St Aloysius College - Rozelle Site

Acoustics Report

Noise Impact Assessment for State Significant Development Application

Prepared for: PMDL

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Date: 27th January 2022

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Revision

Revision	Date	Comment	Prepared By	Approved By
001	21/10/2021	Draft for comment	Julia Knight	Elle Hewett
002	24/10/2021	Update to Section 5.5.(Mechanical Noise)	Julia Knight	Elle Hewett
003	27/01/2022	Update to address DPIE comments	Julia Knight	Elle Hewett

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Executive Summary

An acoustic assessment for the proposed development of a remote campus for Aloysius College has been conducted. This document forms part of the documentation package to be submitted to the Department of Planning as part of the SSD application.

This assessment includes the refurbishment of the building and outside area of 48 Victoria Road and the use of a school building at 2a-2b Gordon Street, Rozelle

This report has provided criteria, in-principle noise mitigation and design recommendations, which aim to achieve the statutory criteria as discussed in the report. In terms of noise criteria, the following have been provided:

- Break-in internal noise levels in accordance with the NSW Educational Facilities Standards & Guidelines
- Noise criteria for emissions from the development in accordance with the NSW EPA Noise Policy for Industry and Association of Australian Acoustical Consultants (AAAC) guidance
- Noise criteria for noise impact on the school playground in accordance with the NSW EPA Noise Policy for Industry
- Construction noise criteria as recommended by the NSW EPA Interim Construction Noise Guideline
- Construction vibration criteria, as recommended by NSW EPA Assessing Vibration Guideline, German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures” and British Standard BS7385-Part 2: 1993 “Evaluation and Measurement for Vibration in Buildings”

An operational noise assessment has been conducted for the school facilities and activities impact on the local environment. Recommendations for noise mitigation and management have been made where necessary to provide an acceptable amenity to nearby residents, without being onerous for the school.

In-principle advice has been provided for any future mechanical services additions or modifications, should the existing condensers located at the eastern side of the front wall facing the courtyard be replaced.

An analysis of the impacts of noise from traffic on the playground has been conducted and a barrier/fence has been recommended to control the noise for playground use.

The traffic noise impact on the post-development generated traffic has been assessed and it is expected to comply with the requirements of the NSW RNP.

A construction noise and vibration assessment has also been conducted and recommendations made to minimise the noise and vibration impact. It should be acknowledged that the proximity of the nearest residents to the site will result in some inevitable construction noise impact.

It is the finding of this assessment that the approval of this project should not be refused on the grounds of excessive noise generation and recommended noise control and management is considered standard industry practice.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to selection of air-conditioning units, modifications to the building and outside areas and introduction of any additional noise sources.

1. Introduction

As part of the State Significant Development Application (SSDA) documentation process, Stantec has been engaged by PMDL to provide a noise and vibration impact assessment for the development of a remote campus for Aloysius College. The campus will be used initially to accommodate displaced students during the construction works at Kirribilli but also as a dedicated campus for a secondary year group. The campus will accommodate approximately 180 – 200 students and 15 staff and includes the building at 48 Victoria Road as well as the use of multiple rooms within 2a-2b Gordon St.

This assessment discusses the likely noise impact of the proposed development upon the nearest most-affected residential receivers and the noise impact on the proposed development.

This assessment has been prepared considering the following documents:

- Educational Facilities Standards & Guidelines (EFSG) DG 11
- Department of Planning (DoP) – Development near Rail Corridors and Busy Roads – Interim Guideline 2008.
- AS/NZS 2107:2016: “Acoustics – Recommended design sound levels and reverberation times for building interiors”.
- NSW Environment Protection Authority (EPA) Noise Policy for Industry, 2017 (NPI 2017).
- NSW Road Noise Policy, 2011 (RNP 2011).
- NSW Environment Protection Authority (EPA) Interim Construction Noise Guideline (ICNG July 2009).
- Assessing Vibration – A Technical Guideline (NSW AV-TG), issued February 2006 by the Department of Environment and Conservation NSW, now part of the NSW EPA.
- British Standard BS5228: Part 1:1997 “Noise and Vibration Control on Construction and Open Sites.”.
- British Standard BS7358:1993 “Evaluation and Measurement for Vibration in Buildings” – Part 2: “Guide to Damage Levels from Ground borne Vibration”.
- German Standard DIN4150-Part 3 “Structural vibration in buildings – Effects on structures.”

This report provides:

- Project specific noise and vibration criteria.
- Results from attended and unattended monitoring of the acoustic environment at the site location.
- Indicative recommendations for noise mitigation measures for the proposed development to meet the relevant. criteria.

1.1 SEARs

The Secretary’s Environmental Assessment Requirements from application number SSD-27208140 are addressed in the sections presented in Table 1.

