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Acoustic Report

- Internal Noise & Environmental Noise Assessment-

For proposed development at

No. 28 Lockwood Avenue, Belrose

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15/05/2019	Initial Report	Domeniki Tsagaris	Moussa Zaioor
06/12/2019	Final Report	Domeniki Tsagaris	Moussa Zaioor

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1.0 SCOPE OF WORK

The aim of this report is to determine the building materials to be used and the construction methods to be adopted such that the proposed development at No. 28 Lockwood Avenue, Belrose is built to achieve acceptable internal noise levels as per Northern Beaches Council Conditions/ Requirements.

Noise intrusion levels are to be within the limits adopted by the Building Code of Australia, AS 2107 'Acoustics – Recommended Design Sound Levels and Reverberation Times' and Northern Beaches Council requirements, such that all habitable rooms in the proposed development shall be designed to limit internal noise levels.

The use and operation of all proposed Mechanical Plant & Equipment is to comply with the NSW Noise Policy for Industry and Northern Beaches Council Conditions/Requirements.

The site is located on the corner of Lockwood Avenue and Glen Street in the suburb of Belrose (Figure 1 – Site Location). The architectural plans by DKO Architecture Pty Ltd dated October 31st, 2019 are for the proposed construction of a four (4) storey mixed used development with three (3) levels of basement parking. The site is located in a mixed-use district with predominately retail and residential developments (Figure 2 – Surrounding Environment). The proposed site is affected by the operational activities from Glenrose Village, with the driveway entrance to Glenrose Village car park, mechanical plant servicing Glenrose Village and the Woolworth loading dock located opposite the site (Figure 3 – Surrounding Environment – Glenrose Village). Additionally, the proposed development is affected by the noise generated from the Caltex Petrol Station neighbouring the site as well as Glen Street Theatre located opposite the site (Figure 4 – Surrounding Environment – Caltex Petrol Station).

Figure 1- Site Location

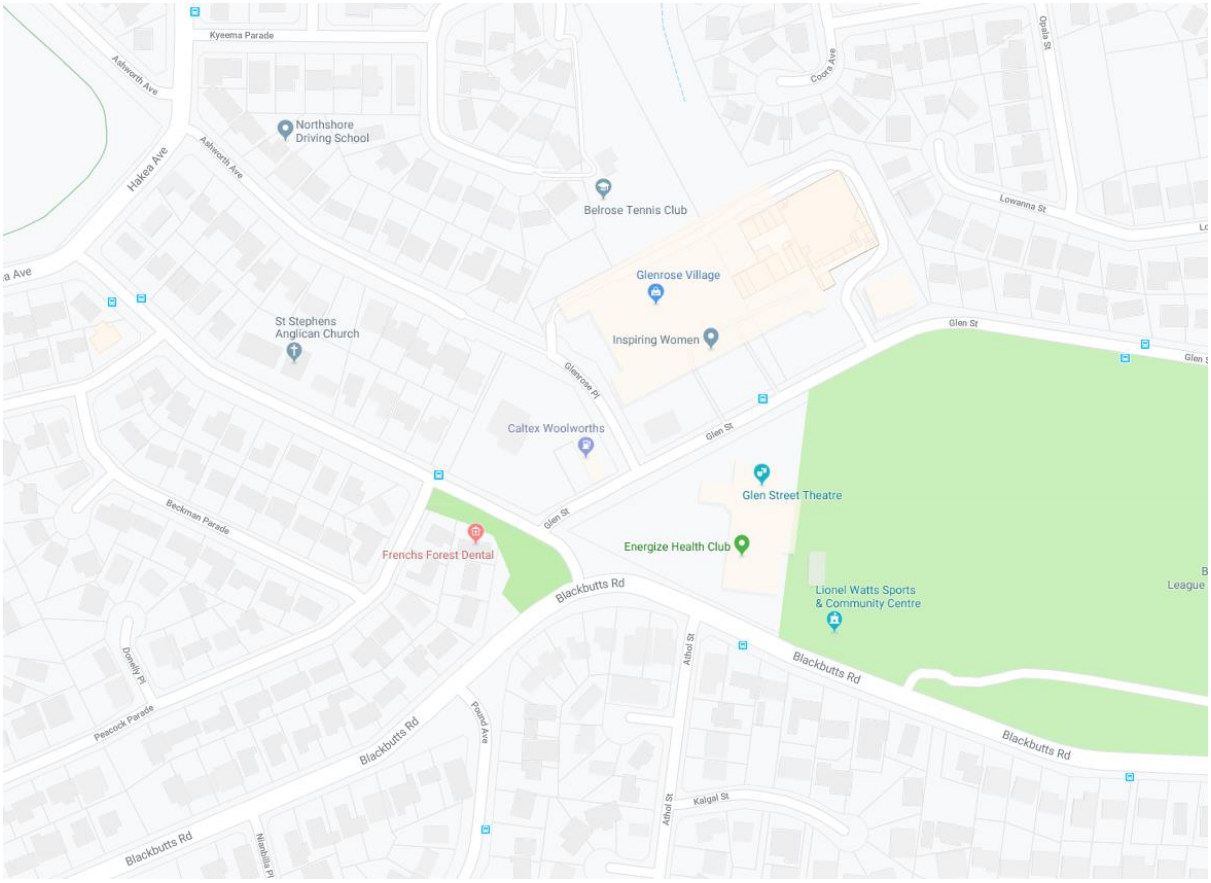


Figure 2 - Surrounding Environment

Figure 3 - Surrounding Environment - Glenrose Village (Woolworth loading dock and car park entrance)

