REVERB ACOUSTICS

Noise and Vibration Consultants

Noise Impact Assessment
Alesco Senior College
27 Chapman Street
Charlestown NSW

August 2020

Prepared for Workers Educational Association - Hunter
Report No. 20-2526-R1

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

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1.1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for the Alesco Senior College at 27 Chapman Street, Charlestown. This assessment considers noise generating items and activities such as school children, PA system, amplified entertainment, etc. This report nominates appropriate wall, floor/ceiling systems, doors and external facade treatments to comply with the criteria.

The assessment has been requested by Workers Educational Association - Hunter 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.

This report is preliminary in that partition selection and floor treatments have not been finalised, details are not addressed (eg. partition junctions, ceiling, etc), and acoustic issues are based on assumptions and general guidelines given.

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.*

NSW Environment Protection Authority (2006). *Assessing Vibration: A Technical Guideline.*

AS 2670.2-1990 *Evaluation of Human Exposure to Whole Body Vibration. Part 2: Continuous and Shock-Induced Vibration in Buildings (1 to 80Hz).*

Plans supplied by CKDS Architecture Pty Ltd, dated 24 June 2020. 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
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2.1 PROJECT DESCRIPTION

Workers Educational Association - Hunter seeks approval for change of use from a church to an Educational Facility for the Alesco Senior College at 27 Chapman Street, Charlestown. The proposal will consist of learning spaces, a computer room, amenities, a kitchen, offices, courtyard, and multi-purpose centre.

Noise sources of concern include mechanical plant, occasional use of PA system and amplified entertainment in the multi-purpose centre, students in outdoor areas. Due to the small size of the school ,and close proximity of all areas, no school bell or siren will be installed. The school will typically operate during school hours 8am-4pm Monday to Friday, with minimal activity outside normal hours.

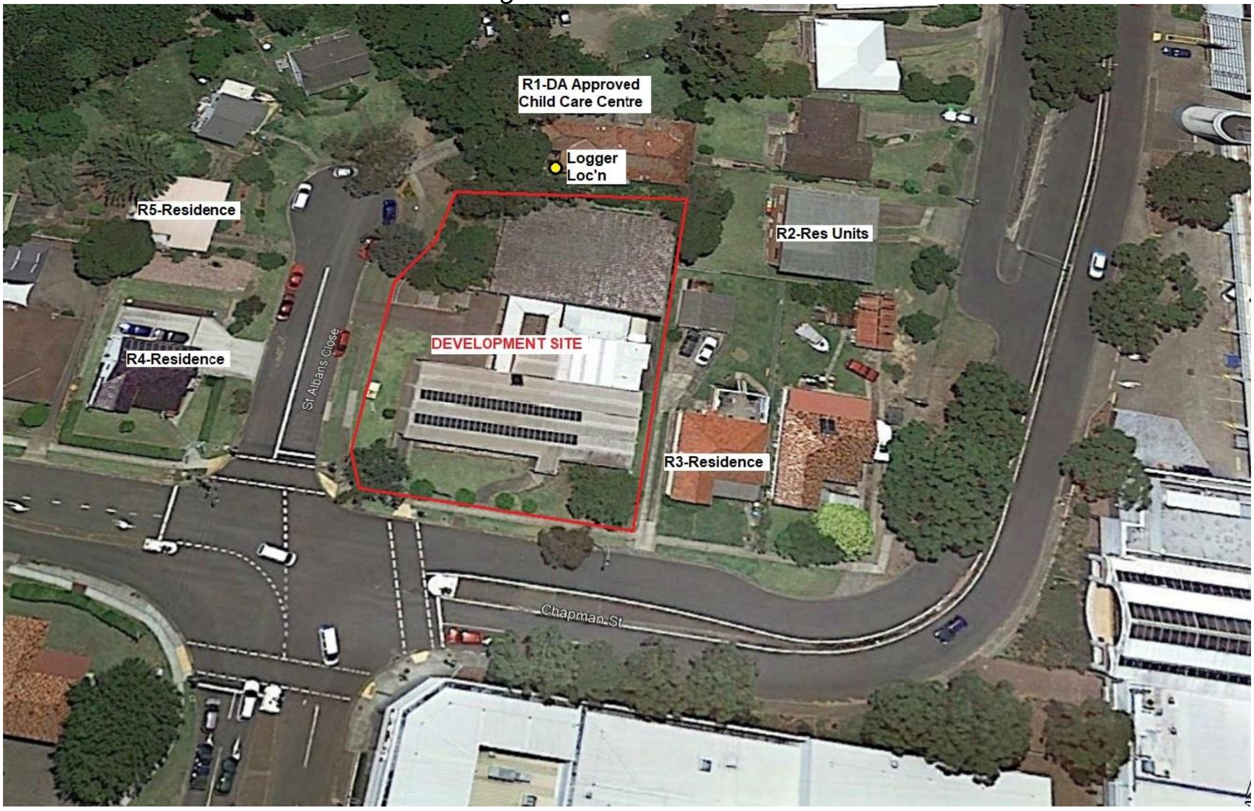
The SEAR's document for the proposal requires the following acoustic issues to be addressed:

