REVERB ACOUSTICS
Noise and Vibration Consultants

Noise Impact Assessment
New Science & Learning Building
St Patrick's College
1 & 2 Edgar Street
Strathfield NSW

March 2020

Prepared for St Patrick's College
Report No. 20-2448-R1

Building Acoustics – Council/EPA Submissions - Modelling - Compliance - Certification

REVERB ACOUSTICS PTY LTD
ABN 26 142 127 768 ACN 142 127 768
PO Box 252 BELMONT NSW 2280
Telephone: (02) 4947 9980
email: sbradyreverb@gmail.com

TABLE OF CONTENTS

SECTION 1
Introduction

1.1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for the new Science and Learning Building at St Patrick's College, Strathfield. This assessment considers noise generating items associated with operation of the new building such as mechanical plant, PA system, tennis courts, vehicle movements and school bell. Further assessment has been carried out of the noise and vibration impacts at nearest receivers during construction of the building.

The assessment has been requested by St Patrick's College in support of and to accompany a State Significant Development Application (SSDA) and to ensure any noise control measures required for the building are incorporated during the design stages.

1.2 TECHNICAL REFERENCE / DOCUMENTS

NSW Environment Protection Authority (2017). *Noise Policy for Industry*

NSW Environment Protection Authority (2009). *Interim Construction Noise Guideline.*

NSW Environment Protection Authority (1999). *Environmental Criteria for Road Traffic Noise*

NSW Roads and Traffic Authority (2001). *Environmental Noise Management Manual*

Office of Environment and Heritage (2011). *NSW Road Noise Policy.*

NSW Environment Protection Authority (1994). *Environmental Noise Control Manual*

Department of Environment and Climate Change NSW (2010). *Noise Guide for Local Government.*

Plans supplied by BVN Pty Ltd. Note that variations from design, supplied to us may affect the acoustic recommendations.

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

SECTION 2

Project Description
Existing Acoustic Environment
Assessment Criteria

2.1 PROJECT DESCRIPTION

St Patrick's College seeks approval for a new Science and Learning Building at St Patrick's College, Strathfield. The building will consist of the following:

Basement	Carpark for approximately 60 vehicles
Ground:	Circulation, canteen, food technology, dining, foyer
First:	Circulation, science labs, open plan learning, meeting
Second:	Circulation, science labs, open plan learning, meeting, outdoor learning
Roof:	Tennis courts, shaded area

Noise sources of concern include mechanical plant, PA system, tennis courts, vehicle movements and school bell. The school will typically operate during school hours 8am-3.30pm with expected use of the roof-top tennis courts up until 5-6pm.

The SEAR's document for the proposal requires the following acoustic issues to be addressed:

Noise and Vibration

- *Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
- *Identify and assess operational noise, including consideration of any public address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*

This assessment will focus on the noise impact at nearest residential receivers and it should be acknowledged that compliance with criteria at these locations will ensure satisfactory results at more remote locations. Nearest receivers identified during our site visits are shown on Figure 1.

Figure 1: Location Plan

2.2 EXISTING ACOUSTIC ENVIRONMENT

A background noise level survey was conducted using a Class 1, Svan 977 environmental noise logging monitor, installed on the south side of Edgar Street, approximately 60 metres west of the Fraser Street intersection (see Figure 1). The selected location is representative of the acoustic environment in the receiver area and is considered an acceptable location for determination of the background noise in accordance with Appendix B of the NSW Environment Protection Authority's (EPA's) Noise Policy for Industry (NPI).

Noise levels were continuously monitored from 26 January to 2 February 2020, to determine the existing background and ambient noise levels for the area. The instrument was programmed to accumulate environmental noise data continuously and store results in internal memory. The data were then analysed to determine 15 minute Leq and statistical noise levels using dedicated software supplied with the instrument. The instrument was calibrated with a Brüel and Kjaer 4230 sound level calibrator producing 94dB at 1kHz before and after the monitoring period, as part of the instrument's programming and downloading procedure, and showed an error less than 0.5dB.

Table 1 shows a summary of our noise survey, including the Assessment Background Levels (ABL's), for the day, evening and night periods. From these ABL's the Rating Background Level (RBL) has been calculated, according to the procedures described in the EPA's NPI and by following the procedures and guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures". A complete set of logger results is not shown, but available on request.

Table 1: Summary of Noise Logger Results, dB(A)

Time Period	Background L90			Ambient Leq		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
26-27 Jan	-	41.4	34.6	-	56.5	43.5
27-28 Jan	39.6	39.5	38.1	59.5	57.6	44.2
28-29 Jan	41.1	41.3	36.2	56.8	55.5	47.0
29-30 Jan	41.7	40.8	36.9	56.3	54.3	46.6
30-31 Jan	40.6	40.5	36.8	56.3	53.5	45.6
31J-1F	41.1	41.0	36.9	54.8	52.5	44.5
1-2 Feb	39.4	39.7	36.6	55.2	55.9	46.4
2-3 Feb	41.9	-	-	62.3		
RBL	**41.1**	**40.8**	**36.8**	**--**	**--**	**--**
LAeq	**--**	**--**	**--**	**58.1**	**55.4**	**45.6**

Site, weather and measuring conditions were all satisfactory during the noise survey. We therefore see no serious reason to modify the results because of influencing factors related to the site, weather or our measuring techniques.

