ARUP

NSW Department of Education

Bungendore High School

Noise and Vibration Assessment Report

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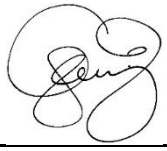
Signature			

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1. Introduction

This Noise and Vibration Assessment Report has been prepared to support a Review of Environmental Factors (REF) for the NSW Department of Education (DoE) for the construction and operation of the new Bungendore High School (the activity).

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

This document has been prepared in accordance with the Guidelines for Division 5.1 assessments (the Guidelines) by the Department of Planning, Housing and Infrastructure (DPHI) as well as the Addendum Division 5.1 guidelines for schools and Addendum October 2024 (Consideration of environmental factors for health services facilities and schools). The purpose of this report is to:

- Identify noise-sensitive receivers affected by operation and construction of the school
- Set noise and vibration criteria based on relevant standards
- Establish current ambient and background noise levels at and around the site
- Quantify the main sources of construction noise and vibration
- Assess the main operational noise sources, including building services and traffic.
- Determine if criteria are met and recommend mitigation measures if needed.

The assessment evaluates noise and vibration impacts on the surrounding community and land uses, as well as noise intrusion on the proposed development.

1.1 Site description

The current street address is part of 18 Harp Avenue, Bungendore, NSW, 2621 (the site), and is legally described as part Lot 125 in Deposited Plan 1297613. As shown at Figure 1, the proposed school site forms part of a larger lot which is the subject of a proposed residential subdivision.

The site is located within the North Bungendore Precinct (Elm Grove Estate) in Bungendore. As a result of precinct wide rezonings, the surrounding locality is currently transitioning from a semi-rural residential area to an urbanised area with new low density residential development.

The site is zoned R2 Low Density Residential, with all adjoining land also zoned R2 Low Density Residential.

The site has three frontages:

- Approx 500m southern frontage to Birchfield Drive.
- Approx 500m northern frontage to Bridget Avenue.
- Approx 100m eastern frontage to Winyu Rise.

The site is currently cleared of all vegetation and consists of grassland, having been prepared for the purposes of future low density residential development.

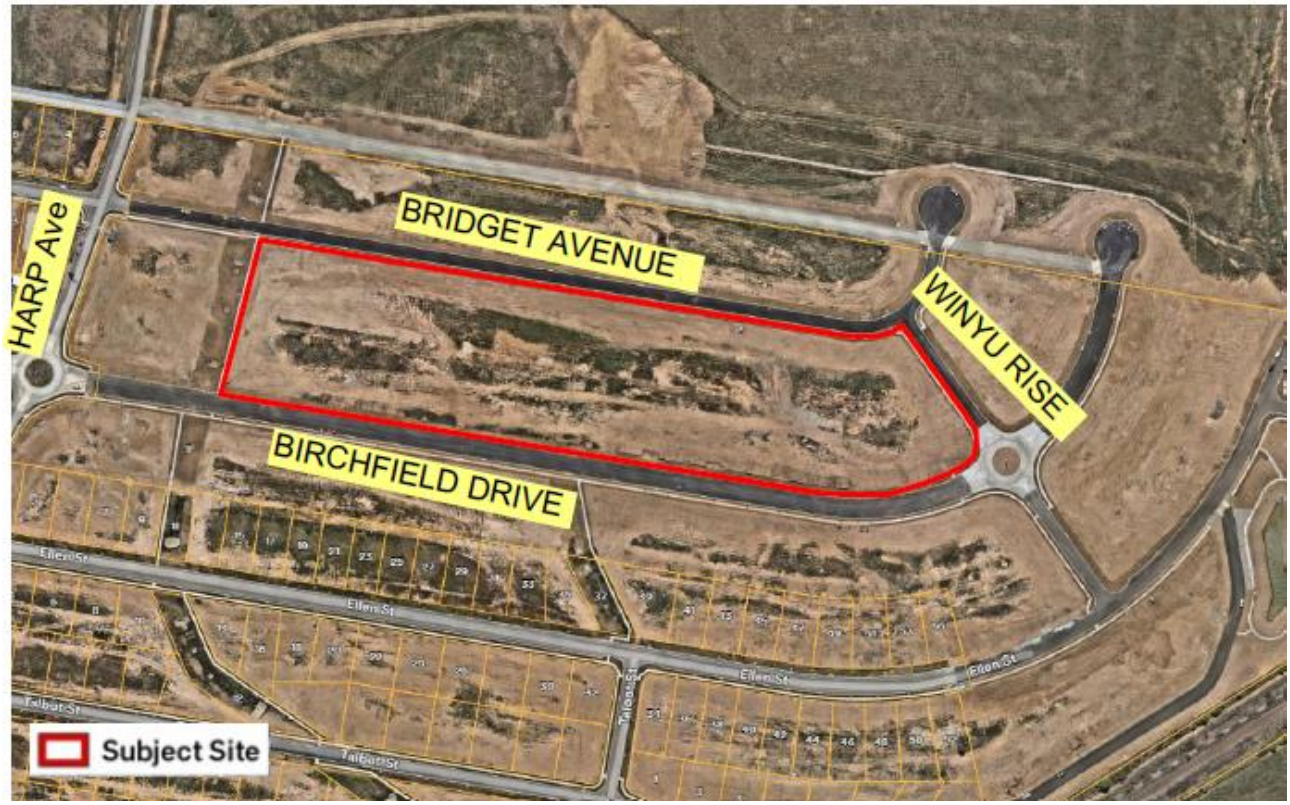


Figure 1: Aerial image of the site (Source: Urbis 2024)

The surrounding locality is currently undergoing a transformation from semi-rural land to residential development following its rezoning in 2020.

The immediately surrounding land is described as follows:

- North, East and South: Land to the north, east and south is comprised of existing semi-rural land which is currently being prepared for future low-density residential development. This includes the construction of future road alignments and lot layouts.
- West: Land immediately west of the site is currently vacant, however further west of the site are several low-density residential dwellings indicative of the future locality. Outside of the boundary of the Elm Grove Estate subdivision are a number of existing low density residential dwellings.

As the area is under development, there are limited existing noise sensitive receivers, with the nearest being located in the order of 200 m to the west of the site. This location will be used as the basis of assessing construction noise impacts.

The nearest registered residential lots shown in Figure 1 are in the order of 110 m to the west of the site and 77 m to the south of the site. Future development of residential lots will extend to the vacant land immediately surrounding the site, in line with the approved Elm Grove Planning Proposal and subdivision application. A 5 m set back from the road edge and drainage channel is assumed for the cadastral boundary for future residential lots not marked in Figure 1. This equates to a distance in the order of 19 m between the site boundary and future potential residences surrounding the site. This distance includes the school set back, road/drainage channel width and the residential set back. Assessment of operational impacts is undertaken to future unregistered residential lots whilst assessment of construction impacts is undertaken to existing receiver locations.

Figure 2 summarises NSW Planning Portal zone classifications for surrounding land uses.

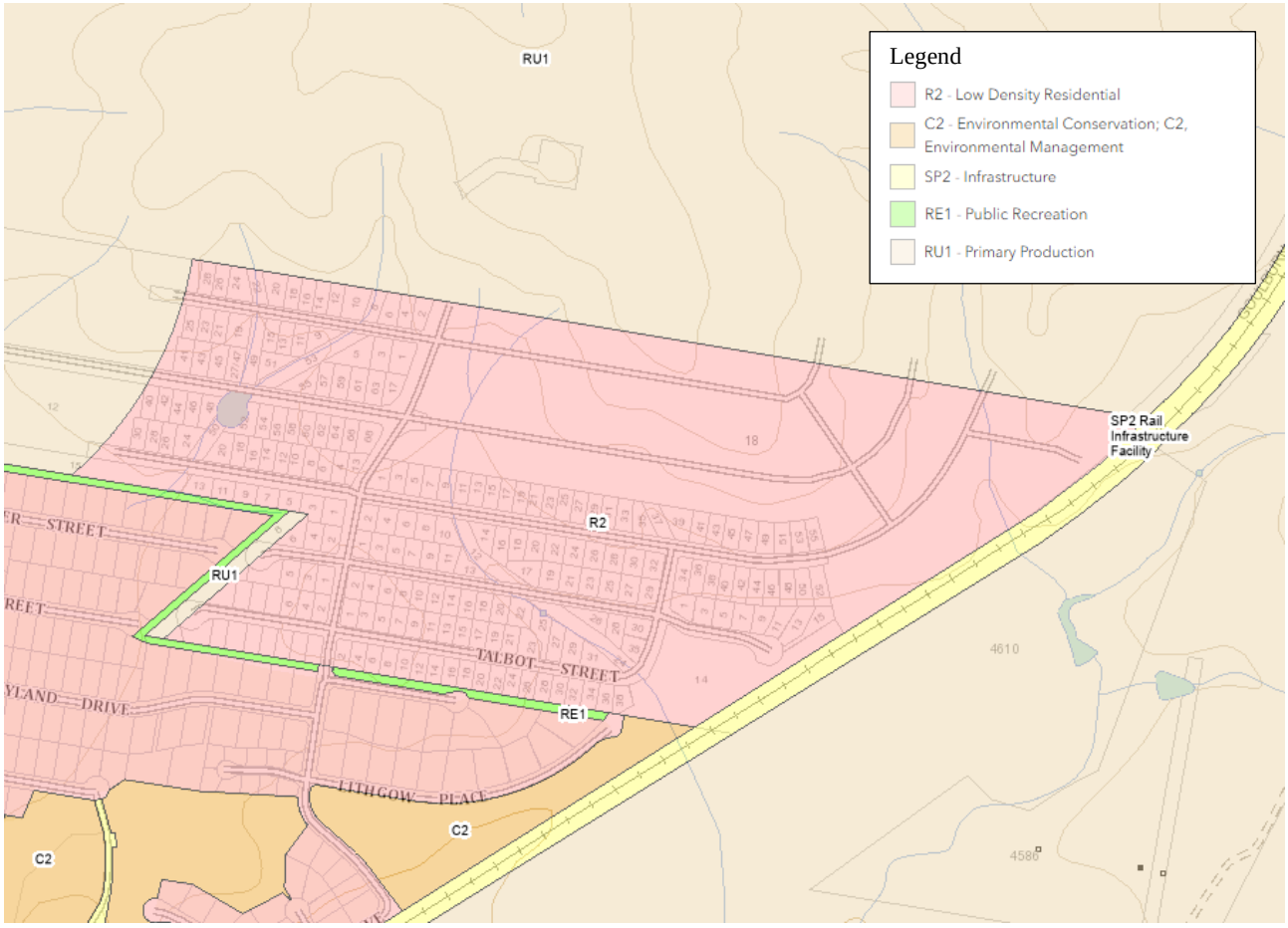


Figure 2: NSW Planning Portal zone classifications

1.2 Proposed activity description

The proposed activity is for the construction and operation of a new high school in Bungendore at part 18 Harp Avenue, Bungendore (the site). The new high school will accommodate 600 students and 68 staff. The school will provide 26 general learning spaces, and three support learning spaces across two buildings. The buildings will be predominantly three-storeys in height and will include permanent and support teaching spaces, specialist learning hubs, a library, administrative areas and a staff hub.