Noise and Vibration

- *Identify and provide a quantitative assessment of the main noise and vibration generating sources during site preparation and construction activities. 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 school hall for any concerts, etc, (both during and outside school hours) and any out of hours community use of school facilities.*
- *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 sensitive 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



Source: Google Earth

2.2 EXISTING ACOUSTIC ENVIRONMENT

A background noise level survey was conducted using a Class 1, Svan 977 environmental noise logging monitor, installed at the west facade of the existing residence (to be demolished) directly north of the site in St Albans Close. 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 (NPfI).

Noise levels were continuously monitored from 12 December to 19 December 2019, to determine the existing background and ambient noise levels for the area for the adjoining development. 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. Measured road traffic noise levels at the site are shown in Table 2.

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
12-13 Dec	39.3	38.0	28.4	46.6	45.2	41.3
13-14 Dec	38.7	37.4	30.3	46.0	44.5	55.1
14-15 Dec	37.9	34.5	32.0	45.6	45.5	40.2
15-16 Dec	34.0	36.3	31.4	44.9	45.6	44.4
16-17 Dec	42.7	34.5	28.2	49.9	45.1	40.5
17-18 Dec	40.0	34.5	28.9	46.2	43.2	40.9
18-19 Dec	39.1	37.1	32.0	46.1	45.5	43.2
RBL	**39.1**	**36.3**	**30.3**	**--**	**--**	**--**
LAeq	**--**	**--**	**--**	**46.7**	**45.0**	**47.0**

Site, weather and measuring conditions were all satisfactory during our noise surveys. 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.

Table 2: Existing Source Noise levels

Time Period	Leq		Lmax		L10		L90	
	Range	Average	Range	Average	Range	Average	Range	Average
Day	39-56	46	54-79	63	40-59	48	32-48	41
Evening	36-50	44	49-75	62	38-56	46	33-44	38
Night	30-71	39	38-79	56	31-77	42	28-47	33

Additional attended road traffic noise level monitoring was conducted along the south building facade, approximately 10 metres from the near lane of traffic on Chapman Street, during the morning and afternoon peak period. All measurements were conducted using a Svan 977 Sound Level Meter. This instrument is Class 1 accuracy, in accordance with the requirements of IEC 61672, 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. 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 instruments' programming and downloading procedure. Table 3 shows a summary of monitoring results at the site.