A summary of the measured noise environment at the site appears in Table 2, taken from our logger results. The measured noise levels are typical for a residential area in a commercial area and near a busy road.

Table 2: Existing Source Noise levels

Time	Leq		Lmax		L10		L90	
Period	Range	Average	Range	Average	Range	Average	Range	Average
Day	41-69	56	53-87	71	43-71	58	38-67	47
Evening	41-64	52	51-85	68	42-65	53	38-62	45
Night	36-56	43	40-80	57	37-56	43	34-48	38

2.3 CRITERIA

2.3.1 Site Activities/Mechanical Plant Noise (Impact on Neighbours)

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the EPA's NPI. However, local Councils and Government Departments may also apply the criteria for land use planning, compliance and complaints management. The NPI specifies two separate criteria designed to ensure existing and future developments meet environmental noise objectives. The first limits intrusive noise to 5dB(A) above the background noise level and the other is based on the total industrial noise in an area in relation to the noise levels from the development to be assessed. Project Noise Trigger Levels are established for new developments by applying both criteria to the situation and adopting the more stringent of the two.

The existing L(A)eq for the receiver areas is dominated by traffic on nearby roads, and neighbourhood activity during the day, evening and night. Reference to Table 2.2 of the NPI shows that all receiver areas are classified as suburban. The Project Amenity Level is derived by subtracting 5dB(A) from the recommended amenity level shown in Table 2.2. A further +3dB(A) adjustment is required to standardise the time periods to LAeq,15 minute. The adjustments are carried out as follows:

Recommended Amenity Noise Level (Table 2.2) – 5dB(A) +3dB(A)

Table 3 below specifies the applicable project intrusiveness and amenity noise trigger levels for the proposed redevelopment.

Table 3: - Intrusiveness and Amenity Noise levels

Period	Intrusiveness Criteria	Amenity Criteria
Day	46 (41+5)	53 (55-5+3)
Evening	46 (41+5)	43 (45-5+3)
Night	42 (37+5)	38 (40-5+3)
Receiver Type: Suburban (See EPA's NPI - Table 2.1)		

Project Noise Trigger Levels, determined as the more stringent of the intrusiveness criteria and the amenity / high traffic criteria, are as follows:

Day **46dB LAeq,15 Minute** 7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening **43dB LAeq,15 Minute** 6pm to 10pm
Night **38dB LAeq,15 Minute** 10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.

School Classrooms:
40dB(A),Leq,15 minute (Internal when in use

2.3.2 Construction Noise – Residential Receivers

Various authorities have set maximum limits on allowable levels of construction noise in different situations. Arguably the most universally acceptable criteria, and those which will be used in this Report, are taken from the NSW Environment Protection Authority's (EPA's) Interim NSW Construction Noise Guideline (ICNG). Since the project involves a significant period of construction activity, a "quantitative assessment" is required, i.e. comparison of predicted construction noise levels with relevant criteria. For assessment of noise impacts at residential receivers Table 3 of the ICNG is reproduced below in Table 4:

Table 4: - Table 3 of ICNG Showing Relevant Criteria at Residences

Time of Day	Management Level Leq (15min)	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(A) i.e**. 51dB(A) day**	- The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured LAEQ (15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. - 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 proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. - If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended Standard hours	Noise affected RBL +5dB(A)	- A strong justification would typically be required for works outside the recommended standard hours. - 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 5dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see Section 7.2.2

Section 4.1.2 of the ICNG also specifies the following internal noise level limits for school classrooms.

School Classrooms **45dB(A),Leq (15 min)** **Internal**

Construction will only occur during standard construction hours, i.e. 7am to 6pm Monday to Friday and 8am to 1pm on Saturday, with no construction permitted on Sundays or public holidays. Table 5 details relevant criteria for potentially affected receivers (also see Figure 1).

Table 5: Criteria Summary

Assessment Location	Standard Construction Hours		Outside
	Noise Affected	Highly Noise Affected	Standard Hours
Residential Dev'p	51	75	48/43 #
School classrooms (internal)	45	65	N/A
School classrooms (external)	55	75	N/A

Evening/night.

2.3.3 Construction Vibration

Personal Comfort

The majority of maximum limits on allowable ground and building vibration in different circumstances and situations are directed at personal comfort rather than building damage. This usually leads, in virtually every situation, to people who interpret the effects of a vibration to ultimately determine its acceptability. The ICNG recommends that the EPA guideline, *Assessing Vibration: A Technical Guideline (2006),* should be used for assessing construction vibration. Limits set out in the Guideline are for vibration in buildings, and are directed at personal comfort for continuous, impulsive and intermittent vibrations. Table 6 shows the Vibration Dose Values for intermittent vibration activities such as pile driving and use of vibrating rollers etc, taken from Table 2.4 of the Guideline, above which various degrees of adverse comment may be expected.

