REVERB ACOUSTICS
Noise and Vibration Consultants

Noise Impact Assessment
ET School Relocation
171 Mann Street-Years (7-10)
125 Donnison Street (Years 11-12)
Gosford NSW

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

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1.1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a preliminary noise impact assessment for relocation of ET School to new premises at the Imperial Arcade at 171 Mann Street, Gosford for Years 7 to 10 and 125 Donnison Street for Years 11 to 12. This assessment considers noise generating items and activities associated with operation of the new locations such as school children, PA system, amplified entertainment, school bell, 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 ET Australia 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).*

Preliminary plans supplied by SHAC 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
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2.1 PROJECT DESCRIPTION

ET Australia seeks approval for relocation to new premises at the Imperial Arcade at 171 Mann Street, Gosford for Years 7 to 10 and 125 Donnison Street for Years 11 to 12. The proposal will consist of the following:

Imperial Arcade 171 Mann Street (Years 7 to 10):
Level 2 Multi-purpose hall, circulation areas, classrooms, office areas, library, amenities.

125 Donnison Street (Years 11 and 12):
Ground Entry reception, office areas.
First Staff areas, specialist, classrooms, meeting room, circulation.

Noise sources of concern include mechanical plant, PA system, amplified entertainment, footfall, school bell, etc. The school will typically operate during school hours 8.30am-5.00pm, 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 assess operational noise, including consideration of any public-address system, school bell, mechanical services (eg 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 sensitive receivers, together with horizontal and vertical noise and vibration transmission to adjoining tenancies. 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 EXTENT OF WORK

2.2.1 Sound Insulation

The transmission of noise within a building can occur in two ways, namely, air-borne noise and structure-borne noise. Air-borne sounds can be considerably attenuated by intervening enclosures i.e. walls, floors, ceilings, glazing, screens, etc. Control of structure-borne noise, such as footfall, dropping of heavy objects, etc, is more difficult as it causes vibration of the building structure and is readily transmitted to adjoining areas with little attenuation. Therefore, structure-borne noise needs to be suppressed at the source by provision of isolation mountings and hangers, anti-vibration pads, resilient flooring, etc.

Just as the terms air-borne and structure-borne define the origin of sound, so direct or indirect defines the method of transmission of noise to the receiving room. The direct sound, whether air-borne or structure-borne, is that which impinges directly on the surface of the intervening partition between the source and receiver and is radiated from the source directly to the receiver. Indirect or flanking sound is that component of the source which reaches the receiving room by way of open or inadequate windows, doors, ceiling plenums or ventilation ducts. Increasing the Weighted Sound Reduction Index (Rw) of the dividing partition will have little effect if the acoustic energy of the indirect field dominates. The weaker insulating path is always the critical one.

The critical areas requiring assessment are detailed below:

- Partitions to hall, music rooms, classrooms, meeting rooms, etc.
- Glazed partitions for media, meeting rooms and private offices.
- Floor/ceiling systems between school areas and tenancies below.
- Reverberation control within larger areas, circulation, classrooms, hall.

2.2.2 Mechanical Services

Mechanical plant can typically be treated within internal spaces using duct lining/lagging, silencers and adequate partitions/floor systems. External plant can be treated in a similar manner with the added inclusion of barriers, closed grid platforms, enclosures, etc.

2.2.3 Room Acoustics

Generally, smaller private offices will be adequately fitted out with soft furnishings, reducing the need to provide reverberation control, whereas consideration of the room acoustics in open plan areas, meeting rooms, multi-purpose hall, etc, is of utmost importance and must be determined according to the room function. The effect of room shape and size, finish, materials and furnishings need to be evaluated where appropriate, to enhance speech intelligibility and/or reduce reverberation.

2.3 DESIGN CRITERIA

2.3.1 Speech Privacy

The design criteria are set according to the use of adjoining rooms and the likely sources of noise within them. Published sound insulation performance in terms of Rw/STC ratings relate to partitions tested in ideal laboratory conditions or opinions based on such measurements. We therefore recommend selecting partitions with a laboratory Rw rating 2-3dB higher than required, to compensate for loss of performance through installation on-site.

There are differing classes of speech privacy which depend on speech level, absorption and background noise level in the adjoining room, and the sound insulation of the common partitions. The background noise level is typically generated by air-flow over grilles or diffusers in offices and by conversation and general people movements in corridors and reception areas.