Figure 4 - Surrounding Environment – Caltex Petrol Station

2.0 ACOUSTIC DESCRIPTORS

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

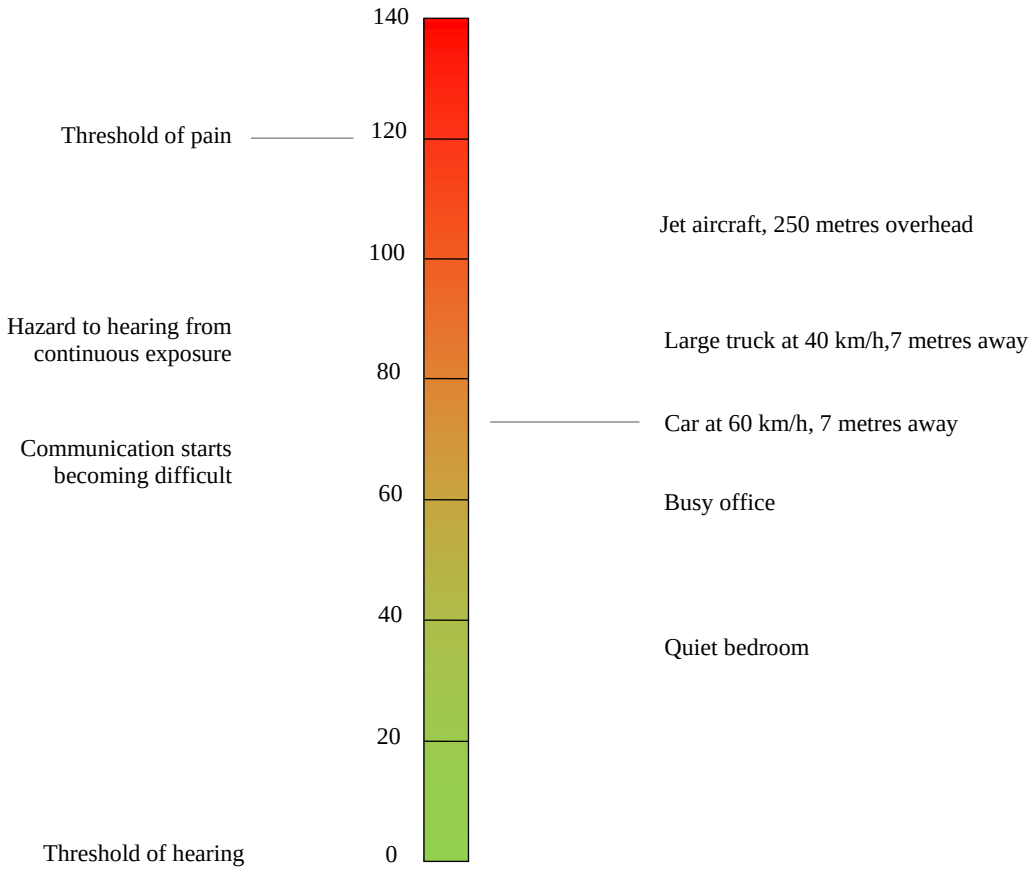
L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and nighttime) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and nighttime.

The level of common sounds on the dB(A) scale as the figure below:



3.0 ACOUSTIC STUDY (AS/NZS 2107:2016)

The above standard has formulated the criteria for developments situated in urban areas. The levels have been derived from relevant Australian Standards, the measurements and analysis of noise conditions in other similar developments and standards established in completed projects.

As noise levels from the surrounding environment are not constant, a Leq noise level descriptor is used when assessing this type of noise source. The Leq is the mean energy level of noise being measured and has been found to accurately describe the level of annoyance caused by commercial and traffic noise.

It is usual practice, when we find it necessary to recommend internal sound levels in buildings to refer to Australian/New Zealand Standard AS/NZS 2107:2016 "Acoustics – Recommended Design Sound Levels and Reverberations times for Building Interiors".

This standard provides recommended noise levels for steady state such as noise from building services and quasi-steady state sounds, such as traffic and industrial noise. The noise levels recommended in AS/NZS 2107:2016 take into account the function of the area and apply to the sound level measured within the space unoccupied although ready for occupancy. The standard recommends the following noise levels for residential buildings.