Table 3: Measured Road Traffic Noise Levels, dB(A)

Time	Date	Lmax	Leq
08:15	17/08/20	81.5	62.5
15:30	17/08/20	80.0	63.0

2.3 CRITERIA

2.3.1 Road Traffic Noise (Impact on Development)

We understand that a DA is currently with Council for Lots directly north of the site, therefore to provide a measure of conservatism, we have assumed the child care centre will be operational in the near future. Department of Planning Industry & Environment's (DPIE's) *"Development near Rail Corridors and Busy Roads - Interim Guidelines*" is used for assessment of road traffic noise impacts on sensitive land-use developments. Limits specified within the Policy are shown below:

Type of Occupancy	*Noise Level in dB(A)*	*Applicable Time Period*
Educational Institutions including Child Care	40 (Internal)	When in use

NOTE: Airborne noise is calculated as LAeq,9 hour (night) and LAeq,15 hour (day).

Table 4 of the RMS' NSW Road Noise Policy (RNP) also recommends that school classrooms should satisfy an internal traffic noise criterion of 40dB(A),Leq (internal) when in use.

2.3.2 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 NPfI. However, local Councils and Government Departments may also apply the criteria for land use planning, compliance and complaints management. The NPfI 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 some commercial activity during the day, evening and night. Reference to Table 2.2 of the NPfI shows that all receiver areas are classified as urban. 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 4 below specifies the applicable project intrusiveness and amenity noise trigger levels for the proposed redevelopment.

Table 4: - Intrusiveness and Amenity Noise levels

Period	Intrusiveness Criteria	Amenity Criteria
Day	44 (39+5)	58 (60-5+3)
Evening	41 (36+5)	48 (50-5+3)
Night	35 (30+5)	43 (45-5+3)
Receiver Type: Urban (See EPA's NPfI - 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	**44dB LAeq,15 Minute**	7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening	**41dB LAeq,15 Minute**	6pm to 10pm
Night	**35dB LAeq,15 Minute**	10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.

We understand that a child care centre is proposed for the adjoining Lots directly north of the site. Toa assess noise impacts on child care centres the Association of Australian Acoustic Consultant's (AAAC's) document, *Technical Guideline. Child Care Centre Noise Assessment*, states the following:

- For proposals that are located within 60 metres of an arterial road or railway line a noise assessment should be submitted with the development application.
- The noise level LAeq,1hr from road, rail traffic or industry at any location within the outdoor play or activity area during the hours when the Centre is operating shall not exceed **55dB(A)**.
- The noise level LAeq,1hr from road, rail traffic or industry at any location within the indoor play or sleeping areas during the hours when the Centre is operating shall not exceed **40dB(A)**.

2.3.3 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). The SEARS document has recommended that a "quantitative assessment" is carried out for construction activities, 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 5:

Table 5: - 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**. 49dB(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

No criteria are contained within the ICNG for assessment of construction noise impacts on child care centres, although Section 4.1.2 of the ICNG also specifies the following internal noise level limits for school classrooms and other educational institutions, which have been adopted for assessment of the proposed child care centre to the north of the site.

School Classrooms/Educational Institution **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 6 details relevant criteria for potentially affected receivers (also see Figure 1).

Table 6: Criteria Summary

Assessment Location	Standard Construction Hours		Outside Standard Hours
	Noise Affected	Highly Noise Affected	
Residential Dev'p	49	75	41/35 #
School classrooms (internal)	45	65	N/A
School classrooms (external)	55	75	N/A

Evening/night.

2.3.4 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 7 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 7: 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 Road Traffic (Impact from Passing Traffic on Centre)

Applicable noise level metrics are those calculated from measurements at the site. A +2.5dB(A) facade adjustment does not need to be added to results, as measurements were conducted adjacent to the existing building facade. Received traffic noise for 2020 is calculated as follows:

measured noise (free field) + *facade correction* = *received noise*

Applying the above formula gives:

Day 63.0dB(A) + 0.0dB(A) = **63.0dB(A) Leq1hr** 7am – 10pm

No recent AADT figures for nearby roads could be sourced at the time of writing this report, therefore for assessment purposes e have assumed 8,000 vehicles pass the site along Chapman Street for the year 2020. A figure of 5% heavy vehicles has been adopted. The AADT's for the year 2020 were applied to our computer programme, based on the EPA and RMS approved CoRTN Method of Traffic Noise Prediction, and noise levels were calculated to the theoretical facade at each level of the development. <u>The adopted AADT figures and CoRTN values are merely arbitrary, as calculated noise levels are adjusted to correlate with our measured peak external noise levels, with the intention is to provide a (theoretical) means of determining the degree of noise control required for a particular building component</u>.