Additional core facilities are also proposed including a standalone school hall with covered outdoor learning area (COLA), a car park, a kiss and drop zone along Birchfield Drive, sports courts and a sports field. The new school also features a single storey building with associated paddocks in the far western portion of the site designed for livestock management and hands-on agricultural learning.

Specifically, the proposal involves the following:

- Building A, a three-storey learning hub accommodating general learning spaces, a special education learning unit (SELU), a physical education centre, a performing arts space, and other core facilities including administrative areas, staff hub, library and end of trip facilities.
- Building B, a part three/part four storey learning hub accommodating general learning spaces, specialist workshops for food, textile, wood and metal workshops, as well as visual arts studios, science labs and staff areas.
- Building C, a standalone school hall with COLA.
- Building D, a single-storey agricultural block comprising an animal storage space, a COLA and internal workshop.
- On-site staff car park with 50 spaces with access via Bridget Avenue.

- Kiss and drop zones and bus bays along Birchfield Drive.
- Open play space including a sports courts and sports field.
- Associated utilities and services including a 1000kv padmount substation.
- Main pedestrian entrance to be located off Birchfield Drive.
- Secondary pedestrian access from Bridget Avenue.
- Public domain/off-site works including the removal of street trees.

The design has been masterplanned to allow for an additional future stage. The second stage does not form part of this proposal.

Figure 3 provides an extract of the proposed site plan.

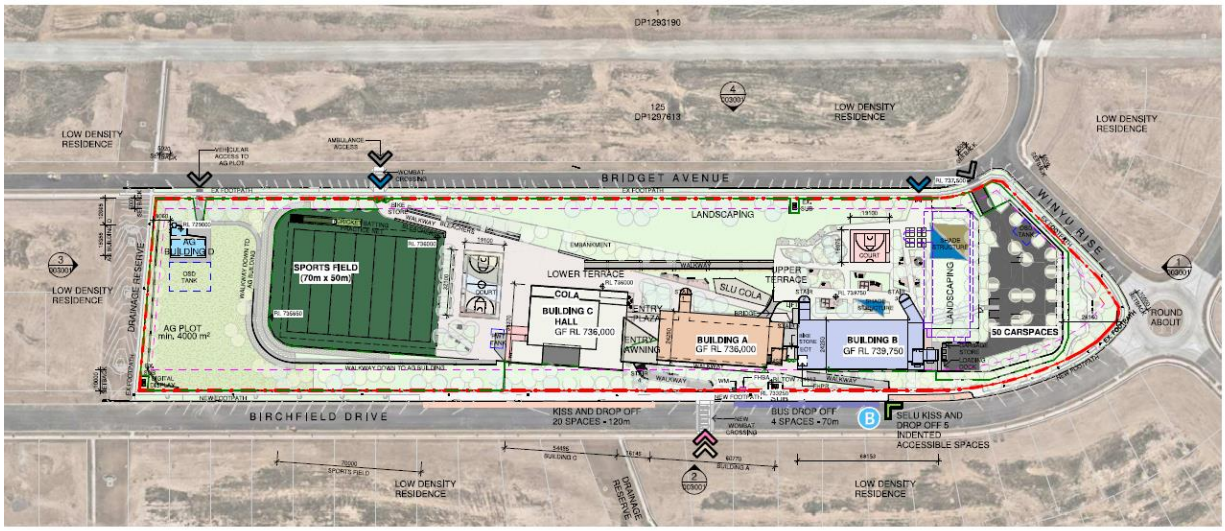


Figure 3: Site Plan (Source NBRS, 2024)

1.3 Existing acoustic environment

The existing acoustic environment at the site is currently impacted by the surrounding development of the residential subdivision. Further, the existing acoustic environment is unlikely to be representative of the future developed locale. As such, guidance from the NSW Noise Policy for Industry (NPI) is used to determine a Rating Background Level representative of the future acoustic environment.

Table 2.3 of the NSW Noise Policy for Industry (NPI) summarises typical existing background noise levels for areas of typical planning zoning. These are reproduced in Table 1 for reference.

Table 1: NPI defined typical background noise levels for different planning zones

Receiver category	Typical planning zoning – standard instrument	Typical existing background noise levels	Description
Rural residential	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime RBL <40 dB(A) Evening RBL <35 dB(A) Night RBL <30 dB(A)	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime RBL<45 dB(A) Evening RBL<40 dB(A) Night RBL <35dB(A)	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime RBL> 45 dB(A) Evening RBL> 40 dB(A) Night RBL >35 dB(A)	Urban – an area with an acoustical environment that: • is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources • has through-traffic with characteristically heavy and continuous traffic flows during peak periods • is near commercial districts or industrial districts • has any combination of the above.

The policy identifies areas primarily zoned as R2 – low density residential as typically being assigned a Suburban classification. Measurement of ambient noise undertaken by SLR in 2020 for a Rail Noise Assessment for the Elmsea Estate also indicated a typical daytime Background Noise Level of 45 dB(A), corresponding to a Suburban classification.

Table 2 summarises Rating Background Levels that will be used as the basis to derive assessment criteria for the project.

Table 2: Project specific Rating Background Levels

Rating Background Level, (dB(A) L_{90})		
Day (7am to 6pm)	**Evening (6pm to 10pm)**	**Night (10pm to 7am)**
45	40	35

2. Acoustic assessment criteria

2.1 Relevant standards, guidelines and regulations

The following have been used to develop the noise and vibration criteria for the project:

Local Council Guidelines and Policies

- Palerang Development Control Policy (2015)

NSW Government Guidelines and Policies

- NSW Department of Education – Educational Facilities Standards and Guidelines v2.0, 0001c Design Checklist – Acoustics
- NSW Department of Planning, Development Near Rail Corridors and Busy Roads – Interim Guideline (2008)
- NSW Department of Environment and Conservation, Assessing Vibration: A technical guideline (February 2006)
- NSW Environmental Protection Authority – Noise Policy for Industry (October 2017)
- NSW State Environmental Planning Policy (Infrastructure) 2007
- NSW Road Noise Policy (March 2011)
- NSW EPA, Environmental Criteria for Road Traffic Noise (1999) Australian and International Standards
- NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline" (ICNG) 2009.
- NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline" (AVTG) 2006.
- NSW Protection of the Environmental Operations (POEO) Act 1997.

National Standards

- AS 2107:2016 Acoustics—Recommended design sound levels and reverberation times for building interiors
- AS 2021:2021 – Acoustics – Aircraft noise intrusion – building siting and construction.
- AS 2436:2010 – Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites.
- AS 1055:1997 – Acoustics – Description and Measurement of Environment Noise.

Industry guidelines

- Association of Australasian Acoustical Consultants (AAAC) — Guideline for Educational Facilities, Version 2.0
- Association of Australian Acoustical Consultants (AAAC) Guidelines for Child Care Centre Acoustic Assessment, V 3.0

Sustainability Standards

- Green Building Council of Australia – Buildings v1

2.2 Queanbeyan-Palerang Local Government Area

There are four DCPs that apply in the Queanbeyan-Palerang Local Government Area. The Pelarang Development Control Plan (2015) does not have any specific acoustic requirements for the development.

2.3 Operational noise emissions

Consideration is given to the following:

- Noise emission from building services
- Noise emission from school activities and operations; and
- Noise emission from additional traffic generated by the development.

The following sections summarise corresponding assessment criteria.

2.3.1 Building services

2.3.1.1 Normal operations

Building services noise emissions is assessed in accordance with the NSW Noise Policy for Industry (NPI) which is primarily concerned with controlling intrusive noise impacts in the short-term for residences and maintaining long-term noise level amenity for residences and other land uses.

The NPI sets out the procedure to determine the project noise trigger levels relevant to an industrial development. The project noise trigger level is a level that, if exceeded would indicate a potential noise impact on the community and so 'trigger' a management response.

Intrusive noise trigger level

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- LAeq,15minute $\leqslant$ Rating Background Level (RBL) plus 5 dB

  (where LAeq,15minute represent the equivalent continuous noise level of the source)

Note that as the Intrusive Noise Trigger Level is established from the prevailing background noise levels at the residential receiver location, the existing background noise level is to be measured.

Recommended and project amenity noise level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the NPI where feasible and reasonable. An extract from the policy is given below in Table 3.

Table 3: NPI Recommended Amenity Noise Levels (RANLs)

Receiver	Noise amenity area	Time of Day	Recommended amenity noise levels (RANLs) L_{Aeq}, dB(A)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40

Receiver	Noise amenity area	Time of Day	Recommended amenity noise levels (RANLs) L_{Aeq}, dB(A)
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Hospital ward – Internal External	 All All	 Noisiest 1-hour Noisiest 1-hour	 35 50
Place of worship – Internal	 All	 When in use	 40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, gold course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Notes:

The recommended amenity noise levels (RANLs) refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

1. The NPI defines day, evening and nighttime periods as:

• Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.

• Evening: the period from 6 pm to 10 pm.

• Night: the remaining period.

(These periods may be varied where appropriate. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$)

Figure 2 and the Planning Portal generally classify the existing surrounding land as low density residential and primary production, with some large lot residential and industrial to the west, rail infrastructure to the east and environmental conservation to the south..

