Frasers Property Australia

Shell Cove Waterfront – Tavern

DA – Supplement acoustic report

AC11

Issue 2 | 21 May 2018

Job number 256688-00

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Document Verification

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Job title		Shell Cove Waterfront – Tavern		**Job number** 256688-00
Document title		DA – Supplement acoustic report		**File reference** AC11
Document ref		AC11		
Revision	**Date**	**Filename**	AC11 (v1) Hotel and Tavern DA Acoustic Supplement.docx	
Issue 1	17 May 2018	**Description**	First issue	
			Prepared by	Checked by	Approved by
		Name	Caspar Jeffrey	Glenn Wheatley	Glenn Wheatley
		Signature			
Issue 2	21 May 2018	**Filename**	AC11 (v2) Hotel and Tavern DA Acoustic Supplement.docx	
		Description	Second Issue	
			Prepared by	Checked by	Approved by
		Name	Caspar Jeffrey	Glenn Wheatley	Glenn Wheatley
		Signature			
		Filename		
		Description		
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename		
		Description		
			Prepared by	Checked by	Approved by
		Name			
		Signature			
				Issue Document Verification with Document	✓

Contents

Appendices

1 Introduction

This report has been prepared following additional acoustic study and assessment for the Waterfront Precinct, further to the strategy outlined in the Development Application acoustic report (Arup *AC03 v5 WFTavern DA Acoustic*, 15 December 2017). The additional study focused on establishing upper limit design criteria for the Precinct, and involved preparation of auralisations, listening studies in Arup SoundLab, and consultation with Frasers Property and Shellharbour City Council.

In addition to the above, The Supplementary DA Report for the Stage 2 Mixed-Use building (Arup *AC09 v2 Stage 2 DA Acoustic supplement*, 8 April 2018) has investigated the impact of precinct-wide noise generating land uses on residential facades. Existing noise levels in the precinct do not presently reflect the level of noise that will be generated once the precinct has been fully developed. Hence this report recommended that internal noise criteria be adopted for proposed residential dwellings to incorporate active and vibrant uses within the greenfield site.

The approach for the Waterfront Precinct is to provide a more balanced approach between operators and receivers. Conceptually, this involves noise sensitive development around the vibrant centre to incorporate a level of acoustic mitigation to respond to the future environment, and enable greater flexibility and opportunities for venues. It is critical however to determine the appropriate balance between the operation of venues and the mitigation requirements and amenity outcomes for noise sensitive development. This report confirms the proposed acoustic criteria, which has been informed by auralisations in Arup SoundLab.

It is noted that any existing or approved development surrounding the Shell Cove Waterfront Tavern site will likely require adoption of more standard policy, which has therefore also been discussed.

2 Development proposal

Figure 1 shows the Waterfront Tavern in the context of Precinct D. Proposed residential receivers as part of the Stage 2 mixed-use DA can be seen nearby.

