REVERB ACOUSTICS
Noise and Vibration Consultants

Revised Noise Impact Assessment Gosford Alive Mixed-Use Development 136 Donnison Street Gosford NSW

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Prepared for Lederer Group Pty Ltd
Report No. 19-2323-R2

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

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TABLE OF CONTENTS

SECTION 1
Introduction

1.1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for the proposed Gosford Alive mixed-use development at 136 Donnison Street, Gosford. The proposal is to construct 5 towers which will include the following:

LEVELS 1-6:
Carparking Retail Commercial Lobby Common Areas Loading Dock

LEVELS 7-26:
Residential Apartments

The purpose of this assessment is to determine the noise impact from passing road traffic and commercial activity within habitable spaces of the development and to ensure that noise levels comply with the requirements of the Roads and Maritime Services (RMS), Department of Planning, Industry and Environment (DPIE), NSW Environment Protection Authority (EPA) and Central Coast Council (CCC). Further assessment has also been carried out to determine the noise impact activities and equipment associated with the development may have on nearby neighbours (i.e. mechanical plant, vehicle movements, loading dock activities).

The assessment was requested by Lederer Group Pty Ltd in support of and to accompany a Development Application to CCC and to ensure any noise control measures required for the site are incorporated during the design stages.

1.2 TECHNICAL REFERENCE / DOCUMENTS

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

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.*

Preliminary plans supplied by Buchan Pty Ltd, dated May 2019. Note that variations from the 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
Existing Acoustic Environment
Assessment Criteria

2.1 EXISTING ACOUSTIC ENVIRONMENT

Consideration must be given to the extent of the existing acoustic environment and whether such levels are appropriate for the land use of the receiver area. As such, attended noise level monitoring was conducted at various locations at the site (See Figure 1). 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, and showed an error less than 0.5dB.

Table 1 shows a summary of our noise surveys, including the Assessment Background Level's (ABL's), which were determined according to the procedures described in the EPA's Noise Policy for Industry (NPfI) and with reference to guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures".

Table 1: Measured Noise Levels, dB(A)

Time	Date	Lmax	L90	Leq
Monitoring Location 1 – Donnison Street				
08:00	13/06/19	81.5	39.5	62.0
01:45	14/06/19	78.4	37.5	56.5
Monitoring Location 2 – Albany Street North				
08:30	13/06/19	80.6	45.5	65.0
02:05	14/06/19	78.5	39.0	57.0
Monitoring Location 3 – Henry Parry Drive				
08:50	13/06/19	81.5	46.5	66.5
02:30	14/06/19	78.4	39.4	60.5

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.

The Sound Pressure Level's (SPL's) of additional noise sources identified during our site visits are listed below:

Item	*SPL dB(A),Lmax*	*Comments*
Mechanical plant (S1)	62	@ 10m
Cars in carpark (S2)	72	passby at 3m
Cars in carpark (S3)	52	passby at 3m
Cars in carpark (S4)	68	passby at 3m
Mechanical plant (S5)	51	@ 20m
Cars in carpark (S6)	64	passby at 3m
Cars in carpark (S7)	64	passby at 3m

Figure 1 – Locality Plan

2.2 CRITERIA

2.2.1 Road Traffic

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
RESIDENTIAL BUILDINGS	
Houses and apartments near major roads	
Living areas	35 – 45
Sleeping areas	35 – 40
Common areas (foyer, lobby)	45 – 50
SHOP BUILDINGS	
Small retail stores	<50
OFFICE BUILDINGS	
Reception areas	40 – 45
General office areas	40 – 45
Executive offices	35 – 40

DPIE's *"Development near Rail Corridors and Busy Roads - Interim Guidelines"* (released in December 2008) is a more recent document for assessment of road traffic noise impacts on residential developments. Limits specified within the Policy, which are virtually identical to those in AS/NZS2107-2016 are shown below:

Type of Occupancy	*Noise Level in dB(A)*	*Applicable Time Period*
Sleeping areas (bedroom)	35	Night 10pm to 7am
Other habitable rooms (excluding garages, kitchens bathrooms & hallways)	40	At any time

The RMS describes cognate criteria for the assessment of road traffic noise upon residential developments in their Environmental Noise Management Manual. Reference to Page 160 of the RTA's Manual, indicates that noise reduction measures for new developments should endeavour to meet the noise level targets set out in the EPA's Environmental Criteria for Road Traffic Noise (ECRTN). The ECRTN has been superceded by the NSW Road Noise Policy (RNP) which contains a number of criteria applied to a variety of road categories (freeway, arterial, sub-arterial and local roads) and situations (new, upgraded roads and new developments affected by road traffic). Table 2 shows the relevant category, taken from Table 3 of the RNP:

Table 2: - Extract from Table 3 of RNP Showing Relevant Criteria.