The recommended amenity noise levels (RANLs) represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level (PANL) represents the objective for noise from a single industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

- Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A)

To standardise the time periods for the intrusiveness and amenity noise levels, the policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,\ period}$ + 3 decibels (dB),

2.3.1.2 Project specific noise trigger levels

Based on the background and ambient noise monitoring, Table 4 summarises the derived project specific noise levels based on the NPI.

Table 4: NPI Project specific noise levels

Receiver	Time Period	Project Specific Noise Levels – dB $L_{Aeq,\ 15min}$	
		Intrusive Noise Trigger Levels	Project Amenity Noise Level (PANL)
Nearest residential receivers	Day	**50**	53
	Evening	45	**43**
	Night	40	**38**
School outdoor areas	When in use	-	55
Notes: 1 – As stated in table 2.2 note in the NPI, in the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$.			

The school is not expected to operate during the night-time period, therefore daytime criterion is taken as the most onerous target on which assessment of noise emission is based.

2.3.1.3 Modifying factors

Table C1 of the NPI sets modifying factor corrections for annoying noise characteristics such as tonality, dominant low frequency, intermittency or irregularity.

When assessing low frequency impacts, an initial screening test is first undertaken by evaluating whether the difference in noise levels in C-weighted and in A-weighted are 15 dB or more at the receivers, which identifies the potential for an unbalanced spectrum in which case further assessment is required.

2.3.1.4 Sleep disturbance

The NSW NPI also recommends criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am. The school is not expected to operate during this time period, therefore potential sleep disturbance is not being considered.

2.3.1.5 Emergency equipment

There are no provisions in NSW legislation for noise impacts associated emergency plant.

In lieu of relevant criteria, the VIC EPA State Environment Protection Policy (SEPP) No. N-1 states:

> *Where the noise source under consideration is a standby generator, standby boiler or fire pump, the noise limit shall be increased by 10 dB for a day period and by 5 dB for all other periods.*

This is considered an appropriate provision for short and intermittent operation of equipment during testing such as stair pressurisation fans.

2.3.2 School activity

There are no specific regulatory policies or guidelines for noise associated with general school activity. Furthermore, the following is noted from NSW Land and Environment Court (LEC) proceeding (Meriden School v Pedavoli, 22 Oct 2009, case NSW LEC 183)

> *"All noise that emanates from the normal activities at a school is not offensive".*

Notwithstanding, assessment of noise impacts from this type of activity is typically made with reference to the Association of Australasian Acoustical Consultants (AAAC) Guideline for Child Care Centre Acoustic Assessment. The Guideline states the following with respect to outdoor activity:

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

The guidance relating to up to 4 hours outdoor play is deemed appropriate in the context of typical high school programme and activity.

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

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

The Guideline states the following with respect to indoor play:

> *The cumulative Leq,15 minute noise emission level resulting from the use and operation of the childcare centre, with the exception of noise emission from outdoor play discussed above, shall not exceed the background noise level by more than 5 dB at the assessment location as defined above. This includes the noise emission resulting from:*
>
> - *Indoor play;*
> - *Mechanical plant;*
> - *Drop off and pick up;*
> - *Other activities/operations (not including outdoor play).*

Assessment of school activities will be guided by these noise management levels to assist in operational management of the school, noting they are aspirational criteria and not mandatory requirements.

2.3.3 Road traffic noise

The NSW Road Noise Policy (RNP) includes assessment criteria for existing noise sensitive receivers affected by additional traffic on existing roads generated by land use developments. These criteria are reproduced in Table 5 for reference.

Table 5: Road traffic noise assessment criteria for residential land uses.

Road category	Type of project / land use	Assessment criteria	
		Day (7am–10pm)	Night (10pm–7am)
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60 dB $L_{Aeq, (15\ hour)}$ (external)	55 $L_{Aeq, (9\ hour)}$ (external)

Road category	Type of project / land use	Assessment criteria	
		Day (7am–10pm)	Night (10pm–7am)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	55 $L_{Aeq, (1\ hour)}$ (external)	50 $L_{Aeq, (1\ hour)}$ (external)

Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria.

In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

2.4 Noise intrusion

2.4.1 Internal background noise levels

Section 0.03 of the EFSG Acoustic Checklist states the following:

> *An internal noise level assessment must be carried out for all new buildings to ensure comfortable acoustic conditions for the spaces occupied.*
>
> *The internal noise levels within the space must meet the limits stipulated in Table 11.06.1 of Section 11.6 Acoustic Performance Guidelines or be within the range stipulated in Table 1 of the AS/NZS 2107:2016 standard. The more stringent of the two should be met.*

For normal operations, internal noise levels are to be met cumulatively taking into account the sources discussed in the following sections.

2.4.1.1 Building services noise

Building services are typically the predominant source of background noise within a space. Internal building services noise targets are set at 3 dB below overall internal noise criteria to allow for cumulative compliance once noise intrusion through façade elements is added.

2.4.1.2 Road traffic noise intrusion

In addition, the EFSGs stipulate that road noise shall be assessed in accordance with the requirements of the State Environmental Planning Policy (Infrastructure) 2007 (ISEPP). The ISEPP is supported by the Development Near Rail Corridors and Busy Roads – Interim Guideline, which sets the following internal noise criteria for educational facilities:

Table 6: ISEPP internal airborne noise criteria.

Receiver type	Time	Airborne noise daytime $L_{Aeq,15h}$	Airborne noise night time $L_{Aeq,9h}$
Educational Institutions including child care centres	When in use	40	40

Based on the use of the different spaces, lower internal noise levels may be required in line with the EFSG, therefore, the ISEPP criteria should be considered as a minimum legislative requirement.

2.4.1.3 Natural ventilation implications

The internal noise criteria are generally achieved through a sealed building. Ideally where natural ventilation is to be provided, the same criteria would also be achieved, particularly for critical spaces, where higher ambient noise levels may otherwise impact on speech intelligibility or unduly impact concentration.

For less critical uses, research has indicated that occupants are willing to accept trade-offs in the ambient noise levels where natural ventilation is provided. The ISEPP guideline generally allows for a + 10 dB concession for the 'open windows' condition. It is noted that for teaching and learning spaces this recommendation is based on the ability to close the windows to achieve internal noise targets.

2.4.2 Outdoor areas

The criteria from the NSW State Environmental Planning Policy (Infrastructure) (ISEPP) considers the impact of road traffic noise on internal comfort, but does not address external amenity.

The NSW Environmental Criteria for Road Traffic Noise (ECRTN) and the NSW Road Noise Policy (RNP) provide criteria for school playgrounds and childcare outdoor play areas respectively.

Criteria for outdoor learning areas are not provided by any of the relevant policies and guidelines referenced.

The proposed aspirational noise criteria for outdoor areas are presented in Table 7.

Table 7: Aspirational noise criteria for outdoor areas.

Type of space	Assessment Criteria, $L_{Aeq, 1hr}$
Outdoor school playgrounds	55
Outdoor learning areas	50

The above criteria should be aimed for where possible and practical. But they may not be feasible nor necessary to achieve based on the site constraints and the specific uses proposed for the different areas.

2.5 Construction noise and vibration

2.5.1 Hours of work

Construction works will be undertaken within the hours outlined in Table 8, in accordance with ICNG standard hours of construction

Table 8: Proposed Hours of Construction

Day	Standard construction hours
Monday to Friday	7.00 am to 6:00 pm
Saturdays	8.00 am to 1:00 pm
Sundays or Public Holidays	No construction

In some additional cases, after-hours permits may be sought from the relevant authorities where special requirements exist, for example oversized deliveries.

2.5.2 Construction noise criteria

The Interim Construction Noise Guideline (ICNG) provides recommended noise levels for airborne construction noise at sensitive land uses. The ICNG provides construction management noise levels above which all 'feasible and reasonable' work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These noise management levels (NMLs) for residential receivers and other sensitive receivers are reproduced in Table 9 and in Table 10 respectively.

Table 9: Construction noise management levels (NMLs) at residential receivers

Time of day	Management level[1] $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Note:

1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 10: Construction noise management levels (NMLs) at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)
1 - Noise management levels apply when receiver areas are in use only.		

For work within standard construction hours, if after implementing all 'feasible and reasonable' noise levels the site still exceeds the noise affected level, the ICNG does not require any further action – since there is no further scope for noise mitigation.

For out-of-hours work, the ICNG uses a noise level 5 dB below the noise-affected level as a threshold where the proponent should negotiate with the community.

Measured noise data obtained at the logger location most representative of each noise catchment area has been used to derive appropriate noise management levels for the project. These are summarised in Table 4.

Table 11: Construction Noise Management Criteria for Residential Premises

Time Period	Description	NML Criteria $L_{Aeq\ (15\ min)}$[1]
During recommended standard hours	Noise affected	55
	Highly noise affected	75
Outside recommended standard hours	Noise affected	50
1 - Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.		

2.5.3 Construction vibration criteria

2.5.3.1 Disturbance to buildings occupants

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW Assessing Vibration; a technical guideline. The criteria outlined in the guideline is based on the British Standard BS 6472-1992. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 12.

Table 12: Types of vibration – Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).

Type of vibration	Definition	Examples
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

For continuous and intermittent vibration, the preferred and maximum values (in are weighted acceleration values (Wg for z axis and Wd for x and y axes). For intermittent vibration, the preferred and maximum values are Vibration Dose Values (VDVs), based on the weighted acceleration values.

Table 13 reproduces the 'Preferred' and 'Maximum' acceleration values for continuous and impulsive vibration (Wg for z axis and Wd for x and y axes). Table 14 reproduces the 'Preferred' and 'Maximum' Vibration Dose Values (VDVs) for intermittent vibration, based on the weighted acceleration values (Table 2.2 and 2.4 of the Guideline respectively).

Table 13: Preferred and maximum vibration acceleration levels for human comfort, m/s^2

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis[3]	x- and y-axes[3]	z-axis[3]	x- and y-axes[3]
Continuous vibration (weighted root-mean-square (RMS) acceleration, m/s^2, 1-80Hz)					
Critical areas[4]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshop	Day- or night-time	0.040	0.029	0.080	0.058
Impulsive vibration (weighted2 RMS acceleration, m/s^2, 1-80Hz)					
Critical areas4	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis[3]	x- and y-axes[3]	z-axis[3]	x- and y-axes[3]
Workshop	Day- or night-time	0.64	0.46	1.28	0.92

Notes:

1_Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am

2_None (to avoid confusion with the acceleration unit)

3_Two frequency weightings (Wg and Wd) are required for the general measurement of whole body vibration with respect to its effect on activities. The weightings should be applied to measurements made in the three vibration axes: Wg for z axis and Wd for x and y axes.