Type of occupancy/activity	Design sound level ($L_{Aeq,t}$) range	Design reverberation time (T) range, s
RESIDENTIAL BUILDINGS (see Note 5 and Clause 5.2)		
Houses and apartments in inner city areas or entertainment districts or near major roads—		
Apartment common areas (e.g. foyer, lift lobby)	45 to 50	—
Living areas	35 to 45	—
Sleeping areas (night time)	35 to 40	—
Work areas	35 to 45	—
Houses and apartments in suburban areas or near minor roads—		
Apartment common areas (e.g. foyer, lift lobby)	45 to 50	—
Living areas	30 to 40	
Sleeping areas (night time)	30 to 35	
Work areas	35 to 40	—

4.0 NOISE SURVEY & INSTRUMENTATION

On the 23rd November 2019, Acoustic, Vibration & Noise P/L went to the above address to carry out acoustic attended and unattended measurements at the boundary of the site (Figure 5 – Noise Reading Locations). The unattended environment noise monitoring (Point A) was conducted for seven (7) days from Saturday 23rd November to Saturday 30th November 2019, at the western boundary. Additional attended noise readings were carried out at the site boundary facing the Caltex Station (Point B) and Glenrose Village (Point C). The attended noise readings were taking between 11:30am and 12:30 pm on Saturday 23rd November 2019, to anticipate the greatest noise generated from the Caltex petrol station and Glenrose Village during the period where the shopping centre is expected to be at its busiest time.

All sound pressure levels are rounded to the nearest whole decibel. All measurements were taken in accordance with the Australian Standards AS 1055 "*Acoustics- Description and Measurements of Environmental Noise*".

