Modification Acoustic Assessment – Eastlakes Town Centre, South Site – October 2019

Crown Group

Level 29, 1 Market Street

Sydney NSW 2000

2019-10-11 Modification Acoustic Assessment - Eastlakes Town Centre, South Site – October 2019

14 October 2019

Version: Final

Modification Acoustic Assessment – Eastlakes Town Centre, South Site – October 2019

PREPARED BY:

Pulse Acoustic Consultancy Pty Ltd
ABN 61 614 634 525
Level 4, 73 Walker Street, North Sydney, 2060

Matthew Furlong
Mob: +61 425 467 764
E: matthewfurlong@pulseacoustics.com.au www.pulseacoustic.com.au

DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
2019-10-11 Modification Acoustic Assessment - Eastlakes Town Centre, South Site – October 2019.docx	Draft	11th October 2019	Matthew Furlong	Matthew Harrison	
2019-10-14 Modification Acoustic Assessment - Eastlakes Town Centre, South Site – October 2019.docx	Draft	14th October 2019	Matthew Furlong	Matthew Harrison	Matthew Harrison
2019-10-14 Modification Acoustic Assessment - Eastlakes Town Centre, South Site – October 2019.docx	Final	14th October 2019	Matthew Furlong	Matthew Harrison	Matthew Harrison

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 Report Objectives

Approval for the redevelopment of the Eastlakes Shopping Centre (located on Lot 30 and 31 DP1246820) was granted by the Minister for Planning & Infrastructure on 19 September 2013.

Pulse Acoustical Consultancy Pty Ltd (Pulse Acoustics) has been engaged to provide the Acoustical Assessment to accompany the development application for the amendments to this approved development.

This assessment addresses the noise impact of existing road traffic and aircraft overflights on the amenity of internal spaces and sets criteria for noise emission from the development with respect to mechanical plant, traffic generation and activity noise from the retail spaces.

The development will be assessed against the Department of Planning & Infrastructure's (DoP&I) Project Approval for Application No. MP09_0146, dated 19th September 2013, as well as other relevant statutory regulations and guidelines including of the Bayside Council's ('Council') *Development Control Plan (DCP) 2013*, The NSW government's *State Environmental Planning Policy (SEPP) (Infrastructure) 2007* and the acoustic requirements of the Environment Protection Authority's (EPA) *Noise Policy for Industry* (NPI). Criteria for construction noise associated with the development will also be established according to the requirements of the EPA's *Interim Construction Noise Guideline (ICNG) 2009.* Acoustic separation criteria required by the National Construction Code (NCC) for internal construction within the development will also be identified.

Key aspects of the project include:

- Controlling noise intrusion from road traffic;
- Controlling noise emission from the mechanical services associated with the development to satisfy the requirements of the Environment Protection Authority (EPA) and Council's standard conditions of consent;
- Providing constructions that ensure compliance with the constraints of the BCA/NCC and the quality requirements of the project;
- Mitigating impacts associated with noise emission from the operation of the development, such as from loading dock activity; and
- Specifying construction noise criteria that the contractor will need to comply with when developing the projects to satisfy the requirements of the EPA's ICNG.

1.2 Project Background

This acoustic assessment follows an original acoustic assessment of the entire shopping centre redevelopment by Vipac Engineers and Scientists Ltd, titled, "*Eastlakes Shopping Centre Redevelopment – Acoustic Impact Assessment for a Part 3A Project Application*" (Report No. 20C-11-0070-TRP-466470-5), dated 6th July 2012. Reference is also made to an acoustic assessment for South Site of the Eastlakes Town Centre development by Acoustic Logic Consultancy, titled "*Eastlakes Town Centre – South Site, SEAR's Application – Acoustic Assessment*" (reference 20181051.2/2108A/R0/YK) dated 21st August, 2018. Prior to this modification Pulse Acoustics prepared an original modification report titled "*Modification Acoustic Assessment – Eastlakes Town Centre South Site"* dated 30th May 2019. This current report prepared by Pulse Acoustics largely replaces and supersedes these earlier acoustic assessments.

Approval for the redevelopment of the Eastlakes Shopping Centre was granted for a mixed use development involving:

- Demolition and removal of all existing buildings;
- Construction of a mixed use development generally between 2 - 6 storeys above podiums in height except at the corner of Evans Avenue and Racecourse Place, where a maximum height of RL 48.7 AHD applies;
- Maximum ground floor retail and community floor space of 14,404m²;
- Maximum 405 residential apartments with a maximum GFA of 34,636m2;
- 916 basement car parking spaces over two levels;
- Associated landscaping;
- Associated infrastructure, stormwater and utility works; and
- Stratum subdivision basement car parking, ground floor retail area with residential above, communal open space, public domain landscaping and associated infrastructure works.

Crown Group proposes to amend the previously approved development to address the various required Design Modifications, specified in Part B of the Approval, as well as to provide an improved development. These proposed design amendments include:

- Building J has been reduced by one storey (now 10 storeys) and has been stepped at the southern end;
- Separation between Building D and Building J is now ADG compliant;
- Oculus over retail has been further detailed and contains NLA accessible to residents and the public on podium level 2;
- Level 1 retail has been relocated to surround the oculus and an increase in total Retail and Commercial GFA;
- A reduction of approx. 38 apartments to the previous scheme (Total of approx. 361 apartments);
- On ground, the interface with the park has been amended and RL's adjusted;
- Amendments to B1;
- Back of house activation along Barber Avenue;
- Building F Ground Floor retail exhaust relocated;
- Plant spaces on Level 1 updated;
- Level 1 retail spaces reclaimed;
- Level 1 void over Ground Floor amended;
- Ground Floor retail glazing lines adjusted to suit amended void above;
- Added external stairs from Level 1 Lower Podium;
- Level 1 South West corner shape amended;
- Added glass canopy over "East Lane";
- Level 2 skylight and extent of oculus updated;
- Level 2 podium updated;
- Building J north elevation updated;
- Building J south elevation updated;
- Level 1 new units elevation updated;
- Building F elevation updated; and

- Building G - Level 1 elevation updated.

1.3 Relevant Guidelines

Noise intrusion into the development is controlled by the requirements of the Bayside Council's DCP and the Infrastructure State Environmental Planning Policy (ISEPP). The noise criteria for construction and operations are based on criteria produced by the Environment Protection Authority (EPA) and the Department of Planning (DoP). Internal construction requirements are governed by the requirements of Section F5 of the Building Code of Australia (BCA) component of the National Construction Code (NCC).

The guidelines applicable to this assessment include:

- *Bayside Council Development Control Plan (DCP) 2013;*
- *Interim Construction Noise Guideline* (ICNG) 2009;
- *State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP);*
- *Development near rail corridors and busy roads: interim guideline 2008;*
- Section F5 of the Building Code of Australia (BCA) component of the National Construction Code (NCC);
- *EPA Noise Guide for Local Government 2013 (NGLG);*
- *NSW Noise policy for Industry* 2017 (NPI);
- *NSW Road Noise Policy* 2011 (RNP);
- *NSW Road Noise Policy – Application Notes* 2013;
- *Australian / New Zealand Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors;*
- *Australian Standard AS 2021:2015 Acoustics - Aircraft noise intrusion - Building siting and construction; and*
- *British Standard 8233:1999 'Sound insulation and noise reduction for buildings – Code of practice.*

1.4 Noise Descriptors and Terminology

Environmental noise constantly varies in level with time. It is therefore necessary to measure environmental noise in terms of quantifiable time periods and statistical descriptors. Typically environmental noise is measured over 15 minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dB(A), the A indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' arithmetic does not apply, e.g. adding two sources of sound of an equal value results in an increase of 3dB (i.e. 60 dB(A) plus 60 dB(A) results in 63 dB(A)). A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the L_{Aeq}, L_{A1}, L_{A10} and L_{A90} noise levels. These L_{Aeq} noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period and is equivalent to a level that would have been experienced had the fluctuating noise level remained constant during the measured time period.

The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels are sometimes thought of as the maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included as Appendix A.

2 DESCRIPTION OF EASTLAKES TOWN CENTRE, SOUTH SITE DEVELOPMENT

The Eastlakes Town Centre South Site or Stage 2 of the Eastlakes Town Centre redevelopment project is located at the corner of Evans Avenue and Barber Avenue, Eastlakes. The site is currently occupied by the Eastlakes Shopping Centre and is bounded by Evans Avenue to the north, Barber Avenue to the south and east and Eastlakes Reserve to the west. Evans Avenue and Barber Avenue are both two lane local roads, with medium to low volumes of traffic.