4_Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.

Table 14: Acceptable vibration dose values (VDV) for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[3]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1_Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am

2_Note that the VDV is dependent upon the level and duration of the vibration event and the number of vibration events occurring during the assessment period; a higher vibration level is permitted if the total duration of the vibration event(s) is small.

3_Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above such as assessing intermittent values against the continuous or impulsive criteria for critical areas and/or referring to criteria in Section 1.2)

2.5.3.2 Impact on structures and services

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 and/or German Standard DIN4150-3.

Standard structures

British Standard 7385 Part 1:1990, defines different levels of structural damage as:

> *Cosmetic – The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
>
> *Minor – The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
>
> *Major – Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

BS7385-2 (Table 1 and Section 7.4.2) sets limits for the protection against the different levels of structural damage and those levels (for frequencies within the range 4-250 Hz) are reproduced in Table 15. The criteria

relate predominantly to transient vibration that does not give rise to resonant responses in structures, and to low rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, the BS7385-2 values may need to be reduced by up to 50%. Activities considered to have the potential to cause dynamic loading in some structures (e.g. residences) include rock breaking/hammering and sheet piling activities. On the basis that the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range) a conservative vibration damage screening level per receiver type is given below:

Reinforced or framed structures: 25.0 mm/s PCPV

Unreinforced or light framed structures: 7.5 mm/s PCPV

At locations where the predicted and/or measured vibration levels are greater than above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

Table 15: BS 7385-2 Structural damage criteria – low rise building

Line	Type of structure	Damage level	Peak component particle velocity1 (PCPV), mm/s					
			Where vibration that does not give rise to resonant responses in structures[3]			Where vibration might give rise to resonant responses in structures[4]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above	4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50			25		
		Minor2	100			50		
		Major2	200			100		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50	7.5 to 10	10 to 25	25
		Minor2	30 to 40	40 to 100	100	15 to 20	20 to 50	50
		Major2	60 to 80	80 to 200	200	30 to 40	40 to 100	100

Notes:

1_Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

2_Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

3_Levels relates to transient vibrations in low-rise buildings.

4_A 50% reduction might apply to the guide levels for “vibration that does not give rise to resonant responses in structures” if there is potential for continuous vibration to give rise to dynamic magnifications. Activities considered to have the potential to cause dynamic loading in some structures (e.g. residences) include rock breaking/hammering and sheet piling activities.

Sensitive structures

German Standard DIN 4150 – Part 3 ‘Structural vibration in buildings – Effects on Structure’ is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings.

Heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound and should otherwise be assessed in accordance with BS7385-2. If a heritage building or structure is found to be structurally unsound (following inspection) DIN 4150-3, line 3 as outlined in Table 16, provides a conservative cosmetic damage objective that should be adopted unless

alternative limits are justified by a dilapidation or structural survey. The sensitivity of heritage buildings and other potentially at-risk structures are subject to confirmation by the contractor prior to start of any works.

Table 16: DIN 4150-3 structural damage guideline values

Line	Type of structure	Peak component particle velocity (PCPV), mm/s				
		Vibration at the foundation at a frequency of			At horizontal plane of highest floor	In the vertical direction, at floor slabs
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz1	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under a preservation order)3	3	3 to 8	8 to 10	8	202
Notes 1_At frequencies above 100 Hz, the values given in this column may be used as minimum values. 2_Guideline value might have to be lowered to prevent minor damage						

Buried services

DIN 4150-2:2016 part 3 sets out guideline values for vibration effects on buried pipework (see Table 17).

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

Table 17: Guideline values for vibration impacts on buried pipework

Line	Pipe material	Peak component particle velocity (PCPV) measured on pipe, mm/s	
		Where vibration that does not give rise to resonant responses in structures[3]	Where vibration might give rise to resonant responses in structures[4]
1	Steel, welded	100	50
2	Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80	40
3	Masonry, plastic	50	25
-	High pressure gas pipelines2	75 Monitoring required if predicted above 50. No piling within 15 m of pipeline without detailed assessment.	
-	Electrical cables/Telecommunication services (such as fibre optic cables)	50 to 100 Detailed assessment should be carried out.	

Notes:

1_For gas and water supply pipes within 2 m of buildings, the levels given in DIN4150-3 should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

2_Based on UK National Grid's specification

3_Levels relates to transient vibrations.

4_A 50% reduction to the guide levels for "vibration that does not give rise to resonant responses in structures" might be appropriate if there is potential for continuous vibration to give rise to dynamic magnifications. Activities considered to have the potential to cause dynamic loading in some structures include rock breaking/hammering and sheet piling activities.

3. Operational noise and vibration assessment

3.1 Operating Hours

Typical hours of school operations used as the basis of assessment are summarised in Table 18.

Table 18: School hours of operation

Operation	Times
School hours	8am to 4pm, Monday to Friday
Recess and lunch	8am to 4pm, Monday to Friday Various times throughout the day Expected total less than 4 hours
Administration / Office	8am to 4pm, Monday to Friday
Waste collection	Outside of school hours Monday to Friday

3.2 Building services

The preliminary mechanical strategy for the school is expected to provide mechanical ventilation and conditioning via the following main items of mechanical plant:

- Condenser units
- Fan coil units; and
- Exhaust fans

Key acoustic considerations of mechanical plant as follows:

- Duct borne noise transmission to internal spaces;
- Noise and cross-talk control if fresh air/exhaust air path/fans are required for natural ventilation;
- Vibration control;
- Environmental noise ingress via façade, ducts and louvres; and
- Environmental noise emissions.

During ongoing design of the development, equipment will be selected and provided with noise and vibration attenuation measures as required to meet the Project goals. Noise mitigation treatment will likely be required, including:

- Specification of maximum sound power levels for all items of plant as part of the project documentation.
- Use of attenuators to control fan noise.
- Acoustic louvres to control noise from plantroom ventilation openings.
- Vibration isolators to reduce vibration input to the building structure.
- Acoustic screens around external plant, where required.
- Incorporation of sound absorptive treatments in plantroom spaces.

Equipment selection and placement will be fundamental to achieving compliance with environmental noise emission criteria. This will be worked through with the Mechanical Engineers during subsequent stages of design.

3.2.1 Electrical equipment

The new 1000kVA substation proposed to the south of the site is expected to be readily controlled via standard enclosure. Adverse impacts to either the school or nearby noise sensitive receivers is not anticipated provided sufficient attenuation is specified for these items of electrical equipment, the details of which are to be worked through in subsequent phases of design.

3.3 Operational activities

3.3.1 Outdoor play areas

Assessment of noise emission from outdoor play areas is based on the following assumptions:

- Both passive (e.g. courtyard) and active (e.g. sports) outdoor play areas defined in the architectural site plan (refer Figure 3).
- Noise source levels of students playing outdoors determined in accordance with the method outlined in the AAAC Guidelines (refer Table 19).
- Number of students occupying an outdoor play area derived based on expected class sizes and scaled to incorporate a combination of active and passive play.
- Court and sports field are each assessed to have 30 students engaged in active play, and the quadrangle is assessed to have 300 students engaged in active play, and 300 students engaged in passive play.

Table 19: Sound power spectra for outdoor play areas - AAAC

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

Resultant predicted noise levels from outdoor play activity are summarised in Table 20.

Table 20: Predicted noise levels from outdoor play areas

Receiver	Distance to activity (m)	Target criterion – day ($dBL_{Aeq,15min}$)	Predicted noise level ($dBL_{Aeq,15min}$)	Compliance?
Nearest receiver to north	19	55	55	Yes
Nearest receiver to south	19	55	52	Yes
Nearest receiver to west	25	55	50	Yes
Nearest receiver to east	60	55	44	Yes

Noise levels during times when the entire student body is using the outdoor play areas (i.e. recess and lunch) are expected to comply with the operational noise criteria. This is considered a worst case scenario. During more frequent periods when the outdoor areas are used for structured learning activities, noise levels are expected to be significantly lower.

To help mitigate this impact, strategic site planning has been implemented, incorporating buffer zones that increase the distance between major activity areas and nearby receivers. The current design places active play areas away from residential areas and utilizes perimeter buildings to shield much of the noise generated to the south, east and west.

3.3.2 Outside School Hours Care

To minimise disruption to nearby residential receivers during sleeping hours, it is recommended that all Outside School Hours Care activities between 6 a.m. and 7 a.m. take place indoors, with windows and doors closed.

3.3.3 Hall noise breakout

Assessment of noise breakout from the Hall has been undertaken based on the following scenarios:

- Noise source: internal reverberant level of up to 75 dBA which considers a typical worst case noisy learning activity / setting from sports and music.
- Windows / doors open – this includes bifold glazing doors and high-level louvres for natural ventilation

Table 21 summarises predicted noise levels at the nearest noise sensitive receiver locations due to noise breakout from the Hall.

Table 21: Predicted Hall noise breakout

Receiver	Distance to activity (m)	Target criterion ($dBL_{Aeq,15min}$)			Predicted noise level ($dBL_{Aeq,15min}$)		Compliance?
		Day	Evening	Night	Bifold doors to north and west closed	Bifold doors to north and west open	
Nearest receiver to north	80	50	43	38	20	44	Yes, during day time use with bifold doors open. Marginal exceedance during evening use with bifold doors open considered negligible. Compliance during night time use with bifold doors closed only.
Nearest receiver to west	215	50	43	38	9	31	Yes
Nearest receiver to south	45	50	43	38	21	24	Yes
Nearest receiver to east	225	50	43	38	3	22	Yes

Predicted noise breakout from typical Hall use is expected to comply with target criteria during all time periods at all locations with the exception of future potential receivers to the north. Compliance is predicted to future potential residences to the north during the daytime and evening in the scenario that bifold doors are open, with a 1 dB exceedance being considered negligible. Exceedances are expected to future potential receivers to the north in the night time period in the scenario that bifold doors are open but compliant with doors closed.

3.3.4 Covered outdoor workshop area

The metal and wood workshops are a significant source of noise emission. It is understood that the undercover space outside the workshop is being considered for extended operation of the internal workshops. There is a potential for significant disturbance to both external receivers and learning spaces within the school.