Table 6: Acceptable Vibration Dose Values ($m/s^{1.75}$)
Above which Degrees of Adverse Comment are Possible

Location	Day (7am-10pm)		Night (10pm-7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas #	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Hospital operating theatres, precision laboratories, etc.

Building Safety:

Other criteria specifically dealing with Building Safety Criteria include Australian Standard AS2187.2-1993, dealing specifically with blasting vibration, specifies a maximum peak particle velocity of 10mm/sec for houses and a preferred limit of 5mm/sec where site specific studies have not been undertaken.

German Standard DIN 4150 - 1986, Part 3 Page 2, specifies a maximum vibration velocity of 5 to 15 mm/sec in the foundations for dwellings and 3 to 8 mm/sec for historical and sensitive buildings, for the range 10 to 50Hz. British Standard BS 7385 Part 2, specifies a maximum vibration velocity of 15mm/sec at 4Hz increasing to 20mm/sec at 15Hz increasing to 50mm/sec at 40Hz and above, measured at the base of the building.

Additionally, The Australian and New Zealand Environment Conservation Council (ANZECC) guideline *"Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration"* limit peak particle velocities from blasting to below 5mm/sec at residential receivers, with a long term regulatory goal of 2mm/sec.

The above listed criteria vary from 3mm/sec up to 15mm/sec, therefore, the more conservative limit of **3mm/sec** will be adopted for the purposes of Building Safety Criteria. It should be acknowledged, however, that intermittent ground vibration velocities at 5mm/sec are generally considered the threshold at which architectural (cosmetic) damage to normal dwellings may occur and velocities at 10mm/sec should not cause any significant structural damage, with the exception of the most fragile and brittle of buildings.

SECTION 3
Noise Impact Assessment

3.1 METHODOLOGY

3.1.1 Site Noise (Impact on Neighbours)

Future noise sources on the site cannot be measured at this time, consequently noise levels produced by mechanical plant and site activities have been sourced from manufacturers' data and/or our library of technical data. This library has been accumulated from measurements taken in many similar situations on other sites, and allows predictions of future environmental noise at each receiver and recommendations concerning noise control measures most likely to be required on this site.

All noise level measurements were taken with a Svan 912AE Sound and Vibration Analyser. This instrument is Type 1 accuracy, in accordance with the requirements of AS1259, and has the capability to measure steady, fluctuating, intermittent and/or impulsive sound, and to compute and display percentile noise levels for the measuring period. A calibration signal was used to align the instrument train prior to measuring and checked at the conclusion. Difference in the two measurements was less than 0.5dB. Each measurement was taken over a representative time period to include all aspects of machine/process operation, including additional start-up noise where applicable. Items of equipment, which produced a brief burst of noise, were measured for a similarly brief time period to ensure the results were not influenced by long periods of inactivity between operations. Sound measurements were generally made around all sides of each machine, to enable the acoustic sound power (dB re 1pW) to be calculated. The sound power level of each item is then theoretically propagated to each receiver with allowances made for spherical spreading, directivity, molecular absorption, intervening topography or barriers and ground effects giving the received noise level at the receiver from that particular plant item.

Addition of the received Sound Pressure Level (SPL) for each of the individual operating sources gives the total SPL at each receiver, which is then compared to the relevant criterion. Where noise impacts above the criterion are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels.

The theoretical assessment is based on a worst-case scenario, where all fixed plant items are operating simultaneously and noise generating activities occurring in a location most exposed to the surrounding residences. In reality, many items will not always be operating in the most exposed areas, so actual received noise levels are expected to be less than the predictions shown in this report, or at worst equal to the predicted noise levels for only part of the time.

Due to the non-continuous nature of some site activities, adjustments for duration have been made using the following in-house mathematical formula. Note that fixed plant items such as air conditioning/exhaust plant will be continuous over the entire assessment period and no duration adjustment is necessary.

Equation 1:

$$L_{eq},T = Lw - 10 \log (2 \pi r^2) + 10 \log \frac{(D \times N)}{T}$$

Where
Lw is sound power level of source (dB(A))
R distance to receiver (m)
D is duration of noise for each event (sec)
N is number of events
T is total assessment period (sec)

3.2 ANALYSIS

3.2.1 Received Noise – Site Operation (Activities/Equipment)

The Acoustic Power Levels (Lw's) of anticipated activities and equipment associated with the new building, which were input into our computer model, are shown in the following Table for peak periods. The Table gives the A-weighted sound power levels for each listed item or activity, principally based on manufacturers' data and our library of technical data. Also shown is the number of items/activities expected during a 15 minute assessment period.

Table 7: Equipment/Activities (15 minute Assessment Period)

Item/Activity	Lw dB(A)	Fraser St Entry/Ramp	Building GL West Side	Outdoor Seating GL North/East	Roof
Vehicles[1]	78/82	60			
School Bell/Siren[2]	96		1		
PA System[3]	92		2		
Students[4]	80			90	
Air Con plant[5]	88			6	
Kitchen Exhaust[6]	86				2
Carpark Exhaust[7]	90				2
Tennis Activities[8]	78				2

NOTES:
1. Vehicles entering/leaving & negotiating carpark ramp. Based on 60 spaces.
2. Located on west side building.
3. Located on west side building.
4. Students seated in outdoor area, continuous over duration of assessment period.
5. Packaged units on roof.
6. Outlets 1 metre above roof level.
7. Outlets 1 metre above roof level.
8. Both courts used.

