building occupants: vibration which inconveniences or interferes with the activities of the occupants or users of the building
- effects on building structures – vibration which may compromise the condition of the building structure itself.

In general, vibration criteria for human disturbance are more stringent than vibration criteria for effects on buildings. Building occupants will normally feel vibration readily at levels well below those which may cause a risk of cosmetic or structural damage to a structure. However, it may not always be practical to achieve the human comfort criteria. Furthermore, unnecessary restriction of construction activities can prolong construction works longer than necessary, potentially resulting in other undesirable effects for the local community.

Construction vibration criteria have been adopted from the following sources:

- Cosmetic and structural damage to buildings: German Standard DIN 4150-3[1]
- Human comfort: *Assessing Vibration – A Technical Guideline* (the Vibration Guideline)

4.2.1 Cosmetic and structural damage

DIN 4150-3 summarises structural and cosmetic damage assessment criteria for different types of buildings, which are presented in Table 8, which are widely used for the assessment of construction vibration effects on buildings in Australia. The criteria are specified as Peak Particle Velocity (PPV) levels measured in any direction at or adjacent to the building foundation.

Table 8 DIN 4150-3 vibration cosmetic and structural damage criteria

Structure type	Peak Particle Velocity (PPV), mm/s			
	Foundation of structure			Vibration at horizontal plane of highest floor at all frequencies
	< 10 Hz	10-50 Hz	50-100 Hz	
Buildings used for commercial, industrial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwelling and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in rows 1 and 2, and are of great intrinsic value (e.g. heritage-listed buildings)	3	3 to 8	8 to 10	8

With respect to the project site, there are no neighbouring State heritage sites on the NSW Office & Environment Heritage Register.

DIN 4150-3 states that exposing buildings to vibration levels higher than that recommended would not necessarily result in damage. Rather, it recommends these values as maximum levels of short-term construction vibration at which experience has shown damage reducing the serviceability of structures will not occur due to vibration effects. DIN 4150-3 is considered to be suitable for the assessment of both structural and cosmetic damage as it considers a reduction in serviceability of the structure is deemed to have occurred if:

- cracks form in plastered surfaces of walls
- existing cracks in the building are enlarged
- partitions become detached from loadbearing walls or floors.

[1] German Standard DIN 4150-3, 1999, *Structural Vibration – Part 3: Effects of vibration on structures*.

4.2.2 Human comfort

The ICNG recommends that vibration from construction works be assessed under *Assessing Vibration – a technical guideline* (the Vibration Guideline), consistent with the SEARs issued by DPE.

The vibration assessment criteria defined in the Vibration Guideline are for human comfort and represent goals that, where predicted or measured to be exceeded, require the application of all feasible and reasonable mitigation measures. Where the maximum value cannot be feasibly and reasonably achieved, the operator would need to negotiate directly with the affected community.

The Vibration Guideline defines vibration assessment criteria for continuous, impulsive and intermittent vibration. Vibration can be classified according to the following definitions:

- Continuous vibration: continues uninterrupted for a defined period. Applies to continuous construction activity such as tunnel boring machinery.
- Impulsive vibration: rapid build-up to a vibration peak followed by a damped decay or the sudden application of several cycles of vibration at approximately the same magnitude providing that the duration is short. Applies to very occasional construction activities that create distinct events such as the occasional dropping of heavy equipment.
- Intermittent vibration: interrupted periods of continuous vibration (such as a drill) or repeated periods of impulsive vibration (such as a pile driver).

The majority of construction activities as part of the proposed works would be expected to be continuous or intermittent in nature.

Table 9 presents the management levels for continuous and impulsive vibration at different land uses. The management levels specified are as overall unweighted RMS vibration velocity levels. The Vibration Guideline specifies the management levels as suitable for vibration sources predominantly in the frequency range 8-80 Hz as would be expected for construction vibration.

Table 9 RMS velocity management levels for continuous and impulsive vibration

Land use	Continuous vibration – RMS vibration velocity, mm/s		Impulsive vibration – RMS vibration velocity, mm/s	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.1	0.2	0.1	0.2
Residences – daytime[2]	0.2	0.4	6.0	12.0
Residences – night time[3]	0.14	0.28	2.0	4.0
Offices, schools	0.4	0.8	13.0	26.0
Workshops	0.8	1.6	13.0	26.0

(2) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(3) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(4) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

For intermittent vibration, the Vibration Dose Value (VDV) is used as the metric for assessment as it accounts for the duration of the source, which will occur intermittently over the assessment period. The VDV management levels at different land uses for intermittent vibration sources are presented in Table 10.

Table 10 VDV management levels for intermittent vibration

Land use	VDV – intermittent vibration, m/s$^{1.75}$	
	Preferred	Maximum
Critical areas[1]	0.1	0.2
Residences and hospital wards – daytime[2]	0.2	0.4
Residences and hospital wards – night time[3]	0.13	0.26
Offices, schools	0.4	0.8
Workshops	0.8	1.6

(1) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

4.3 Operational noise criteria

Noise emissions from the project when operational should comply with the requirements of the NSW Noise Policy for Industry (NPI). The NPI applies to noise emissions from rooftop plant and the like at the development.

The NPI sets two separate noise criteria to meet desirable environmental outcomes:

- Intrusiveness – steady-state noise from the site should be controlled to no more than 5 dB(A) above the background noise level in the area. In this case, the steady-state L_{eq} noise level should not exceed the RBL measured for different time periods in the environment. The intrusiveness criteria is measured over a 15 minute period.
- Amenity – amenity criteria are set based on the land use of an area. It requires noise levels from new industrial noise sources to consider the existing industrial noise level such that the cumulative effect of multiple sources does not produce noise levels that would significantly exceed the amenity criteria. As the amenity criteria is provided in the NPI document as a period level i.e. between 7am and 6pm for day time activities, 3 dB is added to the amenity noise level to approximately represent a 15 minute period for direct comparison to the intrusiveness criterion. For new noise sources 5 dB must be subtracted from the amenity criterion to minimise noise creep over time as more noise sources are introduced to an area.

Internal and external noise criteria are also set by the NPI for non-residential land uses such as hospital wards, educational facilities and active recreation areas.

Both intrusiveness and amenity criteria are derived from the ambient noise survey and the NPI. They are then compared with each other and the lowest and most stringent noise level is adopted to represent the project specific noise criterion for the relevant time period, day, evening and night time.

4.3.1 Normal operation

Table 11 presents the NPI noise emission criteria for residential land uses for the Day, Evening and Night periods.

Table 11 NPI noise emission criteria for residential land uses

Location	NPI Noise Level (dB re 20 µPa) during Period		
Residential receivers	**Daytime 07:00 – 18:00**	**Evening 18:00 – 22:00**	**Night-time 22:00 – 07:00**
Rating Background Level (RBL)	37	38	32
Intrusive criterion (RBL + 5 dB)	42	43	37
Amenity Criterion (NPI amenity level – 5 dB + 3 dB) (Rural[1])	48	43	38
NPI Project specific criteria for residential land uses[2]	**42**	**43**	**37**

(1) A rural classification has been adopted for the site, described as an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic.

(2) The project-specific criteria are the lowest of the Intrusive criterion and the Amenity criterion for new sources for each time period.

4.3.2 Outdoor recreation

Noise impact from the general operation of the proposed school is to be assessed with respect to the site-specific noise criteria based on site monitoring and the NPI intrusive noise criteria (Table 11).

Table 12 presents the intrusiveness criteria for all surrounding residential receiver areas. This was calculated by adding 5 dB to the period background noise levels (RBL). Furthermore, noise criteria for children playing is typically background +10 dB(A). Depending of the situation, the application of this RBL + 10 dB(A) noise limit may be time limited, however, it is usually seen as appropriate for up to 2 hours per day as per the AAAC guideline for Child Care Centre Acoustic Assessment[2].

Table 12 Outdoor recreation noise criteria

Location	NPI / AAAC Noise Level (dB re 20 µPa) during Period		
Residential receivers	**Daytime 07:00 – 18:00**	**Evening 18:00 – 22:00**	**Night-time 22:00 – 07:00**
Rating Background Level (RBL)	37	38	-
NPI Intrusive criterion (RBL + 5 dB)	42	43	-
AAAC Guideline(2) Intrusive criterion for up to 2 hours (total) per day (RBL + 10 dB as per)	47	48	-
Project specific criteria for residential land uses	**47**	**48**	**-**

For the purposes of this assessment Resonate has assumed that outdoor recreation areas will generally be used for up to 2 hours per day and have therefore used the AAAC guideline approach to set the noise targets (RBL + 10 dBA).

[2] Association of Australian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment, October 2013

5 Construction Assessment

5.1 Construction noise

5.1.1 Construction noise sources

Table 13 summarises the assumed sound power levels (L_w) for the major construction noise sources which would reasonably be expected to be on site during each phase. The sound power levels have been based on data obtained from previous measurements conducted by Resonate and those within the BS 5228-1[3], AS2436[4] and CNVG:2016[5]. An overall sound power level for each phase has also been assumed based on the loudest typical source(s) operating for each works phase.

Table 13 Construction noise source sound power levels

Stage	Plant and equipment	Plant items	Lw, dB(A)	Reference
A) Site establishment	Tracked excavator 21t	1	110	BS 5228-1:2009
	Roller (vibratory)	1	109	AS2436
	Dozer 41t	1	108	BS 5228-1:2009
	Dump truck	1	110	CNVG: 2016
	Total Lw		**115**	
	Total Lw including operating time per 15 min.		**115**	
B) Substructure	Piling Rig (Bored)	1	111	AS2436
	Wheeled mobile crane	1	98	BS 5228-1:2009
	Excavator (tracked) 35t	1	110	CNVG: 2016
	Concrete agitator	1	109	AS2436
	Concrete pump truck	1	109	AS2436
	Water cart	1	107	AS2436
	Total Lw		**116**	
	Total Lw including operating times		**114**	
C) Installation of temporary structures	Wheeled mobile crane	1	98	BS 5228-1:2009
	Portable Generator 2.5 kV*A	1	98	BS 5228-1:2009
	Franna crane	1	98	CNVG: 2016
	Power tools	1	94	?

[3] BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*

[4] AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*

[5] CNVG:2016 *RMS NSW - Construction Noise and Vibration Guideline*

Stage	Plant and equipment	Plant items	Lw, dB(A)	Reference
	Diesel scissor lift	1	106	BS 5228-1:2009
	Ute/crew truck	1	103	AS2436
	Dump truck	1	110	CNVG: 2016
	Total Lw		**113**	
	Total Lw including operating times		**111**	
D) Superstructure and façades	Concrete agitator	1	109	AS2436
	Concrete pump truck	1	109	AS2436
	Wheeled mobile crane	1	98	BS 5228-1:2009
	Hand tools	1	94	-
	Water cart	1	107	AS2436
	Dump truck	1	110	CNVG: 2016
	Total Lw		**115**	
	Total Lw including operating times		**111**	
E) External landscaping	Tracked excavator 21t	1	110	BS 5228-1:2009
	Grader	1	113	CNVG: 2016
	Dump truck	1	110	CNVG: 2016
	Total Lw		**116**	
	Total Lw including operating times		**113**	
F) Paving / asphalting	Pavement laying machine	1	114	CNVG: 2016
	Dump truck	1	110	CNVG: 2016
	Asphalt truck & sprayer	1	106	CNVG: 2016
	Concrete agitator	1	109	AS2436
	Smooth drum roller	1	107	CNVG: 2016
	Total Lw		**117**	
	Total Lw including operating times		**116**	
G) Demolition	Excavator (tracked) 35t	1	110	CNVG: 2016
	Jackhammer	1	121	AS2436
	Dump truck	1	110	CNVG: 2016
	Water cart	1	107	AS2436

Stage	Plant and equipment	Plant items	Lw, dB(A)	Reference
	Total Lw		**122**	
	Total Lw including operating times		**118**	

5.1.2 Typical construction noise levels

Typical worst-case construction noise levels have been predicted using a three-dimensional environmental noise model of the site and surrounds, developed in SoundPLAN version 7.4 environmental noise modelling software, including:

- topography
- building structures
- ground absorption (ground assumed to be 60% absorptive and 40% reflective)
- air absorption
- attenuation with distance.

Predictions have been carried out based on the environmental noise prediction algorithms documented in ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*. This provides predictions typical of conditions where the receiver is downwind of the source or where there is a moderate ground-based temperature inversion.

It is important to note that these predictions are typical worst-case predictions as they assume that:

- The construction works are occurring at the nearest point to each receiver and that the receiver is located at the most exposed position (e.g. the nearest point of each receiver).
- The noisiest construction sources are operating continuously for the entire 15-minute period. This will not occur at all times as equipment will regularly be stood down or idled while other activities are undertaken.

Typical worst-case predicted noise levels are shown in Table 14 to Table 23 for each sensitive-receiver location and each phase of works. Receivers predicted at 75 dB(A) and over are highly noise affected are highlighted in **bold** type. Furthermore, it is noted that due to the low background levels in the rural area around the premises, the NML for standard working hours is exceeding in all receiver locations during all work types.

As the nature of construction noise is transient, the noise impact at any one location will be at a worst-case for only a short time, as plant and activities will vary in intensity and location.

Recommendations for construction noise management are provided in Section 5.3. The following Sections 5.1.3 to Section 5.1.12 show the results at each receiver for all stages.

5.1.3 Stage 1 – Primary School

Table 14 below shows the construction noise impact during Stage 1. The highly affected receivers are summarised as follows.

- R1 during site establishment, substructure and installation of temporary structures for the relocation of temporary primary school buildings.
- R1 during site establishment for the multi-purpose hall.
- R1 during site establishment and paving / asphalting for the temporary on-ground parking.
- R3, R4 during the demolition of the existing house.
- R3, R4 during the demolition of the Existing on ground car park.

Table 14 Typical worst-case predicted external construction noise levels during construction Stage 1

Stage 1	**Relocate primary school building (temporary) – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	**81**	66	58	58	57	57	61	64	63	67
	B) Substructure	**80**	65	57	57	56	56	60	63	62	66
	C) Installation of temporary structures	**77**	62	54	54	53	53	57	60	59	63
	Multi-purpose hall (temporary) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	**75**	72	60	60	60	59	62	62	61	64
	B) Substructure	74	71	59	59	59	58	61	61	60	63
	C) Installation of temporary structures	71	68	56	56	56	55	58	58	57	60
	On-ground parking (temporary) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	**81**	63	57	57	57	57	61	65	66	72
	F) Paving/ asphalting	**82**	64	58	58	58	58	62	66	67	73
	Play space (temporary) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	73	66	58	57	58	58	62	63	61	63
	Existing house (demolition) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	G) Demolition	61	71	**87**	**80**	69	67	65	60	59	60
	Existing on ground car park (demolition) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	G) Demolition	61	69	**91**	**82**	69	67	65	61	58	59

5.1.4 Stage 2 – Primary School

Table 15 below shows the construction noise impact during Stage 2. The highly affected receivers are summarised as follows.