2.3.2 Definitions

We have defined the following **classes of privacy**:

Confidential Privacy:
The occupant doesn't want their conversation overheard or to be disturbed by intruding noise. Often occupants need this degree of privacy to be able to converse with a select individual or group without being overheard. Depending on the level of speech, it is either inaudible or audible but not intelligible.

Normal Privacy:
The occupant wants freedom from disturbing intruding speech. Depending on the level of speech it is either occasionally intelligible or audible but not intelligible, i.e. general office areas.

Poor Privacy:
No requirement for privacy. Speech is clearly audible and intelligible, i.e. corridors, open plan offices, reception areas, etc.

We have defined the following **speech efforts**:

Soft: Lowest level of speech possible but still audible to a listener in close proximity.

Restrained: Less than normal speech but not soft.

Normal or Conversational: The situation in offices.

Raised: In conference rooms or lobbies people usually increase their speech effort to a raised voice level.

Loud: Exceptional cases such as auditoria, function rooms, etc.

2.3.3 Criteria

Combinations of voice levels and privacy requirements lead to the following **privacy ratings**:

Open Plan

1. Poor Privacy
2. Soft Voice - Normal Privacy
3. Soft Voice - Confidential Privacy (or Restrained Voice - Normal Privacy)
4. Restrained Voice - Confidential Privacy

Enclosed

1. Poor Privacy
2. Normal Voice - Normal Privacy
3. Normal Voice - Confidential Privacy (or Raised Voice - Normal Privacy)
4. Raised Voice - Confidential Privacy (or Loud Voice - Normal Privacy)
5. Loud Voice - Confidential Privacy (or Normal Voice - Normal Privacy)

The required rating will depend on user/client requirements, space limitations, budgetary constraints and practicalities. A meeting with the client and appropriate colleagues is recommended to ensure the client's expectations are realised.

We recommend the following Rw ratings based on a typical background noise level and a modest degree of absorption:

		Background Noise level		
Privacy Class	*Code*	*30-35dB(A)*	*35-40dB(A)*	*40-45dB(A)*
		Rw Rating	*Rw Rating*	*Rw Rating*
Loud voice-Confidential privacy	LV-CP	50-55	45-50	40-45
Raised voice-Confidential privacy	RV-CP	45-50	40-45	35-40
Raised voice-Normal privacy	RV-NP	40-45	35-40	30-35
Normal voice-Normal privacy	NV-NP	35-40	30-35	25-30

Shown below is the range of sound insulation ratings and the expected acoustic result:

Rw/CAC 30-35	Raised speech can be easily heard and usually understood
Rw/CAC 35-40	Raised speech can be easily heard and occasionally understood.
Rw/CAC 40-45	Raised speech is difficult to hear and unintelligible.
Rw/CAC 45-50	Raised speech is difficult to hear although audio visual/PA is audible.
Rw/CAC 50-55	Raised speech inaudible and audio visual/PA is occasionally heard.
Rw/CAC 55-60	Raised speech and audio visual/PA is generally inaudible, amplified entertainment occasionally heard.

The maximum noise levels (in dBA) for quasi steady-state noise sources have been set in accordance with AS/NZS 2107-2016 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"* and are detailed below:

Room Type	*dBA*
EDUCATIONAL BUILDINGS	
Assembly halls up to 250 seats	30 – 40
Corridors and lobbies	<50
Interview/counselling rooms	40 – 45
Office areas	40 – 45
Professional & admin offices	35 – 40
Teaching spaces	<45
SHOP BUILDINGS	
Small retail stores	<50
OFFICE BUILDINGS	
Reception areas	40 – 45
General office areas	40 – 45
Executive offices	35 – 40

2.3.4 Room Acoustics

The reverberation times (T_{60}) have been set in accordance with AS/NZS 2107-2016 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"* and are detailed below:

Room Type	Reverberation Time, T_{60} (seconds)
EDUCATIONAL BUILDINGS	
Corridors and lobbies	<0.8
Interview/counselling rooms	0.3 – 0.6
Office areas	0.4 – 0.6
Professional & admin offices	0.6 – 0.8
Teaching spaces	0.4 – 0.6

The multi-purpose hall will be used for a variety of activities either unassisted or with the use of a PA system. In this sense there is less reason to observe the requirements of natural acoustics. The PA system will invariably supply adequate levels of acoustic power, therefore, a requirement to supplement direct sound by reverberation for speech is not as important. The design aim is to provide a reverberation time rather less than the optimum for speech auditoria, as speech intelligibility will increase as the room is made more absorbent or "dead".