Table 8 shows calculations to predict the cumulative noise impact during peak periods at the nearest residential boundaries west of the building (R1) with no noise control in place.

**Table 8: Received Noise - Site Activities dB(A),Leq (Peak Periods)
Propagated W to Nearest Residential Boundaries R1 (NO NOISE CONTROL)**

Item/Activity	Lw dB(A)	Ave Dist Rec (m)	Duration (sec)	No. of Events	Barrier Loss/Dir	Received dB(A)
Vehicles Fraser St entry	78	25	5	60	2	35
Vehicles carpark ramp	82	30	5	60	4	36
School bell	96	60	5	2	0	33
PA system	92	60	10	4	0	35
Students	80	80	900	1	8	26
Air con on roof	88	60	900	6	8	44
Kitchen exhaust on roof	86	60	900	2	8	37
Carpark exhaust on roof	90	60	900	2	8	41
Tennis game on roof	78	60	900	2	8	29
				Combined		**48**
				Criteria (D/E)		**46/43**
				Impact		**2/5**

As can be seen by the results in Table 8, the cumulative noise impact from all activities and equipment associated with the new building is predicted to be exceed the criteria by up to 2dB(A) during the day and 5dB(A) during the evening at nearest residential boundaries west of the building (R1).

Reference to our theoretical calculations reveals that roof-top mechanical plant is the main noise source of concern. Noise produced by the school bell/siren and PA system, while compliant with the criteria, creates maximum noise levels that may be disruptive to neighbours. Several options of noise control have been investigated with the following strategies expected to be the most cost effective:

1. Limit noise output of school bell/siren and PA system or relocate to east or north side of the building in a location shielded from residences.
2. Select mechanical plant with limiting SPL output or provide acoustic barriers
3. Select exhaust with limiting SPL output or provide attenuator at discharge side of fan.

Table 9 shows calculations to predict the cumulative noise impact during peak periods at the nearest residential boundaries west of the building (R1) with the above noise control in place.

Table 9: Received Noise - Site Activities dB(A),Leq (Peak Periods)
Propagated W to Nearest Residential Boundaries R1 (NOISE CONTROL IN PLACE)

Item/Activity	Lw dB(A)	Ave Dist Rec (m)	Duration (sec)	No. of Events	Barrier Loss/Dir	Received dB(A)
Vehicles Fraser St entry	78	25	5	60	2	35
Vehicles carpark ramp	82	30	5	60	4	36
School bell	96	60	5	2	0	33
PA system	92	60	10	4	0	34
Students	80	80	900	1	8	26
Air con on roof	80	60	900	6	8	26
Kitchen exhaust on roof	82	60	900	2	8	33
Carpark exhaust on roof	82	60	900	2	8	33
Tennis game on roof	78	60	900	2	8	29
				Combined		**43**
				Criteria (D/E)		**46/43**
				Impact		**0/0**

As can be seen by the results in Table 9, the cumulative noise impact from all activities and equipment associated with the new building is predicted to be compliant with the day and evening criteria at nearest residential boundaries (R1), providing acoustic modifications and strategies detailed in Section 4 are incorporated into the design of the building.

Table 10 shows a summary of predicted noise impacts during all time periods at nearest receivers with noise control in place.

Table 10: Summary Received Noise – All Nearby Receivers

Receiver Loc'n	Received Noise (Day/Evening/Night)			
	Period	dB(A),Leq	Criteria	Impact
Residence W R1	Day	43	46	-
	Evening	43	43	-
Residence W R2	Day	42	46	-
	Evening	42	43	-
Classrooms E Coghlan	Day	44	40#	4
	Evening	44	40#	4
Classrooms S Hanrahan/Hickey	Day	36	40#	-
	Evening	36	40#	-

Internal criteria.

As can be seen by results in the above Table, noise associated with site activities and equipment will be compliant with the criteria during all time periods at all nearby residential receivers, providing acoustic treatment detailed in Section 4 is implemented. Exceedances of up to 4dB(A) are predicted within nearest buildings to the east of the classrooms. However, the noise sources responsible for the exceedances are the school bell/siren and PA system. Since these sources are intended to be audible, they are exempt from calculations, implying compliance.

SECTION 4
Summary of Recommended Noise Control

4.1 NOISE CONTROL RECOMMENDATIONS

4.1. No noise control is required for individual plant items on the roof of the building, i.e. air conditioning, exhaust, providing noise emissions for individual items are below the specified limits:

Item	*Max SPL at a Dist of 1 metre*	*Lw*
Air Conditioning	74dB(A)	80dB(A)
Exhaust Discharge	76dB(A)	82dB(A)

4.2 No noise control is required for mechanical plant located in the basement carpark

4.3 Acoustic barriers are to be constructed at the fan discharge of exhaust plant that exceeds the limits specified in 4.1 above. Barriers must fully enclose at least three sides towards any residence. In our experience, a more efficient and structurally secure barrier is one that encloses all four sides. The barrier must extend at least 600mm above and below the fan centre and/or the discharge outlet and must be no further than 1200mm from the edges of the exhaust. Barrier construction should consist of *either* Acoustisorb panels (available through Modular Walls) *or* an outer layer of one sheet of 12mm fibre cement sheeting (Villaboard, Hardiflex), or 19mm marine plywood. The inside (plant side) is to be lined with an absorbent foam to reduce reverberant sound (fibrous infills are not recommended as they will deteriorate if wet), Note that variations to barrier construction or alternate materials are not permitted without approval from the acoustical consultant. Barrier construction is based solely on acoustic issues. Visual, wind load issues must be considered and designed by appropriately qualified engineers.