Equivalent continuous noise levels were calculated for each traffic lane separately on the basis that the noise source (i.e. the traffic) was located in approximately the centre of the respective lane. In particular, this gives an accurate estimation of the location of bus and truck exhausts which are generally located on the right hand side, being approximately at the same point for both traffic directions. Our calculations have been modified to compensate for the differing acoustic centres of cars and heavy vehicles, by modelling each separately and logarithmically adding received noise levels.

3.1.2 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 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)

3.1.3 Amplified Music – Multi-Purpose Centre (Impact on Neighbours)

A theoretical assessment of live and recorded amplified music has been carried out to predict the noise level at the nearest potentially affected boundaries. No live bands or loud Discos are proposed at the site. There may however, be occasional "low-impact" musical performances occurring. Using noise data for the above scenarios and the known criterion at nearby residences enabled calculation of the required transmission loss of each building element.

The Sound Power Levels, Lw dB(A), of a typical soloist or duo are shown in the following Table. From consideration of the known dimensions and orientation of each building component the sound pressure level immediately outside was propagated to nearest residences using an equation[1] giving the sound field due to an incoherent plane radiator.

Table 8: Lw, Soloist/Duo, dB(A),L10

	Octave Band Centre Frequency, Hz								
dB(A)	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
95	58	75	79	81	88	92	85	84	69

[1] Equation (5.104), DA Bies and CH Hansen, _Engineering Noise Control_, E & FN Spon, 1996.

3.2 ANALYSIS

3.2.1 Road Traffic (Impact on Development)

Shown below is a sample calculation detailing the procedure followed in order to calculate required glazing for the Computer Room on the south facade, facing Chapman Street. The traffic noise level at the outer face of the glazing is calculated as follows,

Table 9: Sample Calculation - Traffic Impact at Computer Room

		Octave band Sound Pressure Levels, dB(A)							
Propagation calculation	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Facade traffic noise, Leq[1]	63	43	51	52	56	58	55	49	41
Architectural shielding[2]		0	0	0	0	0	0	0	0
Directivity/distance Correction[3]		0	0	0	0	0	0	0	0
Traffic noise at window	63	43	51	52	56	58	55	49	41

1. Measured noise level. 2. Intervening structures/enclosed balustrade. 3. Includes angle of incidence correction.

As the criterion for the Computer Room is 40dB(A), see Section 2.3.1, the required traffic noise reduction is *TNR* = 63-40 = 23dB(A). The traffic noise attenuation, *TNA*, required of the glazing is calculated according to the equation given in Clause 3.4.2.6 of AS 3671,

$$TNA = TNR + 10\log_{10}[(S/S_f) \times 3/h \times 2T_{60} \times C] \qquad \textit{equation 1}$$

where
- S = Surface area of glazing = 2.5m^2
- S_f = Surface area of floor = 15m^2
- h = Ceiling height, assumed to be 2.6m
- T_{60} = Reverberation time, s
- C = No. of components = 4 (glazing, wall, roof)

Assuming that the room is acoustically average (neither too 'live' nor too 'dead') equation 9.26 in *Noise and Vibration Control*, L.L. Beranek, 1971, gives a reverberation time of 0.56s. Consequently, the value of 0.6s was used in equation 1.

Using the values listed above gives

TNA = 23dB(A) for the glazing

Substituting this value into the equation given in Clause 3.4.3.1 of AS3671 gives

Rw = *TNA* + 6 ≈ 29.