The effect of room shape and size, finish, materials and furnishings needs to be evaluated where appropriate, to enhance speech intelligibility and/or reduce reverberation. Reverberant noise levels within these spaces should be acceptable for intelligible conversation at distances exceeding 4 metres. In this regard, the spaces may be considered as 'speech auditoria' for assessment purposes and reverberation times should satisfy $T60=0.35\log(V)-0.19$ where V is the enclosed volume in cubic metres.

The design reverberation time for speech auditoria at the dimensions of the hall is 0.8-0.9 seconds, however, the aim is to produce an acceptable environment within the spaces for various activities. Therefore, a more realistic and achievable design reverberation time, considering economic constraints, in the order of 1.0 second is the aim of this assessment. The recommendations for reverberation times within AS/NZS 2107-2016 refer to medium frequencies from 500Hz to 1kHz, while it is generally considered favourable in large volumes to have some increase in reverberation time towards the low frequencies.

2.3.5 Road Traffic Impact

Criteria for the assessment of quasi-steady-state noise sources, such as continuous road traffic and mechanical services, are sourced from AS/NZS 2107-2016 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"* and are detailed below.

Room Type	*dBA*
EDUCATIONAL BUILDINGS	
Assembly halls up to 250 seats	30 – 40
Corridors and lobbies	<50
Interview/counselling rooms	40 – 45
Office areas	40 – 45
Professional & admin offices	35 – 40
Teaching spaces	<45

SECTION 3

Analysis & Recommendations

3.1 PERFORMANCE REQUIREMENTS

3.1.1 Air-Borne Noise

The following options are offered for consideration to ensure activities associated with the school are inaudible in tenancies adjoining and below, together with adjacent school areas:

Loud Voice – Confidential Privacy. Based on the performance ranges shown in Section 4.1.2 the partition would need to achieve >55Rw/CAC rating, i.e. loud speech audio visual and amplified entertainment is generally inaudible.

Raised Voice – Confidential Privacy. Based on the performance ranges shown in Section 4.1.2 the partition would need to achieve >50Rw/CAC rating, i.e. raised speech is generally inaudible, while audio visual and amplified entertainment is occasionally audible.

Raised Voice – Normal Privacy. Based on the performance ranges shown in Section 4.1.2 the partition would need to achieve >45Rw/CAC rating, i.e. raised speech is generally unintelligible and occasionally audible.

Normal Voice – Normal Privacy. Based on the performance ranges shown in Section 4.1.2 the partition would need to achieve >40Rw/CAC rating, i.e. raised speech is audible and occasionally intelligible.

Normal Voice – Poor Privacy or Soft Voice – Normal Privacy. Based on the performance ranges shown in Section 4.1.2 the partition would need to achieve ≥35Rw/CAC rating, i.e. raised speech is audible and often intelligible.

3.1.2 Structure-Borne Noise

Activities such as footfall, jumping, running, dropping large objects, scraping chairs, etc, can be sources of structure-borne noise transmission to tenancies below. AS2670.2-1990 and the EPA's document, *"Assessing Vibration: A Technical Guideline* are useful in determining acceptable levels of exposure to continuous and impulsive vibration dependent on the time of day and intended use of the occupied space. An extract from Table 2.2 of the EPA Guideline is reproduced below in Table 1 to aid in determining limits on vibration impacts within tenancies below:

Table 1: Extract from Table 2.2 – Preferred & Maximum Weighted rms Values For Continuous & Impulsive Vibration Acceleration (m/s²) 1-80Hz

Location	Assessment Period	Preferred Values		Maximum Values	
		z-axis	x & y axes	z-axis	x & y axes
Offices, schools and educational institutions	Day or Night	0.020	0.014	0.040	0.028

3.2 DESIGN OPTIONS

Suggested and actual wall and floor systems have been input into Marshall Day's Insul Predictive Program and compared laboratory test results. This enabled us to calibrate the Insul model and vary building components to accurately predict the performance of individual complex systems. All wall types are full height, i.e. floor to structural slab above, unless otherwise specified.