It is proposed to demolish the existing shopping centre development on site and construct a new multi-storey mixed-use development which will include:

- Four levels of basement car parking,
- Ground level retail precinct,
- A childcare centre and retail on the podium level, and
- Five residential towers between 5 and 11 levels with a total of 361 units.

The site will have three areas of vehicle access, two along the south of the site in Barber Avenue and another to the north along Evans Avenue. The driveway which is located along Evans Road will be only for passenger vehicles and will provide access to all four basement levels (B1 and B2 are for retail and B3 and B4 are for residents only). The two driveways which are along Barber Avenue are split into loading dock and passenger vehicles. The loading dock driveway is along the south-east corner and passenger vehicles along the south-west

The site is surrounded by residential properties with local road networks carrying low to medium volumes of traffic. The surrounding nearest affected receivers are as follows;

- Residential properties along Barber Avenue – 18 to 34 Barber Avenue, Eastlakes.
- Residential Properties along Evans Avenue – 14 to 18 Evans Avenue, Eastlakes.

The modified site plan is shown in Figure 1. The east, west, north and south elevations are shown in Figure 2 to Figure 5 below.

Figure 1 Site Plan – Drawing Number: 2000, Revision M01

Figure 2 East Elevation – Drawing Number: 3000.01, Revision M01

Figure 3 West Elevation – Drawing Number: 3000.01, Revision M01

Figure 4 North Elevation – Drawing Number: 3000.2, Revision M01

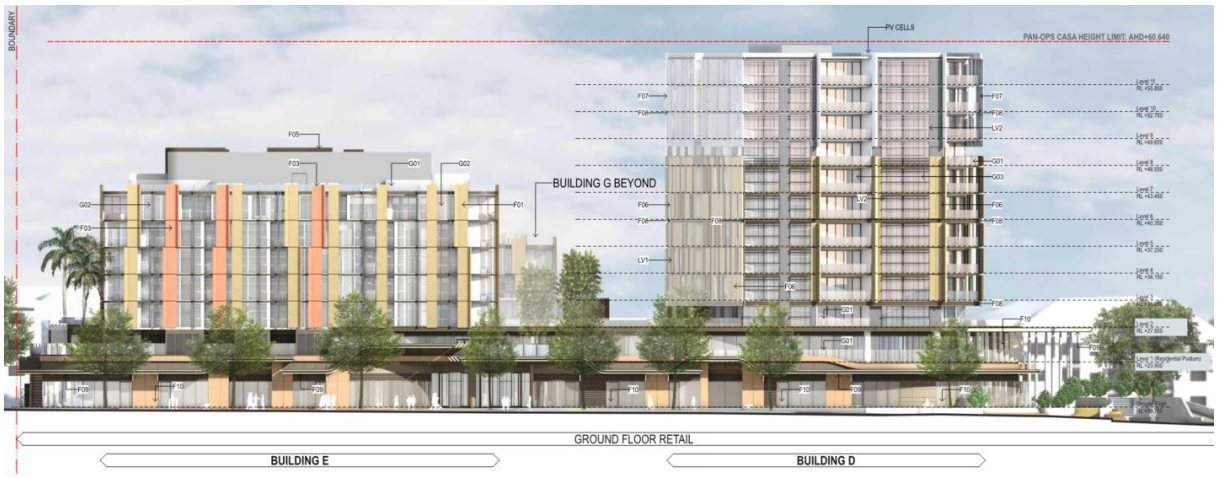


Figure 5 South Elevation – Drawing Number: 3000.2, Revision M01

2.1 Drawing list

The architectural drawings used for this assessment are those issued on 14th October 2019 and include:

Table 1 Architectural Drawing List

Drawing Author	Drawing Number	Drawing Title	Drawing Date	Drawing Revision
Fjmt studio	2000.00	Site Plan	11/10/2019	M01
Fjmt studio	2000.GF	Ground Level	11/10/2019	M01
Fjmt studio	2000.01	Level 1 Lower Podium	11/10/2019	M01
Fjmt studio	2000.02	Level 2 Upper Podium	11/10/2019	M01
Fjmt studio	2000.03	Level 3	11/10/2019	M01
Fjmt studio	2000.04	Level 4	11/10/2019	M01
Fjmt studio	2000.05	Level 5	11/10/2019	M01
Fjmt studio	2000.06	Level 6	11/10/2019	M01
Fjmt studio	2000.07	Level 7	11/10/2019	M01
Fjmt studio	2000.08	Level 8	11/10/2019	M01
Fjmt studio	2000.09	Level 9	11/10/2019	M01
Fjmt studio	2000.10	Level 10	11/10/2019	M01
Fjmt studio	2000.11	Level 11	11/10/2019	M01
Fjmt studio	2000.12	Roof	11/10/2019	M01
Fjmt studio	2000.B1	Basement 1	11/10/2019	M01
Fjmt studio	2000.B2	Basement 2	11/10/2019	M01
Fjmt studio	2000.B3	Basement 3	11/10/2019	M01
Fjmt studio	2000.B4	Basement 4	11/10/2019	M01
Fjmt studio	3000.01	East and West Elevation	11/10/2019	M01
Fjmt studio	3000.02	North and South Elevation	11/10/2019	M01
Fjmt studio	4000.01	Longitudinal Section	11/10/2019	M01
Fjmt studio	4000.02	Cross Section	11/10/2019	M01
Fjmt studio	9100.01	Solar Access Compliance Summary Plan	11/10/2019	M01
Fjmt studio	9100.02	Cross Ventilation Compliance Summary Plan	11/10/2019	M01

3 ACOUSTIC SURVEY

In order to determine the existing ambient noise levels, two unattended noise surveys are considered:

- A survey conducted by Pulse Acoustics, between 8 October and 26 October 2018; and
- An earlier survey conducted by Acoustic Logic Consultancy (ALC), between 25 July and 3 August 2018.

The measurements results from both surveys are discussed in detail in the following sub-sections.

3.1 Unattended Noise Survey – 8 October to 26 October 2018 – Pulse Acoustics

The unattended noise survey which was conducted by Pulse Acoustics between 8th October 2018 and the 26th October 2018 at Unit 1, 16 Evans Avenue (Location 1) and 234 Gardeners Road (Location 2) are shown in Figure 7 and 8 below.

This measurement survey was conducted at 16 Evans Avenue (Location 1) in order to determine the existing ambient noise levels which are representative of the nearest potentially noise affected receivers to the development. The noise survey at 234 Gardeners Road (Location 2) was conducted to determine traffic noise levels on the Northern side of the development site.

Instrumentation for both surveys comprised of two Svan 971 noise logger (serial numbers 39165 and 61521). Calibration of both loggers was checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the Pulse Acoustic measured daily noise data are attached in Appendix B. The charts present each 24-hour period and show the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise levels for the corresponding 15-minute periods. This data has been filtered to remove periods affected by adverse weather conditions based on weather information obtained from Sydney Airport (station ID 066037).

Additionally, the wind speed data obtained from the weather station has been corrected to the height of the noise logger. These corrections were carried out according to the procedures provided in Standard "*AS / NZ 1170.2-2011 Structural design actions – Wind actions"* as outlined in the Proceedings of Acoustics 2004 paper titled "*Converting Bureau of Meteorology wind speed data to local wind speeds at 1.5m above ground level".*

As shown in Figure 6 below shows the nearest affected residences to the Eastlakes South development, in conjunction with the locations where noise monitoring have been conducted by Pulse Acoustics. Residences located along Evans Avenue are addressed at 16-18 Evans Avenue, Eastlakes.

The existing ambient noise levels around the development site are mostly influenced by the local road traffic, in particular along Gardeners Road, Southern Cross Drive, Racecourse Place, and Evans Ave.