Table 1 SEAR's Requirements

SEARS Requirement		Addressed in Section
4. Assess amenity impacts on the surrounding locality, including acoustic impacts. A high level of environmental amenity for any surrounding residential or other sensitive land uses must be demonstrated.		See Sections below.
9. Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environmental Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise including:	Public address system	Section 5.2
	Events and out of hours use of school facilities	Section 5.6
	Vibration impacts on nearby sensitive receivers and structures	Section 0
	Noise intrusion	Section 6
	Proposed management mitigation measured that would be implemented	Sections 5.1.3, 5.2, 5.4, 5.5, 6.1, 6.2.2

Project Overview

1.2 Site Description

The site location at 48 Victoria Road is shown in Figure 1. To the north of the site is Victoria Road with commercial premises opposite. To the west of the site there is a commercial storefront with residents directly behind adjacent to the site at 66 Victoria Road. Residential receivers also surround the site to the south and West and to the east is the Community college and Church. The unattended logging location is labeled U1, the attended measurements are labelled A1, A2 and A3 and closest residents R1 and R2 and R3.

Figure 1 Aerial image of the area showing an overview of the site and measurement locations

2. Noise Survey

2.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyser Casella, S/N 4257387
- Brüel & Kjær Sound Calibrator, S/N 2709826
- Brüel & Kjær Type 2250 Environmental Noise Logger, S/N 3011850

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

2.2 Attended Noise Survey Results

Attended noise measurements were conducted on site to characterise the acoustic environment for noise intruding into the development and to determine the existing background acoustic environment around the site. A summary of the attended noise measurements taken at the proposed development site are shown in Table 2.

Table 2: Summary of results for attended noise surveys

Location	Time	Duration	L_{Aeq} dB(A)	L_{A90} dB(A)	L_{Amax} dB(A)	Comments
A1	5.10 pm	15 min	65	55	89	Located 3m from the façade of the nearest residence, 15m set back from Victoria Road. Traffic is free flowing, near traffic lights busy.
A2	5.30 pm	15 min	60.5	53	75	Traffic from Victoria Road dominant but further set back than location A1

2.3 Unattended Noise Survey Results

Unattended noise monitors were placed at position L1 (shown in Figure 1) to measure the background and ambient noise that is representative of the most affected noise-sensitive receivers. The noise logger was installed from the 23rd September to the 5th October 2021. The results for the unattended background noise survey are shown in Table 3 below (for the day, evening, and night periods). Note that any rain affected data during the period of logging has been excluded from the calculations.

Table 3: Summary of results for background and ambient noise surveys

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	63	60	55	50	47	38
R1 corrected values [1]	66	-	-	53	-	-

1. Simultaneous measurements at the receiver looking directly over the proposed basketball court (Location A1) and the logger location (U1) showed a 3dB difference. This is due to the receiver being closer to the road than the logger location. To account for the difference, a correction has been applied to estimate the background daytime noise levels at the nearest receiver at 66 Victoria Road (R1).

3. Noise Criteria

3.1 Internal noise levels

3.1.1 The Educational Facilities Standards & Guidelines

For internal noise criteria, the Educational Facilities Standards & Guidelines (EFSG) DG 11 has been used as it generally mirrors Australian Standards 2107:2016. The EFSG presents internal noise levels for educational facilities when the development is impacted by traffic noise, and that the assessment shall be consistent with the requirements of the SEPP Infrastructure Clause 102. The internal noise levels from the EFSG as presented in Table 4 shall be met as the Victoria Road carries more than 40,000 vehicles AADT (which is the recommended volume for an assessment from the DoP Interim Guideline).

Note that these levels are generally based on the satisfactory recommended levels by Australian Standard (AS) 2107:2016 – *'Acoustics- Recommended design sound levels and reverberation times for building interiors.*

Table 4: Internal noise levels according to EFSG

Room	Internal Noise Level, L_{Aeq}, dB(A)
Art/craft studios	40
Corridors and lobbies	45
Music practice rooms	35
Office areas	40
Open plan teaching areas	40
Professional and Administrative offices	35
Staff common rooms	40
Teaching spaces – Hearing impaired	30
Teaching spaces – Secondary schools	35
Toilet/change/showers	50

3.1.2 Department of Planning– Interim Guideline Developments Near Rail Corridors and Busy Roads

The Department of Planning (DoP) interim Guideline details the application of SEPP Infrastructure Clause 102 which is required to be used when an educational development is adjacent to a freeway, a tollway, or transitway or a road with an annual average daily traffic volume (AADTV) of more than 40,000 vehicles. Based on the RMS traffic volume data, Victoria Road has approximately 40,000 daily vehicle movements, therefore the DoP Interim Guideline has been applied.

Based on the DoP Interim Guideline, the maximum recommended internal noise level to educational institutions is 40dB(A) when in use. As the internal noise levels from the EFSG have been derived to be consistent with the requirements of the SEPP Infrastructure, the levels from Table 4 have been used.

3.2 Noise levels in the outdoor area/ playground

3.2.1 Noise Policy for Industry – Active Recreation

The Noise Policy for Industry, provides a recommended amenity noise level of 55 dB(A) for active recreation areas including school playgrounds. This specifically relates to noise due to industrial noise sources but for the assessment of this project may be used as a goal for noise due to other sources, such as traffic.

3.3 Environmental Noise Emission Criteria

3.3.1 Mechanical plant – Noise Policy for Industry

The NPI sets out noise criteria to control the noise emission from industrial noise sources. The external noise due to mechanical services from the proposed development is also addressed following the guideline in the NSW EPA's NPI.