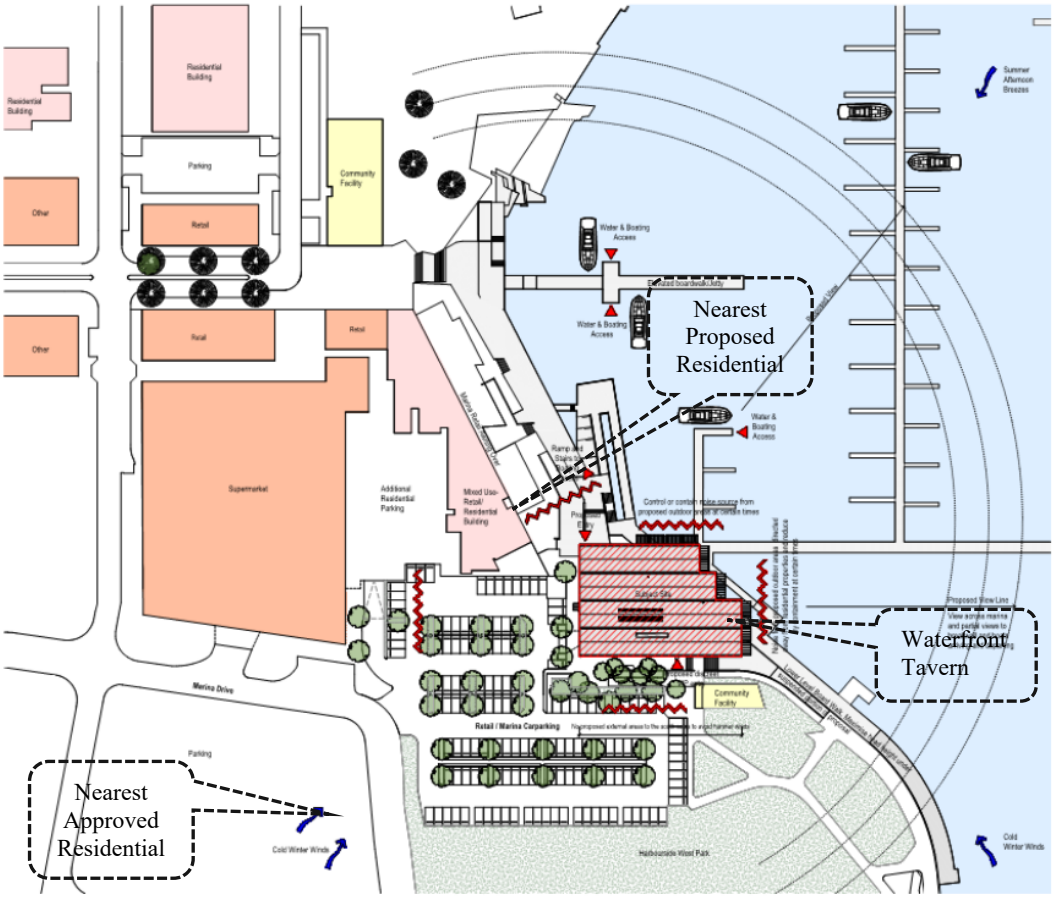

Figure 1: Precinct D – Site Analysis plan (H&E 2392 DA0010 rev 3)

Figure 2 shows the layout within the Waterfront Tavern. Outdoor seating areas can be seen around the northern and eastern boundaries of the property.