- R7 during site establishment and building of the substructure for the primary school block
- R8 during paving / asphalting for the multipurpose court and cricket nets

Table 15 Typical worst-case predicted external construction noise levels during construction Stage 2

Stage 2	**Primary school block – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	62	64	62	62	60	63	**78**	64	60	58
	B) Substructure	61	63	61	61	59	62	**77**	63	59	57
	D) Superstructure and façades	58	60	58	58	56	59	74	60	56	54
	Village green – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	67	63	57	57	56	57	64	66	62	63
	K-2 play space – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	62	63	59	59	59	60	72	66	60	58
	Multipurpose court and cricket nets – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	63	60	57	57	57	57	65	73	62	62
	F) Paving/ asphalting	66	63	60	60	60	60	68	**76**	65	65

5.1.5 Stage 3A – Primary School

Table 16 below shows the construction noise impact during Stage 3A. The highly affected receivers are summarised as follows.

- R7 during the site establishment, building of the substructure and superstructure and façades for the primary school block.
- R7 during the external landscaping for the part civic heart construction.
- R7 during the site establishment and paving / asphalting of the southern entry to future underground parking.

Table 16 Typical worst-case predicted external construction noise levels during construction Stage 3A

Stage 3A	**Primary school block, including library and staff room on 3rd and 4th floors – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	61	65	62	62	63	66	**80**	62	58	59
	B) Substructure	60	64	61	61	62	65	**79**	61	57	58
	D) Superstructure and façades	57	61	58	58	59	62	**76**	58	54	55
	Part civic heart construction under library building – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	59	63	60	60	61	64	**78**	60	56	57
	Southern entry to future underground parking – NML 47 dB(A) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	60	63	62	62	64	67	**78**	60	56	58
	F) Paving/ asphalting	61	64	63	63	65	68	**79**	61	57	59
	Play space to south-west corner (temporary) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	58	61	62	62	65	70	74	57	55	56

5.1.6 Stage 3B – Early Learning Centre

Table 17 below shows the construction noise impact during Stage 3B. The highly affected receivers are summarised as follows.

- R8 during the site establishment, substructure, superstructure and façades for the ELC.
- R8 during the site establishment and paving / asphalting of the ELC car park and kiss & drop.

Table 17 Typical worst-case predicted external construction noise levels during construction Stage 3B

Stage 3B	**Early Learning Centre ELC – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	68	61	56	55	57	57	63	**78**	69	70
	B) Substructure	67	60	55	54	56	56	62	**77**	68	69
	D) Superstructure and façades	64	57	52	51	53	53	59	74	65	66
	ELC outdoor play area – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	67	60	54	53	55	55	60	71	64	65
	ELC car park and kiss & drop – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	62	61	59	60	60	61	73	**83**	69	64
	F) Paving/ asphalting	63	62	60	61	61	62	74	**84**	70	65

5.1.7 Stage 4 – Secondary School

Table 18 below shows the construction noise impact during Stage 4. The highly affected receivers are summarised as follows.

- R2 during the site establishment and substructure for the secondary school block.

Table 18 Typical worst-case predicted external construction noise levels during construction Stage 4

Stage 4	**Secondary school block with specialist science facilities – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	68	**78**	62	60	61	60	63	61	58	62
	B) Substructure	67	**77**	61	59	60	59	62	60	57	61
	D) Superstructure and façades	64	74	58	56	57	56	59	57	54	58
	Part Village Green construction – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	65	70	59	59	59	59	66	62	58	60

5.1.8 Stage 5 – Secondary School

Table 19 below shows the construction noise impact during Stage 5. The highly affected receivers are summarised as follows.

- R2 during the site establishment, substructure, superstructure and façades for the secondary school block.
- R5 and R6 during paving / asphalting for the temporary on-ground kiss & drop car park.

Table 19 Typical worst-case predicted external construction noise levels during construction Stage 5

Stage 5	**Secondary school block with Café, TAS, Performing Visual Arts, Secondary Library and Staff room – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	64	**82**	65	63	63	63	67	60	58	60
	B) Substructure	63	**81**	64	62	62	62	66	59	57	59
	D) Superstructure and façades	60	**78**	61	59	59	59	63	56	54	56
	Part Civic Heart construction – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	63	72	65	65	64	64	68	61	59	60
	B) Substructure	62	71	64	64	63	63	67	60	58	59
	D) Superstructure and façades	59	68	61	61	60	60	64	57	55	56
	On-ground Kiss & Drop (temporary) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	F) Paving/ asphalting	59	63	67	69	**78**	**82**	70	59	57	58

5.1.9 Stage 6 – Secondary School

Table 20 below shows the construction noise impact during Stage 6. The highly affected receivers are summarised as follows.

- R2 during the site establishment and substructure for the secondary school block extension.

Table 20 Typical worst-case predicted external construction noise levels during construction Stage 6

Stage 6	**Secondary school block with specialist TAS facilities and remaining homebased – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	61	**77**	70	66	63	63	62	59	57	56
	B) Substructure	60	**76**	69	65	62	62	61	58	56	55
	D) Superstructure and façades	57	73	66	62	59	59	58	55	53	52
	TAS outdoor workshops – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	57	69	73	66	63	62	60	56	55	55
	Services pavilion – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	B) Substructure	57	66	75	68	63	62	60	55	55	56
	D) Superstructure and façades	54	63	72	65	60	59	57	52	52	53

5.1.10 Stage 7 – Multi-purpose Hall & Gurdwara

Table 21 below shows the construction noise impact during Stage 7. The highly affected receivers are summarised as follows.

- R4 during the site establishment for the multi-purpose hall, Gurdwara, Langar.
- R4, R5, R6 during site establishment and substructure of the underground car park.
- R6 during the superstructure and façades for the underground car park.
- R5 and R6 during the demolition of the temporary parking to south-east corner.
- R1 during the demolition of the temporary multi-purpose hall.

Table 21 Typical worst-case predicted external construction noise levels during construction Stage 7

Stage 7	**Multi-purpose Hall & bridge link / Gurdwara & Langar – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	60	68	71	**75**	74	70	67	60	57	58
	B) Substructure	59	67	70	74	73	69	66	59	56	57
	D) Superstructure and façades	56	64	67	71	70	66	63	56	53	54
	Finish Civic Heart construction – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	60	65	67	68	70	70	69	59	55	58
	B) Substructure	59	64	66	67	69	69	68	58	54	57
	D) Superstructure and façades	56	61	63	64	66	66	65	55	51	54
	Landscaping along Tallawong Road – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	56	62	72	**78**	**79**	**79**	62	55	53	55
	Secondary school courtyard – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	E) External landscaping	73	71	58	58	58	57	60	60	59	62
	Underground car park – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	60	65	67	70	**78**	**81**	**77**	60	57	58
	B) Substructure	59	64	66	69	**77**	**80**	**76**	59	56	57
	D) Superstructure and façades	56	61	63	66	74	**77**	73	56	53	54
	Temporary parking to south-east corner (demolition) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	G) Demolition	61	65	69	71	**81**	**84**	72	61	59	60
	Temporary multi-purpose hall (demolition) – NML 47 dB(A)									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	G) Demolition	**79**	75	63	63	63	62	65	65	64	67

5.1.11 Stage 8 – Administration Building & Forecourt

Table 22 below shows the construction noise impact during Stage 8. The highly affected receivers are summarised as follows.

- R1 during the demolition of relocatable classrooms and temporary car park to north-west corner.

Table 22 Typical worst-case predicted external construction noise levels during construction Stage 8

Stage 8	**Administration building / Final 3 GLAs for Primary school / School reception and sick bay / Principal and support staff office – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	61	65	62	62	63	65	73	61	58	59
	B) Substructure	60	64	61	61	62	64	72	60	57	58
	D) Superstructure and façades	57	61	58	58	59	61	69	57	54	55
	Temporary car park to north-west corner (demolition) – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	G) Demolition	**84**	66	60	60	60	60	64	68	69	**75**
	Relocatable classrooms (demolition) – NML 47 dB(A)										
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	G) Demolition	**85**	69	61	61	60	60	64	67	66	70

5.1.12 Stage 9 – Student Boarding House

Table 23 below shows the construction noise impact during Stage 9. The highly affected receivers are summarised as follows.

- R1 during the site establishment and substructure for the boarding house.

Table 23 Typical worst-case predicted external construction noise levels during construction Stage 9

Stage 9	**Boarding House / Staff apartments / Undercroft parking for boarding house – NML 47 dB(A)**									
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**
	A) Site establishment	**79**	67	58	58	59	57	61	65	66	71
	B) Substructure	**78**	66	57	57	58	56	60	64	65	70
	D) Superstructure and façades	75	63	54	54	55	53	57	61	62	67

5.1.13 Summary of construction noise impact

Due to the low existing background noise environment at this greenfield site the Noise Management Level is relatively low for construction noise, being 47 dB(A). This coupled with the proposed residential development adjacent the school site on all sides, means that there is a relatively short distance between the construction activities and the residential receivers. This means that a degree of adverse noise impact is inevitable. This is shown by the results for all receivers and activities in Table 14 to Table 23 inclusive. In addition, there are also some instances of the Highly Noise Affected Criteria (75 dBA) being exceeded. These are, typically either when the construction works get very close to the receivers, or during demolition.

Nevertheless, any adverse noise impact can be minimised by applying noise mitigation and management measures recommended in Section 5.3.

It should be noted that the existing noise sensitive receivers close to the site at 163 and 141 Tallawong Road are further away than the modelled future residential receivers adjacent the site. Therefore, predicted construction noise levels at the existing residential properties will be similar To R3 for 163 Tallawong Road and lower at 141 Tallawong Road.

5.2 Construction vibration

Table 24 summarises recommended safe working distances for key vibration-generating activities that would be expected during the construction phase, based on prior measurements conducted by Resonate Consultants.

Table 24 Recommended safe working distances for key vibration generating activities

Plant	Rating	Typical safe working distance for occupant comfort, m		Typical safe working distance for building damage, m	
		Preferred vibration target	Maximum vibration target	Heritage structure	Commercial building
Vibratory roller	< 7t	≥ 35	≥ 20	≥ 10	≥ 2
	7t – 12t	≥ 50	≥ 30	≥ 15	≥ 5
	≥ 13t	≥ 75	≥ 40	≥ 20	≥ 10
Excavator	Large excavator digging	≥ 25	≥ 15	≥ 5	≥ 1
Bored piling	≤ 800mm	≥ 20	≥ 10	≥ 2	≥ 1
Jackhammer	Handheld	–(1)	–(1)	≥ 3	≥ 1

(1) Avoid contact with structure

Based on the safe working distances above, occupant comfort vibration impacts on buildings may be expected at locations in line with R1, R2, R3, R4, R5, R6, R7 whilst work is being conducted. The distances to the above mentioned receivers could be below the safe working distance criteria for large vibratory roller (7t - ≥13t). Where equipment is being used at distances lower than the safe working distances, recommendations are provided in Section 5.3 for the management of construction vibration from the works.

5.3 Recommendations for construction noise and vibration

To manage the potential impact of noise and vibration during construction, feasible and reasonable management measures and work practices should be implemented as detailed below.

5.3.1 Construction Noise and Vibration Management Plan

Prior to the commencement of major construction works the contractor should develop a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP should:

- identify relevant construction noise and vibration criteria as detailed in this report.
- Identify neighbouring sensitive land uses for noise and vibration.
- Summarise key noise and vibration generating construction activities and the associated predicted levels at neighbouring land uses.
- Identify reasonable and feasible work practices to be implemented during the works.
- Summarise stakeholder consultation and complaints handling procedures for noise and vibration.

5.3.2 Stakeholder consultation

Nearby stakeholders should be consulted prior to the works and kept regularly informed of potential noise and vibration impacts from the works. Specifically, this would involve:

- Consultation with the residents around Sikh Grammar School to inform them of the works.
- A noise and vibration complaints handling procedure and register should be developed and implemented during construction.

5.3.3 Work programming

Construction stage programming should be implemented such that works, and particularly noisy works, occur during standard working hours wherever feasible, namely:

- Monday to Friday 7 am to 6 pm.
- Saturday 8 am to 1 pm.
- No work on Sundays or public holidays.
- Schedule construction works during school holidays.
- Implementation of respite hours agreed with residents if necessary.

5.3.4 Respite periods

Where noisy works are expected to occur for a significant duration over a number of days or weeks, respite periods can be agreed with the community, where noisy works do not occur in certain time windows to provide the residents respite from the noise.

5.3.5 Truck movements and site access

Truck movements during long term construction projects have the potential to cause annoyance for sensitive receivers, even where trucks may be travelling on sealed roads. The design and selection of site access routes shall consider the potential disturbance to residents. In particular:

- Site access and delivery points shall be located as far away from residences as possible.
- Truck movements shall use arterial roads and be diverted away from residential streets where feasible.
- Deliveries to/from site shall not occur during the night time period and outside of standard working hours where possible.

5.3.6 Site management

Site management procedures should include the following:

- Processes that generate lower noise/vibration levels should be selected where feasible. In particular small vibratory rollers < 7t should be used along the site boundary as the larger models exceed the safe working distance criteria for vibration.
- Noisy plant should be located as far away from residences as is practical to allow efficient and safe completion of the task.
- Site compounds should be located as far away as possible from residences.
- Equipment that is used intermittently should be shut down or throttled down to a minimum during periods where it is not in use.
- Works should be planned to minimise the noise from reversing signals.
- Warning horns should not be used as signalling devices.
- Two way radios should be set to the minimum effective volume.
- Noise associated with packing up plant and equipment at the end of works should be minimised.
- Potential shielding provided by site topography and intervening buildings should be considered in locating equipment.
- It is recommended to use mobile noise barriers/enclosures when possible. Examples of a mobile enclosure and demountable noise barriers are shown in Figure 2 and Figure 3.