Road Category	Day	Night
New residential developments affected by noise from existing freeway/arterial /sub-arterial roads	55 LAeq,15hr	50 LAeq,9hr

Table 3 summarises satisfactory internal noise levels for residences, used for the basis of this assessment.

Table 3: Internal Traffic Noise Level Criteria (Residential)

Location	Criteria – dB(A),Leq		Remarks
	Day	Night	
Sleeping areas	-	35	Windows closed
	-	45	Windows open
Other habitable rooms	40	-	Windows closed
	50	-	Windows open

Note: Provision for air conditioning will be available, therefore windows open criteria do not apply in this case.

Note that limits specified in the EPA documents are in agreement with those contained in AS/NZS 2107-2016 and DPIE's Guideline. Therefore, the aim of the assessment is to ensure that the allowable noise levels shown above and in Table 3 are not (theoretically) exceeded within any habitable room due to road traffic noise. Transmission paths considered in the assessment are windows and doors with allowances made for shielding by balconies, intervening acoustic barriers, buildings/terraces, etc.

2.2.2 Site Noise/Mechanical Plant

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the EPA's Noise Policy for Industry (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 aims to protect against progressively increasing noise in developing areas, based on the existing (Leq) noise level from industrial noise sources. 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 commercial activity during the day, evening and night. Reference to Table 2.2 of the NPfI shows that the receiver area is 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: - Base Noise Level Objectives

Period	Intrusiveness Criteria	Amenity Criteria
Day	45 (40+5)	58 (60-5+3)
Evening	45 (40+5)	48 (50-5+3)
Night	43 (38+5)	43 (45-5+3)
Receiver Type: Urban (See EPA's NPfI - Table 2.2)		

Project specific noise levels, determined as the more stringent of the intrusiveness criteria and the amenity / high traffic criteria, are as follows:

Day **45dB LAeq,15 Minute** 7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening **45dB LAeq,15 Minute** 6pm to 10pm
Night **43dB LAeq,15 Minute** 10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.

Commercial:
65dB LAeq,15 Minute when in use.

Place of Worship:
40dB LAeq,15 Minute (internal) when in use.

School Classroom:
35dB LAeq,15 Minute (internal) when in use.

2.2.3 Maximum Noise Level Event Assessment - Sleep Arousal

Section 2.5 of EPA's NPfI requires a detailed maximum noise level event assessment to be undertaken where the subject development/premises night-time noise levels exceed the following:

- LAeq (15 minute) 40dB(A) or the prevailing RBL plus 5dB whichever is greater, and/or
- LAFmax 52dB(A) or the prevailing RBL plus 15dB, whichever is greater.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night period.

2.2.4 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 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**. 50dB(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 4.2 of the ICNG also specifies the following noise level limits for various land uses.

Industrial premises	**75dB(A),Leq (15 min) external**
Offices, retail outlets	**70dB(A),Leq (15 min) external**
Classrooms at schools, etc	**45dB(A),Leq (15 min) internal**
Places of Worship	**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	50	75	45/43[1]
Commercial Dev'p	70	75	70
Classrooms	45[2]	-	45[2]
Place of Worship	45[2]	-	45[2]

1. Evening and night periods. 2. Internal criteria.

2.2.5 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 Site Noise/Mechanical Plant

The sound power level of each activity impacting on the site was determined according to the procedures described in AS2102 or AS1217 as appropriate, and theoretically propagated at to nearby receivers. Propagation calculations were carried out using the following in-house equation. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels in the residential area.

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)

3.1.2 Road Traffic

Applicable noise level metrics, namely, Leq (day peak) and Leq (night) are those calculated from our measurements at the site, following the methodology outlined in the EPA's RNP. A +2.5dB(A) adjustment is required as all measurements were taken in free-field conditions.

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

Applying the above formula gives:

Donnison Street:

Day	62.0dB(A) + 2.5dB(A) =	**64.5dB(A) Leq15hr**	7am – 10pm
Night	56.5dB(A) + 2.5dB(A) =	**59.0dB(A) Leq9hr**	10pm – 7am

William Street/Albany Street North:

Day	65.0dB(A) + 2.5dB(A) =	**67.5dB(A) Leq15hr**	7am – 10pm
Night	57.0dB(A) + 2.5dB(A) =	**59.5dB(A) Leq9hr**	10pm – 7am

Henry Parry Drive:

Day	66.5dB(A) + 2.5dB(A) =	**69.0dB(A) Leq15hr**	7am – 10pm
Night	60.5dB(A) + 2.5dB(A) =	**63.0dB(A) Leq9hr**	10pm – 7am

No current RMS traffic station is located near the site along nearby roads. We have therefore assumed 15000 vehicles pass the site each day for the year 2019. A figure of 5% heavy vehicles has been adopted. The AADT's for the year 2019 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. 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.