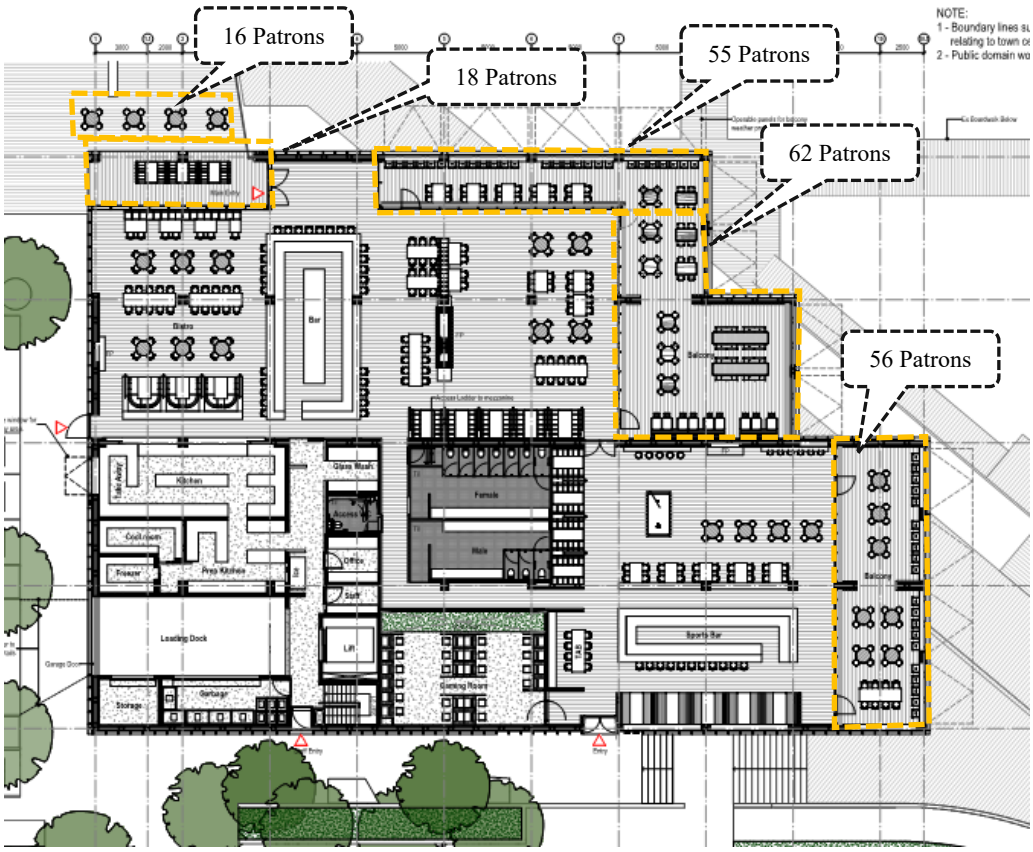

Figure 2: Waterfront Tavern with outdoor patron numbers marked – Ground Level plan (H&E 2392 DA1101 rev 6)

3 Acoustic criteria

3.1 Overview

To enable activation of the public realm and allow a reasonable usage of outdoor areas of the Tavern, it is recommended that criteria apply inside residential dwellings for proposed buildings in the nearby vicinity such as the Stage 2 Mixed-Use development, due to the limitations on mitigating noise to external areas. As acknowledged in the Shellharbour DCP, residential premises around the town centre may require mitigation, and thus, internal criteria, rather than external criteria are appropriate.

Achieving the internal noise criteria will primarily be dependent on the external noise exposure at nearby residential façades and the sound insulation performance of the residential façade. Therefore, noise limits for noise generating developments are still warranted.

The overall approach has given consideration to:

- Desired internal acoustic amenity for new residential premises
- External acoustic amenity for new residential premises, despite focus on internal acoustic criteria
- External acoustic criteria at existing residential development.
- Operational opportunities and flexibility for noise generating development
- Performance, practicality and feasibility of the residential façade design.

Further to modelling of the proposed Tavern, auralisation and stakeholder consultation, the following has been established.

1. Internal noise criteria for new residential premises as per Arup Acoustics document *AC09 (v2) Stage 2 DA Acoustic Supplement*
2. Noise emission criteria, including patron, music and building services noise

3.2 Noise emission criteria

The following criteria relates to noise emission from the Tavern development, including patron noise as well as building services noise. Noise emission criteria is split into two types of residential receivers:

- New proposed residences within precinct D – Noise emission criteria is to be met internally within dwellings with resulting ‘at façade’ criteria present in Section 3.2.1
- Existing or currently approved residences – Noise emission criteria is to be met at the building’s façade as per Section 3.2.2.

3.2.1 New receivers

As outlined in *AC09 (v1) Stage 2 DA Acoustic Supplement*, the ultimate amenity criteria for residential premises is to apply inside the dwelling, which has been reproduced in Table 1 for reference.

Table 1: New residential receivers – noise ingress internal design levels

Time period	**$L_{Aeq(15minute)}$ [dB(A)][1]**	
	Bedrooms	**Living Rooms**
7 am – 10 pm	35	40
10 pm – 7 am	30	35

Notes:

1 - Noise levels are to be achieved with windows and doors closed. Where the internal noise levels are exceeded by more than 10 dB with windows open, alternative ventilation shall be provided

While it will be the responsibility of the residential buildings to be designed to meet the required internal levels, relevant external criteria have been defined for noise generating uses.

Table 2 outlines the cumulative acoustic criteria for noise emission at new receivers within the Precinct. It is noted that an acoustic masterplan report is to be developed to assign targets to each proposed retail use, as well as defining the expected external noise levels at each new receiver.

As the alternative criteria are generally intended for activating the public realm, noise sources would primarily relate to patron noise and building services. It was determined during consultation that music noise should be well below patron noise emissions, and thus lower targets have been set.

Table 2: Noise emission criteria at new residential premises

Assessment location	**Noise source**	**Time period, $L_{Aeq(15minute)}$ ($L_{Ceq(15minute)}$)**			
		7 am – 6 pm	**6 pm – 8 pm**	**8 pm – 10 pm**	**10 pm – 7am**
Façade – (free field)	Patrons	60	60	55	50
	Music	50 (60)	50 (60)	45 (55)	40 (50)
	Mechanical[1]	50	45	45	40
Internal[2]	Patrons	5 dB below criteria in Table 1			
	Music	10 dB below criteria in Table 1			
	Mechanical plant	10 dB below criteria Table 1			

Notes:

1- Shall take into account the modifying factors outlined in the NSW *Noise Policy for Industry*

2 - Low frequency noise shall $L_{Ceq} - L_{Aeq} < 20$ dB

3.2.2 Existing receivers

It is proposed that existing receivers are assessed to an external location, given that they would not necessarily have incorporated specific mitigation measures.