The establishment of the relevant noise criteria are derived from the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

Intrusiveness Criteria

The NSW EPA NPI states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as follows:

$L_{Aeq,\ 15\ minute} \leq$ RBL background noise level + 5 dB(A)

The intrusiveness criterion for the closest residential receivers is presented in Table 5 below. Note the values from L1 has been used in this assessment to define the background and ambient noise level of the most affected residential receivers (R1).

Table 5: EPA NPI Intrusiveness Criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – Receivers R1 $L_{Aeq,15mins}$
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	55
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	52
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	43

Amenity Criteria

The NSW NPI states the following:

"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 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities" (Miedema and Voss, 2004).

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

"Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)"

The applicable parts of Table 2.2: Amenity noise levels which are relevant to the project are reproduced below:

Table 6: NSW NPI Table 2.2 amenity criteria for external noise levels

Type of Receiver	Noise Amenity Area	Time of Day	L_{Aeq} , dB(A) Project amenity noise level	Adjusted Acceptable Levels $L_{Aeq,15mins}$
Residential Receiver	Urban*	Day	60	55
	Urban*	Evening	50	45
	Urban*	Night	45	40

*Urban area as defined in EPA NSW NPI Table 2.3

Sleep Disturbance

The NPI establishes sleep disturbance criteria for residential receivers in close proximity to industrial noise sources during the night-time period, such as vehicle movements and car door slams on private roads. The criteria for protecting the amenity of surrounding residential receivers regarding sleep disturbance is:

- $L_{Aeq,15min}$ 40 dB(A) or prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52 dB(A) or prevailing RBL plus 15dB, whichever is greater

3.3.2 Project Noise Trigger Levels

In summary, there are two criteria specific to this project. The overall criteria from all industrial plant noise sources were established using the lowest values of the NPI noise levels mentioned above. These levels are shown in Table 7 below.

Table 7: Project noise trigger levels for industrial noise emissions

Period	Descriptor	Project Specific Noise Emission Levels dB(A)
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	55
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	45
Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	40

3.4 Development Generated Traffic Noise Criteria

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise. Road traffic noise impact is assessed in accordance with the NSW Road Noise Policy (RNP, Office of Environment and Heritage 2011). The criterion *(Table 3 – Road Traffic Noise Assessment Criteria for Residential*

Land Uses) divides land use developments into distinct categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown in Table 8.

Table 8: NSW Road Noise Policy – Traffic Noise Assessment Criteria

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

Section 3.4.1 Process for applying the criteria – Step 4 states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'. The inherent quality of noise from vehicles on public roads arriving to and departing from the site would be indistinguishable from other traffic noise on public roads.

4. Construction Noise and Vibration Criteria

4.1 Construction noise

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Environment Protection Authority (EPA). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW EPA ICNG (July 2009) provides the following management levels.

Table 9: NSW EPA ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ 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 residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(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 in, 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)	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Note: 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 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW DECCW ICNG

4.2 Construction vibration

The EPA has developed a document, "Assessing Vibration: A Technical Guideline (2006)" to assist in preventing people from excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects.

Vibration and its associated effects are usually classified as continuous, impulsive, or intermittent.

4.2.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 10. It should be noted that the human comfort for vibration is more stringent than the building damage criteria.

Table 10: RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
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 place of worship	Day or night-time	0.020	0.014	0.040	0.028
Impulsive vibration					
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 place of worship	Day or night-time	0.64	0.4I6	1.28	0.92

4.2.2 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Numerous studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 11: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26

4.2.3 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in *German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures"* and *British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings".* Table 12 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur. The residences closest to the site and most at risk would have vibration criteria shown in Line 2.

Table 12: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g., buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 13 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage may be a risk as per BS7385-Part 2:1993. Cosmetic damage, such as small visible cracks of chipping paint may result at lower levels than would cause damage to the structure.

Table 13: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

4.2.4 Construction Vibration Objectives

Table 14 indicates the construction vibration criteria applicable to the residential properties located adjacent to the development site.

Table 14: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $mm/s^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Day time	10 - 20	7 - 14	0.20 - 0.40	5-20
	Night-time	7 - 14	5 - 10	0.13 - 0.26	5-20

5. Operational Noise Assessment

5.1 Outdoor recreation

The outdoor area between the existing building and Victoria Road is proposed to contain a half basketball court as well as handball courts for outdoor recreation. Directly adjacent to the basketball court/hoop are residents at 66 Victoria Road. The façade and balconies are approximately 5m from the recreation area and are assessed for noise impact.