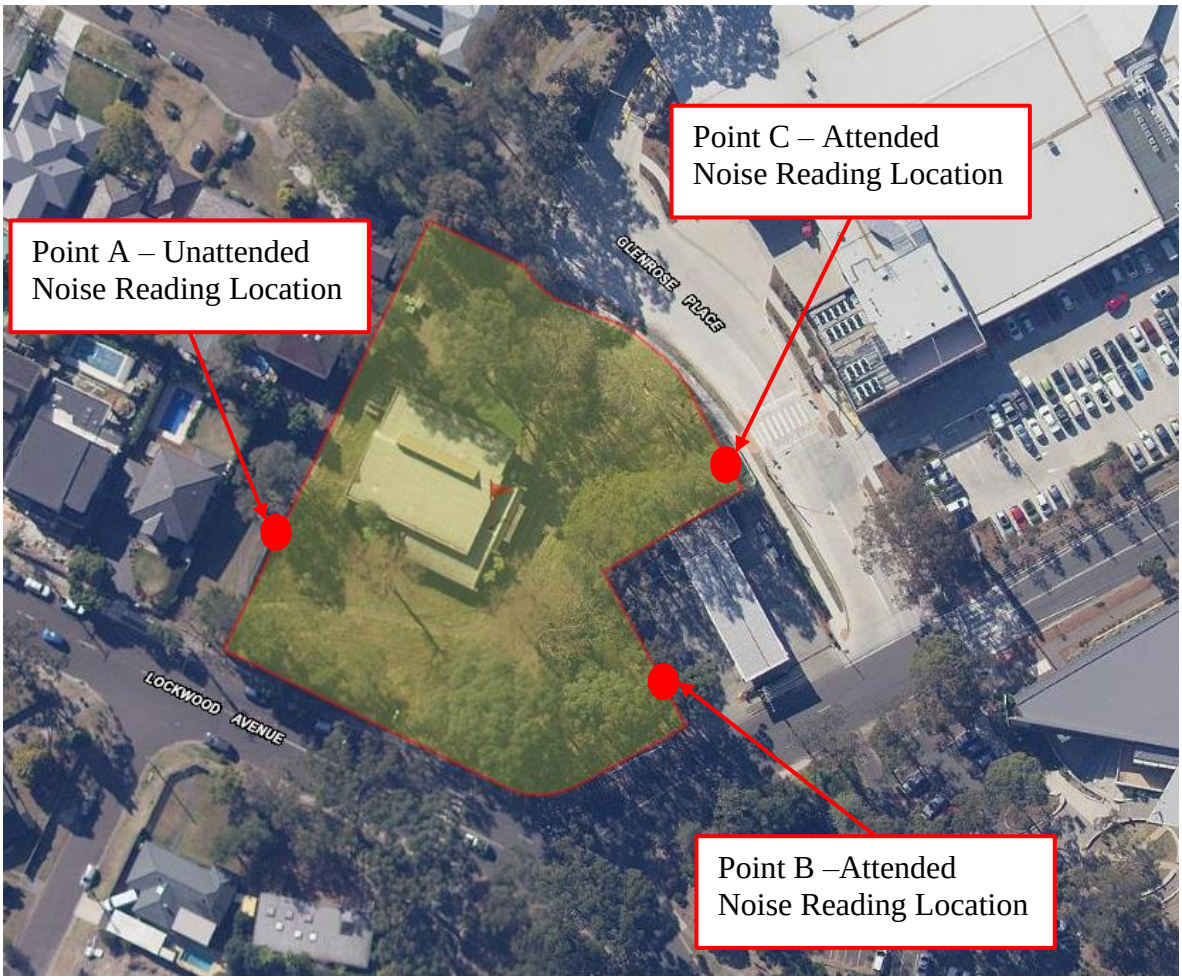


Figure 5 - Noise Reading Locations

The measurement procedure and the equipment used for the noise survey are described below. All sound pressure levels are rounded to the nearest whole decibel. All sound level measurements and analysis carried throughout this report are carried with Svantek 977 Noise and vibration level meter which has the following features:

- Type 1 sound level measurements meeting IEC 61672:2002
- General vibration measurements (acceleration, velocity and displacement) and HVM meeting ISO 8041:2005 standard
- Three parallel independent profiles
- 1/1 and 1/3 octave real time analysis
- Acoustic dose meter function
- FFT real time analysis (1920 lines in up to 22.4 kHz band)
- Reverberation Time measurements (RT 60)
- Advanced Data Logger including spectra logging
- USB Memory Stick providing almost unlimited logging capacity
- Time domain signal recording
- Advanced trigger and alarm functions
- USB 1.1 Host & Client interfaces (real time PC "front end" application supported)
- RS 232 and IrDA interfaces
- Modbus protocol

The noise logger was positioned at a maximum height of 1.5m from the ground. The machine was calibrated prior and after reading using our Svantek SV 33A S/N: 90200 class 1 Calibrator. Any readings affected by strong wind or rain have been disregarded. The Full Average Statistical Noise Parameters $\mathbf{L_{(Aeq,\ 15\ minutes)}}$, $\mathbf{L_{(A90,\ 15\ minutes)}}$, $\mathbf{L_{(A10,\ 15\ minutes)}}$, $\mathbf{L_{(A1,\ 15\ minutes)}}$ are presented in Figure 6 – Noise Survey. Summary of the unattended noise readings at Point A is presented in the Table 3.1.

Table 3.1- Summary of Unattended Noise Readings between 23rd November and 30th November 2019

At Point A	Arithmetic Mean LAeq dB(A)	Arithmetic Mean LA90 dB(A)	RBL dB(A)
Day Time – 7:00am-6:00pm	49	44	40
Evening Time – 6:00pm-10:00pm	46	43	37
Night & Early Morning Time – 10:00pm-7:00am	44	38	32

L_{eq} – the level of noise equivalent to the energy average of noise levels occurring over a defined measurement period.
L_{90} – the level of noise that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise level.