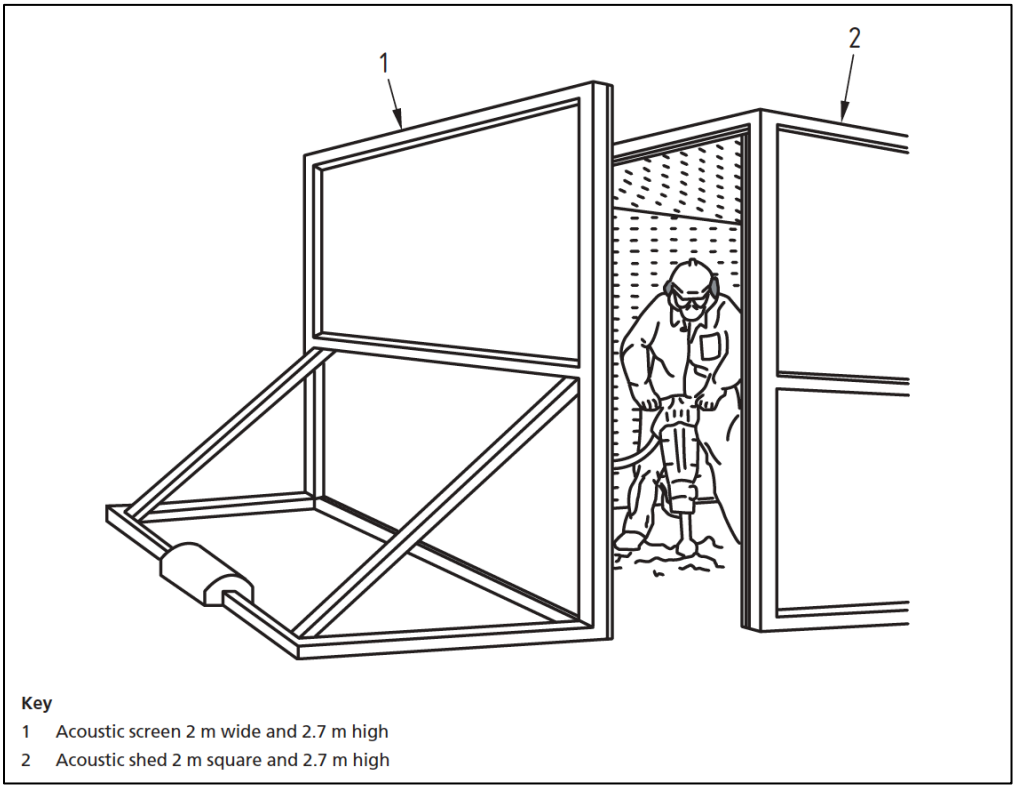


Figure 2 Example of acoustic shed taken from BS 5228-1:2009

Figure 3 Example of a demountable noise barrier (Photo from Flexshield.com.au)

5.3.7 Equipment management

Equipment management should include the following:

- Selection of low-noise plant and equipment where possible.
- Equipment should be well maintained.
- Equipment should have quality mufflers and silencers installed where relevant.
- Equipment not in use on site should be shut down.
- Tasks should be completed using the minimum feasible power and equipment.

5.3.8 Vibration monitoring

It is recommended to conduct vibration monitoring when construction work is being undertaken inside or close to the safe working distances, in order to provide measurement records should a complaint be received. If complaints of vibration are received it may be necessary to stop the work and take a vibration measurement and inspect the building for signs of damage before a view is taken whether to resume the work, or introduce another less invasive technique to carry out the work in question. This may involve using different or smaller lower powered plant and equipment, which may take longer, but still achieve the same aim.

6 Operational Noise Assessment

The following noise generating activities associated with the proposed school, Gurdwara and Langar development, are as follows:

- External mechanical plant.
- Public Address (PA) system, school bells and non-emergency alarms.
- Use of grounds by students and staff as outdoor recreation/play and teaching areas.
- On-site car park activity noise
- Use of the Gurdwara for performance/sporting events, particularly outside of regular operating hours.

6.1 Mechanical services plant

6.1.1 Overview of external mechanical services plant locations

A preliminary assessment of indicative mechanical services plant and equipment has been undertaken, using a reverse engineering method, calculating the maximum allowable sound level based on the noise attenuation from distance and shielding provided by the building roofs on which the plant is located. It is understood that the following outside areas are proposed for mechanical plant to be located (clockwise around site from southwest corner):

- **Stage 3B** - Early Learning Centre (ELC) – Plant location on rooftop (A)
- **Stage 3A** - Primary School – Plant location on rooftop (B)
- **Stage 8** - Administration / Underground parking – Plant location on rooftop (C)
- **Stage 7** - Gurdwara, Langar & Multipurpose Hall – Plant location on rooftop (D)
- **Stage 5** - Secondary School – Plant location on rooftop (E)
- **Stage 9** - Boarding House – Plant location on rooftop (F)

External mechanical services for school buildings would typically operate during the daytime period. Mechanical services for the Gurdwara would operate during the daytime and evening period, night during occasional events).

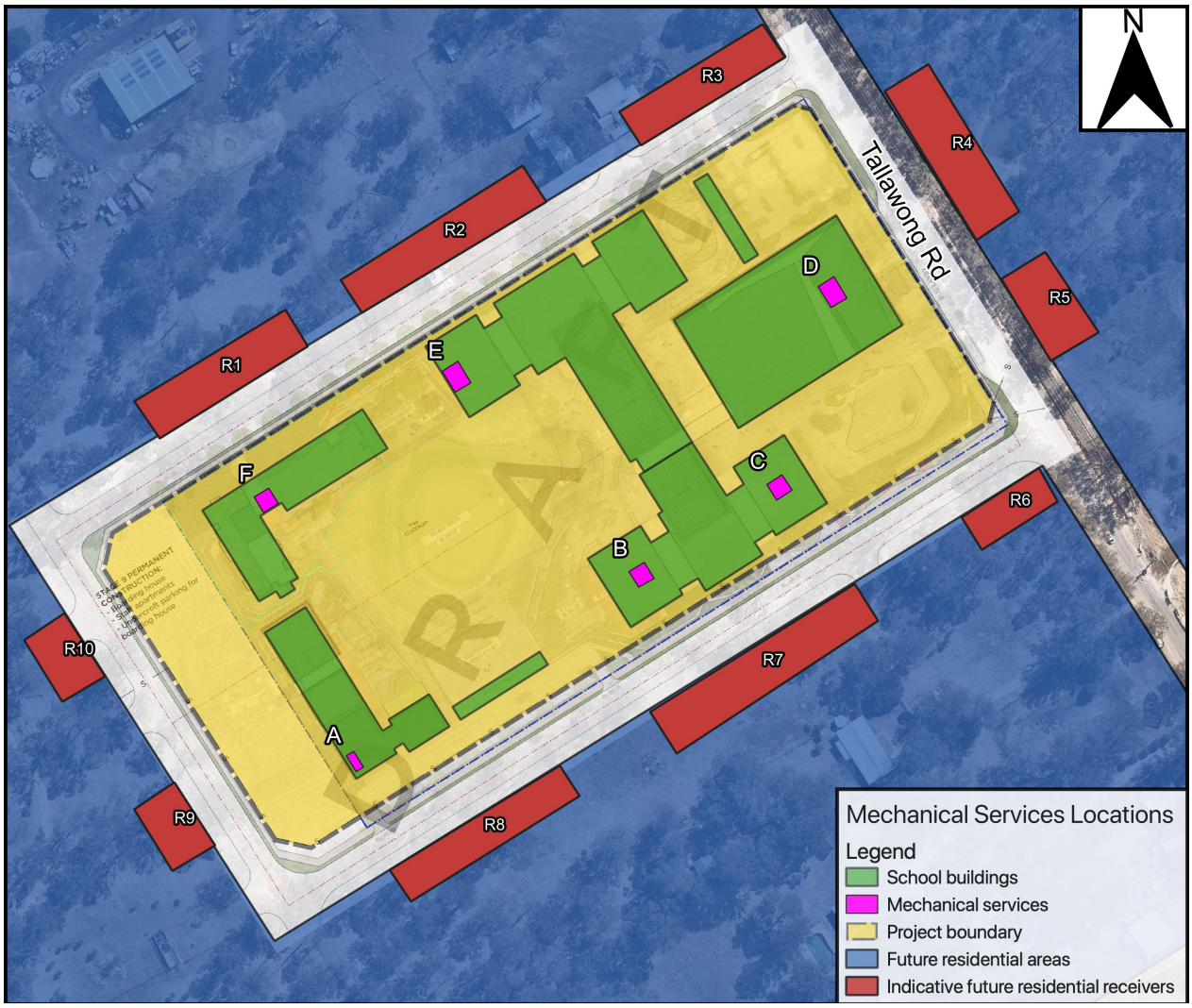


Figure 4 Mechanical plant locations - Sikh Grammar School

6.1.2 Early Learning Centre (A)

At the current location on the rooftop, 33 m from the nearest residential receiver (R8) the condenser units would not be allowed to exceed a sound pressure level of approximately 74 dB(A) at one metre during the daytime and evening period to meet the relevant noise criteria. The condenser units are not expected to operate during the night-time period. Any changes in condenser selection and locations during the detailed design stage would require further assessment to show compliance with the project design criteria.

6.1.3 Primary School (B)

At the current location on the rooftop, 36 m from the nearest residential receiver (R7) the condenser units would not be allowed to exceed a sound pressure level of approximately 75 dB(A) at one metre during the daytime and evening period to meet the relevant noise criteria. The condenser units are not expected to operate during the night-time period. Any changes in condenser selection and locations during the detailed design stage would require further assessment to show compliance with the project design criteria.

6.1.4 Administration building / Underground parking (C)

At the current location on the rooftop, 37 m from the nearest residential receiver (R7) the condenser units and exhausts would not be allowed to exceed a sound pressure level of approximately 75 dB(A) at one metre during the daytime and evening period to meet the relevant noise criteria. The condenser units are not expected to operate during the night-time period. Any changes in condenser selection and locations during the detailed design stage would require further assessment to show compliance with the project design criteria.

6.1.5 Gurdwara, Langar & Multipurpose Hall (D)

At the current location on the rooftop centre of the Gurdwara, 46 m from the nearest residential receivers (R4 and R5) the condenser units and exhausts would not be allowed to exceed a sound pressure level of approximately 81 dB(A) at one metre during the daytime and evening period respectively and 76 dB(A) during the night-time period to meet the relevant noise criteria. The condenser units are not expected to operate during the night-time period. Any changes in condenser selection and locations during the detailed design stage would require further assessment to show compliance with the project design criteria.

6.1.6 Secondary School (E)

At the current location on the rooftop, 30 m from the nearest residential receiver (R2) the condenser units would not be allowed to exceed a sound pressure level of approximately 75 dB(A) at one metre during the daytime and evening period to meet the relevant noise criteria. The condenser units are not expected to operate during the night-time period. Any changes in condenser selection and locations during the detailed design stage would require further assessment to show compliance with the project design criteria.

6.1.7 Boarding House (F)

At the current location on the rooftop, 32 m from the nearest residential receiver (R1) the condenser units would not be allowed to exceed a sound pressure level of approximately 74 dB(A) at one metre during the daytime and evening period to meet the relevant noise criteria. The condenser units are not expected to operate during the night-time period. Any changes in condenser selection and locations during the detailed design stage would require further assessment to show compliance with the project design criteria.

6.1.8 Summary of Mechanical Plant Noise Assessment

This assessment has not considered the erection of noise barriers around the plant areas at this stage. However, the addition of noise barriers around the plant will likely increase the maximum predicted allowable sound levels noted above for each plant location by approximately 10 dB(A). At this early stage of planning, this plant noise assessment shows that an adverse noise impact to the surrounding noise sensitive receivers is unlikely and the option of further noise reduction with the addition of a noise barrier is available as a practical noise control method. Further plant noise control methods such as attenuators, lined ducts/bends/angled ducts away from noise sensitive receivers, quieter plant selection, relocation of plant are all available, if required. The risk of an adverse plant noise impact to the community is considered negligible, however, detailed review is recommended during the relevant design phases for each stage when it occurs.

6.2 Public Address System (internal)

Location of Public Address System

A public address (PA) system has been assumed to be a distributed system split into zones around the school to ensure appropriate coverage and allow more control at commissioning of sound levels to each zone around the major internal school areas as appropriate. Zones will be added as each development stage is completed. The PA system will typically be used for making public announcements. Loudspeakers are also expected to be installed inside the buildings in the General Learning Areas (GLAs), Early Learning Centres (ELCs), other teaching spaces, offices,

library, multipurpose hall and other spaces, which will make up the PA zones. It is not clear whether the PA will double as a voice alarm system.

Assessment methodology and results

To achieve a good level of speech intelligibility needed for effective communication, PA sound levels must exceed background levels by at least 10-15 dB (10-15 dB Signal no Noise Ratio (SNR)) across all zones.

At this stage it is expected that the PA loudspeakers will be located inside the school buildings and Gurdwara, Langar and multipurpose hall , therefore, the impact to the noise sensitive receivers outside of the school will be reduced by the sound insulation provided by the building envelope of the school buildings.

Occupational noise levels in the school areas where the PA is installed are not expected to be greater than 60 dB(A) during normal school activities. To achieve a SNR of 15 dB at the perimeter of each zone will not exceed 75 dB(A).

Figure 5 shows the nearest sensitive receiver to possible PA zones in the school. Noise predictions for the nearest sensitive receivers have been undertaken and a conservative 10 dB noise reduction through an open window has been assumed. The predicted noise levels compared with the relevant criteria are shown in Table 25.

Figure 5 Nearest receivers (R1, R2, R4, R7 and R8) for internal PA loudspeakers

Table 25 Predicted PA noise levels at most affected sensitive receivers

Receiver	Description	Approx. distance to receiver, m	NPI Criterion $L_{Aeq,15min}$ dB(A)	Predicted Noise Level dB(A)	Meets Criterion?
R1	Residential external	28	Day 42dB	28	✓
			Evening 43dB	28	✓
			Night 37dB	28	✓
R2	Residential external	19	Day 42dB	31	✓
			Evening 43dB	31	✓
			Night 37dB	31	✓
R4	Residential external	35	Day 42dB	26	✓
			Evening 43dB	26	✓
			Night 37dB	26	✓
R7	Residential external	24	Day 42dB	29	✓
			Evening 43dB	29	✓
			Night 37dB	29	✓
R8	Residential external	29	Day 42dB	27	✓
			Evening 43dB	27	✓
			Night 37dB	27	✓

6.3 School bells

At this stage, there are no external School bells/Period alarms planned. Any new services will be located internally in the new buildings. However, as a guide 10 dB(A) can be added to the noise prediction in Table 25, which would still result in compliance with the criteria. Therefore, the risk of an adverse noise impact to the community is considered negligible, but should be further reviewed during the relevant design stages when further information is available.