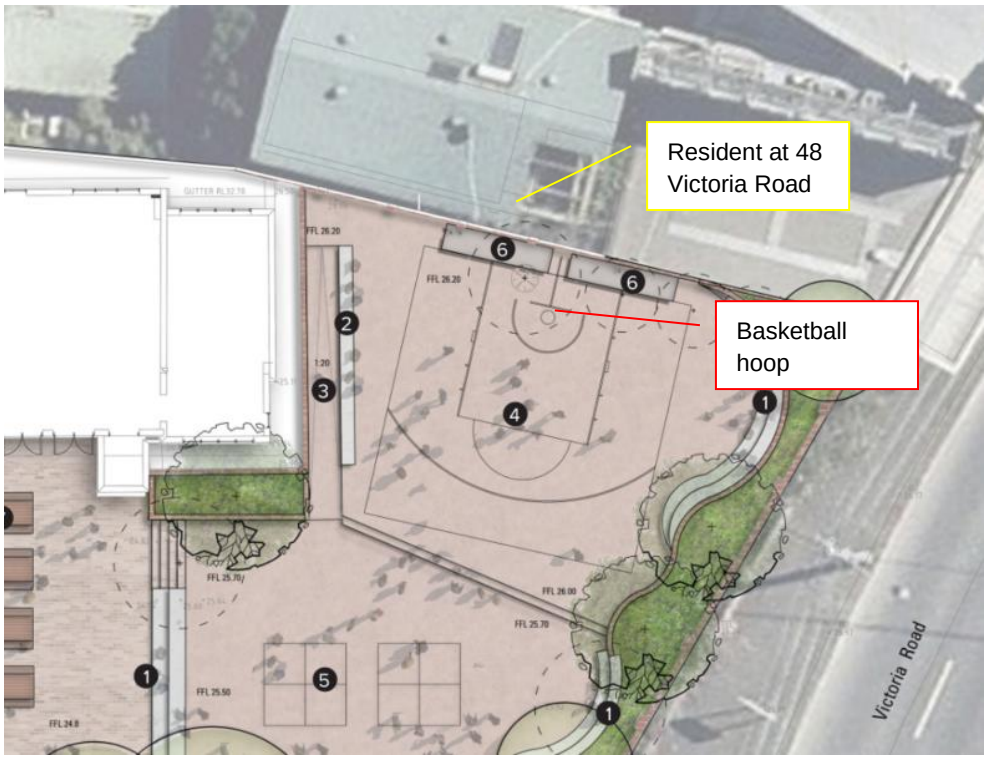

Figure 2 Landscape drawing showing basketball courts and nearest residents

5.1.1 Criteria

There are two approaches for criteria for the recreational activity noise. See Table 15 for a summary of criteria.

- Noise Policy for Industry – A criterion of 55dB(A) during the daytime (Table 7) would be applied if outdoor recreation had no time limits and could potentially continue constantly during the whole daytime period.
- The AAAC Guideline for Childcare introduces a factor for children playing outside with restricted hours. This guideline recommends that the rated background level can be exceeded by 10dB if outdoor recreation is limited to a total of 2 hours per day. This would result in a criterion of 63dB(A) (**Table 3** R1 adjusted background + 10dB) at the nearest resident.

Table 15 Predicted noise level versus criteria for outdoor recreation based on time limits

	Unlimited outdoor recreation hours (NPI Criterion)	Maximum of 2 hours outdoor recreation (AAAC Childcare Criterion)	Predicted noise level	Compliance ×/✓
Allowable noise levels at the façade of 66 Victoria Road residents	55 dB(A)	63 dB(A)	61 dB(A)	× Does not comply with the NPI criterion
				✓ Does comply with the AAAC Childcare Criterion

5.1.2 Assessment

Assessment assumptions

- The basketball hoop, backboard and court are 5m from the closest resident's façade
- Over a 15-minute period of recreational play at the basketball court there are:
    - 15 boys shouting events lasting 2 seconds each
    - 7.5 minutes of boys raised voices
    - 75 times where the basketball strikes the backboard

Noise levels for the above events were sourced from AAAC guidelines, as well as measurements taken by Stantec of children playing basketball in a similar outdoor setting.

Table 16 Source noise levels used for outdoor recreation assessment

Source Noise levels used for the assessment	Boys Shouting	Boys Raised voices	Basketball Backboard Strikes
Sound Power Lw dB(A)	89	67	62

For the above scenario a noise level of **61 dB(A)** was predicted at the façade of residents at 66 Victoria Road (R1). Noise at this level does not comply with NPI criterion for daytime. However, it would comply with the AAAC criterion based on a maximum of 2 hours of this scenario taking place per day.

5.1.3 Recommendations

- Adopt the intent of the criterion recommendations provided in the AAAC guideline and limit the amount of outdoor recreation in the basketball area to 2 hours per day total.
- The basketball hoop could be moved further away from the residential boundary to mitigate the impact noise from the basketball rebounding off the backboard.
- Alternatively, a Perspex barrier applied to the boundary of the site in front of the balcony area of the residents could also attenuate noise further.

5.2 School bell and public address system

The bell and the PA systems should be installed to reduce the noise spill and impact on the adjacent residential properties.

It is noted that the background noise level from Victoria Road is relatively high and will have a useful masking effect on noise from the PA system beyond the school boundaries.

Table 17 Landscape drawing showing potential loudspeaker locations

This can be achieved using measures such as:

- Use the natural shielding provided by the L-shape of the building when choosing speaker locations to reduce noise to residents at 66 Victoria Road.
- Using a larger number of lower powered loudspeakers distributed around where coverage is required, rather than fewer speakers with higher power.
- Using directional horn loudspeakers angled downwards.
- Orient the speakers away from the nearest residential receivers i.e., directed inwards to the school, and locate the speakers such that there is significant shielding to the residences to minimise the noise impact.