As can be seen by the above results, the glazing must have a tested Rw29 rating. Based on typical laboratory performance data the glazing would consist of single-glaze laminated or Vlam Hush glass fitted with acoustic seals at sliders.

Similar calculations to those above have been performed for windows and doors on affected facades. From these calculations, a schedule of required glazing has been compiled. See Section 4.

3.2.2 Received Noise – Activities/Equipment (Impact on Neighbours)

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 10: Equipment/Activities (15 minute Assessment Period)

Item/Activity	Lw dB(A)	Carpark	Multi-Purpose Centre	Outdoor Seating	Roof
Vehicles[1]	82	5			
Amplified music[2]	102		1		
PA System[3]	86		1		
Students[4]	85			30	
Air Con plant[5]	70			3	
Kitchen Exhaust[6]	72				1

NOTES:
1. Vehicles entering/leaving & parking on site.
2. Multi-purpose centre performance.
3. Multi-purpose centre during assembly.
4. Students seated in outdoor areas, continuous over duration of assessment period.
5. Located on roof.
6. Outlet 1 metre above roof level (assumed for possible future upgrade).

Table 11 shows calculations to predict the cumulative noise impact during peak periods at the nearest residential boundaries west of the building (R5).

Table 11: Received Noise - Site Activities dB(A),Leq (Peak Periods)
Propagated W to Nearest Residential Boundaries R5

Item/Activity	Lw dB(A)	Ave Dist Rec (m)	Duration (sec)	No. of Events	Barrier Loss/TL	Received dB(A)
Vehicles in carpark	82	30	10	5	0	10
PA System MP Centre	86	35	900	1	5	42
Students	85	60	900	1	14	29
Air con on roof	70	40	900	1	0	34
Kitchen exhaust on roof	72	40	900	1	0	32
				Combined		**43**
				Criteria (Day)		**44**
				Impact		**-**

As can be seen by the results in Table 10, the cumulative noise impact from all activities and equipment associated with the site is predicted to be compliant with the criteria during the day at nearest residential boundaries west of the building (R5). There is the potential for exceedance however, if activities occur outside normal school hours. To ensure ongoing compliance, the following noise control measures will be necessary:

1. Limit noise output of PA system or close west doors.
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.

The above strategies are discussed in more detail in Section 4.

3.2.3 Received Noise – Amplified Music (Impact on Neighbours)

The following Tables show calculations of noise emanating from the multi-purpose centre, while a musical performance is taking place in the multi-purpose centre, and the resulting impact at the nearest residences west of the site (R5).

Table 12: Calculated SPL Amplified Music in Multi-Purpose Centre Propagated to Nearest Residence West (R5) – Doors/Windows Open

		Octave Band Centre Frequency, Hz								
Item	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
Source Lw	**95**	58	75	79	81	88	92	85	84	69
TL glazing[1]		0	0	0	0	0	0	0	0	0
Barrier loss[2]		3	2	1	1	0	0	0	0	0
SPL at rec	**53**	**13**	**31**	**36**	**38**	**46**	**50**	**43**	**42**	**29**
Crit (Day/Evening)	**44/41**									
Impact	**9/12**									

1. Doors/windows open. 1. Intervening topography and structures.

Table 13: Calculated SPL Amplified Music in Multi-Purpose Centre Propagated to Nearest Residence West (R5) – Doors/Windows Closed

		Octave Band Centre Frequency, Hz								
Item	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
Source Lw	**95**	58	75	79	81	88	92	85	84	69
TL glazing[1]		8	14	17	21	24	26	29	25	31
Barrier loss[2]		3	2	1	1	0	0	0	0	0
SPL at rec	**28**	**13**	**31**	**36**	**38**	**46**	**50**	**43**	**42**	**29**
Crit (Day/Evening)	**44/41**									
Impact	**0/0**									

1. Doors/windows closed. 1. Intervening topography and structures.

Theoretical results in the above Tables show that noise emissions from amplified music in the multi-purpose centre are predicted to exceed the criteria at nearest residences during the day and evening if all external windows and doors. Compliance will be achieved however, if all external windows and doors are closed.