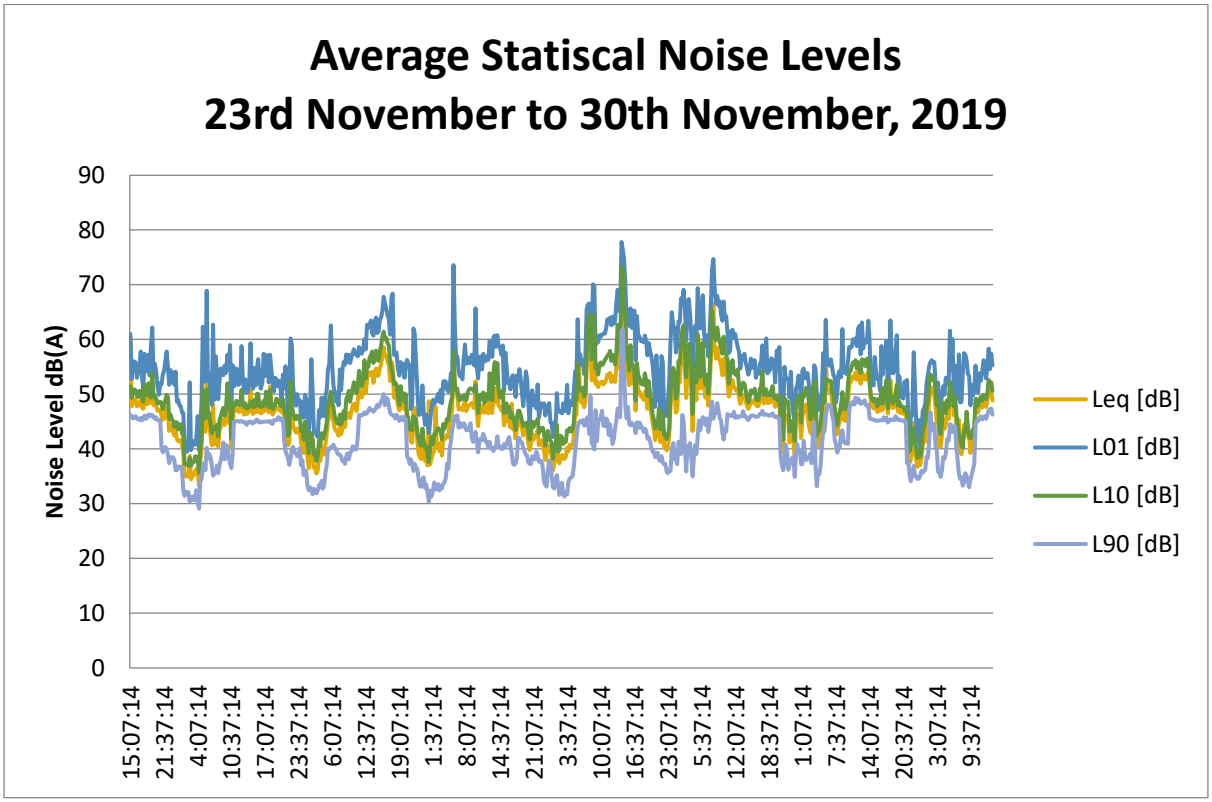


Figure 6 - Noise Survey – Unattended Noise Reading

A Summary of the attended noise readings carried out at the site boundary facing the Caltex Station (Point B) and Glenrose Village (Point C) are presented in the Table 3.2.

Table 3.2- Octave Band Centre Frequencies Summary of Attended Noise Readings on 23rd November 2019 at Location B & C

Noise Reading Location		***Typical Maximum Sound Power Levels Lw (dB) at Octave Band Centre Frequencies (Hz)***								
	dB(A)	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***16k***
Point B	**65.8**	56.9	54.5	56.3	58.4	59.6	57.5	55.3	48.1	35.7
Point C	**60.8**	41.3	45.3	49.1	53.1	56	53.8	52.4	47.5	36.5

5.0 RECOMMENDATIONS

5.1 WINDOWS/SLIDERS, WALLS, DOORS AND ROOFS

Building Component	Rw Rating to be Achieved
Windows & Sliding Doors in Retail Areas on Basement 2, Lower Ground and Ground Floor are to be 10.38 mm laminated with full perimeter Schlegel Q-Lon acoustic seals (1).	33-36
Windows & Sliding Doors in Living/Dining/Kitchen Area and all Bedroom Areas are to be as follows: *{Please see Figure 5-8 – Window Specifications/Locations}* - 10.38mm laminated with full perimeter Schlegel Q-Lon acoustic seals (1). - 6.38 mm laminated with full perimeter Schlegel Q-Lon acoustic seals (1).	 33-36 30-32
Windows in Bathrooms/Ensuites/Laundries etc in all Units are to be unrestricted and to be in accordance with AS 2047 (Windows in Buildings). (1)	-
External Walls are to be 270/250 mm double brick, brick veneer construction or any other method of wall construction with an Rw of 44.	40-44
Roof of all Units is to be Minimum 150mm Concrete Roof AND/OR Galvanised Steel Trough Roofing (0.5mm), on 10 gypsum plaster board ceiling with 75mm thick, 11kg/m³ mineral wool batts between ceiling joists.(2)	39-41

NB: This report is to be read in conjunction with the BASIX certificate and any other related building specification.
(1). No weep holes in windows/sliders. All gaps between window & door frames and the masonry alls are to be sealed using acoustic foam Hilti CP620 or similar. Glass wool batts can be applied prior to the application of the foam to seal larger gaps. (2). All gaps are to be acoustically sealed.

*****Glazing Notes -Leaks & Glazing Attenuation-**

- The Acoustic performance of a glazing system highly depends on the leaks around and within the glazing frame and façade. A double-glazing system with Rw of 40 will have its acoustic performance dropped to Rw of 30 (less than that of 6.38 mm glass) at a leak of 0.1 %. Moreover, a double-glazing system with Rw of 40 will have its acoustic performance dropped to Rw of 20 (less than that of 3.0 mm float glass) at a leak of 1 % of the glazing area.

- A 10.38mm laminated glazing system with Rw of 35 will have its acoustic performance dropped to Rw of 29 (less than that of 6.38 mm glass) at a leak of 0.1 %. Moreover, 10.38m mm laminated glazing system with Rw of 35 will have its acoustic performance dropped to Rw of 20 (less than that of 3.0 mm float glass) at a leak of 1 % of the glazing area.

- A double-glazing system with Rw of 40, a 10.38m mm laminated glazing system with Rw of 35, and a 6.38 mm laminated glazing system with Rw of 32 will all attain almost the same Rw of around 20 (less than that of 3.0 mm float glass) at a leak of 1 % in the façade or a within/around the glazing system.

The graph below shows the actual transmission loss achieved inside a room with different glazing thicknesses relative to small leaks occurring along the window frame and façade.