The implementation of these measures will assist in minimising the noise spill from the school grounds to the nearby residences.

5.3 Traffic noise generated by the school

The Road Noise Policy states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'.

In this respect the expected low numbers of traffic movements resulting from the school during drop off and pick up times would be indistinguishable from other traffic noise on public roads, as the noise environment around the school is dominated by the >20,000 AADT flow from the adjacent Victoria Road.

Assessment assumptions

In the absence of a traffic report the following assumptions have been made;

- There are no car parking spaces on site (other than a loading dock area) and car movements would be drive by drop off and pick up only.
- During a peak time for vehicle movement (for example when students are being dropped off before school) 30 cars may arrive then depart the premises in a 15-minute period.
- There are multiple residential developments nearby as well as the Community College that would generate their own vehicle movements on a larger scale.

To increase the noise due to traffic on the road by 2 dB, the number of cars would need to increase by at least 60%. It is unlikely that 30 vehicles over a 15-minute period would constitute a 60% increase as there is likely significantly more car movements currently existing on Gordon Street and Victoria Road.

A more detailed assessment should be completed as design progresses and a traffic assessment is completed.

5.4 Waste Collection

It is assumed that the loading dock area will be used for waste collection. The following was assumed for the waste collection assessment:

Figure 3 Landscape drawing showing site layout

- Residents along Prince Street are approximately 30m away from the dock and have the line of sight to the loading dock completely blocked by the school building.
- Residents at 66 Victoria Road are approximately 30m away from the dock with little to no shielding from the landscaping of the site. This is expected to be the worst-case scenario for noise impact due to waste collection.
- The waste collection estimated to take approximately 7 minutes out of 15-minute noise assessment period.

The NPI criteria are 50 dB(A) in the daytime and 45 dB(A) in the evening. For residents at 66 Victoria Road, the predicted noise level of the garbage truck is 45 dB(A) $L_{Aeq,15min.}$ It is expected that noise levels from garbage collection would comply with the NPI criteria during daytime and evening periods for all residents.

Recommendations

The waste collection should be conducted between 7am and 10pm to reduce noise impact from waste collection from the site and achieve the NPI criteria.

5.5 Mechanical services noise

Noise sources from general operations of the site would typically include mechanical services noise from air-conditioning condensers and exhaust fans etc. It is currently proposed to use the existing condenser units to provide air-conditioning to the school, which are located on the eastern facade of the front of the school building facing the courtyard. As these units are existing there is no requirement for additional noise control. However, should these condenser units not be considered sufficient for any reason and additional plant is required, or the condensers need to be relocated then a noise assessment shall take place, and specific noise control advice provided and incorporated into the design.

In this case, the assessment would typically employ a relevant selection of the following good practice noise mitigation measures:

- Position mechanical plant away from residential receivers on Prince Street and at 66 Victoria Road where possible and take advantage of any natural shielding due to the building shape and orientation.
- Select low sound level condenser units
- Reduce or eliminate the operation of mechanical plant between 10pm and 7am.
- Spread condensers out where possible as to not concentrate the noise from one location
- As units are selected it may be required to ventilate the condenser plant space with the use of acoustic louvres
- Provide screening around mechanical plant blocking line of site to nearest residents where possible

As a result an adverse noise impact to the community from mechanical services servicing the school is not expected and the relevant NPI criteria can be met.

5.6 Typical teaching activities during school hours

The noise breaking out of a typical classroom environment to the nearest residential receivers on Prince and Maney Street across from classrooms 2a-2b Gordon Street has been assessed. The following assumptions were made:

- A typical active classroom environment with teachers and students engaged in a class has a sound power level of 78 dB(A)
- There are multiple windows to each classroom that would be open as a worst case
- The nearest residential façades for classrooms at 48 Victoria Road are across Prince Street and are approximately 10m from the façade of the nearest classroom
- The nearest residential façades for the classrooms at 2a-2b Gordon Street are across Maney Street and are approximately 10m from the façade of the nearest classroom

Acoustic calculations with the above variables predict a sound pressure level of approximately 40 dB(A) at the façade of the nearest residents. Taking 10dB(A) sound attenuation through an open window the noise level would reduce again be less than 35dB(A) inside. The AS2107[1] recommend 35 to 45 dB(A) internal noise level for living spaces in urban areas. Worst case predicted noise levels from the classroom use with windows open is predicted to be less than the lower end of this range and is likely to have a negligible impact for residents.

Table 18 - Predicted levels at residential receivers due to classroom noise

Classroom Source	Receiver Location	Criteria	Predicted levels	Compliance (✓/✗)
48 Victoria Road	R2 – Residents on Prince Street	35 dB(A) inside	< 35 dB(A) inside	✓ Yes
2A-2B Gordon Street	R3 – Residents on Maney Street	35 dB(A) inside	< 35 dB(A) inside	✓ Yes

Figure 4 - Residents closest to classrooms

[1] Australian Standard AS2107:2016 – Recommended design sound levels and reverberation times for building interiors

5.7 School events and out of hours activities

It is understood that there would be very few occasions when the school would be used after hours. Typical after-hours events for a school campus might include:

- Additional classes or tutorials for students or community learning
- Community meetings/gatherings

There is not expected to be events with amplified music or speech.