It is considered reasonable that the criteria factor in the overall change in acoustic environment that is expected under full development of the precinct, rather than be based upon the existing ambient environment.

As presented in the DA acoustic report, Table 3 presents a summary of the criteria options, along with that proposed for adoption. These criteria would be considered the cumulative requirement for patron and mechanical plant noise impacts. The proposed criteria are also considered minimum targets for initial planning purposes, such that if future background noise levels after development are notably higher than estimated, they may be revised according to standard noise policy.

It is noted that sleep disturbance criteria, which is typically in terms of L_{AMax}, has not been proposed, generally as it is expected that the L_{Aeq} criteria will appropriately address the assessment of precinct noise. Given the distance between the 'City Centre' where activity is proposed and existing residential areas, sound levels are expected to be characterised by more steady-state or quasi-steady-state noise, rather than intermittent discrete events.

Table 3: Existing residential receivers – external design levels

Criteria,	**Time Period[1], $L_{Aeq\ 15minute}$ dB**		
	Day	**Evening**	**Night**
Intrusiveness – measured [1]	44	42	38
Intrusiveness – AS1055 – R2	50	45	40
Suburban Amenity Goals (NSW NPI)	55	45	40
PROJECT CRITERIA[2]	**50**	**45**	**40**

Notes:

1 - Daytime: 7.00am to 6.00pm Monday to Saturday, 8.00am - 6.00pm on Sundays and Public Holidays; Evening: 6.00pm to 10.00pm; Night-time: 10.00pm to 7.00am, 10.00pm - 8.00 am on Sundays and Public Holidays.

2 - Assessment shall take into account the modifying factors outlined in the NSW *Noise Policy for Industry*

4 Noise emission assessment

4.1 Tavern noise emissions

Noise emissions from the Tavern are primarily dictated by outdoor seating / dining areas. Modelling parameters and predictions of patron noise levels are based upon the following temporal plan:

- 7am - 8pm, normal operation of outdoor areas
- 8pm - 10 pm, zone 1 and 2 patrons removed, zone 3 shutters closed
- 10pm onwards, zone 1 and 2 patrons removed, zone 3 and 4 shutters closed

Outdoor zones are defined in Figure 3.

4.2 Source noise levels

Noise emission from all outdoor areas has been factored into the model based upon the seating counts shown in Figure 3.