3.2.1 Wall Types

WT1 (>Rw50) Raised Voice – Confidential Privacy:
- 2 x 13mm fire rated Pb
- 76/92mm steel studs
- 2 x 13mm fire rated Pb
- 75mm Cavity Insulation (10kg/m^3)

WT2 (Rw45-50) Raised Voice – Normal Privacy:
- 1 x 13mm fire rated Pb
- 64/76mm steel studs
- 2 x 13mm fire rated Pb
- 75mm Cavity Insulation (10kg/m^3)

WT3 (Rw40-45) Normal Voice – Normal Privacy:
- 1 x 13mm FR Pb
- 64/76mm steel studs
- 1 x 13mm FR Pb
- 75mm Cavity Insulation (10kg/m^3)

3.2.2 Glazed Partitions

Configuration/Description	*Rw Rating*
G1: Single-glaze 3-4mm clear float	24-26
G2: Single-glaze 5-6mm clear float	27-28
G3: Single-glaze 8-10mm clear float	30-32
G4: Single-glaze 6.38mm laminated	32
G5: Single-glaze 10.38mm laminated	35
G6: Single-glaze 6.5mm Vlam Hush	35
G7: Single-glaze 10.5mm Vlam Hush	38
G8: Double-glaze 4mm CL Fl x 12 x 4mm Cl Fl	30
G9: Double-glaze 10mm CL Fl x 12 x 4mm Cl Fl	35
G10: Double-glaze 6.5mm Hush x 12 x 6.5mm Hush	37
G11: Double-glaze 6.38mm Lam x 76 x 6.5mm Hush	45

3.2.2 Floor Types

FT1: ≤55 L'n,w
- Timber flooring
- Regupol 3-5mm 4515, or comparable Regupol underlay
- 180-220mm reinforced concrete
- Minimum 200mm airspace
- Suspended plasterboard or acoustic tile ceiling

FT2: ≤60 L'n,w
- Carpet tile no underlay, cushioned vinyl
- 180-220mm reinforced concrete
- Minimum 200mm airspace
- Suspended plasterboard or acoustic tile ceiling

FT3: ≤65 L'n,w
- Timber flooring, tile
- 180-220mm reinforced concrete
- Minimum 200mm airspace
- Suspended plasterboard or acoustic tile ceiling

NOTE: A lower L'n,w rating implies improved performance.

3.3 RECOMMENDATIONS

3.3.1 Wall Type Design Options

Table 1: Recommended Wall Types:

Location	WT1 Rw50+	WT2 Rw45-50	WT3 Rw40-45	G3-G4 Rw30-32
Multi-Purpose Hall/Music		✓		
Adjoin Classrooms/Labs/Specialist		✓		
Classrooms to Circulation			✓	✓
Library to Adjoining		✓		
Library to Circulation			✓	✓
Adjoining Meeting/Exec Office		✓		
Meeting/Exec Office to Classroom	✓	✓		
Meeting/Exec Office to Circ			✓	✓
Adjoining Private Office			✓	
Private Office to Circulation			✓	✓

Glazed partitions in the above Table are based on the most practical and economic option for most situations. It should be acknowledged that speech will be audible and occasionally intelligible for single-glaze applications. To achieve *confidential privacy* a double-glaze system such as G11 noted in Section 3.2.2 would be required. Confirmation with the client is critical to ensure expectations are realized and achieved.

3.3.2 General Design Considerations

Light switches and power points must not be back-to-back, and should preferably be limited to one per stud opening, if unavoidable we recommend installing fire rated switch boxes. (i.e. PROMAT, CLIPSAL or HPM).

Gaps at wall junctions are to be filled to a minimum depth of plasterboard thickness with a non-setting (gunnable) sealant. If gaps are greater than 10mm in width a backing rod must be inserted prior to sealant.

Where double-layers of plasterboard are specified, sheets must be staggered (min 600mm), i.e. do not line up the joins, or the first sheet is to be fixed horizontal and the second sheet vertical.

All furniture, fittings, etc, must be isolated from the common wall, by using rubber rawlnuts at fixing points or by fixing into a wallboard sheet that is isolated from the common wall on resilient mounts to furring channels. In this way, the sound of closing draws and cupboard doors will not be transmitted to adjoining areas. Similarly, the sound of placing hard objects on benches in kitchen areas will not be transmitted.

Recessed tray type fluorescents are not permitted where full height walls are not specified and/or where mechanical plant is installed in the ceiling void. Either install surface mounted lighting, fire rated downlights such as Regal R1012/FRD, or Tenmat FF109 Downlight Covers above all lights. Downlights are generally not recommended, although they can be installed if limited to 3 for every 6m² ceiling area.