Alternatively, attenuators with the following insertion loss values must be installed at the discharge side of fans.

Required Insertion Loss Values for Attenuator – dB

	Octave Band Centre Frequency, Hz							
	63	125	250	500	1k	2k	4k	8k
IL	12	23	24	22	22	16	14	12

4.4 Acoustic barriers are to be constructed adjacent to air conditioning plant that exceeds the limits specified in 4.1 above. Acoustic barriers 300mm above the highest plant item must be erected between the plant and residences. Barrier construction is to consist of *either* Acoustisorb panels (available through Modular Walls) *or* an outer layer of 12mm fibre cement sheeting, 25mm construction plywood, Hebel Powerpanel, or similar material, with an absorbent inner surface of perforated metal (minimum 10-15% open area) backed with a water resistant acrylic batt or blanket. The acoustic barrier must continue at least 300mm below the top of the plant deck. Alternatively, plant can be located in the service yard or similar shielded location.

4.5 The contractor responsible for supplying and installing mechanical plant must provide evidence that installed plant meets this noise emission limit, or that noise control included with the plant is effective in reducing the sound level to the specified limit. Once the plant layout has been finalised, details should be forwarded to the acoustic consultant for approval.

4.6 Any school bell/siren and PA system must be located away from residences, preferably on the east side of the building shielded from residences. Once selections and locations have been finalised, details should be forwarded to the acoustic consultant for approval.

4.7 Construction Certificate documentation must be forwarded to Reverb Acoustics to ensure all recommendations within this report have been incorporated into the design of the site.

4.8 Usage of tennis courts should be restricted to the day and evening, say from 9am-9pm.

SECTION 5
Construction Noise & Vibration Management Plan

5.1 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

5.1.1 Predicted Noise levels - Construction Plant and Equipment

Received noise produced by anticipated construction activities is shown in Table 11 below, for a variety of distances to a typical receiver, with no noise barriers or acoustic shielding in place and with each item of plant operating at full power. Entries in bold type highlight exceedances of the day Noise Affected criteria of **75dB(A),Leq** for residential receivers.

Table 11: Predicted Plant Item Noise Levels, dB(A)Leq

Plant/Activity	(Lw)	Distance to Residence			
		20m	50m	100	200m
Tower crane	(104)	70	62	56	50
Excavator	(104)	70	62	56	50
Excavator with j'hammer	(114)	80	72	66	60
Positrack	(108)	74	66	60	54
Hammering	(98)	64	56	50	44
Angle grinder	(106)	72	64	58	52
Air wrench (silenced)	(98)	64	56	50	44
Compactor	(111)	**77**	69	63	57
Road truck	(104)	70	62	56	50
Grader	(102)	68	60	54	48
Air compressor	(94)	60	52	46	40
Framing gun	(95)	61	53	47	41
Concrete Agitator	(112)	**78**	70	64	58
Concrete Pump	(110)	**76**	68	62	56
Circular saw	(109)	75	67	61	55
Pile boring rig	(112)	**78**	70	64	58

Residential receivers are closer than 50 metres from the construction site and some construction activities are may exceed the criteria, particularly excavation and placing of piles. Noise levels above 75dB(A) are likely to occur on occasion at closest locations, and community reaction is possible. The ICNG recommends that as a first course of action, consideration should be given as to whether any alternate feasible or reasonable method of construction is possible. Consultation with the construction contractor confirms that due to the nature of ground conditions there are no quieter alternates available. The ICNG further recommends that when alternate feasible and reasonable options have been considered the proponent then should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and any respite periods that will be provided. These strategies will be discussed in more detail in Section 5.2.3.

When excavation occurs noise levels above 70dB(A) are possible at nearest locations, which we acknowledge is high. To reduce noise levels any appreciable amount a physical barrier would be required to intercept the line of site between the source and receivers. We suggest that temporary acoustic barriers between the source and receiver. Placing shipping containers or similar moveable barriers adjacent to a rig is another practical method of noise control. Note that barriers will not be required in situations where intervening structures provide acoustic barriers between the source and receiver. The above strategies may reduce noise levels at residential locations by up to 10dB(A),

It should be noted that calculations are based on plant items operating in exposed locations and at full power, with no allowances made for intervening topography or shielding provided by intervening structures. Cumulative impacts, from several machines operating simultaneously, may be reduced when machines are operating in shielded areas not wholly visible to receivers. In saying this, if two or more machines were to operate simultaneously on the site, received noise levels would be raised and higher exceedances may occur.