Figure 6 Unattended Noise Monitoring Locations - Pulse Acoustics

Figure 7 Noise Monitor Location – Location 1 (16 Evans Avenue)

Figure 8 Noise Monitor Location – Location 2 (234 Gardeners Road)

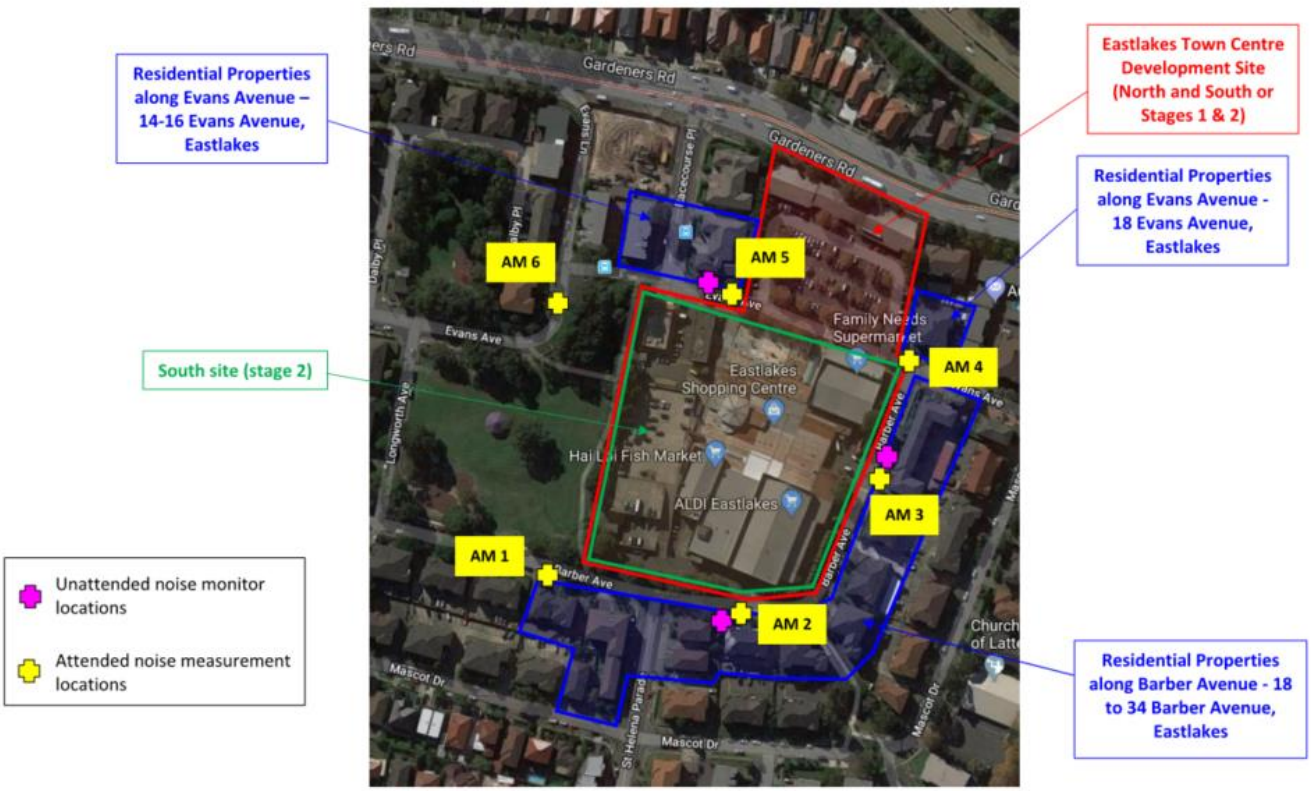
3.2 Unattended Noise Survey – 25 July to 3 August 2018 – Acoustic Logic Consultancy (ALC)

Unattended noise monitoring was conducted by Acoustic Logic Consultancy between 25th July and 3rd August 2018, using three Acoustic Research Laboratories (ARL) noise monitors. Additional details of this noise monitoring can be found in the ALC report referenced previously.

- Monitor 1 – Installed in the front yard of the residential property at 22 Barber Avenue, Eastlakes. Noise levels measured by this logger are representative of ambient noise levels at the residential receivers to the south of the site. Refer to Appendix 1 for this logging data.
- Monitor 2 – Installed in the front yard of the residential property at 34 Barber Avenue, Eastlakes. Noise levels measured by this logger are representative of ambient noise levels at the residential receivers to the east of the site. Refer to Appendix 1 for this logging data.
- Monitor 3 – Installed along the southern boundary of the residential property at 16 Evans Avenue, Eastlakes. Noise levels measured by this logger are representative of ambient noise levels at the residential receivers to the north of the site. Refer to Appendix 1 for this logging data. Note – Malfunction recorded in monitor after 11pm on the 30th July. Hence shorter monitoring period data attached in Appendix 1.

The noise monitoring locations conducted by ALC are shown in Figure 9 below.

Figure 9 Extract of Acoustic Logic Consultancy Report - Noise monitoring locations



3.3 Noise Measurements for Industrial Noise Assessment

The measurement results for the unattended noise survey are summarised in Table 2 in accordance with the time periods recommended by the NSW Environment Protection Authority (EPA).

The measurement results have also been processed to account for the morning "shoulder period" where the proposed operating hours extends partially into the EPA night time period. These results are summarised in Table 3 below. These shoulder periods results have been used for the assessment of loading dock activity, waste collection and traffic generation that will occur during the proposed extended operating hours.

Table 2 Measured ambient noise levels – Unattended noise survey

Measurement Location	Daytime[1] 7:00 am to 6:00 pm		Evening[1] 6:00 pm to 10:00 pm		Night-time[1] 10:00 pm to 7:00 am	
	L_{A90}[2]	L_{Aeq}[3]	L_{A90}[2]	L_{Aeq}[3]	L_{A90}[2]	L_{Aeq}[3]
Pulse Acoustics Monitoring Results						
Logger Location (16 Evans Avenue)	53	64	47	58	45	59
Logger Location (234 Gardeners Road)	58	69	51	63	41	62
Acoustic Logic Consultancy (ALC) Monitoring Results[5]						
22 Barber Avenue	52	-	52	-	46	-
34 Barber Avenue	55	-	55	-	53	-
16 Evans Avenue	59	-	57	-	53	-

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{A90} noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Note 4: Corrected for façade reflection -2.5dBA.

Note 5: ALC report does not provide L_{Aeq} levels for the EPA defined periods.

Table 3 Measured Ambient Noise Levels – Morning Shoulder Time Periods[3]

Measurement Location	Parameter	
	RBL [1]	L_{Aeq} [2]
Pulse Acoustics Monitoring Results		
Logger Location 1 (16 Evans Ave) Shoulder period: 5:00 am – 7:00 am	**53**	**65**
Logger Location 2 (234 Gardeners Road) Shoulder period: 5:00 am – 7:00 am	55	68

Note 1: The RBL noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Note 3: The L_{A90} and L_{Aeq} noise levels for the shoulder periods are not provided in the ALC report.

As can be seen by the noise monitoring results provided in Table 2 and Table 3 above, the background noise level at Evans Avenue is the same in the early morning shoulder period between 5:00 am and 7:00 am as it is for the daytime period generally and will be considered as such for all receiver locations.

3.4 Road Traffic Noise Measurements

Traffic noise levels are generally represented by the L_{Aeq} noise level for the 15-hour daytime period between 7:00 am and 10:00 pm and the 9:00 hour night period between 10:00 pm and 7:00 am. Maximum 1-hour noise levels during the night and day time periods are also used in the assessment of traffic generation.

The traffic noise levels at the monitoring locations are given in Table 4 below.

Table 4 Measured traffic noise levels

Measurement Location	Noise Level, dB(A)			
	Day, $L_{Aeq, 15hr}$	Night, $L_{Aeq, 9hr}$	Day, $L_{Aeq, 1hr}$	Night $L_{Aeq, 1hr}$
Pulse Acoustics Monitoring Results				
Residences (16 Evans Ave)	63	59	65	63
Residences (234 Gardeners Rd)	68	62	70	67
ALC Monitoring Results				
22 Barber Avenue	66	60	-	-
34 Barber Avenue	70	65	-	-
16 Evans Avenue	68	63	-	-

Note 1: The L_{Aeq} noise levels for the periods identified above are not provided.

From the measurements shown in Table 4, the following is noted:

- From visual inspections conducted on site, it is observed that Evans Avenue handles a higher road traffic volume compared to Barber Avenue.

  Also, monitoring results presented by ALC for 34 Barber Avenue are considered to be representative of major arterial roads such as Pacific Highway (i.e. roads with a traffic volume of 40,000 AADT to 80,000 AADT). This is not the case for Barber Avenue which is considered to be a local road.

  Therefore, we are of the opinion that noise measurements at 34 Barber Avenue have been influenced by other extraneous noise sources besides local road traffic, such as mechanical plant and noise emissions from the existing loading dock facing the monitoring location.

  Based on the observations above, it is expected that road traffic noise levels along Barber Avenue should be equal or lower than those corresponding to Evans Avenue.