Should external school bells/sounders be used then the following good practice advice should be followed:

- Electronic sounders or loudspeakers should be used in preference to traditional mechanical ‘ringing’ school bells because sound type and directivity can be better controlled to minimise unnecessary noise spill.
- Loudspeakers should be located and orientated to provide good coverage of the school areas while being directed away from residences. The coverage of the system should be subject of the detail design of the sound system, which is often under the remit of the electrical engineer.
- The volume of the system should be adjusted on site so that announcements and sounders are clearly audible over the required coverage areas on the school site without being excessive maintaining a 10-15dB(A) signal to noise ratio. This should not result in noise at surrounding residences exceeding the ambient noise levels by more than 5 dB(A). It may need to be reduced further if complaints are received.
- Loudspeakers should be small, low-power units located in areas close to the listener position. It is recommended to have a higher number of smaller loudspeakers distributed to be close to the listeners rather than fewer more powerful loudspeakers that are required to project the sound large distances to reach the listeners.

- Once the appropriate level has been determined on site, the system should be limited to the acceptable level so that staff cannot increase noise levels. A sound level limiting circuit is an option to be incorporated in the amplifier to control the signal amplitude to a fixed level, regardless of the loudness of the operator's voice.
- The system bell should be set so that it only occurs on school days.

6.4 Outdoor recreation

6.4.1 Proposed hours of operation and student capacity

The hours of operation of the school and Gurdwara are not confirmed at this early stage of the project but will be updated as the project progresses. The following is currently assumed:

- Normal school operating hours: 7am to 6pm. At full capacity there could be up to 588 primary and 672 secondary students.
- Before and after school care would be available from 7am in the morning and up to 6pm in the evening. No students would be on site after 6pm.
- Parent/teacher events would occur periodically. These events would occur inside the school building.
- Play spaces are assumed to have approximately 20 children playing at one time.
- The playing court is assumed to have approximately 30 children playing at one time.

Figure 6 shows the operational plan/locations assumed for the assessment of noise from children at play or in outdoor learning environments during the daytime period (7am to 6pm), and shows distances to the nearest indicative residential receiver.

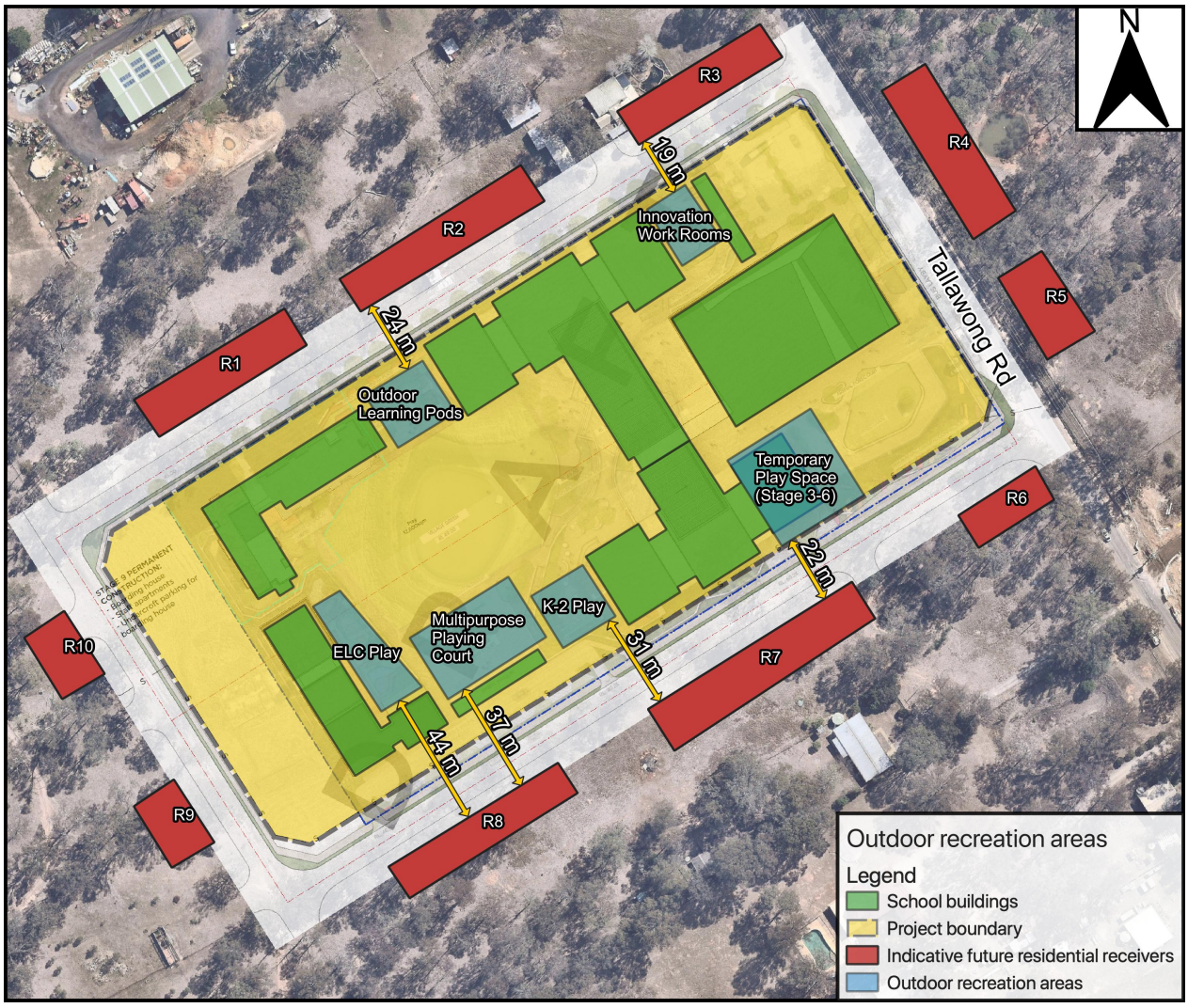


Figure 6 Site plan showing the areas for noise assessment purposes

6.4.2 Outdoor Recreation Assessment

The main outdoor recreation/learning activities are expected in the following areas:

- Multipurpose Playing Court (Stage 2: Primary School)
- K-2 play space (Stage 2: Primary School)
- Temporary play space (Stage 3: Primary School until Stage 6: Secondary School)
- ELC play space (Stage 3B: Early Learning Centre)
- Outdoor learning pods and Innovation work rooms (Stage 7)

Assumptions

- The assessment predicts noise levels at the future residential noise sensitive receivers adjacent the site represented by receivers R1-R10.
- Resonate has made assumptions regarding the number of children outside and speaking in each of the areas in the absence of more detailed information.

- Resonate has assumed that each outdoor recreation area will be used for up to 2 hours per day, which allows for a higher noise criterion (RBL + 10 dBA) as per the AAAC guideline[6]. This is 5dB higher than the NPI criterion (RBL + 5 dBA) see Table 12.
- We have derived source noise levels for children playing from the AAAC guideline[6].
- For the innovation work rooms and outdoor learning pods we have used source noise levels form our in-house database for children speaking at a normal speech effort, to simulate a learning environment as opposed to when they are playing, which will typically involve a greater vocal effort resulting in higher sound levels.

6.4.3 Stage 2 – Multipurpose Playing Court and K-2 Play

Multipurpose court

Playing sport games will include up to 30 children at play which could result in a sound power level of up to 95 dB(A). The nearest residential receiver is located at a distance of 37 m. The Sports Pavilion will have a beneficial shielding effect as it acts as a barrier to the nearest residents to the south. Due to the shielding benefit provided by the Sports Pavilion, the Multipurpose Playing Court complies at the nearest ground floor receiver but the first floor is predicted to exceed the criterion by a marginal 1 dB(A) as the shielding effect is reduced at higher house levels. A 1 dB(A) exceedance the criteria will not be noticeable to residents. Therefore, this could be considered a marginal compliance.

K-2 Play area

The K-2 Play area will include approximately 20 children at play which could result in a sound power level of up to 93 dB(A). The nearest residential receiver is located at a distance of 31 m. Without mitigation this would lead to an exceedance of the operational noise criterion of approximately 5 dB(A) on the first floor and 4 dB(A) on the ground floor.

With a 3.5 m high noise barrier in close proximity to the play area, compliance would be achieved on ground and first floor. As an in-principle solution, it is recommended to move the K-2 Play area into a better shielded position, or erect a 3.5m barrier in close proximity to the play area, or reduce the numbers of children allowed in the play area at any one time. However, it is recommended that the solution is refined in the detailed design stage. Table 26 below summarises the predictions for the Multipurpose Playing Court and K-2 Play.

Table 26 Predicted noise levels due to outdoor recreation

Outdoor recreation source	Nearest receiver	AAAC Criterion $L_{Aeq,15min}$, Day, dB(A)	Predicted Noise Level dB(A)	Meets Criterion? ✖/✓	Predicted Noise Level with mitigation dB(A)	With mitigation Meets Criterion? ✖/✓
Multipurpose Playing Court Lw 95 dB(A)	R7/R8	47	Floor 1 = 48	✖	-	-
			Ground Floor = 47	✓	-	-
K2-Play space Lw 93 dB(A)	R7/R8	47	Floor 1 = 52	✖	Floor 1 = 47	✓
			Ground Floor = 51	✖	Ground Floor = 45	✓

[6] Association of Australian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment, October 2013

6.4.4 Stage 3-6 – Temporary Play Space

The nearest residential receiver is located in a distance of 22 m. Assuming 20 children playing at one time would lead to a sound power level up to 93 dB(A). Without a noise barrier, both nearest receivers R6 and R7 exceed by 1 – 6 dB(A) respectively.

Compliance for ground level receivers would be achieved with the installation of a 3.5 m height noise barrier at the boundary of the play space. The first floor of R7 would still exceed by a marginal 1 dB(A), and would not be noticeable. It is recommended to move the Temporary Play Space further away from the R6 and R7 receivers to the centre of the school's premises, or erect a 3.5m high nose barrier at the southern boundary of the space and wrapping around the sides to block line-of-sight to residential receivers. However, it is recommended that the solution is refined in the detailed design stage.

Table 27 below summarises the predictions for the temporary play space.

Table 27 Predicted noise levels due to the temporary play space

Outdoor recreation source	Nearest receiver	AAAC Criterion $L_{Aeq,15min}$, Day, dB(A)	Predicted Noise Level dB(A)	Meets Criterion? ✗/✓	Predicted Noise Level with mitigation dB(A)	With mitigation Meets Criterion? ✗/✓
Temporary Play Space Lw 93 dB(A)	R7	47	F1 = 53	✗	F1 = 48	✗
			GF = 52	✗	GF = 46	✓
K2-Play space Lw 93 dB(A)	R6	47	F1 = 49	✗	F1 = 47	✓
			GF = 48	✗	GF = 45	✓

6.4.5 Stage 3B – ELC Play Space (Stage 3B: Early Learning Centre)

There is a play space for the ELC proposed to give students the possibility to play outdoors. The play space's location makes excellent use of the ELC building itself, as a noise shield between the play area noise source and sensitive residential receivers to the west and south. Assuming 20 children playing at one time could lead to a sound power level up to 93 dB(A). Table 28 shows that the resultant sound pressure level at the nearest receiver R8 and R10 complies with the criterion. Theoretically, an additional 60 children at play would still comply with the criterion, due to the ELC building working as an acoustic barrier.

Table 28 Predicted noise levels due to ELC play space

Outdoor recreation source	Nearest receiver	NPI Criterion $L_{Aeq,15min}$, Day, dB(A)	Predicted Noise Level dB(A)	Meets Criterion? ✗/✓	Predicted Noise Level with mitigation dB(A)	With mitigation Meets Criterion? ✗/✓
ELC Play Space Lw 93 dB(A)	R8	47	F1 = 41	✓	-	-
			GF = 40	✓	-	-
	R10		F1 = 27	✓	-	-
			GF = 26	✓	-	-

6.4.6 Stage 6 - Innovation Work Rooms

The nearest residential receiver represented by R3 is located at a distance of 19 m from the closet part of the Innovation Work Rooms. The Innovation Work Rooms are teaching spaces under teacher supervision adjacent to the secondary school. Therefore, it is assumed that students will talk in normal voices opposed to loud voices in play areas. We have assumed 40 students in the Innovation Work Rooms engaged in two-way conversations meaning that 20 students are speaking at any one time. This would result in a sound power level of approximately 81 dB(A) during the 15 minute period. Table 29 shows that the resultant sound pressure level at the nearest receiver R3 complies with the criterion.

Table 29 Predicted noise levels due to innovation work rooms

Outdoor recreation source	Nearest receiver	NPI Criterion $L_{Aeq,15min}$, Day, dB(A)	Predicted Noise Level dB(A)	Meets Criterion? ✗/✓	Predicted Noise Level with mitigation dB(A)	With mitigation Meets Criterion? ✗/✓
Innovation Work Rooms Lw 84 dB(A)	R3	47	F1 = 44	✓	-	-
			GF = 44	✓	-	-

6.4.7 Stage 7 – Outdoor Learning Pods / Natural Search & Discovery Forest

The nearest residential receiver (R2) is located at a distance of 24 m. The Outdoor Learning Pods / Natural Search & Discovery Forest are teaching spaces under teacher supervision adjacent to the secondary school. Therefore, it is assumed that students will talk in normal voices as opposed to loud voices in these outdoor areas. We have assumed 40 students speaking in two way conversations meaning that 20 students are speaking at any one time. This area would result in a sound power level of approximately 81 dB(A) during the 15 minute period. Table 30 shows that the resultant sound pressure level at the nearest receiver R2 complies with the criterion.