Initial earthworks are expected to employ an excavator, and dump trucks. The combined acoustic power level of a group of these machines, assuming normal contractor's machines up to 10 years old in reasonably good condition, is expected to be in the range 108 to 112B(A),Leq. However, the machines will typically be spread over the site, and noise at any receiver is typically dominated by the few closest machines, such as an excavator loading a truck, while a second truck reverses into position to be loaded by an excavator. With a combined acoustic power level of 108 dB(A) for 3 typical machines operating at full power, 60dB(A) is expected at the closest residential receivers during peak activity.

Constructing temporary barriers, at least 2m high, at the perimeter of the construction site (or at least adjacent to noisy plant items) may be considered for mitigating some of the construction noise at nearest receivers. These barriers will offer the additional benefit of securing the site from unwanted visitors. With barriers in place, worst case construction will reduce by up more than 5dB(A), although, as previously stated, these noise levels are expected to occur for a relatively short time and reduce as work progresses to a new area.

It should be acknowledged that construction activities that produce higher noise for a shorter period are often more desirable than alternate construction techniques that produce lower noise for a much longer period. This combined with noise control strategies discussed in Section 4 will ensure that minimum disruption occurs.

Section 4.1.2 of the ICNG suggests a conservative estimate of the difference between internal and external noise levels is 10dB, which we are in agreement for an open window. Section 4.1.2 also suggests that the greater reductions can be achieved for fixed glazing and once again we are in agreement. Many activities and equipment sighted in Table 11 are expected to exceed the construction noise criteria within nearby classrooms that have windows (that are not acoustically rated) with an unobstructed view of the construction site. We therefore recommend that construction noise management strategies should be implemented to ensure disruption to the occupants of these buildings is kept to a minimum. Noise control strategies include co-ordination between the construction team and school staff to ensure the timetable for noisy activities does not coincide with classes in nearest classrooms. As a further suggestion, temporary plywood infills could be fitted in closest windows and exposed entries to reduce noise impacts. A final solution would be to relocate classes to more remote locations during major noise generating works. The above strategies are discussed in more detail in later Sections of this report.

5.1.2 Predicted Vibration levels - Construction Plant and Equipment

Occupants of nearby buildings may also have concerns about ground vibration levels from vibrating machinery (excavators, compactors, etc). Ground vibration measurements carried out previously, on other sites, can be used to indicate the likely range of vibration levels produced by construction activities. Previous results do not necessarily apply to this site without considering influencing factors such as ground resonant frequency, energy produced, etc. Table 12 lists the results of previous vibration measurements, with each measurement corrected to a standard distance of 20m to represent nearest residential receivers.

Table 12: Average Maximum Ground Vibration Measurement Results, mm/s Peak.

Ground Type	Measured Distance to Vibration mm/sec	Minimum 20m to Receiver mm/sec
Excavator on clay soil	80m, 0.012	0.14
Excavator on dry alluvial soil	15m, 0.23	0.16
Excavator on wet alluvial soil	10m, 0.52	0.28
Road truck on potholes	10m, 0.15-2.7	0.1-1.2
Compactor on clay	40m, 0.20	0.20

Table 12 shows a variety of vibration levels mainly due to differences in ground conditions from one site to the next. The Table shows a marked difference between clay and dry ground, with low resulting vibration, and water saturated ground with vibration levels an order of magnitude higher. Results from measurements on wet alluvial or clay soil are likely to apply to the site.

Since vibration varies over time for each process the EPA Guideline recommends that the following formula be used to estimate the vibration dose at the receiver location:

Equation 1: $eVDV = 1.4 \times a \times t^{0.25}$

where: k is nominally 1.4 for crest factors below 6 a_{rms} = weighted rms accel (m/s²)
t = total cumulative time (seconds) of the vibration event(s)

The following estimated vibration doses are expected at nearest classrooms:

	eVDV
Excavator	0.36
Compactor	0.42

Based on the above results, adverse comment is possible, particularly when earthworks take place. We therefore recommend that these activities are not carried out unless simultaneous attended vibration monitoring is conducted when within safe working distances noted in Table 13.

As previously stated, in many cases higher levels of vibration (and noise) are preferable that occur for only a short period of time than processes producing lower amplitudes for a much longer time period.

The effect of vibration in a building is observed in two ways, namely, it is felt by the occupant, or it causes physical damage to the structure. Subjective detection can be one of direct perception from rattling of windows and ornaments, or dislodgement of hanging pictures and other loose objects. The second is structural damage which may be either architectural (or cosmetic) such as plaster cracking, movement or dislodgement of wall tiles, cracked glass etc, or major such as cracking walls, complete falls of ceilings, etc, which is generally considered to impair the function or use of the dwelling. Vibration can be felt at levels well below those considered to cause structural damage. Complaints from occupiers are usually due to the belief that if vibration can be felt then it is likely to cause damage. Slamming of doors or footfall within a building can produce vibration levels above those produced by construction activities.