- $L_{Aeq(15\ hours)}$ and $L_{Aeq(9\ hours)}$ measurements by ALC for 22 Barber Avenue, approximate the $L_{Aeq(1\ hour)}$ levels by Pulse Acoustics for 16 Evans Avenue. Additionally, if we were to estimate $L_{Aeq(1\ hour)}$ noise levels for Barber Avenue (by adding 3 dB to the $L_{Aeq(15\ hours)}$ and $L_{Aeq(9\ hours)}$), then these will result in noise levels which are equal or higher than those measured at Evans Avenue.

  Therefore, the $L_{Aeq(15\ hours)}$ and $L_{Aeq(9\ hours)}$ levels are considered to be $L_{Aeq(1\ hour)}$ levels for receivers along Barber Avenue.

- Hence, by considering a 3 dB difference between $L_{Aeq(1\ hour)}$ and $L_{Aeq(15\ hours)}$ or $L_{Aeq(9\ hours)}$, the latter noise levels have been estimated for receivers along Barber Avenue.

- Based on the observations above and measurements results summarised in Table 4, the traffic noise levels used in the acoustic assessment have been summarised as shown in Table 5 below.

Table 5 Incident traffic noise levels used in acoustic assessment

Location	Noise Level, dB(A)			
	Day, $L_{Aeq, 15hr}$	Night, $L_{Aeq, 9hr}$	Day, $L_{Aeq, 1hr}$	Night $L_{Aeq, 1hr}$
Along Evans Avenue (i.e. along northern site boundary)	63	59	65	63
Along Barber Avenue, eastern site boundary	63	57	66	60
Along Barber Avenue, southern site boundary	63	57	66	60

4 PROJECT APPROVAL

Approval for the redevelopment of the Eastlakes Shopping Centre (located on Lot 30 and 31 DP1246820) was granted by the Minister for Planning & Infrastructure on 19th September 2013.

Approval was granted for a mixed use development involving:

- Demolition and removal of all existing buildings;
- Construction of a mixed use development generally between 2 - 6 storeys above podiums in height except at the corner of Evans Avenue and Racecourse Place, where a maximum height of RL 48.7 AHD applies;
- Maximum ground floor retail and community floor space of 14,404m²;
- Maximum 405 residential apartments with a maximum GFA of 34,636m2;
- 916 basement car parking spaces over two levels;
- Associated landscaping;
- Associated infrastructure, stormwater and utility works; and
- Stratum subdivision basement car parking, ground floor retail area with residential above, communal open space, public domain landscaping and associated infrastructure works.

Part B of this Approval required various Design Modifications prior to the issuing of a Construction Certificate. With respect to acoustic requirements, these include:

Additional Information in relation to Acoustic Matters

B8. Recommendations made by ViPAC contained in the Acoustic Impact Assessment prepared dated 14 February 2013 and Acoustic Comments – Response to Atkins Acoustics letter dated 30 April 2013 are to be incorporated as part of development approval and construction certificate plans.

B9. Airborne and structural noise from the loading dock and plant rooms is to be inaudible in residential apartments between 10pm and 7am. Details of acoustic and vibration treatment measures are to be provided prior to the issue of a construction certificate and incorporated in the construction certificate plans.

Part C of the Approval required various Conditions be complied with prior to Construction. With respect to acoustics, these included:

Construction Noise Management

C11. A detailed assessment of construction noise and vibration impacts to the neighbouring premises shall be submitted to the Department and Council for approval prior to the commencement of works. The assessment shall incorporate a Noise and Vibration monitoring program during the demolition and construction period.

C12. A Construction Noise Management Plan prepared by a suitably qualified person, shall be submitted to Council for approval prior to any work being commenced and complied with during any construction works.

Part D of the Approval required various Conditions be complied with during Construction. With respect to acoustics, these included:

Acoustic and Vibration Management

D18. The construction of the premises shall not give rise to transmission of vibration at any affected premises that exceeds the vibration in buildings criteria outlined in the NSW EPA Environmental Noise Control Manual.

D19 The development is to be constructed to meet the requirements the following construction noise requirements:

(a) Construction Noise

Noise from construction activities associated with the development shall comply with the NSW Environment Protection Authority's Environmental Noise Manual – Chapter 171 and the Protection of the Environment Operations Act 1997

(b) Level Restrictions

Noise levels are to be in accordance with the NSW OEH Interim Construction Noise Guidelines

(c) Time Restrictions

Monday to Friday	*07:00am to 06:00pm*
Saturday	*07:00am to 01:00pm*

No Construction to take place on Sundays or Public Holidays.

(d) Silencing

All possible steps should be taken to minimise construction site equipment.

Part E of the Approval required various Conditions be complied with prior to issuing an occupational certificate. With respect to acoustics, these included:

Acoustic Certification

E23. Prior to the issue of Final Occupation Certificate, the proponent shall obtain a certificate from a suitable Acoustic Consultant, certifying that the development complies with relevant Australian Standard, State and local requirements and ViPAC recommended criteria.

Part F of the Approval required various Conditions be complied with during operation / post completion. With respect to acoustics, these included:

Acoustic Certification

F16 The development must comply with the following noise criteria:

(a) The operation of all site generated activities, plant and equipment shall not give rise to an equivalent continuous (L_{Aeq}) sound pressure level at any point on any residential property greater than 5 dBA above the existing background L_{A90} level (in the absence of the noise under consideration).

(b) The operation of all site generated activities, plant and equipment when assessed on any residential property shall not give rise to a sound pressure level that exceed L_{Aeq} 50 dB(A) day time and L_{Aeq} 40dB(A) night time.

(c) The operation of all site generated activities, plant and equipment when assessed on any neighbouring commercial/industrial remises shall not give rise to a sound pressure level that exceeds L_{Aeq} 65 dB(A) day time/night time.

Note: For assessment purposes, the above L_{Aeq} sound level shall be assessed over a period of 10-15 minutes and adjusted in accordance with EPA guidelines for tonality, frequency weighting, impulsive characteristics, fluctuations and temporal content where necessary.

F17 The proponent shall engage a suitably qualified person to prepare a post noise and traffic survey/report/certificate six (6) months after the issue of the Occupation Certification. This report/survey/certificate is to ascertain whether the traffic and noise generated by the redevelopment meet the recommended level contained in the Preferred Project Report. If traffic and noise generated by the redevelopment exceed the recommended level, corrective actions must be provided and adopted by the proponent

5 NOISE INTRUSION ASSESSMENT CRITERIA

5.1 (AS/NZS 2107:2016)

Recommended ambient noise levels and reverberation times for internal spaces are given in a number of publications including Table 1 of Australian / New Zealand Standard 2107:2016 "*Acoustics - Recommended design sound levels and reverberation times for building interiors"*. Unlike the previous version of this Standard, this latest edition recommends a range with lower and upper levels (rather than "satisfactory" and "maximum" internal noise levels) for building interiors based on room designation and location of the development relative to external noise sources. This change has occurred due to the fact that sound levels below 'satisfactory' could be interpreted as desirable, but the opposite may in fact the case. Levels below those which were listed as 'satisfactory' can lead to inadequate acoustic masking resulting in loss of acoustic isolation and speech privacy.

Internal noise levels due to the combined contributions of external noise intrusion and mechanical ventilation plant should not exceed the maximum levels recommended in this Standard. The levels for areas relevant to this development are given in Table 6 below. The mid to maximum points of the internal noise level ranges are generally adopted as the internal design noise criteria for the combined effect of mechanical services and external noise intrusion. In this report we will confine our recommendations to dBA levels, however, where the background noise appears to be unbalanced, AS/NZS 2107:2016 provides direction in terms of suitable diagnostic tools that can be used to assess the spectrum distribution of the background noise.

Table 6 Recommended Design Sound Levels and Reverberation Times

Type of Occupancy/Activity	Design sound level range ($L_{Aeq,t}$)	Design reverb time (T) range, s	Project Design Noise Level [2]	
			Approx. RC Mark II	dBA
Residential Buildings				
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	-	43	**48**
Living areas	35 to 45	-	35	**40**
Sleeping areas (night time)	35 to 40	-	33	**38**
Work areas	35 to 45	-	35	**40**
Shop Buildings				
Small retail stores (general)	< 50	See Note 1	45	**50**
Specialty shops (where detailed discussion is necessary in transactions)	< 45	See Note 1	40	**45**
Restaurants / coffee shops	40 to 45	See Note 1	40	**45**
Office Buildings				
General Office Areas	40 to 45	0.4 to 0.6	38	**43**
Meeting room (small)	40 to 45	< 0.6	38	**43**

Note 1: Reverberation time should be minimized for noise control.
Note 2: Recommended level for mechanical services noise and intrusive noise, combined

Section 6.18 of AS/NZ 2107:2016 notes that the presence of discrete frequencies or narrow band signals may cause the sound level to vary spatially within a particular area and be a source of distraction for occupants. Where this occurs, the sound level shall be determined as the highest level measured in the occupied location(s).