Table 30 Predicted noise levels due to outdoor learning pods / natural search and discovery forest

Outdoor recreation source	Nearest receiver	NPI Criterion $L_{Aeq,15min}$, Day, dB(A)	Predicted Noise Level dB(A)	Meets Criterion? ✗/✓	Predicted Noise Level with mitigation dB(A)	With mitigation Meets Criterion? ✗/✓
Innovation Work Rooms Lw 84 dB(A)	R2	47	F1 = 43	✓	-	-
			GF = 43	✓	-	-

6.4.8 Outdoor recreation noise impact summary

The close proximity of the play areas to the future residential receivers around the perimeter of the site means that it is impractical for the play areas to meet the standard NPI criteria, even with noise barriers. The assessment has assumed that the houses will be two level meaning that the upper level will receive less benefit from any barriers erected. However, it is usual for sleeping areas to be located upstairs and living areas downstairs. Therefore, the upper level is unlikely to be sensitive during the daytime school operating hours.

It is considered appropriate to use the criterion recommended by the AAAC guideline for childcare centres when the areas are used for up to 2 hours per day, which is the background level + 10 dB(A), which is 5 dB higher than the standard NPI criterion. Using the AAAC criterion, compliance is predicted to be achieved without further attenuation for the multi-purpose playing court, innovation work rooms and outdoor learning pods. However, for the K2 play space and temporary play space additional noise reduction is required. In-principle solutions for this are to erect 3.5m high barriers at the perimeter of the play spaces at the boundary of the site. Other options include, the relocation of the spaces further away from the noise sensitive receivers towards the centre of the site using school buildings to provide shielding. This approach has worked well for the ELC play space.

6.5 Car park activity noise assessment

An assessment of on-site activities associated with the car park was conducted to determine potential impacts at the nearest noise sensitive receivers. Figure 7 shows the proposed car park areas and Table 31 provides an overview of typical noise sources associated with the operation of each of the car parks, which have been used to assess noise impact on the community. Table 32 provides noise source levels and the estimated number of noise events in the 15 minute assessment period.

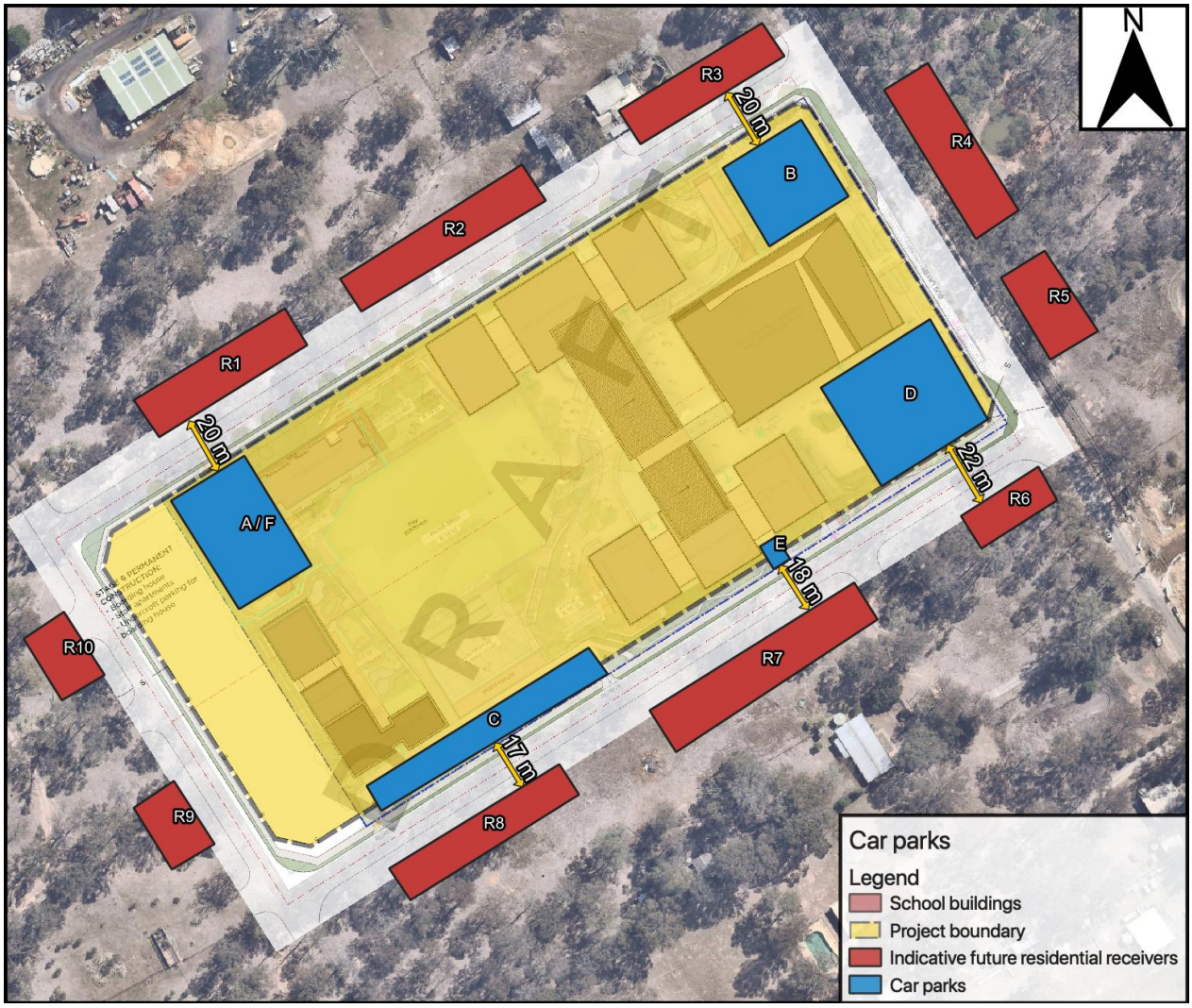


Figure 7 Site plan showing the areas for car parks

- **A) Stage 1** Temporary on Ground parking and kiss & drop for School (Stage 1 – 7)

- **B) Stage 1** Permanent on-ground parking for school (North-East)
- **C) Stage 3B** ELC Parking and Kiss & Drop
- **D) Stage 6** Temporary on-ground parking for school (Stage 6 only and demolished during Stage 7)
- **E) Stage 7** Underground car park
- **F) Stage 9** Student Boarding House – Undercroft car park

Table 31 Typical noise sources associated with each car park

Parking area / Stage	ID on map	Nearest receiver	Distance to receiver	Number of car spaces	Noise sources during parking process ✗/✓		
					Car door closure	Car engine start	Car pass-by
Stage 1 Temporary on Ground parking and kiss & drop for School (Stage 1 – 7)	A	R1	20 m	49	✓	✓	✓
Stage 1 Permanent on-ground parking for school (North-East)	B	R3	20 m	34	✓	✓	✓
Stage 3B ELC Parking and Kiss & Drop	C	R8	17 m	23	✓	✓	✓
Stage 6 Temporary on-ground parking for school (Stage 6 only and demolished during Stage 7)	D	R6	22 m	90	✓	✓	✓
Stage 7 Underground car park	E	R7	18 m	200	✗	✗	✓
Stage 9 Student Boarding House – Undercroft car park	F	R1	20 m	14	✗	✗	✓

6.5.1 Noise Source Levels

Table 32 presents the noise source levels and the number of events estimated for a 'peak' 15-minute time period providing a 'worst case scenario. The previously measured typical noise source levels, corrected for tonality and impulsiveness as per AS1055[7] have been converted to a sound exposure level (L_{AE}), which represents the sound energy condensed into one second. The L_{AE} is then used to calculate the 15 minute L_{Aeq}, which in turn is used to compare against the relevant day and evening criteria.

The car parks are not expected to be used in the night time period after 22:00hrs, except for Gurdwara events that would typically use the underground car park E and may run up to 23:00hrs. Therefore, the worst-case scenario has

[7] Australian Standard AS1055.1 - Description and measurement of environmental noise – General procedures

been assessed against the day time and evening NPI criteria for all car parks except car park E, which has also been assessed against the NPI night time criterion.

Table 32 Typical car park noise sources at 1m

Noise Source	Location	Measured Duration (s)	$L_{eq,T}$ dB	L_{AE} dB	Assumed maximum events per 15 minutes					
					A	B	C	D	E	F
Car door closure	1 m from source	2	75	78	32	24	18	60	-	-
Car engine start	1 m from source	3	72	77	8	8	6	20	-	-
Car pass-by	1 m from source	6	62	70	16	12	6	20	110	5

6.5.2 Noise Prediction Calculation Assumptions

The following assumptions have been made for noise calculations:

- There will be a total of approximately 139 temporary and 271 permanent car parking spaces when all stages are complete.
- Assumptions of noise events for all car parks are based on a reasonable expectation of noise events that may take place over a 15-minute period in the morning peak hour in relation to the total number of car parking spaces available in each car park.
- For the assessment of the Gurdwara underground car park, actual traffic counts from another similar Gurdwara at Glenwood were used to approximate maximum arrivals/departures in a worst case 15-minute period.
- All noise sources including car door closures, engine starts and car pas-bys have been treated as if they all occur at the nearest car park location to the sensitive receivers, which has been assumed to be the car park entrance.
- The method of predicting vehicle noise from the nearest single location is conservative as the car door closures and ignition noise sources would be spread out across the car park at varying distances from the receiver.
- As there are currently no intervening structures or barriers between the car park and the receivers, only distance loss has been applied to the source noise level.

6.5.3 Stage 1: Car park A - Temporary on ground parking predicted car park noise levels at receivers

The proposal includes provision of 43 car parking spaces and 6 Kiss & Drop spaces. It is assumed that during the morning peak hour 16 cars would arrive and 8 leave with a combined 32 car door closures accounting for a mix of one and two people in the arrival and departure cars, within a 15 minute period. This would result in noise levels of 42 dB(A) at the nearest residential receivers represented by R1, which complies with the daytime and evening criteria.

The predicted noise levels from car park activities versus the criteria are provided in Table 33.

Table 33 Stage 1 – Car Park A Predicted Noise Impacts versus NPI criterion

Receiver	Noise Source	Source Level dB L_{AE}(1)	Adjusted Source level(2) to $L_{Aeq,15mins}$	Distance attenuation dB(A)	Predicted External Noise Level L_{Aeq} dB(A)	Daytime criterion	Evening criterion
						42 dB $L_{Aeq,15mins}$	43 dB $L_{Aeq,15mins}$
R1	Car door closure	75	64	26	38	✓	✓
	Car engine start	72	56	26	30	✓	✓
	Car pass-by	76	65	26	39	✓	✓
Total Combined					42	✓	✓

(1) L_{AE} Equivalent sound energy level of a sound event compressed into the time period of 1 second.

(2) Adjusted from L_{AE} source level based on number of events.

Table 33 shows that the expected car park noise generation from car door closures, car ignition and car pass-by meets the all relevant assessment criteria of the NPI.

6.5.4 Stage 1: Car park B – Permanent on-ground parking for school (North-East)

The proposal includes provision of 34 car parking spaces. It is assumed that during the morning peak hour, 12 cars would arrive and 8 leave with a combined 24 car door closures accounting for a mix of one and two people in the arrival and departure cars, within a 15 minute period. This would result in a combined noise levels of 41 dB(A) at the nearest residential receivers represented by R1, which complies with the daytime and evening criteria.

The predicted noise levels from the car park activities versus the criteria are provided in Table 34.

Table 34 Stage 1 – Car park B Predicted Noise Impacts versus NPI criterion

Receiver	Noise Source	Source Level dB L_{AE} (1)	Adjusted Source level (2) to $L_{Aeq,15mins}$	Distance attenuation dB(A)	Predicted External Noise Level L_{Aeq} dB(A)	Daytime criterion	Evening criterion
						42 dB $L_{Aeq,15mins}$	43 dB $L_{Aeq,15mins}$
R1	Car door closure	75	62	26	36	✓	✓
	Car engine start	72	56	26	30	✓	✓
	Car pass-by	76	64	26	38	✓	✓
Total Combined					41	✓	✓

(1) L_{AE} Equivalent sound energy level of a sound event compressed into the time period of 1 second.

(2) Adjusted from L_{AE} source level based on number of events.

Table 34 shows that the expected car park noise generation from car door closures, car ignition and car pass-by meets the all relevant assessment method criteria of the NPI.

6.5.5 Stage 3B: Car park C - ELC Parking and Kiss & Drop

The proposal includes provision of 23 car parking spaces. It is assumed that during the morning peak hour, 6 cars would arrive and 6 leave with a combined 18 car door closures accounting for a mix of one and two people in the arrival and departure cars, within a 15 minute period. This would result in combined noise levels of 41 dB(A) at the nearest residential receivers represented by R1, which complies with the daytime and evening criteria.
The predicted noise levels from car park activities versus the criteria are provided in Table 35

Table 35 Stage 3B – Car park C Predicted Noise Impacts versus NPI criterion

Receiver	Noise Source	Source Level dB L_{AE} (1)	Adjusted Source level (2) to $L_{Aeq,15mins}$	Distance attenuation dB(A)	Predicted External Noise Level L_{Aeq} dB(A)	Daytime criterion	Evening criterion
						42 dB $L_{Aeq,15mins}$	43 dB $L_{Aeq,15mins}$
R1	Car door closure	75	59	25	34	✓	✓
	Car engine start	72	55	25	30	✓	✓
	Car pass-by	76	65	25	40	✓	✓
Total Combined					41	✓	✓

(1) L_{AE} Equivalent sound energy level of a sound event compressed into the time period of 1 second.

(2) Adjusted from L_{AE} source level based on number of events.

Table 35 shows that the expected car park noise generation from car door closures, car ignition and car pass-by meets the all relevant assessment method criteria of the NPI.

6.5.6 Stage 6: Car park D Temporary on-ground parking for school (Stage 6 only and demolished during Stage 7)

The proposal includes provision of 90 car parking spaces made up of 80 general spaces and 10 kiss and ride spaces. It is assumed that during the morning peak hour, 20 cars would arrive and 20 leave with a combined 60 car door closures accounting for a mix of one and two people in the arrival and departure cars, within a 15 minute period. This would result in a combined noise levels of 43 dB(A) at the nearest residential receivers represented by R1, which is a marginal exceedance of the daytime criterion. However, a 1 dB(A) difference in noise level will not be noticeable, and the this assumed worst-case scenario would only occur during the peak hours. Therefore, the 1 dB(A) exceedance is considered negligible and is not expected to result in an adverse impact to the residents.

The predicted noise levels from typical car park activities versus the criteria are provided in Table 36.