Inspection of the site revealed that the roof/ceiling and walls of the centre are satisfactory and will not need to be modified.

While we consider that the controls recommended to reduce amplified music to acceptable levels will be satisfactory, the wide variation in output from entertainment providers may cause higher than predicted noise in the residential area. Should this occur, we recommend the installation of an electronic Sound Limiter in the multi-purpose centre. These devices have been proven capable of controlling low frequency emissions and are a cost-effective solution for minor noise exceedances.

Table 14 shows a summary of predicted noise impacts at all nearest receivers.

Table 14: Summary Received Noise – All Nearby Receivers

Receiver Loc'n	Received Noise (Day/Evening/Night)			
	Period	dB(A),Leq	Criteria	Impact
Future Child Care N R1	Day	31	40#	-
	Evening	30	40#	-
Residence E R2	Day	31	44	-
	Evening	<20	41	-
Residence E R3	Day	36	44	-
	Evening	<20	41	-
Residence W R4	Day	40	44	-
	Evening	26	41	-
Residence W R5	Day	43	44	-
	Evening	28	41	-

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-

SECTION 4
Summary of Recommended Noise Control

4.1 NOISE CONTROL RECOMMENDATIONS

4.1.1 Site Activities/Equipment

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	68dB(A)	74dB(A)
Exhaust Discharge	70dB(A)	76dB(A)

4.2 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

4.3 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.

4.4 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.

4.5 External doors to the multi-purpose centre may be left open during school assemblies when a PA system is used, subject to limits specified in Item 4.6 below.

4.6 A limiting Sound Pressure Level (SPL) of **82dB(A),Leq** is to be set at the main west entry doors to the multi-purpose centre when the PA system is in use. Once this level is achieved, corresponding references should be assigned to the sound system controls.

4.7 All external doors to the multi-purpose centre must remain closed when amplified music is performed.

4.8 In the event that complaints arise from amplified music, we recommend installing an electronic Noise Limiter in the multi-purpose centre. These devices have been proven capable of controlling low frequency emissions and are a cost effective solution for minor noise exceedances. Suppliers include:
https://www.waveformacoustics.com.au/noise-and-sound-limiters
https://www.acousticaldesign.com.au/noise-volume-limiters-indicators

4.9 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.

4.2.1 Building Construction

4.10 Glass installed in window assemblies must comply with AS1288-2006. Materials, construction and installation of all windows are to comply with the requirements of AS2047-2014. Similar calculations to those in Section 3.2.1 were performed for all building elements. From these calculations, a schedule of required glazing has been compiled, shown below. The glazing systems, sighted in the following Table, are presented as a guide for the supplier:

Glazing Systems: Type A: Standard glazing. No acoustic requirement.
Type B: Single-glaze 5-8mm clear float glass.
Type C: Single glaze laminated glass, Vlam Hush.

Note: The typical glazing shown in the following Table should be used as a guide only. The supplier of the window/door must be able to provide evidence from a registered laboratory that the complete system will achieve the specified Rw performance, i.e. do not simply install our recommended glass in a standard window frame.