If tonal components are significant characteristics of the sound within a measurement time interval, an adjustment shall be applied for that time interval to the measured A-weighted sound pressure level to allow for the additional annoyance. If the background sounds include spectral imbalance, then the RC (Mark II) levels indicated in Table 6 above should be referenced (see also Appendix D of AS/NZ 2107:2016 for additional guidance).

Generally, where the final noise levels are within +/- 2 dB of the specified level given above, the design criteria will be considered met. Both the upper and lower limits will need to be satisfied especially where privacy is important or where noise intrusion to be avoided.

5.2 State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP)

SEPP (Infrastructure) 2007 was introduced to assist the delivery of necessary infrastructure by improving regulatory certainty and efficiency. The Infrastructure SEPP has specific planning provisions and development controls for various types of infrastructure and also for development located adjacent to infrastructure.

The Guideline applies to development adjacent to rail corridors and busy roads. It can also provide a useful guide for all development that may be impacted by, or may impact on, rail corridors or busy roads. Busy roads are defined a freeway, tollway or a transitway *or any other road* with an average annual traffic (AADT) volume of more than 40,000 vehicles. *Any other road* is defined as roads with an average annual daily traffic (AADT) volume of more than 20,000 vehicles or a high level of truck movements or bus traffic. Flinders Street is identified in Map 16 of the RTA (RMS) "*Traffic Volume Maps for Noise Assessment for Building on Land Adjacent to Busy Roads"*, as having a traffic volume of 20,000 - 40,000 cars a day. As a result it is 'recommended' that the development comply with Clause 102 of the Infrastructure SEPP.

According to Clauses 87 (rail) and 102 (road), if the development is for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded (with windows and doors closed):

- **In any bedroom in the building – 35 dBA $L_{Aeq(9hour)}$ between 10:00 pm and 7:00 am**
- **Anywhere else in the building (other than a garage, kitchen, bathroom or hallway) – 40 dBA L_{Aeq} at any time (i.e. $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$).**

If internal noise levels with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also meet the ventilation requirements of the National Construction Code 2014 (NCC).

Where windows must be kept closed, the adopted ventilation systems must meet the requirements of the national Construction Code and Australian Standard 1668 – *The use of ventilation and air conditioning in buildings*.

5.3 Botany Bay Development Control Plan 2013

5.3.1 4C Residential Flat Building

Section 4C. 4.5 Acoustic Privacy of the Botany Bay Development Control Plan 2013 (Amendment 8) Enforced 05/09/2017 provides design objectives and controls related to Acoustic Privacy. This section of the DCP specifies the following requirement:

Objectives:

O1. To ensure that all residents are provided with a reasonable level of acoustic privacy.

Controls:

C1. An acoustic report prepared by a certified acoustic consultant will be submitted with the development application addressing the requirements detailed in Controls C2, C3 and C4 below.

C2. New dwellings will be designed and constructed to comply with the criteria specified in Table 7 for all noise intrusion from external noise sources (including mechanical services noise from within the development itself).

C3. Where the height of the proposed development is higher than the existing height of the localised building stock (and the proposed development has a direct line of sight to the seaport and/or the airport) an acoustic assessment by an accredited acoustic consultant is required which takes into account noise from the operations of Port Botany and Sydney Kingsford Smith Airport.

C4. Where multiple dwellings are provided within the same building, the building will be designed and constructed to comply with the requirements of the BCA regarding acoustic insulation and noise transmission of walls and floors.

To meet these requirements, the following design measures maybe incorporated: Buildings are designed and rooms positioned to reduce noise transmission within and between dwellings;

(d) Bedrooms are designed so that wardrobes act as sound buffers between rooms or dwellings;

(e) Windows and doors are located away from external noise sources, or buffers used where separation cannot be achieved;

(f) Materials with low noise penetration properties are used where practical;

(g) Locate bedrooms and private open spaces away from noise sources such as garages, driveways, mechanical equipment and recreation areas; and

(h) Locate mechanical equipment, such as pumps, lifts or air conditioners away from bedrooms or living rooms of dwellings on adjoining properties.

Table 7 - External Noise Intrusion Criteria

Internal area	Time	Repeatable Maximum Laeq (1 Hour) with closed windows and doors	Repeatable Maximum Laeq (1 Hour) with open windows and doors
Living Areas	Day or Night	< 40 dBA	<50dBA
Sleeping Areas	Day or Night	< 40 dBA	<50dBA

Aircraft Noise:

C5. New dwellings on land within the Australian Noise Exposure Forecast (ANEF) Contour 20 or higher will be designed and constructed in accordance with current Australian Standard AS 2021 (Acoustic Aircraft Noise Intrusion-Building siting and Construction) and Part 3J - Development Affecting Operations at Sydney Airport. Applicants are to address the compliance in the Development Application.

C6. New or higher density residential development which, in the opinion of Council is considered to be aircraft noise sensitive will be not supported where the property is located within the 30+ ANEF contour.

C7. The introduction of noise abatement measures to achieve compliance with the current AS 2021 must be integrated into the design of the building.

Road and Rail Noise:

C8. Development on land which is on or is within 100 metres of a railway corridor, a classified road or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RMS) must consider the requirements of the Development Near Rail Corridors and Busy Roads - Interim Guideline (19 December 2008) in accordance with cl.87(3) and cl.102(3) of SEPP (Infrastructure) 2007. An acoustic report prepared by a certified acoustic consultant must be submitted at development application stage to demonstrate compliance with this Guideline.

5.3.2 Part 3J – Development Affecting Operation at Sydney Airport

Section 3J.2 Aircraft Nosie Exposure Forecast, provides the following objectives and controls for development affected by aircraft noise.

Objectives:

O1. To provide a discretionary approach by Council in the assessment of proposed development within localities affected by aircraft noise.

Controls:

Development Classified as "Acceptable"

C1. Where the building site is classified as "acceptable" under Table 2.1 of AS2021-2015, development may take place subject to Council consent, there being no need, in the case of building construction, to provide protection specifically against aircraft noise.

Note: Where the height of the proposed development is higher than the existing height of the localised building stock (and the proposed development has a direct line of sight to the seaport and/or the airport) an acoustical assessment by an accredited acoustical consultant is required which takes into account noise from the operations of Port Botany and Sydney Kingsford Smith Airport.

Development Classified as "Conditional"

C2 Where the building site is classified as "conditional" under Table 2.1 of AS2021-2015, development may take place, subject to Council consent and compliance with the requirements of AS2021-2015.

Note: Where the height of the proposed development is higher than the existing height of the localised building stock (and the proposed development has a direct line of sight to the seaport and/or the airport) an acoustical assessment by an accredited acoustical consultant is required which takes into account noise from the operations of Port Botany and Sydney Kingsford Smith Airport.

Development Classified as "Unacceptable"

C3 In certain circumstances, and subject to Council discretion, Council may grant consent to development where the building site has been classified as "unacceptable" under Table 2.1 of AS2021-2015. For Council to be able to consider such applications for development, the following factors must be complied with:

i. Submission of specialist acoustic advice by an accredited acoustical consultant certifying full compliance with the requirements of Table 3.3 of AS2021-2015;

ii. Submission of plans and documentation indicating the subject premises will be fully air conditioned or mechanically ventilated in accordance with Council guidelines; and

iii. Any additional information considered necessary by Council to enable it to make a decision.

Note: The Standard also requires that the external environment to a dwelling within a 25 to 30 ANEF Contour be considered for aircraft noise impacts. This process has to take the following into account:

1. Whether or not there is an existing residential dwelling on site;

2. What the application of the Standard applies to;

3. Does the dwelling have access to a rear yard within the property, which is currently available for outdoor recreational use by residents of the dwelling; and

4. Does the outdoor environment given the curfew and current operating patterns are such that in daylight hours there will be sufficient opportunity to resort to the private open space without the presence of aircraft noise.