3.1.3 CoRTN Model Conversion

The EPA released their ECRTN in June 1999 and RNP in 2011, which specify modified assessment periods for day and night, namely, Leq,15hr (7am to 10pm) and Leq,9hr (10pm to 7am). These assessment periods have rendered the original Australian version of the CoRTN model invalid, which was designed to assess the impact over a single 24 or 18 hour period. Consequently, modification of the Model is required to adequately describe the new metrics.

The CoRTN algorithm pertaining to traffic flow percentages has been modified by inserting all AADT figures for arterial roads, contained in RMS publications - Traffic Volume Data for Hunter and Northern Regions, 1998, and establishing AADT figures for the applicable day and night periods. Our CoRTN model was then calibrated against long term measurements made at locations with reliable AADT figures.

3.2 ANALYSIS AND DISCUSSION

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 a typical bedroom on Level 10 of Tower 1, located on the west facade, facing Henry Parry Drive. The traffic noise level at the outer face of the glazing is calculated as follows,

Table 8: Sample Calculation - Traffic Impact at Bedroom Window Level 10 West Facade Tower 1

		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]		-2	-2	-2	-2	-2	-2	-2	-2
Directivity/distance Correction[3]		-2	-2	-2	-2	-2	-2	-2	-2
Traffic noise at window	65	45	53	54	58	60	57	51	43

1. Measured noise level. 2. Deck/enclosed balustrade. 3. Includes angle of incidence & distance correction.

As the criterion for the bedroom is 35dB(A), see Section 2.2.1, the required traffic noise reduction is *TNR* = 65-35 = 30dB(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 = 2m^2
- S_f = Surface area of floor = 11m^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 *Noise and Vibration Control*, L.L. Beranek, 1971, gives a reverberation time of 0.46s. Consequently, the value of 0.5s was used in equation 1.

Using the values listed above gives

$$TNA = 25dB(A) \quad \text{for the glazing}$$

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

$$Rw = TNA + 6 \approx 31.$$

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 1-2dB higher than required on site. Therefore, the glazing in the bedroom must have a tested Rw33 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 glazing schedule has been compiled. See Section 7.

DPIE's Guideline states that 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, the National Construction Code (NCC) states that when the minimum criteria cannot be met, mechanical ventilation is required (ref: Section 3.1.2 ABCB Indoor Air Quality, 2016). However. the DPE's Apartment Design Guide Objective 4B-1 specifies all habitable rooms should be naturally ventilated in apartment complexes. A typical open window will reduce noise by 15dB(A) or more when contained within a masonry structure, therefore the windows open criteria will be met. Nonetheless, we understand that mechanical ventilation will be installed in all habitable rooms.

3.2.2 External Noise Sources (Impact on Development)

The following Tables show sample calculations to predict received noise levels from activities/equipment associated with nearby commercial developments propagated to a typical bedroom on Level 10 of Tower 1, located on the west facade, facing Henry Parry Drive. All calculations are based on distances scaled from plans supplied by Buchan Pty Ltd and through measurement during our site visits.

Table 9: Received Noise – External Noise Sources, dB(A),Leq Propagated to Level 10 Bedroom Tower 1 West Facade

Activity	Plant (S1)	Cars (S2)	Cars (S3)	Cars (S4)	Plant (S5)	Cars (S6)	Cars (S7)
Lw dB(A)	88	89	89	89	86	89	89
Ave Dist to rec (m)	25	30	70	120	140	130	90
Duration of event	15 min	20 sec	20 sec	20 sec	15 min	20 sec	20 sec
No. of events	1	30	30	30	1	30	30
Barrier loss/Dir	4	6	24	24	24	24	24
Rec dB(A),Leq	**48**	**43**	**18**	**14**	**11**	**13**	**16**
Combined	**49**						
Criteria (D/E/N)	**45dB(A),Leq / 45dB(A),Leq / 43dB(A),Leq**						
Impact	**4/4/6**						

Table 10: Received Noise – Short Duration Events dB(A),Lmax Propagated to Level 10 Bedroom Tower 1 West Facade