The Department of Education confirmed that strict compliance with outdoor learning space criteria is not required for this space as is not typically used for large class instruction. It is understood that a typical arrangement is to include acoustic louvres where required to mitigate noise intrusion whilst maintaining air flow.

A balance of built form mitigation measures (e.g. louvres, screens, finishes) will be explored during Schematic Design to determine feasibility of proposed usage. It is noted that operational management of uses may be required to mitigate noise disturbance, such as limiting noisy activities undertaken within the space.

3.3.5 Carpark

Assessment of carpark noise impacts to nearby noise sensitive receivers has been made with reference to the AAAC Guidelines. Typical sound power levels for vehicles within the car park area used as the basis of assessment are summarised in .

Table 22: Typical sound power levels for vehicles within the car park

Vehicle	Level (dBL_{Aeq})
Car	81
Delivery van	86

The architectural plans show provision for a 50 space car par with entrance via Bridet Avenue. As a conservative worst-case scenario the car park noise assessment has considered the following:

- Noise source locations closest to the affected residences within the car park area.
- Up to 3 vehicle movements over a 15-minute period

The predicted operational noise levels associated with the car park are summarised in Table 23.

Table 23: Predicted car park operational noise levels

Receiver	Distance to activity (m)	Target criterion ($dBL_{Aeq,15min}$)	Predicted noise level ($dBL_{Aeq,15min}$)	Compliance?
Nearest receiver to east	25	50	44	Yes
Nearest receiver to north	20	50	41	Yes
Nearest receiver to south	35	50	40	Yes
Nearest receiver to west	430	50	10	Yes

The operational noise levels of the car park are expected to meet the relevant criteria. The car park will primarily be used during daytime hours and will feature controls, such as gate access, to restrict public and after-hours usage. Speed limits will help reduce noise emissions from vehicles accessing and navigating the car park.

3.3.6 School traffic

The predicted worst-case traffic volumes (i.e busiest 1-hour periods) on the surrounding road network due to operation of the school is presented in Table 24. This information was provided by Stantec on 25 February 2025 and has been used to determine the predicted relative increase in road traffic noise level as a result of the project by analysing against future predicted road traffic numbers summarised in Section 3.4.2. As advised by the traffic engineers on the project, school traffic has been assigned to be on Birchfield Drive only.

Table 24: Forecast peak hourly traffic – school vehicles

Road	School traffic – AM Peak
Birchfield Drive	313

Based on the predicted increase in road traffic during peak periods, the road traffic noise levels along Birchfield Drive are expected to increase by more than the 2 dB screening criterion summarised in Section 2.3.3.

Predicted road traffic noise levels from traffic generated by the school combined with future general road traffic are expected to be below the NSW Road Noise Policy noise criterion of 55 dB (L_{Aeq1hr}) for the nearest registered residential lots shown in Figure 1, however are expected to exceed the overall criterion at future proposed residential lots on Birchfield Drive during the peak periods (refer Appendix B).

All other times outside of peak times are expected to result in similar noise level to existing conditions due to relatively little road traffic activity from the school during these times.

The NSW Road Noise Policy provides examples of strategies to mitigate noise from traffic-generating developments on existing roads, including the following, where considered reasonable and feasible:

1. Location of private access roads
2. Regulating times of use
3. Noise barriers
4. Property treatment

The design and development phase will be used to inform and implement feasible and reasonable noise mitigation measures for the project.

3.3.7 Public Address

Noise from public address systems has the potential to affect nearby noise sensitive receivers. To reduce the likelihood of noise disturbance to surrounding properties, the following measures are recommended for all public address systems:

- Restrict usage to school hours only (8am to 4pm).
- Use best practice design, including directional speakers that focus inward toward the school and cover only the necessary areas.
- Set volume levels to the minimum required to ensure clarity and audibility within the designated coverage zones, as specified in EFSG.

3.3.8 Waste Removal, Deliveries and Cleaning

There will be a limited number of deliveries or waste removals on any given day. To minimise disturbance to nearby residents, it is recommended that all loading dock activities and waste removal take place between 7:00 AM and 10:00 PM.

To prevent disturbing the sleep of nearby residents, it is recommended that all noisy cleaning activities be conducted between 7:00 AM and 10:00 PM. If activities must occur between 10:00 PM and 7:00 AM, the following measures should be taken:

- Ensure windows and doors are closed to minimize noise emissions.
- Do not operate air conditioning.
- Refrain from performing outdoor cleaning activities (e.g., leaf-blowing).

3.4 Noise intrusion

3.4.1 Rail noise

A Rail Noise Assessment undertaken by SLR in 2020 for the Elmsea Estate indicates that rail noise will have a minimal impact on the site. The school site is located to the northern end of the estate site, more than 200 m away from the rail corridor. Based on measured levels in the SLR report and distance of the school to the rail corridor, rail noise intrusion into outdoor or indoor areas of the school is not expected to be an issue.

3.4.2 Road Traffic

The primary source of noise intrusion for the site is existing and future projected road traffic on the immediately adjacent road network.

A road traffic noise model will be built using the Calculation of Road Traffic (CoRTN) algorithm in SoundPLAN 9.0 to predict road traffic noise levels throughout the site.

Road traffic data noise that used as the model inputs provided by Urbis on 25 January 2025 are summarised in Table 25. Posted speed limits of 50 km/hr will be adopted for all roads surrounding the school site.

Table 25: Forecast peak hourly traffic

		Birchfield Drive	Harp Avenue	Bridget Avenue	Winyu Rise
AM Peak	LV	648	68	34	34
	HV	5	0	0	0
PM Peak	LV	434	25	12	12
	HV	5	0	0	0

Road traffic noise model and outputs are summarised in Appendix B and have been used as the basis of assessments discussed in Section 3.4.3 to 3.4.7. It is noted that predicted levels are based on peak hourly flows and are therefore considered to represent the worst case period of the day.

The following measured road traffic noise spectrum has been scaled based on the outputs of the SoundPLAN model to analyse road traffic noise intrusion into the school buildings.

Table 26: Measured road traffic noise spectrum

Measurement	Octave band centre frequency – Hz (dBZ)							
	63	125	250	500	1k	2k	4k	8k
Measured road traffic noise spectrum	63	60	55	54	57	52	51	46

Façade noise levels have been extracted from the noise model to determine preliminary sound insulation requirements and indicative build-ups to address the internal noise criteria for the project as well as the feasibility for natural ventilation. Predictions have been made against criteria that take into account the cumulative contribution of road traffic noise intrusion and building services noise.

3.4.3 Glazing

Openings and glazing elements typically constitute the weakest acoustic elements in a façade.

Regarding the required noise reductions, 10 dB is typically achieved through a standard open window (opening approximately 5% of floor area). Noise reductions up to 25 dB can generally be readily achieved with sealed facades of moderate acoustic performance. Reductions up to 30 dB would generally require heavier laminated glazing or double glazing, while reductions 35 dB and above would require careful analysis and specification.

Table 27 summarises preliminary façade glazing to control road traffic noise intrusion to internal spaces based on the assumed traffic noise levels and indicative glazing locations. It is noted that the quoted performance is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Façade acoustic performance requirements will be developed further during subsequent stages of design.

Table 27: Preliminary façade assessment

Façade	External Noise Level $L_{Aeq, 1hr}$	Façade glazing	
		Recommended Minimum Sound Insulation Performance $R_{w + Ctr}$	Indicative Construction
Facades facing south	62	33 37	GLS: 10 mm float glass / 12 mm cavity / 6 mm laminated glass SLU: 12.5 mm laminated glass
Facades facing north	46	20	GLS and SLU: Standard 4 mm float

3.4.4 Natural ventilation

The design currently allows for openable windows within General Learning Spaces. It is unlikely that internal noise criteria will be met with the windows open. Further it is noted that operable windows typically do not perform as well acoustically as fixed glazing. The inclusion of mechanical ventilation should allow for windows to remain closed and the option for sealed glazing to be installed for General Learning Spaces.

It is understood that natural ventilation is currently proposed for the Hall. Specific configuration of the proposed ventilation elements is still being developed however in principle it is understood that permanently open louvres would be located along two opposing facades of the top pop up section of the building.

Based on the predicted road traffic noise levels at facades of the Hall, internal noise level criteria are expected to be exceeded by up to 20 dB with the installation of standard weather louvres.

Depending on final configuration of the natural ventilation strategy, preliminary predictions indicate it may be possible to get to within 5 dB of target internal noise criteria for Study/Assemblies if acoustic louvres (R_w 24) are specified for natural ventilation openings.

Should the Hall be proposed to accommodate examinations, it is recommended that strict compliance with internal criteria be sought. This is likely to require a mechanical rather than natural ventilation strategy for the Hall.

The attenuation measures discussed would also serve to mitigate noise emission from activities within the Hall to nearby residential receivers, which may be relevant in the instance of after hours use of the school Hall.

3.4.5 Doors

The current configuration has external entry doors located for many General Learning Areas. Doors also represent an acoustically weak element in the façade and need to be selected to control noise intrusion into noise sensitive learning spaces.

Noise breakout from high noise generating spaces such as wood and metal workshops also needs to be controlled to mitigate noise breakout to external spaces within the school.

Specific minimum sound insulation requirements will be developed and summarised in subsequent design phases.

3.4.6 Façade wall

Masonry and concrete façade walls are sufficient to mitigate noise intrusion. There is a potential for noise intrusion to be more significant where lightweight wall systems are proposed. Minimum sound insulation requirements and indicative constructions for various buildings to which this requirement may apply will be developed during subsequent phases of design where required.

3.4.7 Outdoor areas

Predicted road traffic noise levels across the site are shown in Appendix B and summarised for outdoor areas in Table 28 against target criteria for outdoor areas presented in Section 2.4.2.

Table 28: Predicted road traffic noise levels – Outdoor Areas

Area	Predicted road traffic noise level $dBL_{Aeq,1hr}$	Complies?	Comments
Terrace	40-54	Yes	Within target criteria for outdoor areas. Under cover areas shielded by Building B suitable for outdoor learning.
Outdoor sport areas	44-58	Partial	Majority of sports fields within outdoor criteria. Very edges of western most sport field up to 3 dB above outdoor criteria. Inclusion of barrier/berm not considered feasible in the context of proposed school layout.
Covered outdoor workshop area (COWA)	54-60	No	Considered suitable if enclosed by full height acoustic louvres. Discussed further in Section 3.3.4.
Covered outdoor learning area (COLA)	40-48	Yes	Within criteria for outdoor learning areas.