Note: Where the height of the proposed development is higher than the existing height of the localised building stock (and the proposed development has a direct line of sight to the seaport and/or the airport) an acoustical assessment by an accredited acoustical consultant is required which takes into account noise from the operations of Port Botany and Sydney Kingsford Smith Airport.

General

C4 Notwithstanding the above controls, no applications for new residential development, new educational establishments, new child care centres, new hospitals, new nursing homes, or any other use which, in the opinion of Council, is considered to be aircraft noise sensitive will be supported by Council where the property is located within the 30+ ANEF contour.

C5 Where a building site is considered by Council to be located on or immediately adjacent to an ANEF contour and could be affected by aircraft noise the subject development will be assessed as if it was located within the relevant ANEF contour.

C6 For residential development located within the 25+ ANEF contour the external environment (i.e deck and pergola) to the dwelling must be considered for aircraft noise impacts. The acoustic report must consider the external environment in accordance with AS 2021-2015.

Note: Advice from the Department of Infrastructure and Regional Development's website:

AS 2021 provides an assessment of potential aircraft noise exposure around airports based on the Australian Noise Exposure Forecast (ANEF) metric which applies to the development of airport master plans and is applied in strategic land use planning in the vicinity of airports.

AS2021 currently specifies that it is 'acceptable' to construct noise sensitive developments in areas where the ANEF is less than 20. This may lead to the mistaken perception that intrusive aircraft noise stops at the 20 ANEF contour and that properties immediately adjacent to the contour will not be adversely impacted. For further information please access the Department of Infrastructure and Regional Developments website

5.4 Aircraft Noise Intrusion – Australian Standard 2021:2015 *Acoustics - Aircraft noise intrusion - Building siting and construction*

Australian Standard AS 2021:2015 Acoustics - Aircraft noise intrusion - Building siting and construction recommends that the architectural acoustic treatment should be designed in order to achieve the indoor design noise levels listed in Table 3.3 of the Standard. These levels are shown in Table 7 below. The areas that most relevant to this development are listed in bold.

Table 7 Indoor design noise levels in order to determine acoustic treatment for aircraft noise intrusion

Building type and activity	Indoor Design Noise Level[1], dBA
Houses, home units, flats, caravan parks	
• ***Sleeping areas, dedicated lounges***	**50**
• ***Other habitable spaces***	**55**
• ***Bathrooms*, toilets, laundries**	**60**
Schools, universities	
• *Libraries, study areas*	50
• ***Teaching areas, assembly areas (see Note 5)***[2]	**55**
• *Workshops*, gymnasia	75
Commercial buildings, offices and shops	
• *Private offices, conference rooms*	55
• *Drafting, open offices*	65
• *Typing, data processing*	70
• ***Shops*, supermarkets, showrooms**	**75**

Notes:

1. ** These indoor design sound levels are not intended to be used for measurement of adequacy of construction. For measurement of the adequacy of construction against aircraft noise intrusion see Appendix D of AS2021:2015.*
2. ***Note 5 of AS202:2015**: Certain activities in schools may be considered particularly noise sensitive and 50 dBA may be a more desirable indoor sound level to select for any teaching areas used for such activities. However, the effect of other noise sources should be considered.*

Please note the indoor design noise levels should not be used to confirm, with on-site measurements, the adequacy of the implemented construction, as part of the compliance process. Instead, these measurements should be based on the aircraft noise reduction (ANR) of the completed building space. The ANR is determined as the arithmetic average of the aircraft noise reduction calculated for each flyover (ANR_n). Hence the ANR_n is defined by the following equation:

$$ANR = L_{Aout} - L_{Ain}$$

Where, L_{Aout} is the maximum sound pressure level obtained outside the relevant space, and L_{Ain} is the maximum sound pressure level obtained inside the relevant space. Both sound pressure levels should be measured simultaneously for each flyover using “A” frequency weighting and slow (S) time weighting.

5.5 Noise Intrusion Assessment Criteria Summary

Based on the criteria discussed in previous sections, the relevant noise intrusion criterion relevant to the project, are summarised in below Table 8 together with the monitored external noise levels.

Table 8 Noise Intrusion Assessment Criteria Summary

Measurement Location	$L_{Aeq(1hour)}$ Day	$L_{Aeq(1hour)}$ Night	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$	$L_{Amax,slow}$
Infrastructure SEPP criteria					
for closed windows and doors			40 dBA (elsewhere)	35 dBA (bedrooms) 40 dBA (elsewhere)	
for open windows and doors[1]			50 dBA (elsewhere)	45 dBA (bedrooms) 50 dBA (elsewhere)	
Botany Bay DCP 2013					
for closed windows and doors	< 40 dBA (living and sleeping areas)	< 40 dBA (living and sleeping areas)			
for open windows and doors	< 50 dBA (living and sleeping areas)	< 50 dBA (living and sleeping areas)			
Aircraft Noise Intrusion – Australian Standard 2021:2015					
Sleeping areas, dedicated lounges					50 dBA
Other habitable spaces					55 dBA
Bathrooms, toilets, laundries					60 dBA
Teaching areas, assembly areas					55 dBA
Shops, supermarkets, showrooms					75 dBA

Note 1: If internal noise levels with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also meet the ventilation requirements of the National Construction Code 2014 (NCC).

The L_{Aeq} descriptor represents the logarithmic average noise energy during the measurement period. The "15 Hour" represents the daytime period 7:00 am to 10:00 pm and "9 Hour" represents the night-time period between 10:00 pm and 7:00 am.

In the case of the $L_{Aeq\ (1h)}$ descriptor, the highest 10th-percentile hourly A-weighted L_{eq} noise level applies when the particular class of building / place is in use. The noise intrusion criteria are defined in terms of the repeatable maximum $L_{Aeq(1hour)}$ levels.

The RNP and Infrastructure SEPP sets noise intrusion criteria in terms of $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise levels. Australian Standard 2021:2015 provides aircraft noise intrusion in terms of $L_{Amax,slow}$ levels.

6 OPERATIONAL NOISE EMISSION CRITERIA

6.1 External Noise Criteria

External noise criteria for operational noise are set by NSW EPA's Noise Guide for Local Government and the NSW Noise Policy for Industry (NSW NPI).

6.1.1 NSW Noise Policy for Industry

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The NSW EPA has recently released a document titled *Noise Policy for Industry* (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

6.1.1.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

6.1.1.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

6.1.1.3 Area Classification

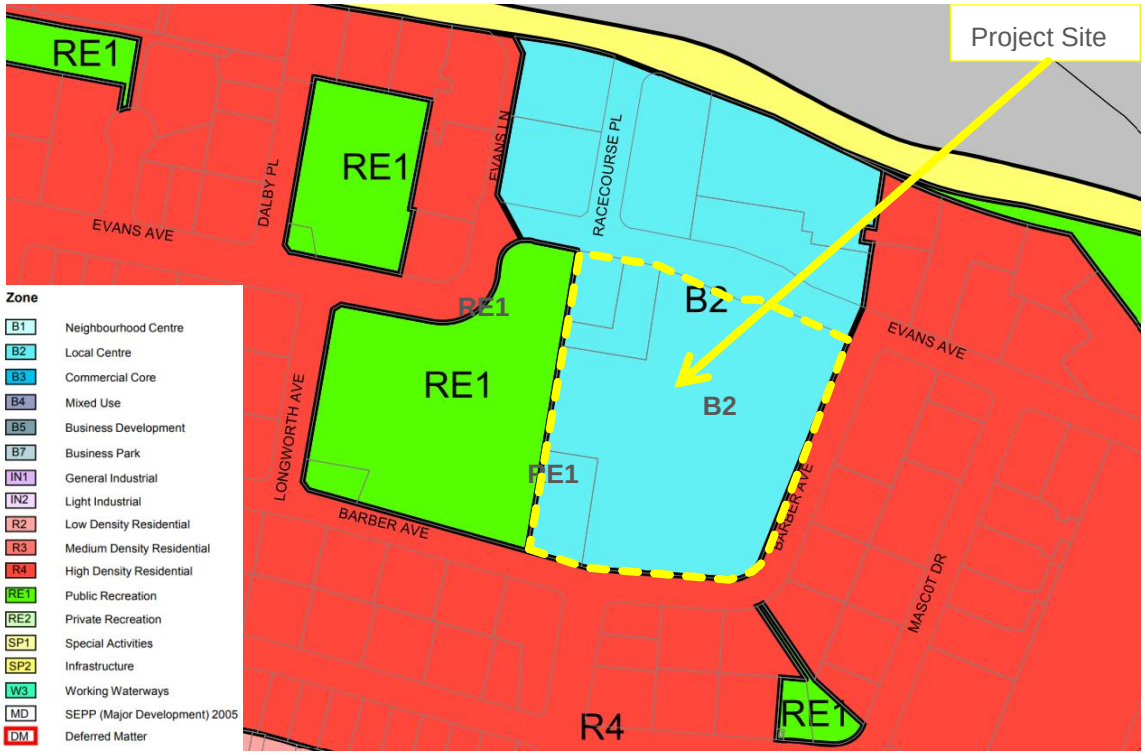
The NSW NPI characterises the "Urban Residential" noise environment as an area with an acoustical environment which shows the following:

- It is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable sources, consisting mostly of traffic and/or industrial related sounds
- Has through traffic with characteristically heavy and continuous traffic flows during peak periods
- is near commercial districts or industrial districts
- It has a combination of any of the above

Figure 10 is obtained from the NSW Government Planning Portal website and shows the land zoning map of the proposed development and the nearest sensitive receivers. According to Figure 10, the residential area surrounding the proposed development falls under the "Urban" area classification (residential areas located within B2 zones are classified as "urban residential" according to Table 2.3 of the NSW NPI). For residential and non-residential receivers in an urban area, the recommended amenity criteria are shown in Table 9 below.

When the existing noise level from industrial noise sources is close to the recommended "Amenity Noise Level" (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area in line with the requirements of the NSW NPI.

Figure 10 Bayside Council (Formerly Botany Bay Council) Zoning Map – LZN_004 – 9th October 2015 to date



The area surrounding the proposed development falls under the "Urban" area classification. For commercial and residential receivers in an urban area, the recommended criteria are shown in Table 9 below.

Table 9 NSW NPI – Recommended L_{Aeq} Noise Levels from Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2]
Residence	Urban	Day	60
		Evening	50
		Night	45
Commercial	All	When in use	65

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound

6.1.2 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions derived from the measured data are presented in Table 10.

The noise levels measured at the southern western corner of the site are considered representative of the levels experienced at the nearest noise sensitive receivers and have been used for the purpose of determining the operational noise limits associated with the development.

In this case, the area surrounding the site is not highly influenced by industrial noise sources so the amenity criterion becomes equal to the Recommended Amenity Criteria for Residences in an Urban Area (ANL or Acceptable Noise Level).

Table 10 External noise level criteria in accordance with the NSW NPI

Location	Time of Day	Project Amenity Noise Level, $L_{Aeq, period}$ [1] (dBA)	Measured $L_{A90, 15\ min}$ (RBL) [2] (dBA)	Measured $L_{Aeq, period}$ Noise Level (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [4,5]
North-eastern corner of the site Residences (16 Evans Ave) - Pulse data	Day	55	53	64	**58**	**58**
	Evening	45	47	58	52	**51**
	Night	40	45	59	**50**	52
	Shoulder period: 5:00am–7:00am	-	53	65	**58**	**58**
North-eastern corner of the site (16 Evans Avenue) [5] - ALC data	*Day*	*55*	*59*	-	*64*	*58*
	Evening	*45*	*57*	-	*62*	*48*
	Night	*40*	*53*	-	*58*	*43*
Residences (234 Gardeners Road)	Day	55	58	69	63	**62**
	Evening	45	51	63	**56**	**56**
	Night	40	41	62	**46**	55
	Shoulder period: 5:00am–7:00am	-	55	68	**60**	61
South of the site (22 Barber Avenue) - ALC data[7]	*Day*	*55*	52	-	**57**	*58*
	Evening	*45*	52	-	**57**	*48*
	Night	*40*	46	-	**51**	*43*
East of the site (34 Barber Avenue) [6] - ALC data[7]	*Day*	*55*	55	-	**60**	*58*
	Evening	*45*	55	-	**60**	*48*
	Night	*40*	53	-	**58**	*43*
Commercial	When in use	60	-	-	-	**63**

Note 1: Project Amenity Noise Levels corresponding to "Suburban" areas, equivalent to the Recommended Amenity Noise Levels (Table 9) minus 5 dBA

Note 2: L_{A90} Background Noise or Rating Background Level

Note 3: Project Noise Trigger Levels are shown in bold

Note 4: This is based on the assumption that the existing noise levels are unlikely to decrease in the future

Note 5: According to Section 2.2 of the NSW NPI, the $L_{Aeq, 15\ minutes}$ is equal to the $L_{Aeq, period}$ + 3 dB

Note 6: This data is much higher than the Pulse Acoustic data and appears to be inconsistent with the levels at the residential façade.

Note 7: This data appears to have been affected by the Australia Post loading dock located across the road from the monitoring location and will not be use as it appears to be affected by mechanical plant noise and loading dock activity.

Note 8: Because the L_{Aeq} noise levels are not listed in the ALC data, it is not possible to set amenity criteria that accounts for the existing level of noise

6.2 Noise Impact on Local Roads

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (NSW RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night time periods.

6.3 Sleep Disturbance

The potential for sleep disturbance from maximum noise level events from the premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages. Section 2.5 of the NSW NPI states:

> *Where the subject development/premises night-time noise levels at a residential location exceed:*
>
> - *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
> - *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*
>
> *a detailed maximum noise level event assessment should be undertaken.*
>
> *The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.*

The NSW RNP provides a summary of the current literature concerning sleep disturbance.

An accurate representation of sleep disturbance impacts on a community from a noise source is particularly difficult to quantify mainly due to differing responses of individuals to sleep disturbance – this is found even with a single subject monitored at different stages of a single night's sleep or during different periods of sleep.

In addition, the differing grades of sleep state make a definitive definition difficult, and even where sleep disturbance is not noted by the subject, factors such as heart rate, mood and performance can still be negatively affected.

An assessment of sleep disturbance should consider the maximum noise level (L_{Amax}) or $L_{A1(1\ minute)}$, the extent to which the maximum noise level exceeds the background level and the number of times this may happen during the night-time period. Factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10.00pm and 7.00am); and
- Whether there are times of day when there is a clear change in the existing noise environment (such as during early morning shoulder periods).

Currently the information relating to sleep disturbance impacts indicates that:

- Maximum internal noise levels below 50–55 dBA is unlikely to cause an awakening from a sleep state.
- One or two noise events per night with maximum internal noise levels of 65–70 dBA are not likely to affect health and wellbeing significantly.

As a result, the adopted sleep disturbance criterion for the project is an internal noise level of 50 – 55 dB L_{Amax}. This criterion is applicable for noise emissions generated by short term events, such as truck movements and loading dock activity occurring during the night time period.

Allowing for a 10 dB noise reduction through open windows**, the proposed screening noise level criterion for sleep arousal is 60 - 65 dB L_{Amax} external at residential properties**

7 INTERNAL SOUND INSULATION CRITERIA

7.1 National Construction Code (NCC) & Building Code of Australia (BCA) 2019

The Building Code of Australia (BCA) 2019 is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. The BCA is produced and maintained by the Australian Building Codes Board (ABCB), and given legal effect through the Building Act 1975. The National Construction Code (NCC) comprises the Building Code of Australia and the Plumbing Code of Australia (the Plumbing Code of Australia is given legal effect through the Plumbing and Drainage Act 2002 (Qld)), and is published in three volumes. Volumes one and two relate to the BCA.

7.1.1 Floors

Section FP5.1 of the BCA states that for Class 2 or 3 buildings:

Floors separating -

a) sole-occupancy units; or

b) sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or a part of a different classification,

must provide insulation against the transmission of airborne and impact generated sound sufficient to prevent illness or loss of amenity to the occupants.

F5.4 provides the sound insulation performance rating of floors as follows:

a) A floor in a Class 2 or 3 building must have an R_w+C_{tr} (airborne) not less than 50 and an $L_{n,w}$ (impact) not more than 62 if it separates—

(i) sole-occupancy units; or

(ii) a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

b) A floor in a Class 9c building separating sole-occupancy units must have an Rw not less than 45.

FV5.1 states that compliance with FP5.1 is verified when it is measured in-situ that the separating floor has -

a) airborne: a weighted standardised level difference with spectrum adaptation term ($D_{nT,w}$ + C_{tr}) not less than 45 when determined under AS/NZS 1276.1 or ISO 717.1; and

b) impact: a weighted standardised impact sound pressure level with ($L_{nT,w}$) not more than 62 when determined under AS ISO 717.2.