Table 15: Glazing Schedule

Facade	Room	Required Rw Must Achieve for Compliance	Typical Glazing System (Not for Specification)
South *Chapman St*	Computer Room	**29**	Type C
	Entry/Corridor	**-**	No acoustic requirement
East	Computer Room	**26**	Type B
	Staff	**-**	No acoustic requirement
	Welfare Office	**27**	Type B

4.11 Existing wall and roof/ceiling construction is acceptable. No further acoustic requirement.

SECTION 5
Construction Noise & Vibration Management Plan

5.1 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

5.1.1 Predicted Noise levels - Construction Plant and Equipment

Our client has informed us that no earthworks or major concrete pours will take place at the site, with only minor internal fitout. Received noise produced by anticipated construction activities is shown in Table 16 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 16: Predicted Plant Item Noise Levels, dB(A)Leq

		Distance to Residence			
Plant/Activity	**(Lw)**	**20m**	**50m**	**100**	**200m**
Hammering	(98)	64	56	50	44
Angle grinder	(106)	72	64	58	52
Air wrench (silenced)	(98)	64	56	50	44
Air compressor	(94)	60	52	46	40
Framing gun	(95)	61	53	47	41
Circular saw	(109)	75	67	61	55

Residential receivers are within 20 metres of the construction site and some construction activities are may exceed the criteria, on occasion. Noise levels above 75dB(A) are not expected to occur, and community reaction is possible but unlikely. 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. Based on similar nearby projects we envisage 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.

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. Some activities and equipment sighted in Table 16 may exceed the construction noise criteria within the adjoining child care centre (if it is constructed prior to construction at the 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 affected parties to ensure the timetable for noisy activities does not coincide with sensitive time periods.

Nearby residents may also have concerns about ground vibration levels from vibrating machinery However, as previously stated no major demolition or construction works are proposed. Generation of ground vibration above normal background levels is therefore not expected from the site at any nearby receivers.

5.2 CONSTRUCTION NOISE STRATEGIES

5.2.1 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.

5.2.2 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 B as a guide.

5.2.3 Equipment Selection

All combustion engine plant, such as 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 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 17 shows some common construction equipment, together with noise control options and possible alternatives.

Table 17:- 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 Alesco Senior College at 27 Chapman Street, Charlestown, 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.

An assessment of external noise impacting on the development has resulted in the compilation of a schedule of minimum glazing to meet the requirements of the EPA and RMS. <u>The recommended construction shown in Table 15 should be used as a guide only.</u> <u>The supplier of the window/door must be able to provide evidence from a registered laboratory that the complete system will achieve the specified Rw performance</u>. <u>Do not simply install the recommended glazing in a standard frame</u>.

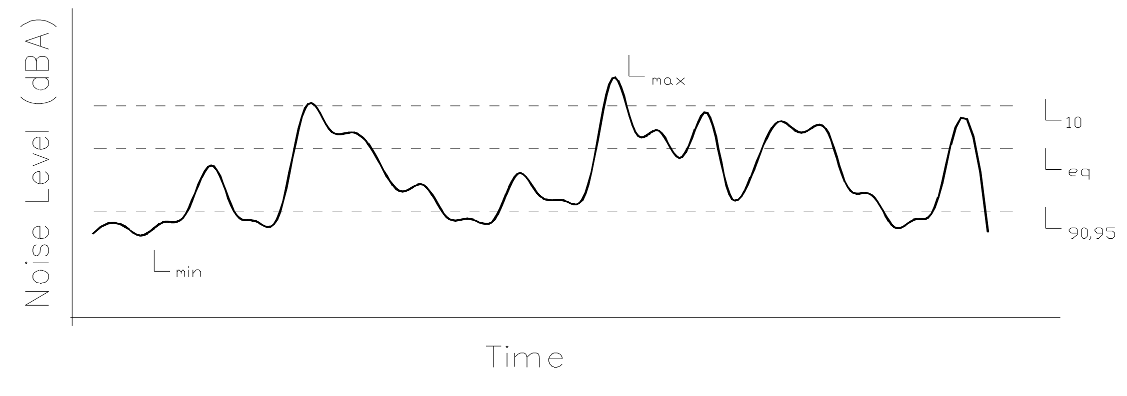
Providing the recommendations presented in this report are implemented noise emissions from operation of the site will not have any long term adverse impact upon the acoustical amenity of nearby residents. We therefore see no acoustic reason why the proposal should be denied.

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