Table 36 Stage 6 – Car park D Predicted Noise Impacts versus NPI criterion

Receiver	Noise Source	Source Level dB L_{AE}(1)	Adjusted Source level(2) to $L_{Aeq,15mins}$	Distance attenuation dB(A)	Predicted External Noise Level L_{Aeq} dB(A)	Daytime criterion	Evening criterion
						42 dB $L_{Aeq,15mins}$	43 dB $L_{Aeq,15mins}$
R1	Car door closure	75	66	27	39	✓	✓
	Car engine start	72	60	27	33	✓	✓
	Car pass-by	76	67	27	40	✓	✓
Total Combined					43	×	✓

(1) L_{AE} Equivalent sound energy level of a sound event compressed into the time period of 1 second.

(2) Adjusted from L_{AE} source level based on number of events.

Table 36 shows that the expected car park noise generation from car door closures, car ignition and car pass-by meets the all relevant assessment method criteria of the NPI.

6.5.7 Stage 8: Car park E Underground car park

The proposal includes provision of 200 underground car parking spaces meaning that noise from car door closures and car ignition will be contained by the underground building envelope. It is assumed from taking the worst-case traffic movement scenario from a similar Gurdwara at Sahib Glenwood that during the morning peak hour, 110 car movements including both arrivals and departures will occur within a 15 minute period. This would result in a predicted noise impact level of 47 dB(A) at the nearest residential receivers represented by R1, which exceeds the period criteria for day, evening and night time by 5 dB(A), 6 dB(A) and 10 dB(A) respectively.

This assessment has assumed that the worst-case scenario occurs in the day and evening as well as night time when the Gurdwara has late events on a Friday or Saturday night, which may run until 23:00hrs. Further, the night time Gurdwara events are anticipated to only occur a few times over the year. For the vast majority of the time there is expected to be minor activity at the car park and the criteria is expected to be met. It is just in the morning, evening

peak times and the occasional event at the Gurdwara that runs passed 22:00hrs. Therefore, the actual noise impact is likely to be less than the noise levels suggest, and there may be justification in relaxing the criterion, especially for night time.

It is impractical to provide physical noise control between the cars and the receivers such as, a barrier along the resident's boundary. However, it may be possible to manage the noise impact by reducing car movement numbers by directing traffic to use other car parks or, having separate entrances/exits to the car park separating and sharing the noise during busy periods.

It should also be noted that the internal noise in the residences will be much lower, even through an open window, which would reduce the noise impact to residents further. The predicted noise levels from typical car park activities versus the criteria are provided in Table 37.

Table 37 Car Park E predicted noise impacts versus NPI criterion

Receiver	Noise Source	Source Level dB L_{AE} (1)	Adjusted Source level (2) to $L_{Aeq,15mins}$	Distance attenuation dB(A)	Predicted External Noise Level L_{Aeq} dB(A)	Daytime criterion	Evening criterion	Night criterion
						42 dB $L_{Aeq,15min}$	43 dB $L_{Aeq,15min}$	37 dB $L_{Aeq,15min}$
R1	Car door closure	75	64	25	-	✓	✓	✓
	Car engine start	72	60	25	-	✓	✓	✓
	Car pass-by	76	72	25	47	×	×	×
Total Combined					47	×	×	×

(1) L_{AE} Equivalent sound energy level of a sound event compressed into the time period of 1 second.

(2) Adjusted from L_{AE} source level based on number of events.

6.5.8 Stage 9: Car park F Student Boarding House

The details about parking for Stage 9 is not available at this stage. However, we have counted 14 car spaces from the SSDA architectural drawings. Therefore, we have assumed that 5 car movements will occur during the peak 15 minute period of the morning peak hour. As the car park is shown to be in an undercroft, noise from car door closures and ignitions will be shielded from the noise sensitive receivers and therefore, have not been included in the assessment. Further assessment will be required during the detailed design process.

The predicted noise levels from typical car park activities versus the criteria are provided in Table 38.

Table 38 Stage 9: Car park F Predicted Noise Impacts versus NPI criterion

Receiver	Noise Source	Source Level dB L_{AE}[1]	Adjusted Source level[2] to $L_{Aeq,15mins}$	Distance attenuation dB(A)	Predicted External Noise Level L_{Aeq} dB(A)	Daytime criterion	Evening criterion
						42 dB $L_{Aeq,15mins}$	43 dB $L_{Aeq,15mins}$
R1	Car door closure	75	64	26	-	✓	✓
	Car engine start	72	60	26	-	✓	✓
	Car pass-by	76	58	26	32	✓	✓
Total Combined					32	✓	✓

(1) L_{AE} Equivalent sound energy level of a sound event compressed into the time period of 1 second.

(2) Adjusted from L_{AE} source level based on number of events.

Table 38 shows that the expected car park noise generation from car door closures, car ignition and car pass-by meets the all relevant assessment method criteria of the NPI.

6.5.9 Car Park Activity Assessment Summary

There are six car parks proposed for the overall development, covering multiple project stages, of which car park D is temporary being used for stage 6 only, before being demolished during the stage 7 construction phase. Generally, the car parks meet the relevant day and evening criteria based on assumptions of the number car pas-bys (arrivals and departures), car door closures and car ignition events in a worst-case 15-minute peak period.

The only car parks that exceeded the criteria to some degree was the temporary carpark D and the Underground carpark E. Temporary car park D exceeds the daytime criterion by a marginal 1 dB(A), which is considered a negligible impact. The temporary nature of the car park also means that any noise generated will not be permanent. Therefore, no further noise mitigation is recommended for car park D.

Car park E is an underground carpark and therefore, noise from car door closures and ignition events will take place underground and not impact residents. However, cars entering and leaving the car park entrance are predicted to exceed the day, evening and night time criteria by 5 dB(A), 6 dB(A) and 10 dB(A) respectively. Due to the low number of occasions that this worst-case scenario may occur there may be justification is relaxing the criteria (see section 6.5.7). The noise levels have been predicted at the boundary of presumed future residential premises directly opposite the car park entrance/exit. It may be possible to manage the noise impact by reducing car movement numbers by directing traffic to use other car parks or, having separate entrances/exits to the car park separating and sharing the noise during busy periods.

Overall the noise impact from the car parks located over the development are expected to be minor.

6.6 Gurdwara / Temporary Multi-Purpose Hall

6.6.1 Stage 1 - Temporary Multi-Purpose Hall

Stage 1 involves the construction of a temporary Multi-Purpose Hall which will be demolished upon completion of the Gurdwara, Langar and Multi-Purpose hall during Stage 7. The nearest noise sensitive residential receiver R2 is located approximately 19 m from the building as shown in Figure 8.

The Gurdwara is a place where Sikhs come together for congregational worship and the Langar is the community kitchen where all faiths are welcomed. The congregational worship may include amplified speech where the congregation is large. Music is generally not played and most activities are not expected to be amplified. To comply with the daytime/evening criteria of 42/43 dB(A), internal reverberant sound pressure levels of up to 86 dB(A) with the hall windows in open position could be tolerated. During the night-time period, the internal sound pressure levels in the hall must not exceed 81 dB(A) (with opened windows). For amplified speech these sound levels are considered reasonable and sufficient to service a relatively large congregation. Internal noise levels would be able to be increased by at least 10 dB(A) with all external windows and doors shut, in the unlikely event that higher noise levels are required. However, it is recommended that external windows and doors are closed for night time events/activities after 22:00 hrs.

The predicted noise levels and recommended maximum allowable internal sound levels are shown in Table 39.

Table 39 Maximum Sound Pressure Level present in Temporary Multi-Purpose Hall with open/closed windows to comply with the NPI criteria.

Source	Indoor Sound Pressure Level dB(A) (Windows Open)	Indoor Sound Pressure Level dB(A) (Windows closed)	Receiver	Approx. distance to receiver, m	NPI Criterion $L_{Aeq,15min}$ dB(A)	Predicted Noise Level dB(A)	Meets Criterion? ✗/✓
Multi-Purpose Hall	Daytime/Evening 86	Daytime/Evening 96	R2	19	Day 42dB	42	✓
					Evening 43dB		✓
	Night-time 81	Night-time 91		19	Night 37dB	37	✓
							✓
							✓

6.6.2 Stage 7 – Gurdwara, Langar and Multi-Purpose Hall

The Gurdwara located on the second floor serves as a place of ceremonies where amplified speech may be present. On west side of the 2nd floor there is an indoor Multipurpose-Hall for sporting activities proposed. The Langar which serves as a large food kitchen is located on the 1st floor. The nearest sensitive residential receiver R4 is located approximately 35 m from the building as shown in Figure 8. To comply with the daytime/evening criteria of 42/43 dB(A), internal noise pressure levels could be up to 91 dB(A) with windows open. During the night-time period, the internal sound pressure levels in the Gurdwara, Langar and Multi-purpose hall must not exceed 86 dB(A) with windows open. With all external windows and doors closed these maximum internal sound pressure levels may be increased by 10 dB(A).

Table 40 Maximum Allowable Reverberant Sound Pressure Level in Gurdwara, Langar and Multi-Purpose Hall with open/closed windows to comply with the NPI criteria.

Source	Indoor Sound Pressure Level dB(A) (Windows Open)	Indoor Sound Pressure Level dB(A) (Windows closed)	Receiver	Approx. distance to receiver, m	NPI Criterion $L_{Aeq,15min}$ dB(A)	Predicted Noise Level dB(A)	Meets Criterion ? ✗/✓
Gurdwara, Langar, Multi-purpose Hall	Daytime/ Evening 91	Daytime/Evening 101	R4	35	Day 42dB	42	✓
					Evening 43dB		✓
	Night-time 86	Night-time 96		35	Night 37dB	37	✓
							✓
							✓

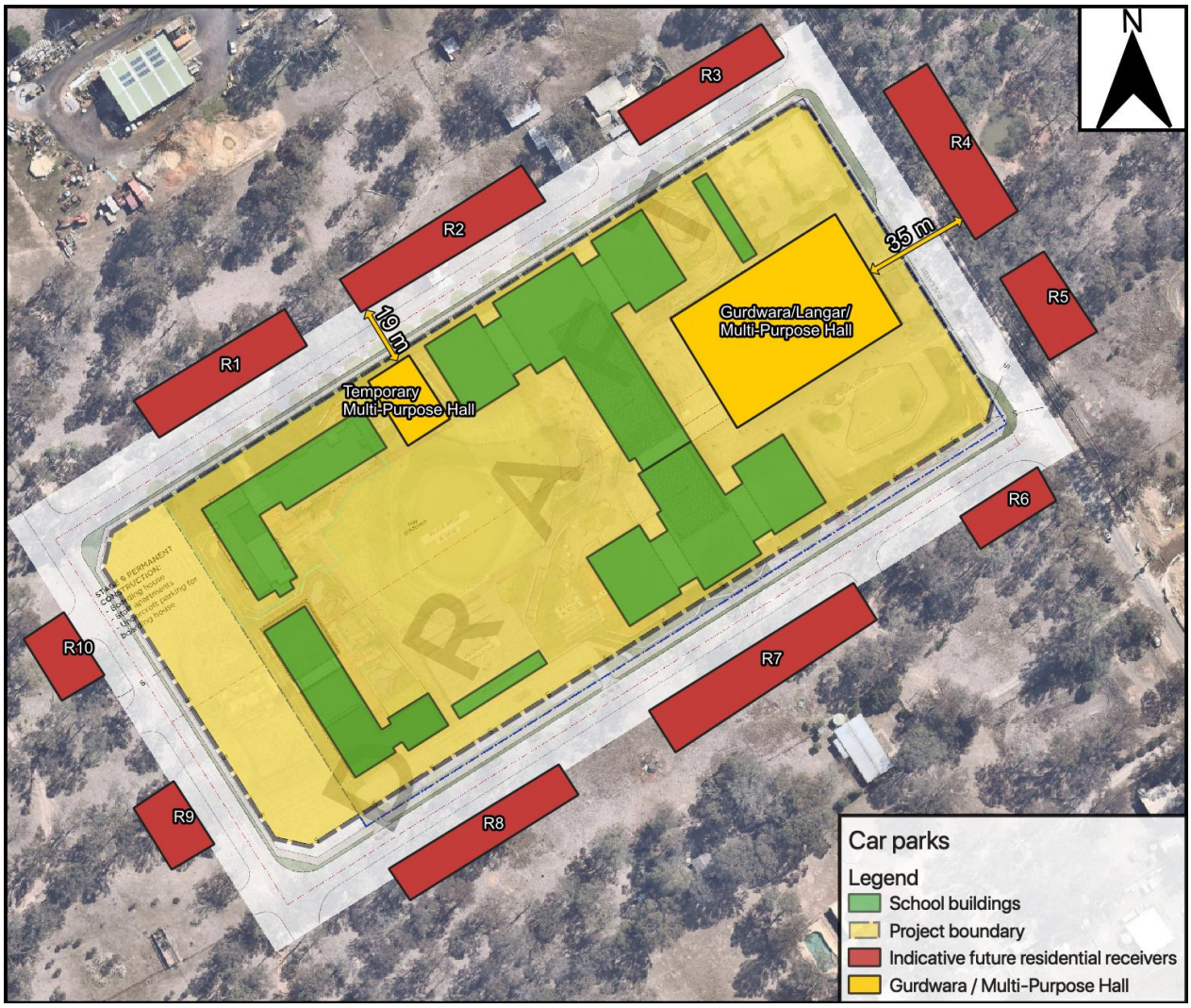


Figure 8 Site plan showing the temporary multi-purpose hall and Gurdwara/Langar for noise assessment purposes

7 Recommendations / Conclusion

The Sikh Grammar School, Gurdwara and Langar development is proposed to be designed and developed over 10 separate construction stages spanning approximately 20 years. This noise impact assessment has considered the effect on the future, largely residential development zone. Therefore, the noise sensitive receivers used to assess the impact do currently not exists, but are understood to be adjacent the school site on all sides.

The site is currently a greenfield site and is dominated by natural sounds, which result in low ambient and background noise levels. As the Rouse Hill suburb grows over the coming years, it is expected that the noise character of the area will naturally increase, despite efforts to control noise creep over time. This means that the criteria developed for this noise impact assessment is based on the existing noise environment, which results in stricter noise targets and a conservative approach.