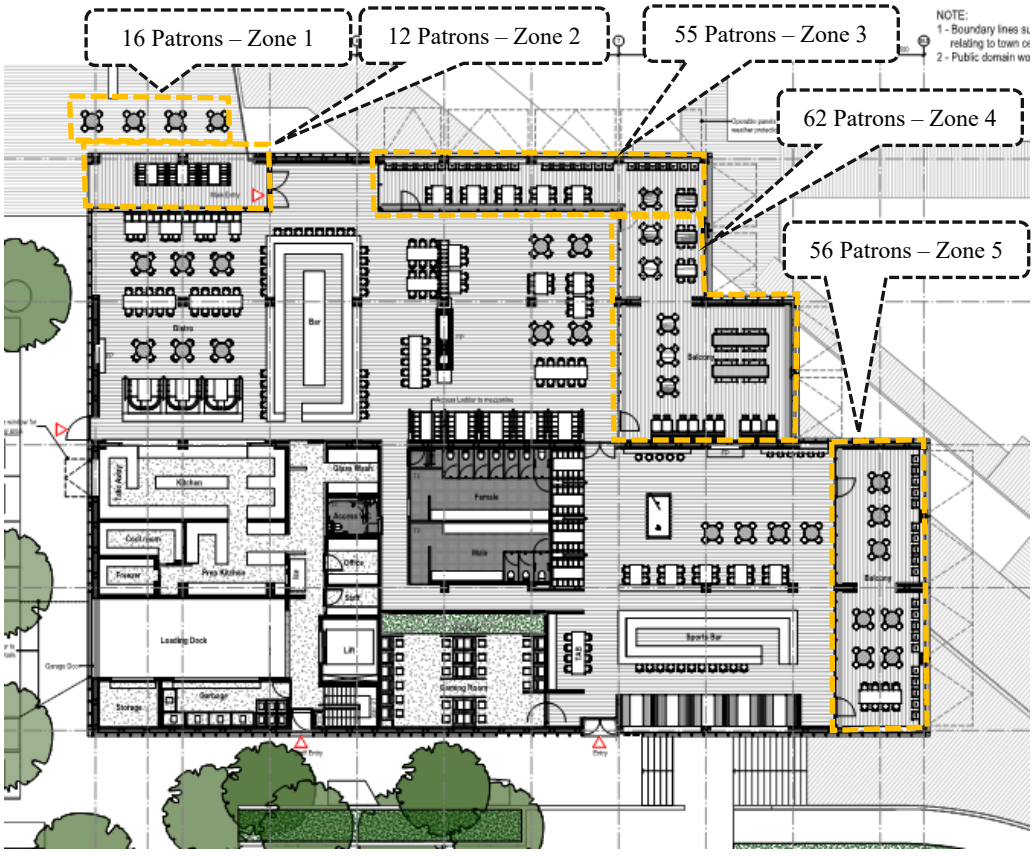

Figure 3 – Waterfront Tavern with outdoor patron numbers marked – Ground Level plan (H&E 2392 DA1101 rev 6)

Noise levels from patrons in outdoor areas have been predicted using formula established in Hayne et al. [2] being:

- L_{WAeq} = 15 x log(Crowd size) + 64 dB(A)

Spectra have been based on Cushing et al. [3] using an energy average of the male and female raised voice spectrum. Predictions are based on full capacity of the outdoor areas, and also include a + 5 dB correction.

4.2.1 Predicted noise levels

Predicted noise levels are presented in Table 4 for the nearest new and existing residential receiver to the Tavern.

The following assessment also considers the cumulative impact of the Tavern and retail tenancies in the ground floor of the Stage 2 mixed-use development. Predictions for the retail tenancies have been taken from Arup Acoustic document *AC09 (v1) Stage 2 DA Acoustic Supplement*. The predictions have subsequently been used to establish project specific criteria for the Tavern.

Table 4: Predicted noise levels

Receiver location	**Operating period**	**Predicted noise level, $L_{Aeq(15minute)}$**			**Criteria, $L_{Aeq(15minute)}$**
		Tavern	**Stage 2 Retail**	**Combined**	
New Residential Stage 2, L1 – southern end of east façade – Room 106	7 am – 6 pm	56	51	57	*60*
	6 pm – 8 pm	56		57	*60*
	8 pm – 10 pm	43		52	*55*
	10 pm onwards	43		52	*50*
New Residential Nearest proposed residential receivers across the marina in Precinct G	7 am – 6 pm	46	41	47	*60*
	6 pm – 8 pm	46		47	*60*
	8 pm – 10 pm	44		46	*55*
	10 pm onwards	41		44	*50*
Existing Residential External boundary South of Stage 2 development	7 am – 6 pm	38	39	42	*50*
	6 pm – 8 pm	38		42	*45*
	8 pm – 10 pm	33		40	*45*
	10 pm onwards	32		40	*40*

The predictions indicate compliance at all locations during all time periods, except for Room 106 after 10 pm. However, the predicted marginal exceedance is not related to noise from the Tavern and is to be address by the Stage 2 retail uses, as outlined the corresponding report. The predicted noise levels also provide some allowance for noise from other sources, albeit less so after 10 pm.