Any future structural damage, whether cosmetic or major, which may occur to any building will only be a result of natural causes such as differential settlement of foundations (particularly if on poorly compacted fill), expansion and contraction cycles due to changes in temperature, shrinkage due to drying out of timber framing and pre-stressed areas of the building. Obvious structural damage from any of these sources can usually be identified with the particular cause. Generally, one particular source is not the cause of damage to a structure, but rather a combination of two or more.

Vibration levels are unlikely to cause direct failure, and it is considered the main action is triggering cracks in materials already subjected to stress or natural forces, however, as previously mentioned, this may also arise from internal forces such as slamming of doors. In our experience, vibration will only begin to trigger "natural cracking" at levels above 1mm/sec. Findings by the Road Research Laboratory, reproduced in Table 13, gives an indication of the effects from varying magnitudes of vibration.

Table 13: Reaction of People and Damage to Buildings

Peak Vel (mm/s)	Human Reaction	Effect on Buildings
0 to 0.15	Imperceptible by people – no intrusion	Highly unlikely to cause damage
0.15 to 0.3	Threshold of perception – possibility of intrusion	Highly unlikely to cause damage
2.0	Vibrations perceptible	Recommended upper level of vibration for historical buildings
2.5	Level at which vibration becomes annoying	Very little risk of damage
5	Annoying to occupants	Threshold at which the risk of damage to houses is possible
10 to 15	Vibrations considered unpleasant and unacceptable	Will cause cosmetic damage and possibly structural damage

5.2 CONSTRUCTION NOISE & VIBRATION STRATEGIES

5.2.1 Noise & Vibration Monitoring Program

We recommend that attended noise and vibration should be carried out at commencement of each process/activity that has the potential to produce excessive noise and/or vibration. Attended monitoring offers the advantage of immediate identification of noise or vibration exceedances at the receiver and ameliorative action required to minimise the duration of exposure. Unattended long-term monitoring only identifies a problem at a later date and is not recommended. Table 14 should be used as a guide for the construction team to consider and follow. When the nominated activity occurs within the safe working distance, attended vibration monitoring should be conducted at the relevant receiver type. It is usual practice to conduct attended noise monitoring in conjunction with vibration monitoring, as activities that produce high vibration amplitudes also regularly produce high levels of noise.

Table 14: Vibration Monitoring Program - Minimum Distance when Monitoring is Required

Activity/Process	Receiver Type	Distance to Receiver (m)
Tracked machine	Heritage structure	50
	Residential building	30
	Classroom	20
Pile boring	Heritage structure	50
	Residential building	30
	Classroom	20
Crane	Heritage structure	30
	Residential building	20
	Commercial	10
Concrete pours	Heritage structure	30
	Residential building	20
	Classroom	10
Truck movements	Heritage structure	20
	Residential building	10
	Classroom	5
Jackhammer	Heritage structure	50
	Residential building	30
	Classroom	20

Note: Attended vibration monitoring should also be conducted for other activities identified by the contractor that have the potential to create vibration, not noted in the above Table.

5.2.2 Acoustic Barriers/Screening

To minimise noise impacts during construction, early work should concentrate on grading and levelling the areas in unshielded locations. In the event of complaints arising we offer the following additional strategies for consideration:

- Place acoustic enclosures or screens directly adjacent to stationary noise sources such as compressors, generators, drill rigs, etc.
- Provide infills to classroom windows and entries.

5.2.3 Consultation/Complaints Handling Procedure

The construction contractor should analyse proposed noise control strategies in consultation with the Acoustic Consultant as part of project pre-planning. This will identify potential noise problems and eliminate them in the planning phase prior to site works commencing.

Occupants of adjacent properties and buildings should be notified of the intended construction timetable and kept up to date as work progresses, particularly as work changes from one set of machines and processes to another.

In particular, occupants should understand how long they will be exposed to each source of noise and be given the opportunity to inspect plans of the completed development. Encouraging resident understanding and "participation" gives the local community a sense of ownership in the development and promotes a good working relationship with construction staff. Programming noisy activities (such as earthworks) outside critical times should be considered.

We recommend that construction noise management strategies should be implemented to ensure disruption to the occupants of nearby buildings is kept to a minimum. Noise control strategies include co-ordination between the construction team and residents to ensure the timetable for noisy activities does not coincide with sensitive activities.

The site manager/environmental officer and construction contractor should take responsibility and be available to consult with community representatives, perhaps only during working hours. Response to complaints or comments should be made in a timely manner and action reported to the concerned party.

All staff and employees directly involved with the construction project should receive informal training with regard to noise control procedures. Additional ongoing on the job environmental training should be incorporated with the introduction of any new process or procedure. This training should flow down contractually to all sub-contractors.

5.2.4 Risk Assessment

A risk assessment should be undertaken for all noisy activities and at the change of each process. This will help identify the degree of noise and/or vibration impact at nearby receivers and ameliorative action necessary. A sample Risk Assessment Check Sheet is included in Appendix C as a guide.

5.2.5 Equipment Selection

All combustion engine plant, such as generators, compressors and welders, should be carefully checked to ensure they produce minimal noise, with particular attention to residential grade exhaust silencers and shielding around motors.