Activity	Plant (S1)	Cars (S2)	Cars (S3)	Cars (S4)	Plant (S5)	Cars (S6)	Cars (S7)
Lw dB(A)	88	89	89	89	86	89	89
Ave Dist to rec (m)	25	30	70	120	140	130	90
No. of events	1	30	30	30	1	30	30
Barrier loss/Dir	4	6	24	24	24	24	24
Rec dB(A),Lmax	**48**	**49**	**23**	**18**	**14**	**18**	**21**
Criteria (night)	**52dB(A),Lmax**						
Impact	**-**	**-**	**-**	**-**	**-**	**-**	**-**

As can be seen by the above results, noise from nearby external activities/equipment is predicted to be exceed the criteria by up to 6dB(A) during the night at nearest facades. The adopted internal criterion of 35dB(A),Leq will be exceeded given that a standard window will only attenuate 10dB(A) when closed. Glazing must therefore be modified acoustically. Theoretical calculations reveal that all glazing within bedrooms in some instances must achieve >Rw31 rating. This can typically be achieved with laminated glass and acoustic seals fitted at sliders. See Section 4 for glazing schedule and required design modifications.

3.2.3 Mechanical Plant (Impact of Dev'p on Neighbours)

Commercial, and retail areas will require air conditioning plant to ventilate habitable spaces and refrigeration plant for cool rooms/cold storage, while carpark exhaust will be required for basement level carparks and air conditioning plant for residential apartments, lobbies, etc. This assessment is based on typical Design Kit Specifications. For assessment purposes we have assumed the majority of mechanical plant will be located within basement plant rooms and on the dedicated roof-top/podium plant decks. The anticipated number and location of noise generating items associated with the development are shown below. Note that a detailed assessment of the noise impacts from all mechanical plant will be required once locations and selections have been finalised.

Location	*Plant Item*
Supermarket Deck	Refrigeration condensers (x5)
	Air conditioning condensers(x4)
Plant Rooms	Exhaust/Supply Air Fan (x1)
	Air conditioning condensers (x3)
	Air conditioning compressors (x2)
	Emergency generator (x1)
	Temp racks (x3)
	Heat pump (x1)
Swim Centre/Gym	Pool pumps (x4)
	Air conditioning condensers (x4)
Specialty Shops	Air conditioning condensers (x10)
	Refrigeration condensers (x4)
	Exhaust discharge (x2)
Liquor Outlet	Air conditioning condensers (x2)
	Refrigeration condensers (x2)
Residential Blocks Roof	Carpark Exhaust each Block (x2)
Residential Air Conditioning	Individual balconies
Child Care	Air conditioning condensers (x2)
	Kitchen Exhaust (x1)

The following Table shows sample calculations to predict noise from anticipated carpark exhaust discharge on the roof of Tower 1, propagated north to nearest commercial receivers.

Table 11: Calculated SPL, Roof-Top Carpark Exhaust – Tower 1 Propagated to Nearest Receivers

		Octave Band Centre Frequency, Hz							
Item	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Combined Lw plant	86	50	56	81	83	80	72	62	42
Barrier loss[1]		2	3	3	4	5	6	7	9
SPL at Receiver	**42**	7	12	37	38	34	25	14	16
Criteria (commercial)	**65**								
Impact	**-**								

1. Intervening structures, parapet, etc.

As can be seen by the results in Table 11, noise emissions from roof-top exhaust plant on the Tower 1 residential roof will be compliant with the night criterion of 38dB(A),Leq at nearest receivers, subject to construction details shown in Section 4. As previously stated, detailed assessment of the noise impacts from all mechanical plant associated with the development will be required once locations and selections have been finalised. In the interim, general acoustic recommendations and noise emission limits are detailed in Section 4.

Sensitive land uses such as churches (R3A, R9A) and TAFE (R7) are 30-60 metres from the site. A typical open window or door will reduce noise by 10-15dB(A) or more when contained within a masonry structure. Therefore, based on an external noise impact of 42dB(A).Leq (see Table 11), internal noise levels below 30dB(A) can be expected within these land uses, i.e. 42dB(A) - 10dB(A)=32dB(A), which are 3-8dB(A) below the criteria and can be considered acceptable..

3.2.4 Basement Level Carparks (Impact of Dev'p on Neighbours)

Vehicles entering, leaving and manoeuvring within the basement level carparks of the proposed development have the potential to cause disturbance to nearby neighbours. Natural ventilation grills may be incorporated along exposed facades, which also provide a means of noise leakage. Vehicles within the carparks will be travelling at approximately 10km/h and will be under slight acceleration at times as they negotiate ramps. Previous noise tests by Reverb Acoustics suggest that a vehicle in good mechanical order will produce a sound power level of 83-85dB(A) under these conditions, thus resulting in an acceptable level of approximately 40dB(A)Leq or 50dB(A),Lmax at the nearest receivers. It should be noted that, if more than one vehicle were to enter the carparks simultaneously, received noise levels would be raised. For instance, if 3 cars were travelling within the car park, in exposed locations, a combined noise level as high as 45dB(A) may be experienced at nearest receivers. To further reduce noise levels, we recommend positioning ventilation grills behind retaining walls or along facades facing away from sensitive receivers.