4.3 Recommendations

4.3.1 Project specific criteria

Based on the assessment and consideration of potential cumulative impacts, the following project specific criteria has been established for the Tavern. Table 5 relates to new residential, while Table 6 relates to existing residential receivers in Precinct C

Table 5: Tavern noise emission criteria at new residential premises

Assessment location	**Noise source**	**Time period, $L_{Aeq(15minute)}$ ($L_{Ceq(15minute)}$)**			
		7 am – 6 pm	**6 pm – 8 pm**	**8 pm – 10 pm**	**10 pm – 7am**
Precinct D Stage 2 mixed use - Façade – free field	Patrons	56	56	46	43
	Music	46 (56)	46 (56)	36 (46)	33 (43)
	Building services/ Mechanical [1]	45	40	40	35
Precinct G Residential - Façade – free field	Patrons	48	48	46	43
	Music	38 (48)	38 (48)	36 (46)	33 (43)
	Building services/ Mechanical[1]	35	35	35	30

Notes:

1- Shall take into account the modifying factors outlined in the NSW *Noise Policy for Industry*

2 - Low frequency noise shall $L_{Ceq} - L_{Aeq} < 20$ dB

Table 6: Tavern noise emission criteria – Existing[1] residential receivers

Criteria,	**Time Period[2], $L_{Aeq\ 15minute}$ dB**		
	Day	**Evening**	**Night**
Total noise emission[3]	45	40	33

Notes:

1 - Existing residential receivers refers to development approved prior to the date of the subject approval.

2 - Daytime: 7.00am to 6.00pm Monday to Saturday, 8.00am - 6.00pm on Sundays and Public Holidays; Evening: 6.00pm to 10.00pm; Night-time: 10.00pm to 7.00am, 10.00pm - 8.00 am on Sundays and Public Holidays.

3 - Assessment shall take into account the modifying factors outlined in the NSW *Noise Policy for Industry*

4.3.2 Tavern noise management

The following outlines in-principle mitigation and management measures for the Tavern design and operation:

- Provide lockable imperforate shutters / panels along the northern perimeter of the Tavern to adequately control noise emission to the nearby receivers.
    - Shutters recommended to be closed after 8 pm on the northern perimeter (zone 3).

  - Shutters should be closed after 10 pm on the north-eastern perimeter (zone 4).
- Vacate outdoor areas at the north-west of the Tavern (zones 1 and 2) after 8 pm
- Close the northern entrance to the Tavern while directing the customers to enter/exit via the west and south after 8 pm.
- Limited background music in external areas, to reduce noise build-up and subsequently the need for patrons to further raise voices in conversation
- Provide acoustically absorptive finishes to the underside of outdoor roof areas
- Utilise furniture and seating that promotes smaller groups sitting close to one another.
- Signage may be implemented to make patrons aware of the close proximity to residences and the need to keep noise to a minimum.
- Operate within the approved patron capacity numbers.
- Install noise monitors and/or limiters to sound systems used throughout the venue. In-house sound systems should incorporate limiters, while monitoring systems will be required for entertainment being provided through other equipment or acoustic instrumentation (i.e. drums).
- The building envelope design will need to consider all emission paths, such as walls, roof, mechanical ductwork and floor (for raised areas). Acoustically absorptive finishes should also be incorporated into the interior design of the Tavern, particularly as windows and doors are likely to be open at most times. Operational requirements, particularly provision of entertainment will be the primary driver for the building envelope design.

4.3.3 Building services equipment

Building service equipment (e.g. mechanical, hydraulic and electrical equipment) for the development has not been selected at this stage of design. During ongoing design of the development, building services equipment will be selected and provided with noise and vibration attenuation measures as required to meet the Project goals.

Noise mitigation treatment is likely to be required, which should give consideration to:

- Specification of maximum sound power levels for all items of plant as part of the project documentation.
- Use of attenuators to control fan noise as required
- Acoustic louvres to control noise from plantroom ventilation openings
- Vibration isolators to reduce vibration input to the building structure
- Acoustic screens around external plant, where required
- Incorporation of sound absorptive treatments in plantroom spaces.

5 Conclusion

This report confirms the proposed acoustic criteria and strategy for The Waterfront development, following consultation with Frasers Property and Shellharbour City Council. The approach seeks to address the planning objectives for a vibrant and active public realm, while also addressing the acoustic amenity of noise sensitive development.

This report also presents assessment against the established criteria and provides recommendations where required.

Regarding the Tavern responsibilities, this is expected to include:

- Management of patron capacities, and usage of outdoor areas after 8 pm. Specific measures are outlined in Section 4.3.2.
- Acoustically absorptive finishes to reduce noise build up in internal and external areas
- Limiting of music noise levels by electronic means
- Appropriate detailing and design of the building envelope to mitigate noise from internal activities
- Design and mitigation of building services noise, having regard to equipment selection and standard attenuation measures.