Given that events are infrequent and low noise, the impact is expected to be negligible.

6. Noise Impact from the Environment

6.1 Noise impact from traffic to the playground

As detailed in Section 3.2, the Noise Policy for industry recommends a maximum noise level of 55 dB(A) for active recreation in outdoor school playgrounds.

Unattended noise logging measured noise levels of 63 dB(A) (**Table 3**, Section2.3) in the centre of the playground during the daytime, which exceeds the recommended level by 8 dB. The exceedance would be higher, in areas of the playground closer to Victoria Road, and lower in areas further away from the traffic.

An option for reducing the noise from traffic on the playground would be to install a fence/barrier blocking line of sight between the traffic on Victoria Road and the students in the playground.

Landscape drawings show an indicative fence in blue in Figure 5 below.

Figure 5 Indicative fence/barrier shown in blue on Victoria Road

Table 19 presents the efficacy of solid versus perforated fence types in reducing the noise to the playground area.

Table 19 Effectiveness of fence types for reducing noise to the playground

Barrier type	Approximate traffic noise attenuation in the centre of the playground.
Solid (no holes) 11kg/m^2	An approximate minimum 10dB(A) reduction in the centre of the playground is predicted for a solid barrier that is 2.2m tall. It would likely reduce the dominant traffic noise level in the playground 53 dB(A). The effectiveness of the barrier would vary depending on the distance of the students to the barrier, but a minimum 10dB(A) reduction is expected for the majority of the playground.
Perforated metal fence with 5-10% open area	The transmission loss of a perforated metal barrier with a 5-10% open area would result in a sound transmission loss through the barrier of approximately Rw 15 and Rw 9 respectively, compared to an approximate Rw40 from 3-5mm sheet steel fence/barrier. The presence of the perforations would result in a significant level of traffic noise passing directly through the fence negating the noise attenuation performance of the barrier. The sound reduction would likely be just perceptible but would not bring the noise level down to the criterion of 55 dB(A).

As shown in Table 19 the small area of perforations significantly reduce the acoustic attenuation of the fence/barrier. Therefore, it is highly recommended to make the fence/barrier solid with no gaps, holes or perforations.

6.2 Façade noise break in

6.2.1 Aircraft noise break in

The Sydney Airport Aircraft Noise Exposure Forecast (ANEF) map was consulted to determine likely impacts of aircraft noise on the proposed school.

The ANEF recommends that for a school or university less than 20 ANEF is acceptable, and the proposed site lies outside the 20-ANEF contour, see Figure 6.

Therefore, the impact from aircraft noise on the site is likely to be negligible.