Trucks and other machines should not be left idling unnecessarily, particularly when close to residences. Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made. Framing guns and impact wrenches should be used sparingly, particularly in elevated locations, with assembly of modules on the ground preferred. Table 15 shows some common construction equipment, together with noise control options and possible alternatives.

Table 15- Noise Control, Common Noise Sources

Equipment / Process	Noise Source	Noise Control	Possible Alternatives
Compressor Generator	Engine	Fit residential muffler. Acoustic enclosure.	Electric in preference to petrol/diesel. Plant to be Located outside building Centralised system.
	Casing	Shielding around motor.	
Concrete breaking Drilling Core Holing	Hand piece	Fit silencer, reduces noise but not efficiency Enclosure / Screening	Use rotary drill or thermic lance (used to burn holes in and cut concrete) Laser cutting technology
	Bit	Dampened bit to eliminate ringing. Once surface broken, noise reduces. Enclosure / Screening.	
	Air line	Seal air leaks, lag joints	
	Motor	Fit residential mufflers.	
Drop/Circular saw Brick saw	Vibration of blade/product.	Use sharp saws. Dampen blade. Clamp product.	Use handsaws where possible. Retro-fitting.
Hammering	Impact on nail		Screws
Brick bolster	Impact on brick	Rubber matting under brick	Shielded area.
Explosive tools (i.e. ramset gun)	Cartridge explosion	Use silenced gun	Drill fixing.
Material handling	Material impact	Cushioning by placing mattresses, foam, waffle matting on floor. Acoustic screening.	
Waste disposal	Dropping material in bin, trolley wheels.	Internally line bins/chutes with insertion rubber, conveyor belting, or similar.	
Dozer, Excavator, Truck, Grader, Crane	Engine, track noise	Residential mufflers, shielding around engine, rubber tyred machinery.	
Pile driving/boring	Hammer impact engine	Shipping containers between pile & receiver	Manual boring techniques

Note: Generally, noise reductions of 7-10dB will be achieved with the use of barriers, 15-30dB by enclosures, 5-10dB from silencers and up to 20-25dB by substitution with an alternate process.

SECTION 6
Conclusion

6.1 CONCLUSION

A noise impact assessment for the new Science and Learning Building at St Patrick's College, Strathfield, has been completed, resulting in noise control recommendations summarised in Section 5 of this Report. The site is suitable for the intended purpose providing recommendations outlined in this report are incorporated into the design. With these or equivalent measures in place, noise from the site will be either within the criterion or generally below the existing noise levels in the area for the majority of the time.

With relatively constant traffic on nearby roads, and the abundance of nearby commercial development, noise generated by the proposed site will be audible at times but not intrusive at any nearby residence. As the character and amplitude of activities associated with the site will be similar to those already impacting the area, it will be less intrusive than an unfamiliar introduced source and should be acceptable to residents.

Providing the recommendations presented in this report are implemented noise emissions from operation of the site will not have any long term adverse impact upon the acoustical amenity of nearby residents. We therefore see no acoustic reason why the proposal should be denied.

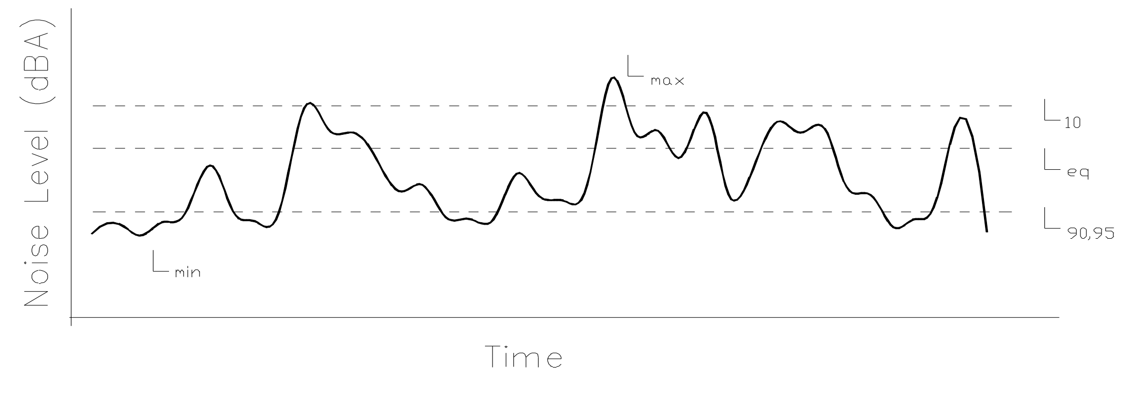
Steve Brady M.A.S.A. A.A.A.S.
Principal Consultant

APPENDIX A

Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
ABL	*Assessment Background Level* – A single figure representing each individual assessment period (day, evening, night). Determined as the L90 of the L90's for each separate period.
RBL	*Rating Background Level* – The overall single figure background level for each assessment period (day, evening, night) over the entire monitoring period.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
L10	The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and was previously used in Australia as the descriptor for intrusive noise (usually in dBA).



APPENDIX B
Risk Assessment Checklist

Risk Assessment Checklist

Item/Date	Risk Identified (Yes/No)	Risk Level (H/M/L)	Noise Control Required (Yes/No)	Noise Control Strategy