4. Construction noise and vibration assessment

4.1 Construction noise

4.1.1 Construction activities

The construction phases used as the basis of this assessment are summarised below and has been based on reference schools. The overall programme for these works is anticipated to be 12 months.

- Site establishment
- Excavation / Earthworks
- Substructure
- Structural / Concreting
- Building envelope
- Fitout / Finishes
- External works / Landscaping
- Demobilisation

Assumed construction equipment to be used for redevelopment works are provided in Table 29.

Equipment sound power levels have been determined by reference to AS2436, BS5228, and Arup's measurement database. The equipment below has been assumed to operate concurrently however equipment sound power levels have been adjusted according to its usage in a worst case 15-minute period, and penalty corrections for impulsive noise characteristics.

The locations of equipment have been based on the locations of the construction works around the precinct.

Table 29: Construction equipment usage and associated sound power levels (Lw)

Plant item	Plant item sound power level, dBL_{Aeq}	Penalty, dB	% of use in worst case 15 mins	Site Establishment	Excavation / Earthworks	Substructure	Structural / concreting	Building Envelope	Fitout & finishes	External works / landscaping	Demobilisation
Truck (>20 Tonne)	107	0	50	1	1	1	1	1	1		1
Crane (Mobile)	113	0	50				1		1		1
Loader (Front-end) (23t)	112	0	50	1	1						1
Generator (Diesel)	113	0	100	1			1		1		
Excavator (10t)	100	0	50		1						
Excavator (10t) + hydraulic hammer	118	5	50		1						
Loader - Skidsteer (Bob-cat) (1/2t)	107	0	50		1					1	
Truck (Dump)	117	0	50		1						
Piling (Bored)	111	0	10			1					
Concrete Pencil Vibrator	105	0	10			1	1				
Concrete Pump	109	0	25			1	1				
Hand Tools (Electric)	110	0	50				1	1	1	1	1
Road Lorry (Full)	108	0	50		1			1			
Concrete Agitator Truck	111	0	50			1	1				
Scissor lift	98	0	50				1	1	1		
Angle Grinder	108	0	25					1			
Welder	110	0	25						1		
Forklift	106	0	50							1	
Crane (Truck Mounted)	108	0	50	1			1	1			

4.1.2 Assessment methodology

Noise emissions from construction activities have been assessed to criteria outlined in Section 2.5.2.

Noise emissions have been modelled using SoundPLAN 9 in accordance with ISO9613-2 algorithms. The model included:

- Construction noise sources listed in Section 4.1.1;
- Surrounding buildings, ground terrain and absorption; and
- Receivers listed in Section 1.1.

Noise emissions have been modelled on the following assumptions:

- Equipment, staging and durations are based on typical scenarios for NSW school projects.
- Construction areas have been derived based on the latest architectural site plans.
- The location of equipment will be spread evenly across the site.

4.1.3 Noise prediction results

Predicted construction noise levels at the closest existing noise sensitive receiver along with the relevant NML for the intended working hours are presented in Table 30.

Table 30: Predicted construction noise levels

Receiver	Classification	NML	Construction Phase							
			Site Establishment	Excavation / Earthworks	Substructure	Structural / Concreting	Building Envelope	Fit out & finishes	External work / landscaping	Demobilisation
64 Birchfield Drive	Residential	51	46	53	40	46	41	45	41	45

Results indicate that noise management levels will be exceeded during excavation and earthworks at the nearest existing residential receiver location. Compliance with criteria is predicted for all other phases of works. There is the possibility that additional exceedances are experienced at any future dwellings that are constructed and inhabited prior to construction of the school.

During construction, plant and equipment will move through the Project area as the Project progresses, changing noise impacts in relation to the nearby individual sensitive receivers. The noise levels experienced at a particular location will rise and fall in accordance with the varying offset distance of the works, the intensity and location of construction activities, the intervening terrain and structure and the type of equipment used. It is unlikely that all construction equipment will be operating at their maximum sound levels simultaneously. In any given period, typically construction equipment would be used with maximum sound levels for only a brief amount of time and at other times the equipment may emit lower sound levels carrying out activities.

In general, construction works are temporary in nature therefore potential noise impact on the community and the surrounding environment will not be permanent or continuous. Where the predicted $L_{Aeq(15min)}$ noise level is greater than the noise management levels all feasible and reasonable work practices should be applied, as recommended below.

4.1.4 Construction noise mitigation and management measures

Indicative noise reduction for different noise mitigation measures relevant to construction activities for the project have been obtained from the guidance of AS2436 - Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites and BS5228.1 - Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise, and are summarised below in Table 22 for reference.

Table 31: Indicative noise reduction provided by noise mitigation measures

Construction equipment	Noise mitigation measure	Indicative noise reduction	Source
Jackhammer	Muffler and screen	20 dBA	Table C2, AS2436:2010
Compressor, Cement mixers, Hand-held tools	Screening	5 dBA	Table C3, AS2436:2010
Excavators/loaders, Trucks, Mobile cranes, Asphalt paver, Bulldozers, Road graders, Rollers/compactors	Residential-grade silencer	10 dBA	Table C2, AS2436:2010 Table B1, BS5228.1:2009
Excavator with hammer attachment	Residential-grade silencer, Screening of hammer attachment	15 dBA	Table C2, AS2436:2010
Piling impact	Resilient pad (dolly) between pile and hammerhead	10 dBA	Table C2, AS2436:2010 Table B1, BS5228.1:2009

Table 32 provides a summary of the potential project specific community consultation measures depending on the extent of NML exceedances. This table has been informed by the Construction Noise and Vibration Strategy (CNVS) and should be reviewed and refined for the development of the Construction Noise and Vibration Management Plan (CNVMP) for the project to be developed by the contractor.

Table 32: Indicative community consultation measures

Construction hours	Receiver perception	Above NML	Management Measures[1,2,3,4]
Airborne noise			
Standard hours (day)	Noticeable	≤ NML (compliant	-
	Clearly audible	≤ NML + 10	-
	Moderately intrusive	≤ NML + 20	N
	Highly intrusive	> NML + 20	N
	Highly noise affected	≥ 75 dBA	N, SN, RP
Outside standard hours (night)[5]	Noticeable	≤ NML (compliant	-
	Clearly audible	≤ NML + 10	N
	Moderately intrusive	≤ NML + 20	N, SN
	Highly intrusive	> NML + 20	N, SN, AA, RP
	Highly noise affected	≥ 75 dBA	N, SN, AA, RP

Notes:

1. N: Notifications (such as letter box drops)

2. SN: Specific notifications such as individual briefings or phone call

Construction hours	Receiver perception	Above NML	Management Measures[1,2,3,4]
3. AA: Alternative accommodation 4. RP: Respite Period 5. No works outside of standard hours is proposed. Management measures are for information only.			

4.2 Construction traffic

Construction-related road traffic is a temporary source of noise that must be assessed and managed, particularly concerning heavy vehicles accessing the site. To minimise disturbance to the neighbouring community, truck arrivals and departures should be scheduled outside peak traffic hours and, wherever possible, during times that are less sensitive to noise.

Details of predicted construction traffic volumes are not available at this early stage of design. The increase in traffic caused by construction is expected to be minimal, with the total number of vehicles rising by less than 60% compared to existing traffic. This increase will result in a noise level rise of under 2 dB, which is below the threshold for traffic noise increase screening criteria as discussed in Section 2.3.3.

It is important to acknowledge, however, that heavy vehicles can produce noise levels higher than regular car traffic, leading to more significant disturbances. To mitigate this, access routes should be limited to major roads and avoid local residential streets as far as practicable. Measures such as avoiding engine braking, adhering strictly to speed limits, and minimising sudden braking or acceleration should also be enforced.

All contractors and subcontractors should be informed about the importance of noise-conscious driving when traveling to and from the construction site. To manage noise from construction traffic, the following measures should be implemented:

- Staging truck arrivals to prevent queuing and idling on public streets.
- Directing vehicles to arrive and depart via designated routes that minimize the use of local roads.
- Reducing the need for reversing to limit the use of reversing alarms (“beepers”) and/or using quieter alarms (e.g., quacker alarms).
- Minimising engine braking and avoiding unnecessary noise from slamming doors, loud radios, shouting, or the use of truck horns for signalling.

The contractor will also need to evaluate cumulative noise impacts as part of the Construction Noise and Vibration Management Plan (CNVMP). Coordination with other contractors and projects in the area will be necessary if construction activities occur simultaneously.

4.3 Vibration

As a guide, the recommended minimum working distances for vibration intensive plant in Table 33 (which has been derived from the TfNSW CNVS) provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers. While the minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions, if a receiver is located within the minimum working distance, vibration monitoring might be required, and equipment selection and/or method of construction might have to be reviewed.

Table 33: Recommended minimum working distances (m) for vibration generating plant

Plant item	Rating / description	Minimum working distance (m)			
		Cosmetic damage – screening criteria			Human response
		Industrial and heavy commercial buildings BS 7385 Line 1 -25 mm/s (See note 2)	Residential and light commercial buildings BS 7385 Line 2 - 7.5 mm/s (See note 2)	Structures unsound DIN 4150 Line 3 – 3 mm/s	
Vibratory roller	< 50 kN (~ 1 to 2t)	2 m	5 m	11 m	15 m to 20 m
	< 100 kN (~ 2 to 4t)	2 m	6 m	13 m	20 m
	< 200 kN (~ 4 to 6t)	5 m	12 m	26 m	40 m
	< 300 kN (~ 7 to 13t)	6 m	15 m	31 m	100 m
	> 300 kN (~ 13 to 18t)	8 m	20 m	40 m	100 m
	> 300 kN (> 18t)	10 m	25 m	50 m	100 m
Hydraulic hammer – Small	300 kg / 5 to 12t excavator	1 m	2 m	5 m	7 m
Hydraulic hammer – Medium	900 kg / 12 to 18t excavator	3 m	7 m	15 m	23 m
Hydraulic hammer – Large	1600 kg / 18 to 34t excavator	9 m	22 m	44 m	73 m
Piling – Vibratory	Sheet piles	9 m	22 m	44 m	73 m
Piling – Bored	⩽ 800 mm	1 m (nominal)	2 m	5 m	10 m
Piling – Hammer	12t down force	6 m	15 m	30 m	50 m
Jackhammer	Hand-held	1 m (nominal)	1 m (nominal)	3 m	5 m
Mechanised bored tunnelling works (Tunnel Boring Machine, Horizontal Directional Drilling, Micro-tunnelling)1	-	1 m to 5 m	2 m to 12 m	4 m to 24 m	6 m to 35 m
Note: 1_Based on TRL document using Godio et al formula, equation 24 2_Where vibration might give rise to resonant responses in structures					

The safe working distances presented are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

The contractor will be required to manage vibration as well as noise and make use of best practice in the management of vibration using simple and practicable techniques such as avoiding dropping heavy items.