3.2.5 Construction Noise & Vibration (Impact on Neighbours)

Received noise produced by anticipated construction activities is shown in Table 12 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.

Table 12: Predicted Plant Item Noise Levels, dB(A)Leq

Plant/Activity	(Lw)	Distance to Residence				
		20m	40m	80m	100m	200m
Tower crane	(104)	70	64	58	56	50
Hammering	(98)	64	58	52	50	44
Angle grinder	(106)	72	66	60	58	52
Air wrench (silenced)	(98)	64	58	52	50	44
Compactor	(111)	**77**	71	65	63	57
Road truck	(104)	70	64	58	56	50
Grader	(102)	68	62	56	54	48
Air compressor	(98)	64	58	52	50	44
Concrete Agitator	(112)	**78**	72	66	64	58
Concrete Pump	(110)	**76**	70	64	62	56
Pile boring machine	(112)	**78**	72	66	64	58
Excavator	(104)	70	64	58	56	50

Sensitive land uses such as churches (R3A, R9A) and TAFE (R7) are 30-60 metres from the site and some construction activities are expected to exceed the criteria, particularly mobile plant. External noise levels above 70dB(A) and 55dB(A) are possible at closest locations, and community reaction is possible. However, churches typically conduct services on Sunday and in the evening outside standard construction hours, reducing the likelihood of noise exceedances. 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 parties 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 8.

If pile boring occurs, noise levels in the order of 75-78dB(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 sensitive 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 1-2 dump trucks. The combined acoustic power level of these machines, assuming normal contractor's machines up to 10 years old in reasonably good condition, is expected to be in the range 100 to 104B(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 102 dB(A) for 3 typical machines operating at full power, above 65dB(A) is expected at the closest residence during peak activity.

Constructing temporary barriers of plywood, excess fill, etc, 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 to 10dB(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 8 will ensure that minimum disruption occurs.

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 13 lists the results of previous vibration measurements, with each measurement corrected to a standard distance of 20m to represent nearest residential receivers.

Table 13: Average Maximum Ground Vibration Measurement Results, mm/s Peak.

Ground Type	Measured Distance to Vibration mm/sec	Minimum 40m 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 13 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 receivers:

	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 17.

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 14, gives an indication of the effects from varying magnitudes of vibration.

Table 14: 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

Construction noise and vibration strategies are discussed in detail in Section 8.

SECTION 4
Summary of Recommended Noise Control

4 NOISE CONTROL RECOMMENDATIONS

Figure 2: Site Plan

4.1 Roof/Ceiling Construction

4.1.1 Roof construction may consist of <u>*either*</u> reinforced concrete <u>*or*</u> sisalation or wire mesh laid down on roof purlins. This is to be completely covered with a 30-40mm foil faced building blanket hard under the roof sheeting (in situations where joists are at centres close enough to avoid excessive sagging of the blanket, the sisalation/wire mesh may be omitted). Close off gaps between purlins and roof sheeting with Unisil Eaves Filler Strips, bituminous compound, or similar. Install an impervious ceiling of 1 sheet of taped and set 10mm plasterboard. To further assist in low frequency attenuation, all ceiling voids should contain a layer of fibreglass or rockwool insulation. The insulation is to be installed in addition to, not in lieu of the building blanket. Specialised acoustic insulation is preferred, however, dense thermal insulation (eg, R3 batts) will suffice and is much less expensive (\$15/m^2 for Rockwool 350 and \$5/m^2 for R3 batts).

4.2 Wall Construction

4.2.1 Brick veneer/cavity brick//masonry construction is acceptable. Where external brickwork stops below the height of the stud frame, plasterboard, Villaboard, or similar, is to be fixed to the outside of the stud frame to fill the void. The infill material is to extend from the top of the top plate to a point in line with the bottom of the top course of brickwork. Alternatively, an overside noggin is to be fixed to the underside of the top plate to project within 10-20mm of the inside surface of the external wall.

4.2.2 Lightweight cladding (i.e. Shadowclad, Colorbond, or similar) should include internal lining 1 sheet taped and set 13mm fire rated plasterboard, and a cavity infill of R1.5/S1.5 fibreglass or polyester insulation. The external face of all lightweight cladding should also be backed with either 6mm fibre cement sheeting (Villaboard, Hardiflex) or 10mm construction plywood.