It would be expected that further detailed design and acoustic certification would be required for the development prior to issue of the Construction Certificate.

References

[1] NSW Environment Protection Authority, "Noise Guide for Local Government," NSW Environment Protection Authority, 2013.

[2] M. Hayne, J. Taylor, R. Rumble and D. Mee, "Prediction of Noise from Small to Medium Sized Crowds," in *Acoustics 2011*, Gold Coast, 2011.

[3] I. R. Cushing, F. F. Li, T. J. Cox, K. Worral and T. Jackson, "Vocal effort levels in anechoic conditions," *Applied Acoustics,* vol. 72, pp. 695-701, 2011.

[4] Standards Australia, "AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors," SAI Global Limited, 2016.

[5] World Health Organisation, "Guidelines for Community Noise," Geneva, 1999.

Appendix A

Glossary

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / min$L_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min$L_{A90,1hour}$ in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting ("A-weighting") to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L_1

The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dB(A) or higher for 1% of the 15 minute measurement period.

L_{10}

The L_{10} statistical level is often used as the "average maximum" level of a sound level that varies with time.

Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

L_{90}

The L_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time.

Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

L_{eq}

The 'equivalent continuous sound level', L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB $L_{Aeq.}$ Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time.

Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".

Impact Sound Pressure Level

The technical parameter used to determine impact sound isolation of floors is the impact sound pressure level, L_i.

In the laboratory, the weighted normalised impact sound pressure level, $L_{n,w}$, is used to represent the impact sound isolation as a single figure.

On site, the weighted normalised apparent impact sound pressure level, $L'_{n,w,}$ and the weighted standardised apparent impact sound pressure level, $L'_{n,Tw}$, are used to represent the impact sound isolation of a floor as a single figure.

These single weighted values are determined by comparing the spectral impact sound pressure levels (as defined in ISO 140-6 & ISO 140-7) with reference values outlined in AS/NZS ISO 717.2.

Sound Exposure Level (SEL)

The Sound Exposure Level or Single Event Noise Exposure Level, denoted SEL or L_{AE}, is a measure of the total amount of acoustic energy contained in an acoustic event. The SEL is the constant sound pressure level that would produce in a period of one second the same amount of acoustic energy contained in the acoustic event. SEL is commonly used to quantify the total acoustic energy contained in transient events such as a vehicle pass-by.

Sound Level Difference (D)

Sound level difference is used to quantify the sound insulation between two spaces, and is equal to the difference in sound level between the two rooms at a particular frequency (e.g. if the sound level in the source room is 100 dB and the sound level in the adjacent room is 75 dB, the sound level difference is 25 dB). The weighted sound level difference, D_w, (as defined in AS/NZS ISO 717.1) is commonly used to provide a single-number descriptor to describe the overall performance of a partition across a wider frequency range.

The terms used to describe the airborne sound insulation rating of a building element when tested on-site are the weighted normalised level difference ($D_{n,w}$), which corrects the measured sound level difference to a reference absorption area in the receiving room, or the weighted standardized level difference ($D_{nT,w}$), which corrects the measurements to a reference reverberation time in the receiving room. These single numbers are determined by comparing the spectral sound insulation test results (as defined in ISO 140-4) with reference values, as outlined in AS/NZS ISO 717.1.

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Sound Reduction Index (R)

The sound reduction index (or transmission loss) of a building element is a measure of the loss of sound through the material, i.e. its sound attenuation properties. It is a property of the component, unlike the sound level difference, which is affected by the common area between the rooms and the acoustics of the receiving room. R is the ratio (expressed in decibels) of the sound energy transmitted through the building element to the sound energy incident on the building element for a particular frequency.

The weighted sound reduction index, R_w, is a single figure description of sound reduction index across a wider frequency range and is defined in BS EN ISO 717-1: 1997. R_w values are calculated from measurements in an acoustic laboratory. Sound insulation ratings derived from site measurements (which are invariably lower than the laboratory figures) are referred to as apparent sound reduction index (R'_w) ratings.

Structureborne Noise

The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.

Vibration

Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.