A test report is to be provided from a recognized acoustic laboratory, verifying that the glazing system (glass, frame and seals) will meet the nominated sound rating required.

Figure 7 - Lower Ground Windows/Sliders Specification

6.38mm Laminated

10.38mm Laminated

Figure 8 – Ground Floor Windows/Sliders Specification

6.38mm Laminated

10.38mm Laminated

Figure 9 - Level 1 Windows/Sliders Specification

6.38mm Laminated

10.38mm Laminated

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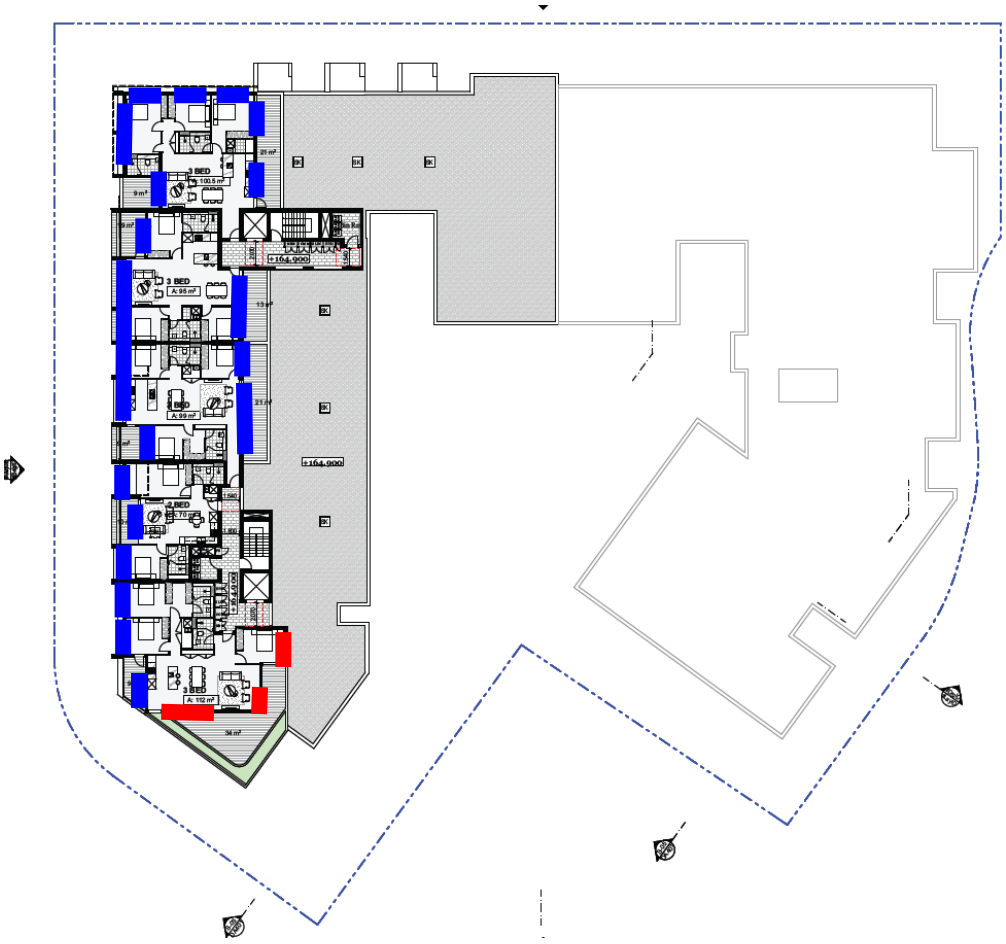

Figure 10 – Level 2 Windows/Sliders Specification

6.38mm Laminated

10.38mm Laminated

6.0 PROPOSED MECHANICAL PLANT, CAR PARK MECHANICAL VENTILATION AND GARAGE ROLLER DOOR

A range of mechanical plant, equipment and ventilation will be included in the proposed development at No. 28 Lockwood Avenue, Belrose emitted by the use of the proposed mechanical plant is assessed by the NSW Noise Policy for Industry.

The proposed levels of basement parking are located below ground level and that makes providing natural ventilation not possible and a mechanical extract system should be used. The mechanical ventilation system needs to achieve six air changes per hour for exhaust fume extract and ten air changes per hour for smoke clearance.

A garage roller door may also be located at the entry of the car park. Predicted noise levels from the operation of garage roller doors have been estimated according to typical rollers doors installed at other developments. The average time duration for a garage roller door to fully open or close is approximately 30 seconds.

7.0 ACCEPTABLE NOISE LEVEL

7.1 NOISE GUIDE FOR LOCAL GOVERNMENT

The Department of Environment and Conservation (NSW) published the amended *Noise Guide for Local Government* in October 2010. The policy is specifically aimed at assessing noise from light industry, shops, entertainment, public buildings, air conditioners, pool pumps and other noise sources in residential areas.