3.3.3 Entry Doors

All doors to high performance areas, i.e. multi-purpose hall, music rooms, meeting rooms, etc, should have the vertical sides and top of the door frames fitting neatly to provide close contact when doors are closed. Where possible avoid having doors opposite or adjacent to each other. Proprietary acoustic seals must be installed to all doors for sensitive areas (suppliers include Raven, Kilargo and Lorient). Note that inspection of installed seals is imperative to ensure they have been installed correctly and perform to specification.

Standard aluminium grills are not to be installed in any air relief door leading to sensitive areas. We recommend *either* installing "cross-talk" doors *or* air relief silencers in the ceiling plenum or wall (available through Nap Silentflo).

In situations where a door is included in a high performance wall, the overall acoustic performance will be degraded. As previously mentioned, the weakest transmission path is the critical one and the door will reduce the overall performance to an unacceptable standard. If high acoustic isolation is required, i.e. equal in performance to the wall, two solid core doors would be required to create an airlock.

3.3.4 Glazed Office Partitions

The acoustic performance and therefore specification for glazed partitions is dependent on the intended use and expectation of adjoining rooms. For instance, if recognition of speech to corridors, etc, is acceptable, we recommend simply glazing the observation panel with a 5-6mm safety glass. In some situations, this is acceptable to corridors, providing the partition between adjoining area has a superior acoustic performance. If however, a higher degree of privacy is required, double-glazed systems are required. In both instances the glazed panel should be as small as practical. In practice, the amount of noise transmitted through a glazed partition depends on its size as well as its Rw rating. For example, a 1200mm x 600mm standard glass window may result in the same noise reduction as a 2400mm x 1200mm laminated window, when these windows are contained in a wall with high Rw rating. Should a high degree of privacy be required we recommend at least *"Normal Voice-Confidential Privacy"*, necessitating at least G8 glazed panels.

3.3.5 Operable Walls

Preference should be given to systems that are faced with absorbent material, particularly on the breakout side of the wall, to reduce reverberation.

If the operable walls main function is visual privacy only a moderate degree of acoustic privacy is required. As such, treatment to the ceiling void above the operable wall is not required. If the operable wall is required to also provide acoustic privacy a minimum performance would be Rw45, with treatment above the operable wall as detailed below:

<u>Option 1:</u>
- Construct stud wall above operable walls.
- Line both sides of stud wall with 13mm plasterboard.
- Include R2/S2 cavity insulation.
- Where air conditioning ducts pass over operable walls, provide metal duct directly above operable walls and connect flexible acoustic duct either side to metal duct (sealing around flexible acoustic ducts is not possible).
- Seal all penetrations with a non-setting sealant.

<u>Option 2:</u>
- Fix 6-8kg Wavebar to slab above.
- Extend Wavebar down to operable walls and then horizontally for 1200mm into one room.
- Lay R2/R2 ceiling batts in adjoining rooms at least 1500mm from operable walls into room.
- Install recessed LED lighting as far as practical from operable walls.
- Wavebar is to be crosscut vertically and horizontally at all penetrations and taped to create an airtight seal.

<u>Option 3:</u>
- Stack 1200mm x 600mm polyester or fibreglass insulation batts directly above the operable walls in the ceiling void.
- Batts must be tightly packed between suspended ceiling and slab above and be directly above the operable walls.
- Provide 1 layer additional insulation batts on both sides of partition wall, extending 1500mm into both rooms.
- Treatment must be completed to the entire perimeter of all rooms.

3.3.6 Floor Type Design Options

Table 3: Recommended Floor Types:

Location	FT1 ≤55 L'n,w	FT2 ≤60 L'n,w	FT3 ≤65 L'n,w
Multi-Purpose Hall	✓		
Classrooms/Music/Labs/Specialist		✓	
Circulation			✓
Library		✓	
Meeting/Private Office		✓	
Open Plan Office		✓	

All floor/ceiling systems must be installed strictly to manufacturer's instructions. A suitable gap (usually 10-15mm) must be left at floor perimeters and filled with a non-setting sealant. Similarly, skirting boards and architraves must be clear of the floor surface and filled with a paintable resilient sealant.

- We recommend laying proprietary gymnasium matting in weight training areas to reduce structure borne noise transmission. Furthermore, weights machines should not be fixed/bolted to walls unless isolated from the structure. As a further suggestion, store 40-50mm thick gymnastic mats (say 2400mm x 1200mm dimensions) in an easily accessible location to be used as an overlay when using exercise equipment that will cause excessive impact and/or vibration.