Being away from major roads and a future, largely residential area, any noise impact from the environment on the operations of the school and Gurdwara is considered highly unlikely. This assessment has focussed on the impact that the operation of the school, Gurdwara and Langar may have on the adjacent residential community. In this respect the following noise sources have been assessed for all the relevant development stages to which each noise source is applicable:

- Construction Noise and Vibration
- Mechanical Plant Noise
- Public Address/school bell systems
- Outdoor Recreation/Play Areas
- Car Park Activity
- Gurdwara, Langar and Temporary Multi-Purpose Hall

Construction Noise and Vibration Summary (Section 5)

Due to the low existing background noise environment at this greenfield site the Noise Management Level is relatively low for construction noise, being 47 dB(A). This coupled with the proposed residential development adjacent the school site on all sides, means that there is a relatively short distance between the construction activities and the residential receivers. This means that a degree of adverse noise impact is inevitable. This is shown by the results for all receivers and activities in Table 14 to Table 23 inclusive. In addition, there are also some instances of the Highly Noise Affected Criteria (75 dBA) being exceeded. These are, typically either when the construction works get very close to the receivers, or during demolition.

Nevertheless, any adverse noise impact can be minimised by applying noise mitigation and management measures recommended in Section 5.3.

It should be noted that the existing noise sensitive receivers close to the site at 163 and 141 Tallawong Road are further away than the modelled future residential receivers adjacent the site. Therefore, predicted construction noise levels at the existing residential properties will be similar To R3 for 163 Tallawong Road and lower at 141 Tallawong Road.

Based on the safe working distances in Table 24, occupant comfort vibration impacts on buildings may be expected at receiver locations in line with R1, R2, R3, R4, R5, R6, R7 whilst work is being conducted. The distances to these receivers may be below the safe working distance criteria for large vibratory roller (7t - ≥13t). Where equipment is being used at distances lower than the safe working distances, recommendations are provided in Section 5.3 for the management of construction vibration from the works.

Mechanical Plant Noise Summary (Section 6.1)

At this early stage of planning, there is little plant noise information available. Therefore, the assessment reversed engineered the maximum allowable plant noise level to still meet the criteria, based on the plant locations in relation to

the receivers. The assessment shows that an adverse noise impact to the surrounding noise sensitive receivers is unlikely and the option of further noise reduction with the addition of a noise barrier is available as a practical noise control method, if required. Further plant noise control methods such as attenuators, lined ducts/bends/angled ducts away from noise sensitive receivers, quieter plant selection, relocation of plant are all available, if required during the design stage when more information becomes available. Therefore, the risk of an adverse plant noise impact to the community is considered negligible, however, detailed review is recommended during the relevant design phases for each stage when it occurs.

PA and School Bell Summary (Section 6.2 and 6.3)

Based on meeting desired signal to background noise targets of 10-15dB(A) and the PA zones being located inside buildings, the relevant criteria are comfortably met at the nearest residences, with school building windows and doors open.

There is no information for the PA or school bell system at this stage. However, by following the good practice recommendations provided in section 6.3, it is expected that the relevant noise criterion can also be comfortably met.

Outdoor Recreation/Play Area Summary (Section 6.4)

The close proximity of the play areas to the future residential receivers around the perimeter of the site means that it is impractical for the play areas to meet the standard NPI criteria, even with noise barriers. The assessment has assumed that the houses will be two level meaning that the upper level will receive less benefit from any barriers erected. However, it is usual for sleeping areas to be located upstairs and living areas downstairs. Therefore, the upper level is unlikely to be sensitive during the daytime school operating hours.

It is considered appropriate to use the criterion recommended by the AAAC guideline for childcare centres when the areas are used for up to 2 hours per day, which is the background level + 10 dB(A). This is 5 dB higher than the standard NPI criterion. Using the AAAC criterion compliance is predicted to be achieved without further attenuation for the multi-purpose playing court, innovation work rooms and outdoor learning pods. However, for the K2 play space and temporary play space additional noise reduction is required. In-principle solutions for this are to erect 3.5m high barriers at the perimeter of the play spaces at the boundary of the site. Other options include, the relocation of the spaces further away from the noise sensitive receivers towards the centre of the site using school buildings to provide shielding.

It is recommended that these in-principle recommendations are further developed during the design phase for the relevant project stages.

Car Park Activity Assessment Summary (Section 6.5)

There are six car parks proposed for the overall development, covering multiple project stages, of which car park D is temporary, being used for stage 6 only, before being demolished during the stage 7 construction phase. Generally, the car parks meet the relevant day and evening criteria based on assumptions of the number car pas-bys (arrivals and departures), car door closures and car ignition events in a worst-case 15-minute peak period.

The only car parks that exceeded the criteria to some degree was the temporary carpark D and the Underground carpark E. Temporary car park D exceeds the daytime criterion by a marginal 1 dB(A), which is considered a negligible impact. The temporary nature of the car park also means that any noise generated will not be permanent. Therefore, no further noise mitigation is recommended for car park D.

Car park E is an underground carpark and therefore, noise from car door closures and ignition events will take place underground and not impact residents. However, cars entering and leaving the car park entrance are predicted to exceed the day, evening and night time criteria by 5 dB(A), 6 dB(A) and 10 dB(A) respectively. Due to the low number of occasions that this worst-case scenario may occur there may be justification is relaxing the criteria (see section 6.5.7). The noise levels have been predicted at the boundary of presumed future residential premises directly opposite the car park entrance/exit. It may be possible to manage the noise impact by reducing car movement numbers by

directing traffic to use other car parks or, having separate entrances/exits to the car park separating and sharing the noise during busy periods.

Overall the noise impact from the car parks located over the development are expected to be minor.

Gurdwara / Temporary Multi-Purpose Hall (Section 6.6)

Both the temporary multi-purpose hall and the complete Gurdwara and Langar have been assessed for potential noise break-out from the buildings during the use of amplified sound used for services and events. Maximum allowable reverberant sound pressure levels inside all of these spaces have been calculated based on the conservative assumption that external windows and doors are open and closed. During both windows open and closed scenarios calculated maximum sound levels are considered sufficient for the proposed uses of amplified speech, but not music.

An adverse noise impact to the community is not expected from activities inside these spaces.

General

This noise impact assessment has provided in-principle advice based on the information available to conclude that, providing due care and attention is given to acoustics in the design phase of each project development stage, an adverse noise impact to the to the community is not expected.

Appendix A – NPI Criteria Derivation for Operational Noise

Unattended noise logging

Unattended noise measurements were conducted during the period Thursday, 25 October to Wednesday, 31 October 2018. The logging equipment was located on the project site, as shown in Figure 1.

Equipment

The equipment used was a Rion NL-42 sound level meter, serial number 00946975. Field calibration was conducted at the commencement and conclusion of the logging period and no significant calibration drift was observed.

The noise logger was configured to record all relevant noise indices, including background noise (L_{A90}) and equivalent continuous noise levels (L_{Aeq}). Samples were accumulated at 15-minute intervals. The time response of the logger was set to 'fast'.

Weather conditions

In order to provide an indication that noise data was obtained during suitable meteorological conditions, half-hourly weather data was obtained from the Bureau of Meteorology (BOM) Automatic Weather Station (AWS) 067105 at Richmond RAAF.

Noise data has been excluded from the processed results if:

- Rain was observed during a measurement period, and/or
- Wind speed exceeded 5 m/s (18 km/h) at the measurement height of 1.5 m above ground. Wind data obtained from the BOM is presented as the value at 10 m above ground. These values are halved for the purpose of estimating wind speed at 1.5 m above ground.

Measured noise levels

For reference, daily logger graphs are provided in Appendix B

Data processing for noise emission criteria

In order to determine mechanical services noise emission criteria, data from the 'background' logger was processed according to the procedures and time periods in the NSW Noise Policy for Industry (NPI) time periods as follows:

- NPI Daytime: 07:00 to 18:00
- NPI Evening: 18:00 to 22:00
- NPI Night-time: 22:00 to 07:00

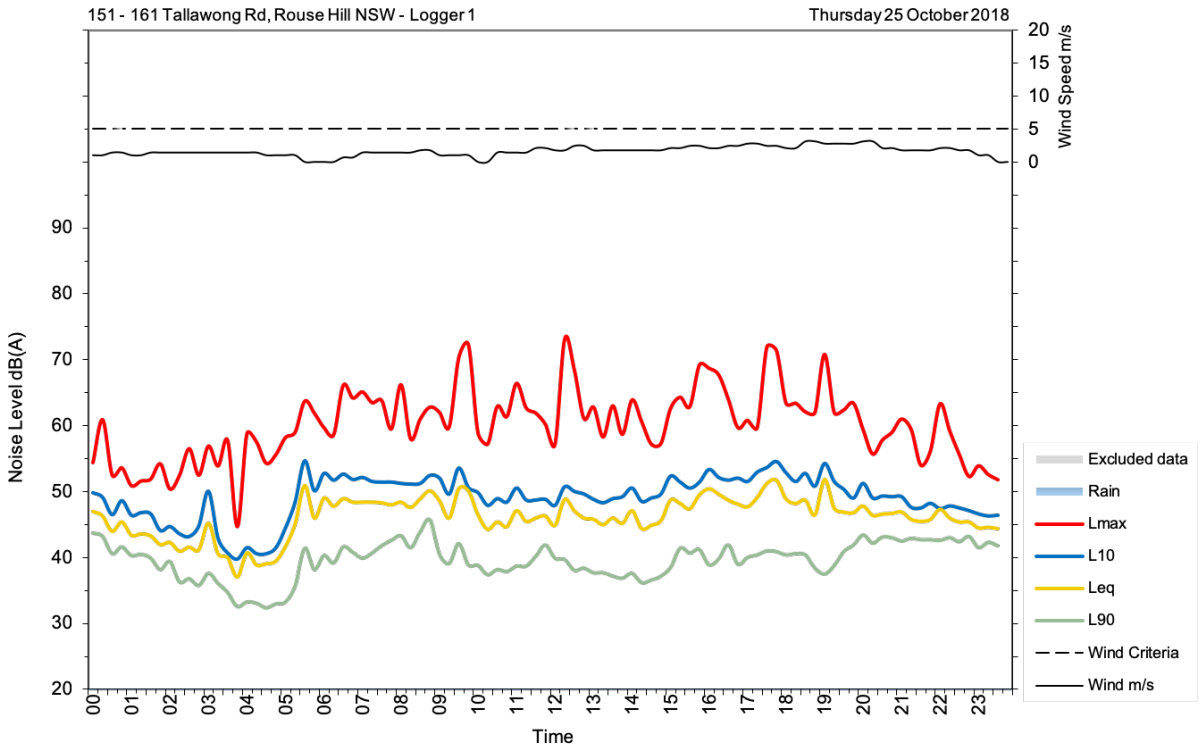
It is necessary to establish a representative noise level for each of these time periods. We have used the procedures in the NSW NPI to derive a representative background noise level (a Rating Background Level or RBL) for the daytime, evening and night-time periods. An RBL is the median of the lowest 10th percentile of the background L_{A90} samples in each daytime, evening and night-time measurement period.

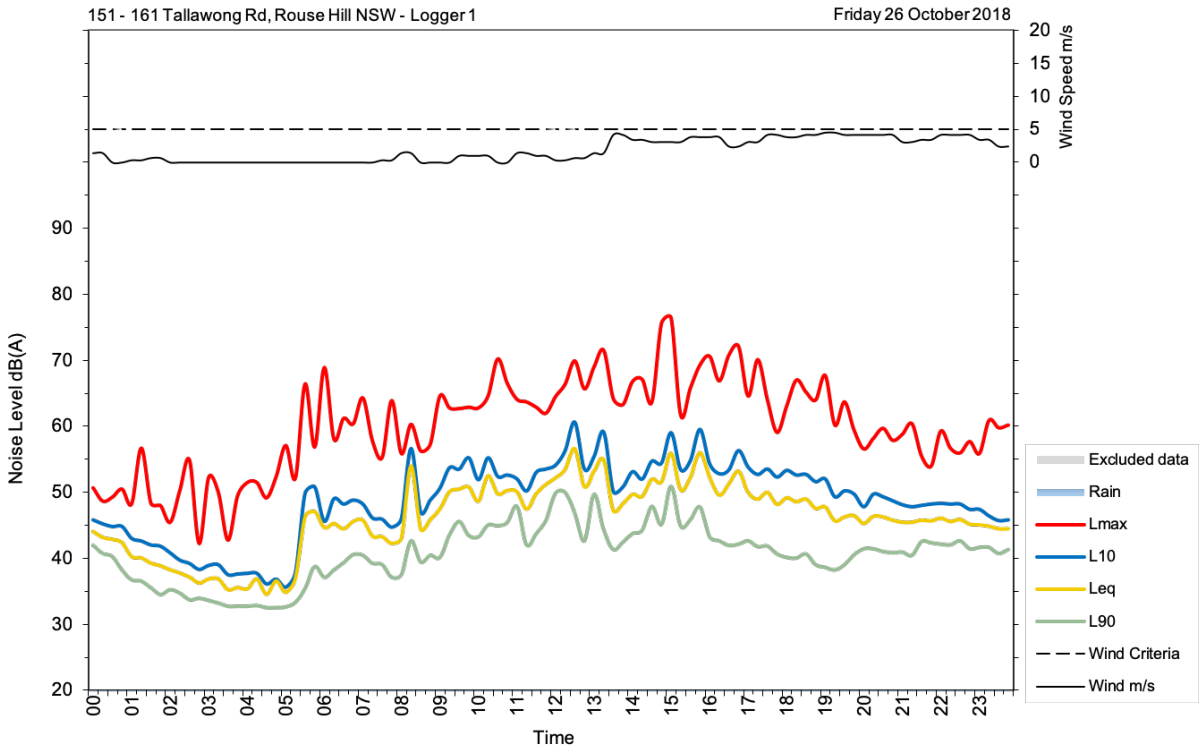
7.1.1 Derivation of noise emission criteria