The appropriate regulatory authority (Local Council) may, by notice in writing given to such a person, prohibit the person from causing, permitting or allowing:

1. any specified activity to be carried on at the premises, or
2. any specified article to be used or operated at the premises.

or both, in such a manner as to cause the emission from the premises, at all times or on specified days, or between specified times on all days or on specified days, of noise that, when measured at any specified point (whether within or outside the premises,) is in excess of a specified level.

It is an offence to contravene a noise control notice. Prior to being issued with a noise control notice, no offence has been committed.

The Protection of the Environment Operations Act 1997 defines “Offensive Noise” as noise:

1. (a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:
2. (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or
3. (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort

or repose of a person who is outside the premises from which it is emitted, or
(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulation.

7.2 NSW NOISE POLICY FOR INDUSTRY (2017)

The above policy seeks to promote environmental well-being through preventing and minimizing noise by providing a framework and process for deriving noise limits conditions for consent and licenses.

The Noise Policy for Industry 2017 recommends two separate noise criteria to be considered, the Intrusive Noise Criteria and the Amenity Noise Criteria. A project noise trigger level being the lowest of the amenity and the intrusiveness noise level is then determined.

If the predicted noise level L_{Aeq} from the proposed project exceeds the noise trigger level, then noise mitigation is required. The extent of any 'reasonable and feasible' noise mitigation required whether at the source or along the noise path is to ensure that the predicted noise level L_{Aeq} from the project at the boundary of most affected residential receiver is not greater than the noise trigger level.

7.2.1 AMENITY NOISE CRITERIA

The amenity noise levels presented for different residential categories are presented in Table 2.2 of the Noise Policy for Industry 2017. These levels are introduced as guidance for appropriate noise levels in residential areas surrounding industrial areas.

For the proposed mixed development at No. 28 Lockwood Avenue, Belrose the recommended amenity noise levels are presented in Table 7.2.1.1 below:

Table 7.2.1.1 - Recommended Noise Levels from Industrial Noise Sources

Type of Receiver	Area	Time Period	Recommended Leq Noise Level, dB(A)
Residence	Urban	Day	60
		Evening	50
		Night	45

Where a noise source contains certain characteristics such as tonality, intermittency, irregularity or dominant low-frequency content, a correction is to be applied which is to be added to the measured or predicted noise levels at the receiver, before comparison with the criteria. Shown below are the correction factors that are to be applied:

Table 7.2.1.2 – Modifying Factor Corrections as per Fact Sheet C (Noise Policy for Industry 2017)

FACTOR	CORRECTION
Tonal Noise	+ 5 dB [1,2]
Low-Frequency Noise	+ 2 or 5 dB [1]
Intermittent Noise	+ 5 dB
Duration	+ 0 to 2 dB(A)
Maximum Adjustment	Maximum correction of 10 dB(A) [1] (excluding duration correction)

1. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.
2. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.

Correction for duration is to be applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the $L_{Aequ,15min}$ equivalent noise criterion is depicted in Table 7.2.1.3 for the duration of the event. This adjustment accounts for unusual and one-off events and does not apply to regular and/or routine high-noise level events.

Table 7.2.1.3 – Adjustment for Duration as per Fact Sheet C (Noise Policy for Industry 2017)

Allowable duration of noise (one event in any 24-hour period)	**Allowable exceedance of LAeq,15min equivalent project noise trigger level at receptor for the period of the noise event, dB(A)**	
	Daytime & evening (7 am–10 pm)	**Night-time (10 pm–7 am)**
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
less than 1.5 minutes	20	10

According to Section 2.4 of the above policy, the project amenity noise level is determined as follows:

> **Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)**

To convert from a period level to a 15-minute level, a plus 3 is added as per section 2.2 of the policy.

Therefore, the project amenity noise level for the proposed boarding house at No. 28 Lockwood Avenue, Belrose is as follows:

Daytime: **60 – 5 + 3 = 58** **dB(A)**
Evening: **50 – 5 + 3 = 48** **dB(A)**
Night-time: **45 – 5 + 3 = 43** **dB(A)**

7.2.2 INTRUSIVE NOISE CRITERIA

Section 2.2.1 of the Noise Guide for Local Government states that a noise source is generally considered to be intrusive if the noise from the source when measured over a 15-minute period exceeds the background noise by more than 5 dB(A). Similarly, The Noise Policy for Industry in Section 2.3 summarizes the intrusive criteria as below:

$$L_{Aeq,\,15\,minute} \leq \text{rating background level plus } 5$$

While the background noise level known as $LA_{90,15\ minutes}$ is the Noise exceeded 90% percent of a time period over which annoyance reactions may occur (taken to be 15 minutes). The RBL is defined as the overall single-figure $L_{A90,15\ minutes}$ background level representing each assessment period (day/evening/night) over the whole monitoring period.