Where vibration intensive works are required within the minimum working distances outlined in Table 33, vibration monitoring at the nearest potential affected building should be considered, where real-time alerts can be generated when measured vibration levels exceed criteria.

5. Mitigation Measures

Table 34: Mitigation measures

Mitigation Name	Section	Mitigation Measure	Reason for Mitigation Measure
Building services	Section 3.2	Appropriate equipment selection and noise mitigation design.	Achieve internal and external building services noise and vibration criteria.
Operational activities	Section 3.3	Outside School Hours Care activities between 6 a.m. and 7 a.m. should take place indoors, with windows and doors closed. Acoustic louvres to be installed within Hall and Covered Outdoor workshop areas where required to achieve environmental noise emission criteria. Implement feasible and reasonable mitigation measures for traffic generation in alignment with the NSW Road Noise Policy. Restrict usage of Public Address to school operation hours only (8am to 4pm). Use directional speakers and set volume levels to the minimum required to ensure clarity and audibility. Where practicable, all loading dock activities, waste removal and noisy cleaning activities should take place between 7:00 AM and 10:00 PM.	To minimise disruption to nearby residential receivers.
Noise intrusion	Section 3.4	Façade glazing and lightweight elements and doors to be designed to control noise break-in to sensitive areas. Natural ventilation to incorporate acoustic louvres where noise break-in is required to be controlled (e.g. Hall). Install acoustically absorptive finishes to underside of outdoor learning areas to control reverberation build up and mitigate noise intrusion.	To control noise intrusion into sensitive spaces throughout the school.

Mitigation Name	Section	Mitigation Measure	Reason for Mitigation Measure
Construction noise and vibration	Section 4	Contractor to develop a detailed construction noise and vibration management plan once specific details of proposed construction activities and staging are known.	To effectively manage construction noise and vibration impacts to the surrounding community.

6. Evaluation of Environmental Impacts

An acoustic assessment has been undertaken of construction and operation of the proposed Bungendore High School. This assessment has been based on information available at this stage of design and has been developed to a level of detail suitable for submission as appendix to the Review of Environmental Factors.

The operational assessment has considered noise emissions from school operations including building services, outdoor play areas, Hall use, outdoor workshop areas and car parks. Road traffic noise increase associated with operation of the school has also been assessed along with noise intrusion into the development site. Various recommendations have been made to mitigate noise sources and enhance the building envelope where feasible and reasonable to demonstrate compliance with target criteria.

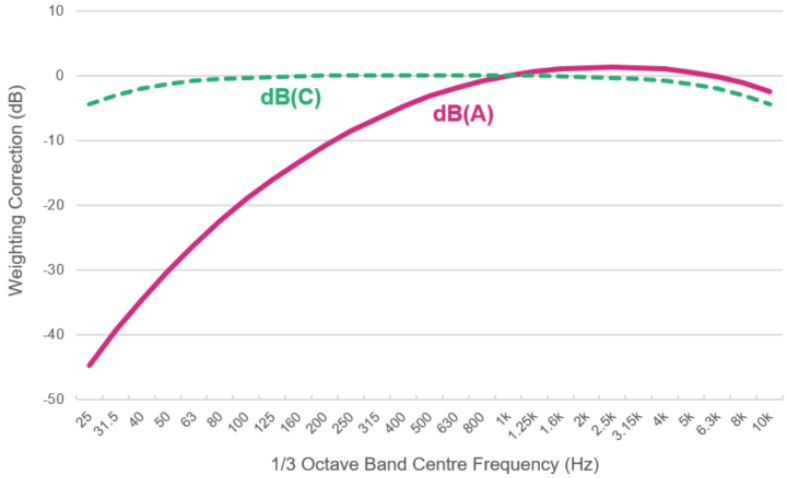
In lieu of detailed information being available at this stage of design, the construction noise and vibration assessment has made various assumptions based on typical approaches to building school developments. Various exceedances of target noise management levels have been identified and indicative mitigation and management measures put forward. A detailed Construction Noise and Vibration Management Plan will be required to be developed by the Contractor once more specific details are known.

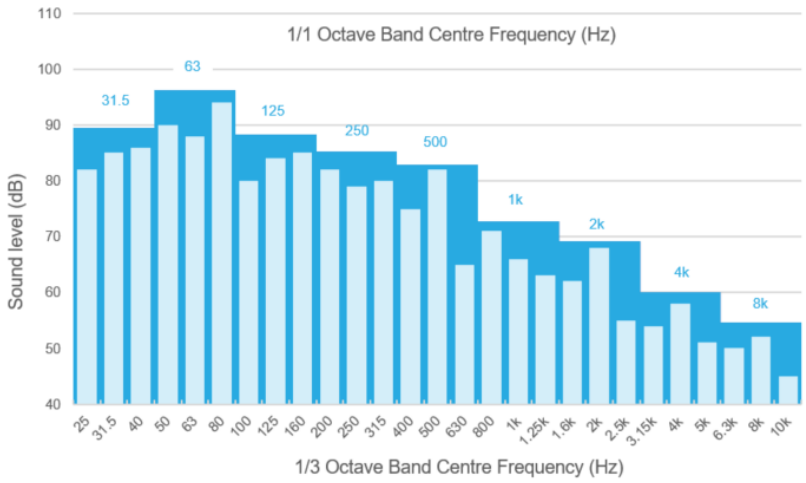
The extent and nature of potential impacts are considered low and not expected to have significant impact on the locality, community and/or the environment. Potential impacts can be appropriately mitigated or managed to ensure that there is minimal impact on the locality, community and/or the environment.

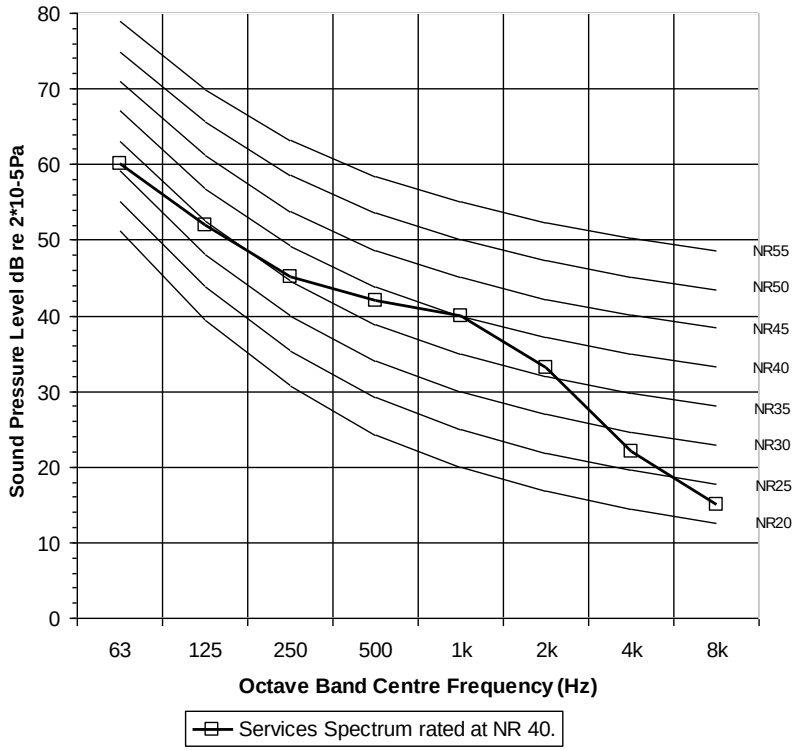
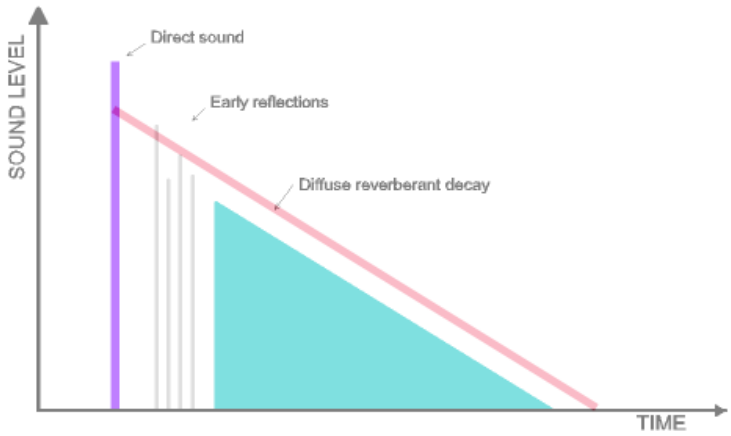
Appendix A