Figure 2: Examples of Typical Additional Matting Overlay.

3.3.7 Reverberation Control

High reverberation times are primarily a consequence of abundant hard (reflective) surfaces and the perceived result is generally high background noise levels, unintelligible speech and a lack of definition in speech and recorded/live music. Accordingly, it will be necessary to apply acoustic absorptive material to as much of the available surface area in larger areas, i.e. multi-purpose hall, circulation areas, classrooms, etc. Generally, the most practical solution is to apply treatment to the ceiling and upper walls, which are large surfaces far enough from trafficable areas to avoid damage.

MULTI-PURPOSE HALL
Suspend/attach functional absorbers such as Armstrong Soundscape Shapes or Ecophon Solo Panels from existing ceiling surface.
https://www.armstrongceilings.com/commercial/en-au/search.html?q=sounscape+shapes
https://www.himmel.com.au/product-listing/2016/07/13/ecophon-solo-panels or Progressive Materials https://www.progressivematerials.com.au/contact/

We recommend 1200mm x 1200mm panels (minimum 0.7 NRC), allowing 3 separate rows along the longer dimension of the hall with 6 panels evenly spaced in each row.

We strongly recommend that some additional treatment is evenly distributed to each wall, ideally above head level. However, as a minimum, treatment should be applied to at least one of each parallel surface. We recommend fixing 30-40mm battens to the upper walls, extending 1-1.5 metres down from wall/ceiling junction. Fix perforated plasterboard or slotted/perforated plywood (minimum 20-25% open area) to the battens and provide a cavity infill of 50mm fibreglass or polyester insulation. Alternatively, Autex panels evenly distributed to 30-40% available area to each wall is recommended.

PRIVATE OFFICES
Achieving appropriate reverberation times within smaller rooms will generally not be an issue, as the rooms will normally be adequately furnished and occupied. This reduces the air volume of the space and supplies additional absorptive surface area so as to disperse echoes and reduce reverberation times. We therefore recommend a moderate degree of absorption, which can be achieved by wall absorbers such as felt covered pinboards. Perhaps a medium to heavy pile carpet or cushioned vinyl may also be considered.

CLASSROOMS/LIBRARY/MEETING ROOMS/CIRCULATION
These areas are inherently "noisy" as a result of excessive reverberation. Treatment for reverberation is not mandatory, but recommended. We suggest suspending functional absorbers say every 4-5 metres or directly above work stations.

We further recommend pinboards evenly distributed throughout each room classroom, typically Autex or Acoufelt covered with fire resistant felt.

3.3.8 Open Plan Teaching and Office Areas

The reduction in speech level, measured 3-4 metres from the noise source, usually behind a screen is termed interzone attenuation. Sounds from sources further away should have interzone attenuation of 20-25dB. If no screen is in place, the interzone attenuation will be no greater than 10dB. Therefore, other methods of attenuation must be employed such as introduced but moderate background noise, or proper orientation of the speaker in relation to the listener.

A sensibly designed open plan area will have workstations arranged so each operator is separated from each other by acoustic barriers with an absorbent wall surface between adjacent workstations. Another major contributor to poor acoustic privacy can be the ceiling. For instance, if a listener is behind a screen and no ceiling is present then interzone attenuation may be as high as 25dB, with a highly absorbent ceiling 20dB is possible, while a reflective ceiling (such as plasterboard) reduces the interzone attenuation to only 10-12dB.

When acoustic privacy is poor, i.e. no screen between individuals, reflective ceiling, etc, and interzone attenuation is low, attempts will be made to increase privacy that will exacerbate the problem. In an effort to maintain privacy the listener will raise their voice in order to be understood when talking on the phone or to co-workers, and in turn the talker at the nearby workstation will do the same.

In summary, the desired parameters required to achieve acceptable privacy in an open plan office situation include:

1. A ceiling with good specular reflective properties (i.e. good absorption).
2. A screen or barrier.
3. Absorbent surfaces on walls near the workstation.
4. A controlled background system (not mandatory).
5. Sensible orientation of speaker, although this is usually not desirable when social interaction is a major functional design aspect of the area.