For the short-term method, the rating background noise level is simply the lowest measured LAF90,15min level. For the long-term method, the rating background noise level is defined as the median value of:

- All day assessment background levels over the monitoring period for the day,
- All evening assessment background levels over the monitoring period for the evening, or,
- All night assessment background levels over the monitoring period for the night.

The predicted noise from the source $L_{Aeq,15\ min}$ is measured as at the most affected point within the most affected residential at the point where the most impact occurs.

Therefore, the acceptable L_{eq} noise intrusiveness criterion for broadband noise during the day, evening & night is as follows:

- **40 + 5 = 45 dB (A)** during the day,
- **37 + 5 = 42 dB (A)** during the evening and
- **32 + 5 = 43 dB (A)** during the night.

7.2.3 PROJECT NOISE TRIGGER LEVEL

A summary of intrusiveness and amenity noise levels as determined in sections 7.2.1 & 7.2.2 are shown in table 7.2.3 below:

Table 7.2.3 - Summary of Intrusiveness and project amenity noise levels

Period	Intrusiveness Noise Level	Project Amenity Noise level
Day Time (7:00am-6:00pm)	45	58
Evening Time (6:00pm-10:00pm)	42	48
Night & Early Morning (10:00pm – 7:00am)	37	43

The project noise trigger level is the lower (that is, the most stringent) value of the amenity and intrusiveness noise levels for the day, evening and night-time. Therefore, the project noise trigger levels for the proposed development are as shown below

Daytime: $L_{Aeq,15\ min}$ **45 dB(A)**
Evening: $L_{Aeq,15\ min}$ **42 dB(A)**
Night-time: $L_{Aeq,15\ min}$ **43 dB(A)**

The proposed mixed development and its activities including all mechanical plant will not exceed the project noise trigger level at the most sensitive location, provided all noise control recommendations in Section 8.0 are adhered to.

8.0 MECHANICAL PLANT & ROLLER DOOR NOISE CONTROL

A range of mechanical plant, equipment and ventilation will be included in the proposed development at No. 28 Lockwood Avenue, Belrose. Noise emitted by the use of the proposed mechanical plant is assessed by the Noise Policy for Industry 2017, and Council conditions/requirements.

Air-conditioning might also be installed in the proposed development. Typical noise levels for air-conditions, car park exhaust fans and security roller door sound power levels are presented in the table below:

Table 8.1 – Typical Mechanical Plant Leq Sound Power Levels

FREQUENCY [Hz]	63	125	250	500	1000	2000	4000	8000	dBA
Typical Car park Exhaust fan	80	82	84	87	86	83	78	71	**90**
Typical Condensing Unit	71	69	67	61	58	54	47	44	**64**
Leq, 15 mins Car-Park security roller door.	62	57	60	60	68	63	62	57	**77**

In order for the operation of the car park and basement garage door to meet the requirements of the NSW Noise Policy for Industry 2017, we recommend the following:

- Ensure maintenance and lubrication of motor bearings, door tracks and joints.
- The proposed security door fitted to the car parking area entrance must be independently mounted on rubber pads to prevent vibration noise transmission through the concrete walls and/or columns.

As the proposed development is still in the initial application stage, we recommend that further acoustic assessment is carried out when the development has been approved and Mechanical Services plans have been prepared for our review. In general, we recommend that all new external air-conditioning units are to be acoustically enclosed or set away by more than 3.0m from any boundary. The assessment of the mechanical plans once available will recommend proper silencer/(s) and duct lagging such that noise levels emitted from the mechanical plant servicing the proposed development at No. 28 Lockwood Avenue, Belrose, meet the requirements of section 7.0 of this report.

9.0 NOISE FROM PROPOSED COMMERCIAL PREMISES

The acoustic design for the proposed development is only for the base building design. Noise from any commercial space (Restaurants, Cafes, Office, Shops, Super Market, Other Shopping outlets (if any)...) is not covered in this report as it will be subject to a separate DA once the base building is approved. Future Reports/Plans accompanying the DA for these commercial spaces should ensure that the combined noise levels from these facilities including their mechanical plant is below the noise trigger level described in section 7.2.3 of this report.

10.0 DISCUSSION & CONCLUSION

The construction of the proposed development at No. 28 Lockwood Avenue, Belrose, if carried out as recommended in the plans and specifications and including the acoustic recommendations in this report, will meet the required noise reduction levels as required in AS 2107 'Acoustics – Recommended Design Sound Levels and Reverberation Times and Northern Beaches Council Conditions/Requirements.

All proposed mechanical plant & equipment will comply with the NSW Noise Policy for Industry (2017) provided recommendations are adhered to.

Should you require further explanations, please do not hesitate to contact us.

Yours Sincerely,

M. Zaioor
M.S. Eng'g Sci. (UNSW).
M.I.E.(Aust), CPEng
Australian Acoustical Society (Member)