4.3 Glazing Construction

4.3.1 Similar calculations to those in Section 3 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 or VLam Hush glass
Type D: Double-glaze or Insulating Glass Unit (IGU)

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	Location	Required Rw Compliance Requirement	Typical Glazing System (Not for Specification)
TOWER 1			
Facing North (William Street)	Commercial/Retail	**28**	Type B or C
	All Bedrooms	**32**	Type C
	All Liv/Din/Kitch	**31**	Type C
	All Bath/WC	**28**	Type B or C
Facing East	Commercial/Retail	**26**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**26**	Type B
Facing South	Commercial/Retail	**27**	Type B
	All cnr Bedrooms #	**33**	Type C
	All Other Bedrooms	**30**	Type C
	All cnr Liv/Din/Kitch #	**32**	Type C
	All Other Liv/Din/Kitch	**29**	Type B or C
	All Bath/WC	**26**	Type B
Facing West (Henry Parry Dv)	Commercial/Retail	**28**	Type B or C
	All Bedrooms	**33**	Type C
	All Liv/Din/Kitch	**32**	Type C
	All Bath/WC	**29**	Type B or C

Apartments closest to Road only.

Table 15: Glazing Schedule

Facade	Location	Required Rw Compliance Requirement	Typical Glazing System (Not for Specification)
		TOWER 2	
Facing North	Commercial/Retail	**27**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**26**	Type B
Facing East	Commercial/Retail	**26**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**26**	Type B
Facing South *(Donnison Street)*	Commercial/Retail	**27**	Type B
	All Bedrooms	**32**	Type C
	All Liv/Din/Kitch	**31**	Type C
	All Bath/WC	**28**	Type B or C
Facing West (Henry Parry Dv)	Commercial/Retail	**28**	Type B or C
	All Bedrooms	**33**	Type C
	All Liv/Din/Kitch	**32**	Type C
	All Bath/WC	**29**	Type B or C
		TOWER 3	
Facing North (William Street)	Commercial/Retail	**28**	Type B or C
	All Bedrooms	**32**	Type C
	All Liv/Din/Kitch	**31**	Type C
	All Bath/WC	**28**	Type B or C
Facing East	Commercial/Retail	**27**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**25**	Type B
Facing South	Commercial/Retail	**-**	No acoustic requirement
	All Bedrooms	**28**	Type B or C
	All Liv/Din/Kitch	**27**	Type B
	All Bath/WC	**-**	No acoustic requirement
Facing West	Commercial/Retail	**27**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**25**	Type B

Apartments closest to Road only.

Table 15: Glazing Schedule

Facade	Location	Required Rw Compliance Requirement	Typical Glazing System (Not for Specification)
TOWER 4			
Facing North	Commercial/Retail	**-**	No acoustic requirement
	All Bedrooms	**28**	Type B or C
	All Liv/Din/Kitch	**27**	Type B
	All Bath/WC	**-**	No acoustic requirement
Facing East	Commercial/Retail	**26**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**26**	Type B
Facing South *(Donnison Street)*	Commercial/Retail	**27**	Type B
	All Bedrooms	**32**	Type C
	All Liv/Din/Kitch	**31**	Type C
	All Bath/WC	**28**	Type B or C
Facing West	Commercial/Retail	**26**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**26**	Type B
TOWER 5			
Facing North	Commercial/Retail	**26**	Type B
	All cnr Bedrooms #	**31**	Type C
	All Other Bedrooms	**28**	Type B or C
	All cnr Liv/Din/Kitch #	**30**	Type C
	All Other Liv/Din/Kitch	**27**	Type B
	All Bath/WC	**25**	Type B
Facing East (Albany Street N)	Commercial/Retail	**27**	Type B
	All Bedrooms	**32**	Type C
	All Liv/Din/Kitch	**31**	Type C
	All Bath/WC	**28**	Type B or C
Facing South (Donnison Street)	Commercial/Retail	**27**	Type B
	All Bedrooms	**32**	Type C
	All Liv/Din/Kitch	**31**	Type C
	All Bath/WC	**28**	Type B or C
Facing West	Commercial/Retail	**26**	Type B
	All cnr Bedrooms #	**32**	Type C
	All Other Bedrooms	**29**	Type B or C
	All cnr Liv/Din/Kitch #	**31**	Type C
	All Other Liv/Din/Kitch	**28**	Type B or C
	All Bath/WC	**26**	Type B

Apartments closest to Road only.