Open plan privacy will be improved through the use of highly absorbent ceilings such as acoustic tile (>NRC 0.7), barriers of maximum allowable height at workstations, and absorption treatment to reflective surfaces. The maximum level of privacy for an open plan space is ¨*Restrained voice-Confidential privacy*¨, which can be achieved with a barrier 200-300mm above a seated person, absorbent ceiling such as perforated plasterboard with minimum 15% open area and absorbent barrier surfaces. We understand that the proposed dividing partitions between workstations has not been specified at this stage. Note that the partitions should continue full length between adjoining workstations at the nominated height. A mix of absorbent surface finish and transparent screen (i.e. glass or similar) is acceptable to provide adequate diffusion of sound, i.e. by alternate application of absorbent and reflective surfaces.

We further recommend that absorbent ceilings are installed in all open plan areas, together with carpet and/or cushioned vinyl. As discussed in previous Sections, this will help provide the best possible outcome in an open plan situation.

3.4 SCHOOL BELL / PA SYSTEM (NOISE IMPACT ON NEIGHBOURS)

Potential noise sources that may be present within school buildings include children (particularly prior to and at conclusion of classes), school bell and PA system. Based on a noise level of 90dB(A) at inside surfaces, the partition must attenuate at least 55dB(A) at 500-1000Hz to provide an acceptable noise environment in tenancies below. To put results into context, an impact of 35 implies that the partition must be capable of attenuating 55dB (i.e. 90dB(A) – 35 = 55).

The existing system is 180-220mm reinforced concrete with a suspended plasterboard and acoustic tile ceiling below. To calculate the Rw (airborne) rating of the floor noted above, we used Marshall Day's Insul Predictive Program The Insul program has predicted that the floor/ceiling system will attenuate 60-70dB(A) at critical speech frequency range and more at higher frequencies. Noise levels from activities associated with operation of the school are therefore predicted to be acceptable in adjoining tenancies. Also see recommendations with regard to floor and wall treatments to the multi-purpose hall to confirm compliance.

3.5 ROAD TRAFFIC (NOISE IMPACT ON SCHOOL AREAS)

Shown below are sample calculations detailing the procedure followed in order to calculate required glazing for typical classrooms. The traffic noise level at the outer face of the glazing is calculated as follows,

Table 4: Sample Calculation - Traffic Impact at Classroom Windows

		Octave band Sound Pressure Levels, dB(A)							
Propagation calculation	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Facade traffic noise, Leq[1]	69	49	57	58	62	64	61	55	47
Architectural shielding[2]		0	0	0	0	0	0	0	0
Directivity/distance Correction[3]		-2	-2	-2	-2	-2	-2	-2	-2
Traffic noise at window	67	47	55	56	60	62	59	53	45

1. Measured noise level. 2. Intervening structures. 3. Includes angle of incidence & distance correction.

As the criterion for the classrooms is 45dB(A), see Section 2.3.5, the required traffic noise reduction is *TNR* = 67-45 = 22dB(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 = 6m^2
- S_f = Surface area of floor = 25m^2
- h = Ceiling height, assumed to be 2.5m
- T_{60} = Reverberation time, s
- C = No. of components = 2 (glazing, wall)

Assuming that the room is acoustically average (neither too 'live' nor too 'dead') equation 9.26 in <u>*Noise and Vibration Control*</u>, L.L. Beranek, 1971, gives a reverberation time of 0.8s. Consequently, the value of 0.5s was used in equation 1.

Using the values listed above gives

TNA = 22dB(A) for the glazing

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

$$Rw = TNA + 6 \approx 27.$$

Published sound insulation performance in terms of Rw or STC ratings relate to partitions tested in ideal laboratory conditions or opinions based on such measurements. Field conditions (eg. flanking paths, penetrations, air leaks etc) caused by lack of supervision of workmanship or inadequate attention to detail at design/specification stage can reduce the Rw rating. For this reason, we recommend selecting partition systems with a laboratory Rw rating 2-3dB higher than required on site. **Therefore, the glazing in classrooms must have a tested Rw30 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.

If road traffic noise criteria cannot be met with windows open then they must be shut, if desired, while also meeting the ventilation requirements of the Building Code of Australia (BCA). This does not preclude the use of operable windows, however, when the minimum criteria cannot be met, mechanical ventilation is required. We understand that all habitable rooms are provided with air conditioning.

SECTION 4
Conclusion

4.1 CONCLUSION

A noise impact assessment for relocation of the ET Australia school to new premises, has been completed, resulting in noise control recommendations summarised in Section 3 of this Report. Both sites are 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 and retail development, noise generated by the proposed may 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.

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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).