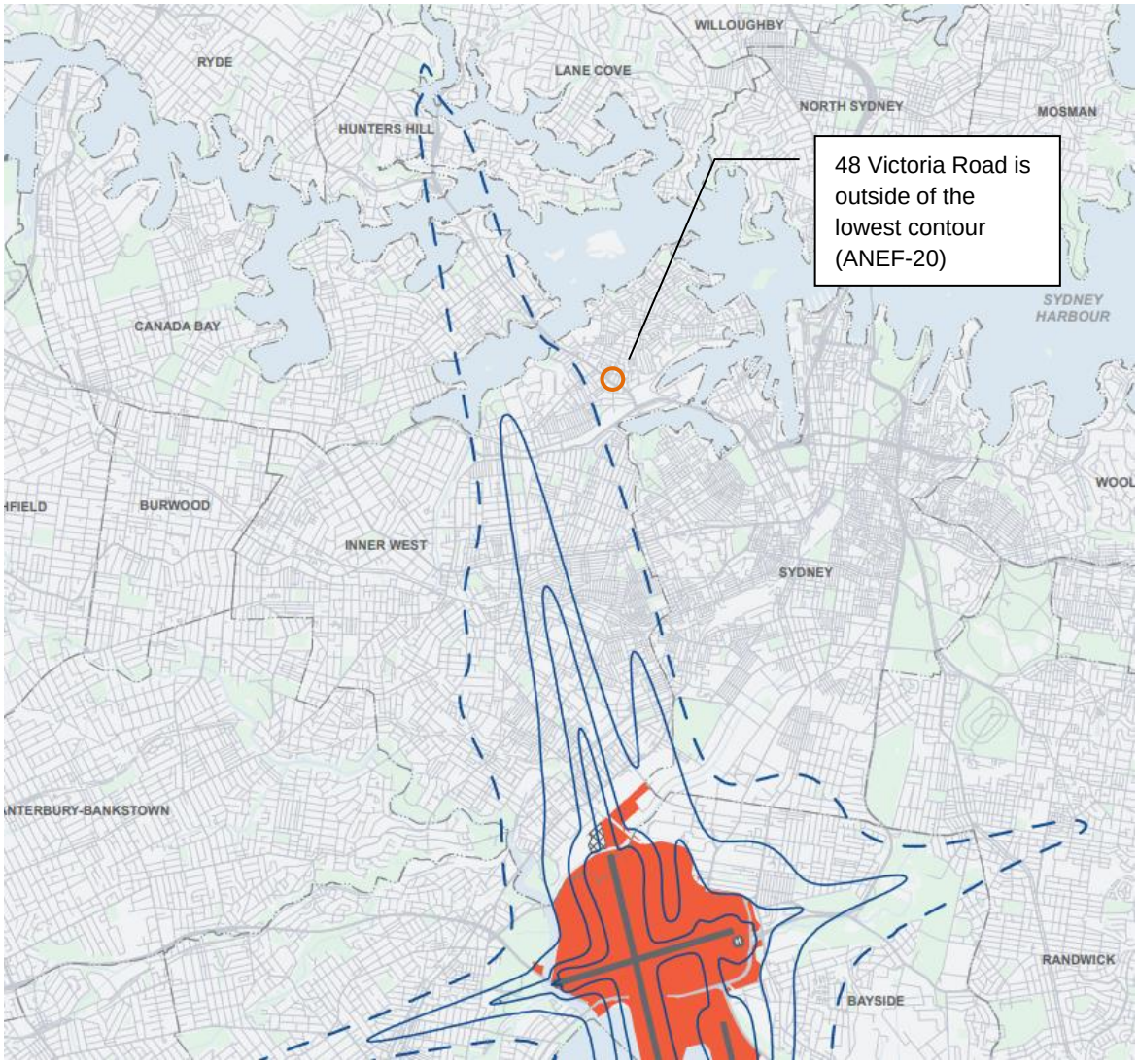

Figure 6 Sydney Airport Aircraft Noise Exposure Forecast map

6.2.2 Traffic noise break in

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. The traffic noise along Victoria Road is the most significant source of traffic noise on the facilities within the school.

As the type of glazing in future classrooms is not yet known, noise levels have been predicted in classrooms based on typical glazing.

The criterion for noise levels inside classrooms for secondary schools teaching spaces is 35dB(A).

The spaces that have a façade facing Victoria Road are the showers and corridors on the ground floor and the music rooms and corridor on level 1. There are also studios on the West side of the building facing Gordon St that also have direct line of site to a section of Victoria Road. In addition, the west side of the building is in proximity to the traffic lights at the Gordon St and Victoria Road intersection, which has been observed to have a back up of cars up to the building, however, there are no windows on this façade.

Table 20 shows the predicted traffic noise intrusion level using a worst-case glazing scenario that assumes that the existing building, because of its age has a minimum glazing thickness of 4mm already installed.

Table 20 - Predicted noise levels within spaces based on different glazing

Room	Criteria	Predicted internal noise level with 4mm glazing	Predicted internal noise level with 10mm glazing
Music practice room 2 (windows closed)	35 dB(A)	39 dB(A)	35 dB(A)
Corridors (doors/windows closed)	45 dB(A)	41 dB(A)	36 dB(A)

For studios and classroom that will be in use while the corridor doors are open, the doors of the studio/classrooms will need to be closed to achieve internal noise criteria.

As the design progresses, the existing glazing can be measured and a more detailed assessment of internal noise levels incorporating reverberation time should be conducted to ensure the criteria are achieved, or that a reasonable outcome is obtained, noting that it isn't anticipated that the glazing would be upgraded.

7. Construction Noise and Vibration

7.1 Construction noise assessment

The proposed construction work will consist of the following phases

- Construction of a new brick lift shaft
- Construction of a new playground
- Minor internal works

7.1.1 Expected construction equipment

The noise sources likely to be associated with the works are presented in. To assess potential noise and vibration impacts during construction from a quantitative point of view, typical scenarios have been considered. The equipment noise levels have been extracted from

- AS2436:2010 “Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites”.
- BS5228-1:2009 “Code of practice for noise and vibration control on construction and open sites”
- DEFRA “Update of Noise Database for Prediction of Noise for Construction and Open Sites”

The following are the assumed construction activities for each scope of work, except for the minor internal works as these are not expected to entail noise activities. In addition, any noise will be attenuated by the building envelope:

Table 21 Construction of a new brick lift shaft

Construction Activity	Sound Power Level Lw dB(A)	Assumed time in operation (%)	Adjusted Sound Power Level Lw dB(A)
Construction of a new brick lift shaft			
Delivery truck	107	10%	97
Truck mixer	109	20%	100
Truck mounted concrete pump	108	40%	103
Scaffolding construction	108	30%	102
Hand tools	102	50%	104
Mobile crane	104	10%	97
		Cumulative sound power level at the source/s	**109 dB(A)**

Table 22 Construction of a new playground

Construction Activity	Sound Power Level Lw dB(A)	Assumed time in operation (%)	Adjusted Sound Power Level Lw dB(A)
Playground construction			
Pneumatic breaker	121	10%	97
Delivery truck	107	10%	97
Excavator	107	50%	104
Roller	108	50%	104

Truck mixer	109	70%	105
Truck mounted concrete pump	108	40%	103.0
Poker vibrator	106	20%	100.0
		Cumulative sound power level at the source/s	**111 dB(A)**

7.1.2 Noise Assessment

The assumptions that were made within the assessment include the following:

- The predicted noise levels represent the worst-case scenario for each receiver based on the location of the work being in nearest proximity
- The height of the receiver has been assumed as 1.5m from ground level
- The noise levels have been assessed using neutral weather conditions.