4.4 Balconies

4.4.1 To reduce the field of view of the noise source (i.e. traffic, mech plant), enclosed balustrade is required for all residential apartments, consisting of stud wall, masonry or fixed glass panels to a height of minimum 900mm. Vertical gaps between each panel that do not exceed 75mm are permitted. A gap of say 50-100mm is permitted at floor level to allow cleaning, hosing, etc

4.5 Mechanical Plant

4.5.1 As part of Construction Certificate documentation a detailed assessment of the noise impacts from all mechanical plant associated with the development will be required once locations and selections have been finalised.

4.5.2 No noise control will need to be incorporated into the design of proposed mechanical plant if the following maximum allowable limits are not exceeded:

Table 16: Mechanical Plant - Noise Emission Limits

Location	Plant Item	Maximum Allowable Noise level	
		SPL @ 3m	Lw
Supermarket Decks	Refrig condenser	77	95
	Air con condenser	74	92
Plant Rooms	Exhaust/Supply Air Fan	47	65
	Air con condensers	68	86
	Air con compressors	72	90
	Emergency generator	94	112
	Temp racks	68	86
	Heat pump	70	88
Swim School (internal)	Pool pumps	68	86
Specialty North East	Air con condensers	50	68
	Refrig condensers	51	69
	Exhaust discharge	48	66
Specialty South West	Air con condensers	50	68
	Refrig condensers	51	69
	Exhaust discharge	48	66
Specialty South East	Air con condensers	50	68
	Refrig condensers	51	69
	Exhaust discharge	48	66
Liquor Outlet Roof	Air con condensers	51	69
	Refrig condensers	52	70
Res Blocks Roof	C'park Exhaust each Block	54	72
Residential Air Con	Individual balconies	50	68
Child Care	Air con condensers	51	69
	Kitchen Exhaust	50	68

4.5.3 Generally acoustic barriers will not be required at the perimeter of the roof-top plant decks. However, if required 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 15% open Area) fixed to furring channels, with a cavity infill of S1.5 polyester insulation.

Barrier heights and locations will be determined as part of the CC documentation, recommended in Item 4.5.1 above.

Acoustic barriers must continue at least 300mm below the top of the plant deck.

NOTE 1: All barrier heights are above top of plant, not height above plant deck

NOTE 2: Any supply/exhaust fans in plant room roof/walls must not produce an SLP >65dB(A) at 1 metre (includes combined noise from fans and plant equipment). Acoustically rated ducts/louvres must be installed at plant room side of fan for any roof opening.

NOTE 3: Should impervious acoustic barriers create ventilation problems for the plant decks or plant room walls, we recommend installing acoustic louvres. The louvres must have the following insertion loss values (typically Fantech SBL1, Nap Silentflo 300S Line or Robertson Type 7010):

Required Insertion Loss Values for Acoustic Barriers/Plant Room Louvres – dB

	Octave Band Centre Frequency, Hz							
	63	125	250	500	1k	2k	4k	8k
NR	10	12	15	19	20	18	18	14
STL	4	6	9	13	14	12	12	8

4.5.4 Any roof-top exhaust plant that produces an SPL above the limits specified in Item 4.5.2 must have acoustic barriers constructed at the fan discharge. 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. The barrier must be no closer than 500mm and no further than 1200mm from the edges of the exhaust. Barrier construction should consist of Acoustisorb panels or similar construction detailed previously for deck barriers. Barrier construction is based solely on acoustic issues. Visual, wind load issues must be considered and designed by appropriately qualified engineers.

4.5.5 Noise emissions from the substation kiosk must not exceed a sound pressure level of 60dB(A),Leq at a distance of 3 metres. Where plant intended to be installed on the site produces noise in excess of specified levels, noise control will be required to ensure satisfactory noise emissions.

4.5.6 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.

4.5.7 Once the plant layout has been finalised, details should be forwarded to the acoustic consultant for approval. Revision of the plant layout may result modified acoustic requirements.

The above noise control recommendations are not necessarily the only options available, but are expected to be the most cost-effective and practical with the information currently to hand. Alternative options can be considered providing they result in the same or lower received noise levels at any nearby residence.

4.6 Commercial/Retail Tenancies

4.6.1 Given the variability of the proposed commercial/retail occupancies, it is not possible to specify exact acoustic controls on a case-to-case basis. For example, a cafe may require exhaust or refrigeration plant, while no significant noise is expected from an office. In addition, the tenancy of retail outlets is usually dynamic dependent upon the success or otherwise of the occupant. For this reason, the onus is upon the tenant to ensure noise emission is kept to a minimum.