Glossary

Term	Definition
Absorption Coefficient, α	The amount of sound absorbed by a material, defined as the ratio of the amount of acoustic absorption of the material (in units of sabins) to the material's surface area. Absorption coefficient is broadly equivalent to the proportion of sound energy absorbed by the material. Noise-reduction Coefficient (NRC): The arithmetic average of the sound-absorption coefficients of a material at 250 Hz, 500 Hz, 1 kHz and 2 kHz. It is a simplified single-number index that provides an indication of the sound absorbing efficiency of a material, typically ranging from 0 to 1. The rating is affected by type, thickness, density and mounting of the material. Weighted absorption coefficient (α_w): The weighted absorption coefficient, defined in ISO 11654 is a frequency-weighted single number absorption coefficient used to categorise the overall absorption effectiveness of a material. Descriptors are used to indicate if the material absorbs strongly at high (H), mid (M) and/or low (L) frequencies – e.g. a material may be rated as α_w 0.85(LH), which indicates that it strongly absorbs at both low and high frequencies. Materials can also be assigned into five absorption classes, with Class A having the highest absorption and Class E having the lowest absorption.
Ambient noise level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a building is being investigated, the ambient noise level is the noise level from all other sources without the fan operating, such as traffic, birds, people talking and other noise from other buildings.
Background noise level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. Assessment Background Level (ABL): A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time. Rating Background Level (RBL / min$L_{A90,1hour}$): A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.
Decibel (dB)	The logarithmic scale used to measure sound and vibration. Human hearing is not linear and involves hearing over a large range of sound pressures, which would be challenging to present on a linear scale. A logarithmic scale allows all sound levels to be expressed based on how loud they are relative to a reference sound (typically 20 µPa, which is the approximate human threshold of hearing). For sound in other media (e.g. underwater noise) a different reference level (1 µPa) is used instead. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

Term	Definition
dB weighting curves	The frequency of a sound affects its perceived loudness and human hearing is less sensitive at low and very high frequencies. When seeking to represent the summation of sound pressure levels across the frequency range of human hearing into a single number, weighting is typically applied. Most commonly, A-weighting, denoted as dB(A), is used for environmental noise assessment. This is often supplemented by the linear or C-weighting curves, where there is the potential for excess low-frequency sound at higher sound pressure levels. 
dB(A)	dB(A) denotes a single-number sound pressure level that includes a frequency weighting (‘A-weighting’) to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).
Flutter Echo	Flutter echo refers to an acoustic defect where sound reflects backwards-and-forwards between a set of parallel surfaces with very little energy loss. The resulting flutter echo decays very slowly and can ‘linger’ in the room long after sound travelling in other directions has been attenuated. Flutter echo can cause distortion to the sound quality, making it sound ‘metallic’, or if the flutter is strong enough or delayed enough, it can cause a sound to be ‘blurred’ and even be heard as a separate sound (a true ‘echo’). Flutter is treated by angling surfaces so they are not parallel (typically a minimum of 7º off-parallel), adding absorption to one or both surfaces, or by adding diffusion to one or both surfaces.

Term	Definition
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as 'pitch'. Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or 'low-pitched' and sounds with a higher frequency are perceived as 'treble' or 'high pitched'. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A thousand Hz is generally denoted as kHz. Human hearing ranges approximately from 20 Hz to 20 kHz. While single weighted sound pressure levels simplify the assessment and evaluation of sound levels, frequency analysis is often undertaken. 'Octave bands', either 1/1 or 1/3 octave bands are most commonly utilised and are referred to by the nominal centre frequency of the band (e.g. 31.5 Hz), while being the summation of all frequencies between a defined lower and upper frequency. 
Impact Sound Pressure Level	The technical parameter used to determine impact sound isolation of floors is the impact sound pressure level, L_i. In the laboratory, the weighted normalised impact sound pressure level, $L_{n,w}$, is used to represent the impact sound isolation as a single figure. On site, the weighted normalised apparent impact sound pressure level, $L'_{n,w,}$ and the weighted standardised apparent impact sound pressure level, $L'_{n,Tw}$, are used to represent the impact sound isolation of a floor as a single figure. These single weighted values are determined by comparing the spectral impact sound pressure levels (as defined in ISO 140-6 and ISO 140-7) with reference values outlined in AS/NZS ISO 717.2.
$L_{10(period)}$	The sound level exceeded for 10% of the measurement period, or alternatively, the sound levels would be lower for 90% of the time. The L_{10} is often defined as the 'average maximum' sound levels, as in AS1055-2018 with the advent of statistical sound level meters.
$L_{90(period)}$	The sound level exceeded for 90% of the measurement period. The L_{90} is often defined as the 'average minimum' or 'background' noise level for a period of measurement. For example, 45 $dBL_{A90,15min}$ indicates that the sound level is higher than 45 dB(A) for 90% of the 15-minute measurement period.
$L_{eq(period)}$	The equivalent ('eq') continuous sound level, used to describe the level of a time-varying sound or vibration measurement. The L_{eq} is often defined as the 'average' level, and mathematically, is the energy-average level over a measurement period – i.e. the level of a constant sound that contains the same sound energy as the measured sound.
L_{peak} / L_{max}	The L_{peak} is the 'absolute maximum' level of a sound or vibration recorded within the measurement period. As the L_{peak} is often caused by an instantaneous event, it can vary significantly between measurements. L_{max} is the maximum rms sound pressure level within a measuring period. L_{max} gives a better picture of what the general maximum level was in a measurement, making it easier to calculate and measure for a noise source waveform that is changing constantly in its magnitude.

Term	Definition
Noise Rating (NR) Curves	A set of internationally-agreed octave band sound pressure level curves, based on the concept of equal loudness. The curves are commonly used to define building services noise limits. The 'NR' value is obtained by plotting the octave band spectrum on the set of standard curves. The highest value curve which is reached by the spectrum is the NR value. Shown below is a mechanical plant noise spectrum at NR 40. 
Reverberation Time (T_{60})	The time, in seconds, taken for a sound within a space to decay by 60 dB after the sound source has stopped is denoted at the reverberation time (RT). The RT is an important indicator of the subjective acoustic within a space. A long RT subjectively corresponds to an acoustically 'live' space, while a short RT subjectively corresponds to an acoustically 'dead' space. 

Term	Definition
Sound Level Difference (D)	Used to quantify the sound insulation between two spaces and is equal to the difference in sound level between the rooms within a particular frequency band. For example, if the sound level in the source room is 100 dB and the sound level in the adjacent room is 75 dB, the sound level difference is 25 dB for that frequency band. The weighted sound level difference, D_w, as defined in AS/NZS ISO 717.1, is used to provide a single-number descriptor to describe the overall performance of a partition across multiple frequency bands. Note however that D_w is only calculated over a frequency range from 100 Hz to 3.15 kHz and hence sound outside of this range is excluded from calculation of D_w – particularly low frequency (bass) sound below 100 Hz. Also used are the weighted normalised level difference ($D_{n,w}$), which corrects the measured sound level difference to a reference sound absorption area in the receiving room, or the weighted standardised level difference ($D_{nT,w}$), which corrects the measurements to a reference reverberation time in the receiving room. These single numbers are determined by comparing the spectral sound insulation test results (as defined in ISO 140-4) with reference values, as outlined in AS/NZS ISO 717.1.
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of the environment and distance from a source. The sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Sound Reduction Index (R)	A measure of the sound level loss through a material for a particular frequency band. Sound reduction index is sometimes also referred to as transmission loss. It is a property of the component, unlike the sound level difference, which is affected by the common area between the rooms and the acoustics of the receiving room. R is the ratio (expressed in decibels) of the sound energy transmitted through the building element to the sound energy incident on the building element for a particular frequency band. The weighted sound reduction index, R_w, is a single figure description of sound reduction index across multiple frequency bands and is defined in BS EN ISO 717-1: 2000. R_w values are calculated from measurements in an acoustic laboratory. Note however that R_w is only calculated over a frequency range from 100 Hz to 3.15 kHz and hence sound outside of this range is excluded from calculation of R_w – particularly low frequency (bass) sound below 100 Hz. Sound insulation ratings derived from site measurements are referred to as apparent sound reduction index (R'_w) ratings.
Spectrum Adaptation Terms (C and C_{tr})	C and C_{tr} denote a spectrum adaptation (in dB) that are added to the R_w or D_w value of a partition to adjust for different sound characteristics. C is used to measure the performance of a partition for medium to high-frequency sound sources, such as speech. C_{tr} is used to measure the performance of a partition for low-frequency sound sources such as road traffic. The values of C and C_{tr} are dependent on the construction of the partition and are usually negative quantities, they typically increase the R_w requirement of a partition. For example, for a partition with an R_w of 56 dB and C_{tr} -6 dB, the R_w+C_{tr} is only 50 dB. The overall performance of the partition is quoted as the sum of the R_w value and the spectrum adaptation terms, e.g. D_w+C 55 dB; R_w+C_{tr} 60 dB.

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Speech Transmission Index (STI)</td><td>STI is a technical index, predictable and measurable using specialised equipment, for assessing speech and vocal intelligibility. STI takes into account the signal/noise ratio of the speech signal and the reverberation of the receiving environment. The higher the value of STI, the higher the expected speech intelligibility.

STI ratings are assigned subjective categories, as follows:

<table>
<tr><th>STI range</th><th>Subjective category</th></tr>
<tr><td>< 0.3</td><td>Bad</td></tr>
<tr><td>0.3 – 0.45</td><td>Poor</td></tr>
<tr><td>0.45 – 0.6</td><td>Fair</td></tr>
<tr><td>0.6 – 0.75</td><td>Good</td></tr>
<tr><td>0.8 – 1.0</td><td>Excellent</td></tr>
</table>
</td></tr>
<tr><td>Structureborne noise</td><td>The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.</td></tr>
<tr><td>Vibration</td><td>Waves in a solid material are called ‘vibration’, as opposed to similar waves in air, which are called ‘sound’ or ‘noise’. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.</td></tr>
</table>

Appendix B

Road traffic noise

A3

26/02/2025 3:44 PM

Legend

- Courts and Playing Field
- Road
- Building

dBLAeq(1 hour)

40 - 42		54 - 56	
42 - 44		56 - 58	
44 - 46		58 - 60	
46 - 48		60 - 62	
48 - 50		62 - 64	
50 - 52		64 - 66	
52 - 54		66 - 68	

Coordinate System: EPSG:28356

0 25 50 m

Rev	Date	By	Chkd	Appd	Authd
A	26/02/2025	AT	MA	--	--

ARUP

Level 5 Barrack Place,
151 Clarence St, Sydney
NSW 2000
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Client

Schools Infrastructure NSW

Project Name

Bungendore High School Stage 1

Drawing Title

Traffic Emissions

Scale at A3

1:1250

Role

--

Suitability

--

Project Number

-

Rev

A

Drawing Name

--

\\global.arup.com\australasia\SYD\Projects\303000\303392-00 SINSW Projects Group\Work\Internal\Bungendore\Acoustics\3_Calcs and models\QGIS\Bungendore_GNM_V3.qgz