The noise levels at the surrounding sensitive receivers are based on the assumptions and cumulative sound power level of the equipment for each construction scope of work. The results of the predicted noise levels are presented in Table 23.

7.1.3 Predicted Noise Levels

Refer to Table 23 for the predicted noise levels to each receiver for the stages of work. For the assessment, each receiver was assumed to be 1.5 meters in height.

Two scenarios have been calculated:

- Worst case – where the work is being undertaken at the point on site nearest to the receiver. That is 5m from residents at 66 Victoria Road and 30m from the Community College. Results for this scenario are provided in Table 23.
- Average case – where work is being undertaken in a central location on the site. That is 15m from residents at 66 Victoria Road and 45m from the Community College. Results for this scenario are provided in Table 24.

Table 23 Worst case predicted noise levels due to construction

Receiver	Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Affected Level $L_{eq,15min}$ dB(A)[1]	Highly Noise Affected Level[2] $L_{eq,15min}$ dB(A)	Compliance with highly noise affected (✓/✖)
Construction of a new brick lift shaft				
Residents at 66 Victoria Rd	87	56	75	✖
Community College	72	56	75	✓
Playground construction				
Residents at 66 Victoria Rd	89	56	75	✖
Community College	73	56	75	✓

Note:

1. The noise affected level represents the point above which there may be some community reaction to noise.
2. The highly noise affected level represents the point above which there may be strong community reaction to noise.

Table 24 Average case predicted noise levels due to construction

Receiver	Predicted Noise Level $L_{eq,15min}$ dB(A)	Noise Affected Level $L_{eq,15min}$ dB(A)[1]	Highly Noise Affected Level[2] $L_{eq,15min}$ dB(A)	Compliance with highly noise affected (✓/✖)
Construction of a new brick lift shaft				
Residents at 66 Victoria Rd	78	56	75	✖
Community College	68	56	75	✓
Playground construction				
Residents at 66 Victoria Rd	79	56	75	✖
Community College	70	56	75	✓

Note:

1. The noise affected level represents the point above which there may be some community reaction to noise.
2. The highly noise affected level represents the point above which there may be strong community reaction to noise.

7.1.4 Construction noise discussion

The site is very close to the three-story residential units located at 66 Victoria Road, and construction activities listed above at close proximity are expected to be at high levels for the receivers. However, there are other factors to consider when assessing the overall impact of the construction noise.

- Standard construction hours should be able to be adhered to, meaning that there should be no after hours or nighttime impact
- It is unlikely all of the plant will be operating at the same time
- The works are unlikely to span several months, and shorter durations of construction work are generally more tolerable, although there may be a trade off between providing respite periods and the overall duration of the works.
- The traffic on Victoria Road already provides high background noise levels, the addition of construction noise would be less of an impact than for a usually quiet location.
- There are several operational measures available to reduce the impact of the noise such as
    - offering respite periods
    - offering temporary relocation
    - reducing the hours of work
    - notifying residents of the construction schedule
    - providing residents with contact details and maintaining complaints register suitable to the scale of the works
    - providing residents with a copy of the noise management plan
    - turning off any plant that is not being used
    - selecting the lowest powered equipment that are appropriate to complete the works
    - locating noisy plant away from potentially affected neighbours or behind a barrier
    - involving workers to minimize noise, such as avoiding dropping materials from a height
    - use of non-tonal reversing alarms

With community consultation and implementing the appropriate mitigation and management measures where possible, the impact of the works can be minimised.

7.2 Construction Vibration Assessment

The vibration associated with construction is dependent on several variables including the types of machinery, the proximity to the nearby receivers as well as the ground type.

Vibration caused by construction plant and equipment can best be managed by selecting smaller plant and adhering to safe working distances for vibration impacts associated with various types of machinery. Table 25 provides safe working distances as presented within the transport for *NSW 'Construction Noise Strategy'* document. This document presents the safe construction working limits for Cosmetic Damage to adjacent structures (in accordance with BS 7385) and Human Comfort (EPA).

Table 25 Safe working distances for construction equipment

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (EPA Vibration Guideline)
Vibratory Roller	<50 kN (Typically 1-2 tonnes)	5m	15m to 20m
	<100 kN (Typically 2-4 tonnes)	6m	20m
	<200 kN (Typically 4-6 tonnes)	12m	40m
	<300 kN (Typically 7-13 tonnes)	15m	100m
	>300 kN (Typically 13-18 tonnes)	20m	100m
	>300 kN (> 18 tonnes)	25m	100m
Small Hydraulic Hammer	(300kg – 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600kg – 18 to 34t excavator)	22m	73m
Jackhammer	Handheld	1m	Avoid contact with structure
Compactor	852G	10	20
Excavator	≤30 Tonne	10	15
Grader	≤20 Tonne	2 (nominal)	10
Truck Movements	-	-	10m

The proximity of the construction work to Residents at 66 Victoria Road has the potential to exceed the safe working distance. The equipment selection should be such that the distances are complied with where feasible. In addition to equipment selection, based on the information presented above in Table 25, vibration measures have been provided in the subsequent section as preventative measures.

Appendix A Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.

Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance, and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

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