Future tenants should be assessed on a case to case basis and required to submit their own Noise Impact Assessment to Council, if noise generating activities are anticipated.

SECTION 5
Construction Noise & Vibration

5 CONSTRUCTION NOISE & VIBRATION CONTROL STRATEGIES

5.1 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 17 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 17: Vibration Monitoring Program - Minimum Distance when Monitoring is Required

Activity/Process	Receiver Type	Distance to Receiver (m)
Tracked machine	Heritage structure	40
	Residential building	20
	Commercial	10
Pile boring	Heritage structure	40
	Residential building	20
	Commercial	10
Crane	Heritage structure	20
	Residential building	10
	Commercial	5
Concrete pours	Heritage structure	20
	Residential building	10
	Commercial	5
Truck movements	Heritage structure	20
	Residential building	10
	Commercial	5

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 Vibration Management Strategies

In addition to vibration monitoring, the following management strategies should also be considered:

Dilapidation Survey: We understand that this has been done as part of the management process.

Monitoring Changes in Building: Use of callipers, tell tales, etc, prior to commencement of major vibration generating works.

Underpinning, Reinforcement, Bracing, etc: Additional structural support to adjoining buildings, excavations, etc.

5.3 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 18 shows some common construction equipment, together with noise control options and possible alternatives.

Table 18: 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.
Rotary drills Boring	Drive motor and bit.	Acoustic screens and enclosures	Thermic lance Laser cutting technology.
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.

5.4 Acoustic Barriers/Screening

To minimise noise impacts during construction, early work should concentrate on grading and levelling the areas closest to buildings. In the event of complaints arising from occupants of nearby buildings, 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.
- Temporary barriers of plywood, excess fill, etc, at least 2m high, at the perimeter of the construction site

5.5 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 nearby 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 public 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 sheet piling) outside critical times for court buildings should be arranged.

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 building occupants 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.

5.6 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.

SECTION 6
Conclusion

6.1 CONCLUSION

A noise impact assessment for the Gosford Alive mixed-use development, has been completed, resulting in noise control recommendations summarised in Sections 4 and 5 of this Report. The report has shown that the site is suitable for the intended purpose, providing our recommendations are implemented. An assessment of external noise impacting on the development has resulted in the compilation of a schedule of minimum glazing, wall, roof construction, etc, to meet the requirements of the EPA and RMS. The recommended construction shown in Table 15 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. Do not simply install the recommended glazing in a standard frame.

The guidelines herein are preliminary in that the selection of building materials depends on user/client requirements, space limitations, budgetary constraints and practicalities that relate to the acoustic design of suites. Adequate building facade design may be achieved through many different combinations of materials, all of which may achieve the same result, subject to review by us.

We have designed exposed facades of the building to ensure maximum noise level passbys from heavy vehicles are below 55-60dB(A). This upper limit is generally considered the threshold at which awakenings may occur.

In conclusion, providing the recommendations given in this report are implemented, external noise impacts (i.e. road traffic, port activities, etc), will comply with the requirements of the EPA, RMS, DPIE and CCC within habitable spaces of the proposed development. We therefore see no acoustic reason why the proposal should be denied.

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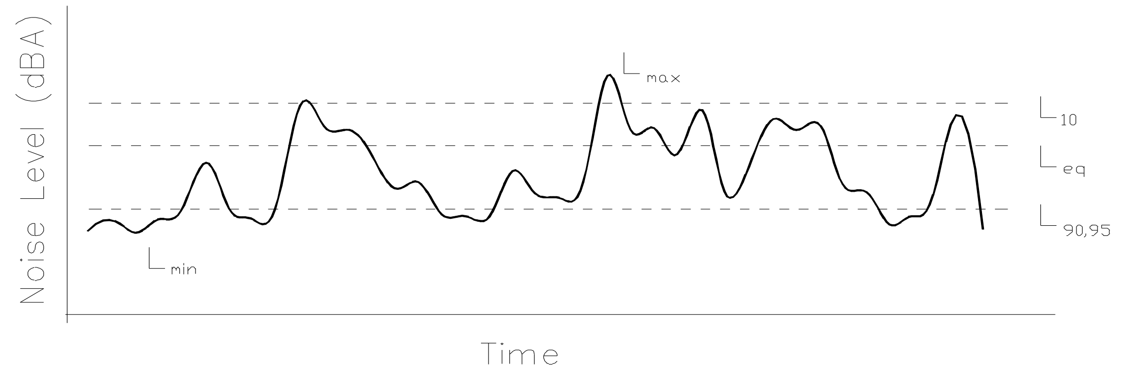
Principal Consultant

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