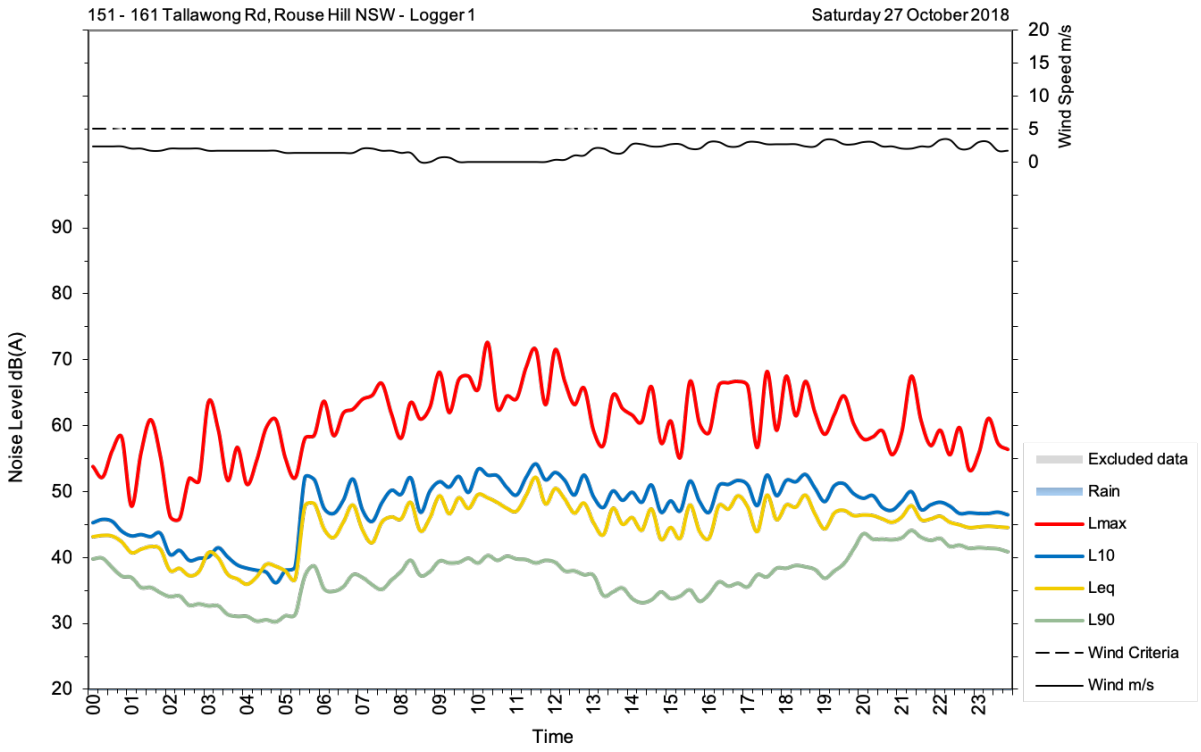
Project specific criteria have been established in accordance with the NPI. In determining existing levels for amenity criteria, it is appropriate to exclude any noise source other than the contribution from industrial sources. Analysis of attended and unattended noise measurements has revealed that the prevailing background noise levels are dominated by natural sounds with a limited impact from road traffic and industrial noise sources.

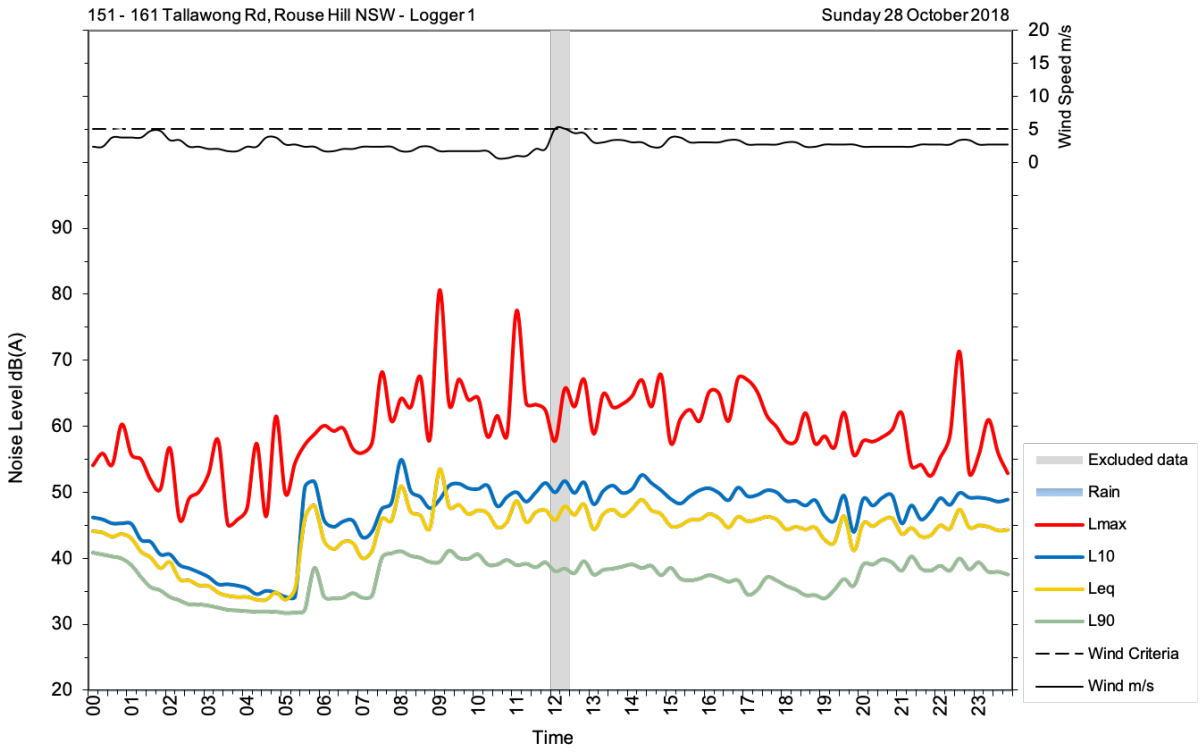
Location	Noise Level (dB re 20 µPa) during Period		
Residential receivers	**NPI Daytime 07:00 – 18:00**	**NPI Evening 18:00 – 22:00**	**NPI Night-time 22:00 – 07:00**
Rating Background Level (RBL)	37	38	32
Intrusive criterion (RBL + 5 dB)	42	43	37
Amenity Criterion (Rural)	48	43	38
NPI Project specific criteria	**42**	**43**	**37**

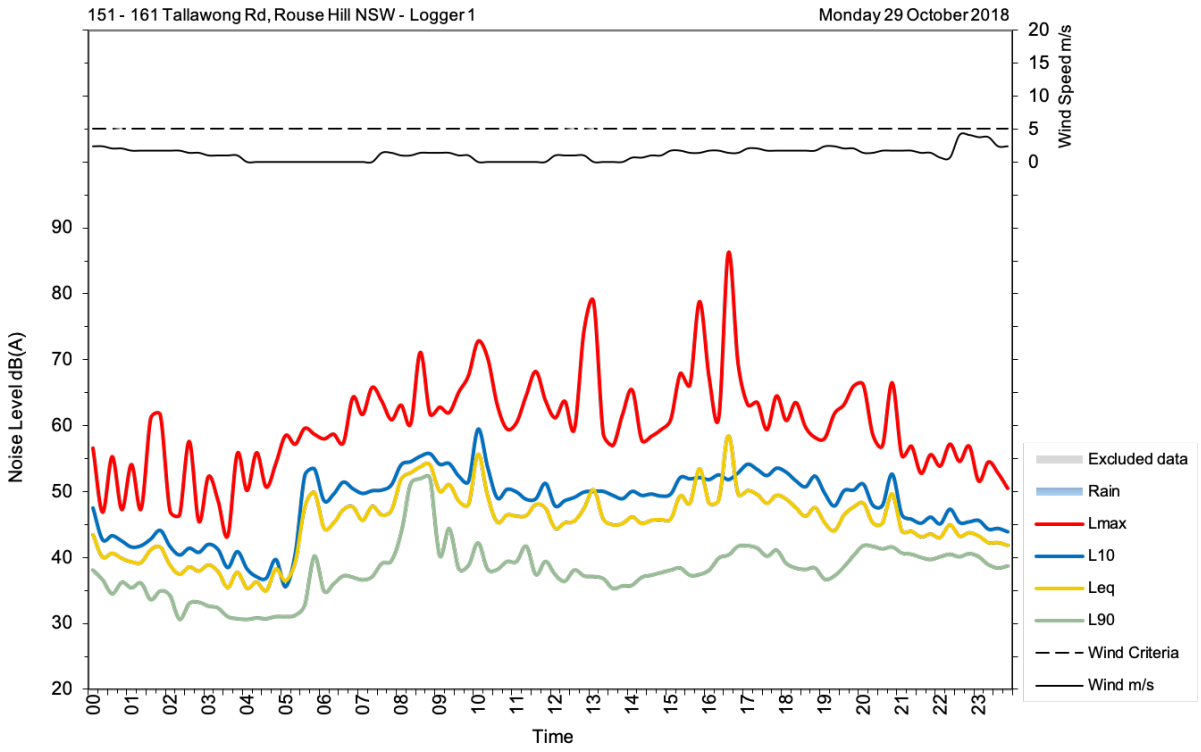
Appendix B – Noise Logging Charts

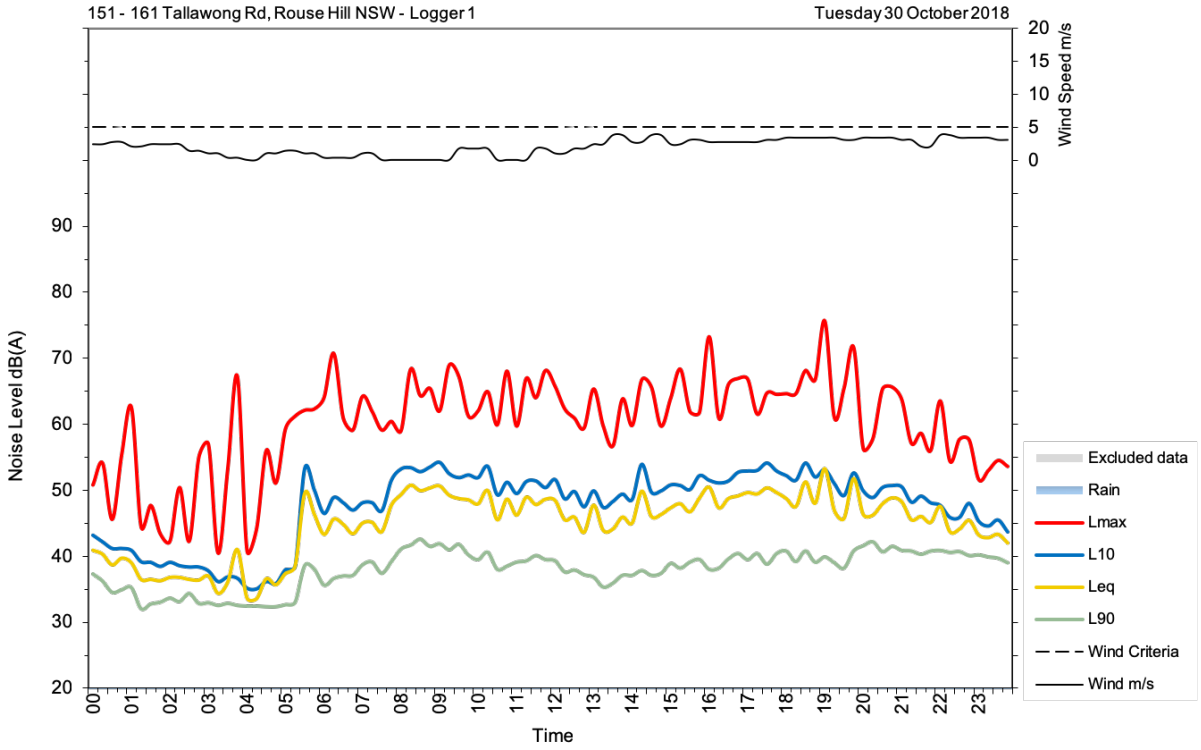

151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Thursday 25 October 2018
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s

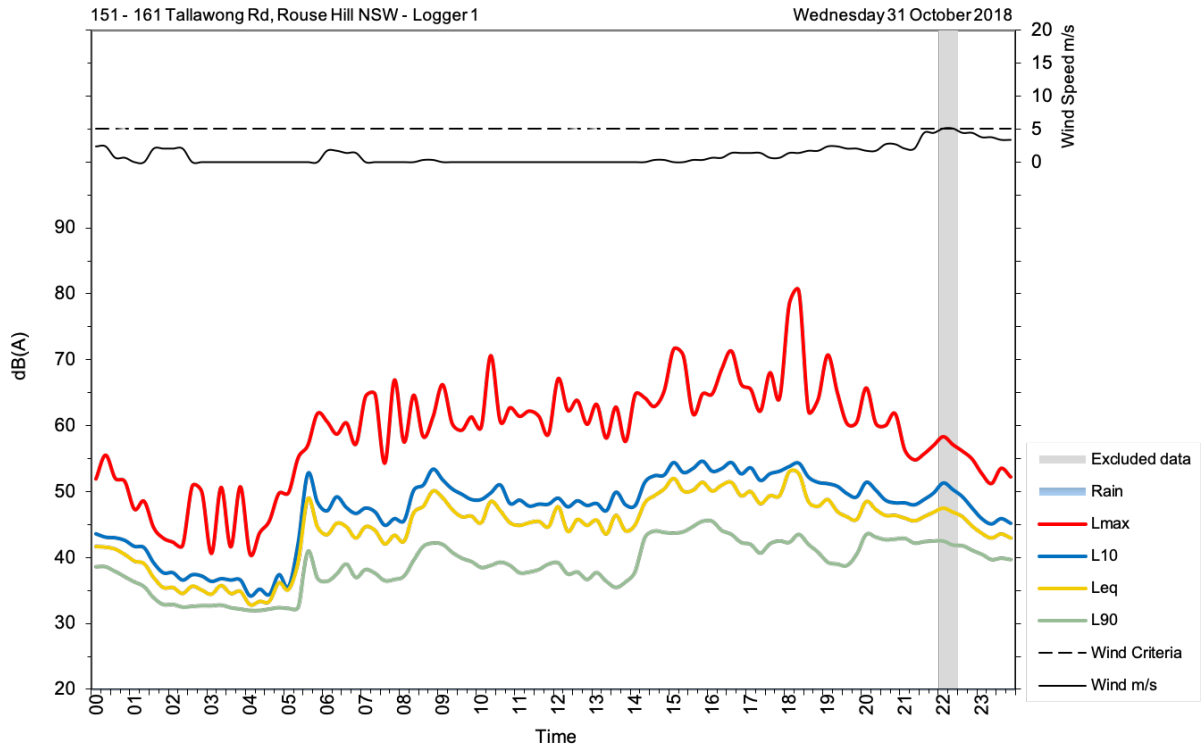

151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Friday 26 October 2018
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s


151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Saturday 27 October 2018
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s


151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Sunday 28 October 2018
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s


151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Monday 29 October 2018
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s


151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Tuesday 30 October 2018
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s


151 - 161 Tallawong Rd, Rouse Hill NSW - Logger 1
Wednesday 31 October 2018
dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s