7.1.2 Walls

Section FP5.2 of the BCA requires:

> *Walls separating sole-occupancy units or a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or parts of a different classification, must provide insulation against the transmission of -*
>
> *a) airborne sound; and*
>
> *b) impact generated sound, if the wall is separating a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit,*
>
> *sufficient to prevent illness or loss of amenity to the occupants.*

F5.5 of the BCA provides the sound insulation performance rating of walls as follows:

a) A wall in a Class 2 or 3 building must -

(i) have an $R_w + C_{tr}$ (airborne) not less than 50, if it separates sole-occupancy units; and

(ii) have an R_w (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and

(iii) comply with F5.3(b) if it separates—

(A) a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or

(B) a sole-occupancy unit from a plant room or lift shaft.

b) A door may be incorporated in a wall in a Class 2 or 3 building that separates a sole-occupancy unit from a stairway, public corridor, public lobby or the like, provided the door assembly has an R_w not less than 30.

c) A wall in a Class 9c building must have an Rw not less than 45 if it separates—

(i) sole-occupancy units; or

(ii) a sole-occupancy unit from a kitchen, bathroom, sanitary compartment (not being an associated ensuite), laundry, plant room or utilities room.

d) In addition to (c), a wall separating a sole-occupancy unit in a Class 9c building from a kitchen or laundry must comply with F5.3 (b).

e) *Where a wall* required to have sound insulation has a floor above, the wall must continue to -

(i) the underside of the floor above; or

(ii) a ceiling that provides the sound insulation required for the wall.

f) Where a wall required to have sound insulation has a roof above, the wall must continue to -

(i) the underside of the roof above; or

(ii) a ceiling that provides the sound insulation required for the wall.

FV5.2 states that compliance with FP5.2(a) to avoid the transmission of airborne sound through walls is verified when it is measured in-situ that –

a) a wall separating sole-occupancy units has a weighted standardised level difference with spectrum adaptation term (DnT,w + Ctr) not less than 45 when determined under AS/NZS 1276.1 or ISO 717.1; or

b) a wall separating a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or parts of a different classification, has a weighted standardised level difference (DnT,w) not less than 45 when determined under AS/NZS 1276.1 or ISO 717.1; or

c) any door assembly located in a wall that separates a sole-occupancy unit from a stairway, public corridor, public lobby, or the like, has a weighted standardised level difference (DnT,w) not less than 25 when determined under AS/NZS 1276.1 or ISO 717.1.

7.1.3 Summary of BCA Acoustic Requirements

A summary of the acoustic requirements of the BCA 2019 for Class 2 or 3 buildings is given in Table 11 below.

Table 11 BCA 2019 Sound Insulation Requirements

Construction	2019 BCA	
	Laboratory performance requirements	Verification method
Walls between sole occupancy units	**$R_w + C_{tr}$ not < 50**	**$D_{nT,w} + C_{tr}$ not < 45**
Walls between a bathroom, sanitary compartment, laundry or kitchen in one sole occupancy unit and a habitable room (other than a kitchen) in an adjoining unit	$R_w + C_{tr}$ not < 50 and **Must have a minimum 20 mm cavity between two separate leaves**	$D_{nT,w} + C_{tr}$ not < 45 "Expert Judgment" Comparison to the "Deemed to satisfy" Provisions
Walls between sole occupancy units and a plant room or lift shaft	R_w not < 50 and Must have a minimum 20 mm cavity between two separate leaves[1]	$D_{nT,w}$ not < 45
Walls between sole occupancy units and a stairway, public corridor, public lobby or the like, or parts of a different classification	R_w not < 50	$D_{nT,w}$ not < 45
Door assemblies located in a wall between a sole-occupancy unit and a stairway, public corridor, public lobby or the like	R_w not < 30 [2]	$D_{nT,w}$ not < 25
Floors between sole-occupancy units or between a sole-occupancy unit and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification	**$R_w + C_{tr}$ not < 50** **$L_{n,w}$ not > 62**	**$D_{nT,w} + C_{tr}$ not < 45** **$L'_{nT,w}$ not > 62**
Soil, waste, water supply and stormwater pipes and ductwork to habitable rooms	**$R_w + C_{tr}$ not < 40**	n/a
Soil, waste, water supply and stormwater pipes and ductwork to kitchens and other rooms	$R_w + C_{tr}$ not < 25	n/a
Intra-tenancy Walls	There is no statutory requirement for airborne isolation via intra-tenancy walls.	

Note 1: A wall must be of "discontinuous construction" if it separates a sole occupancy unit from a plant room or lift shaft. Clause F5.3(c) defines "discontinuous construction" as a wall having a minimum 20 mm cavity between two separate leaves with no mechanical linkage except at the periphery.

Note 2: Clause FP5.3 (b) in the 2019 BCA states that the required insulation of a floor or wall must not be compromised by a door assembly.

Note 3: Masonry walls must be laid with all joints filled solid, including those between the masonry and any adjoining construction

8 CONSTRUCTION CRITERIA

8.1 Noise Goals

8.1.1 Airborne Noise Levels at Residential Receivers

Noise criteria for construction and demolition activities are discussed in the *Interim Construction Noise Guideline* (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all “feasible” and “reasonable” work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage; and
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for residential receivers have been reproduced from the guideline and are listed in Table 12 below.

Please note that according to consent condition D19 stated in Section 4, construction activities are only allowed to be conducted during the following times:

- Monday to Friday: 7:00 am to 6:00 pm
- Saturday: 7:00 am to 1:00 pm

Table 12 ICNG Noise Management Levels

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • 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 75 dBA	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 relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works • Near schools or mid-morning or mid-afternoon for works near residences). • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practice have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2: The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy.

8.1.2 Project Specific Noise Goals at Residential Receivers

Adopting the measured background noise levels in Section 3, the construction noise goals derived for the project using each approach to construction noise are detailed in Table 13.

Table 13 NMLs as basis for the acoustic assessment

Receiver Types	NML, dB $L_{Aeq(15minute)}$	
	Standard Hours **Monday to Friday:** **7 am to 6 pm** **Saturday:** **8 am to 1 pm**	**Outside Standard Hours** **Saturday:** **7 am to 8 am**
Residences: Along Evans Avenue, facing northern property boundary	63	Monday to Friday 6pm to 7pm: 52 Saturday, 7am to 8am: 58
Residences: Along Barber Avenue, facing southern property boundary	62	Monday to Friday 6pm to 7pm: 57 Saturday, 7am to 8am: 57
Residences: Along Barber Avenue, facing eastern property boundary	65	Monday to Friday 6pm to 7pm: 60 Saturday, 7am to 8am: 60

8.1.3 Other Sensitive Land Uses

The proposal specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in Table 14.

The ICNG provides external noise goals for commercial premises, including offices, retail outlets and small commercial premises. This external noise goal is:

- $L_{Aeq(15minute)}$ 70 dBA

Assuming that adjacent commercial premises are fitted with standard glazing then this equates to a project specific internal noise goal with closed windows of $L_{Aeq\ (15\ minutes)}$ 50dBA.

Table 14 Noise Management Levels for Other Sensitive Receivers

Land Use	NML $L_{Aeq(15minute)}$ - Applied when the property is in use
Passive recreation areas: Eastlakes Reserve (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. reading, meditation)	External noise level 60 dBA
Offices, retail	70 (external) 50 (internal)

8.1.4 Ground-borne Noise Management Levels

The ICNG provides residential NMLs for ground-borne noise, which are applicable when ground-borne noise levels are higher than the corresponding airborne noise levels. The ICNG details ground-borne noise levels at residential receivers for evening and night-time periods.

The following ground-borne noise levels are applicable for residential receivers:

- Daytime $L_{Aeq(15minute)}$ 45 dBA
- Evening $L_{Aeq(15minute)}$ 40 dBA
- Night-time $L_{Aeq(15minute)}$ 35 dBA.

For commercial receivers such as offices and retail areas, the ICNG does not provide specific guidance in relation to acceptable ground-borne noise levels. Instead an NML has been proposed for this project based on the ICNG external NML of 70 dBA, and that commercial premises that have windows closed would provide typically 20 dB of noise reduction from outside to inside. This approach will identify when ground borne noise radiating through the building structure will begin to exceed airborne construction noise. The derived goal for ground-borne noise in commercial buildings is:

- $L_{Aeq(15minute)}$ 50 dBA

Ground-borne noise goals are most applicable where the receiver is in close proximity to the works and resides in an area that is structurally connected to the building being worked on. This is not likely to be particularly problematic for this development because the site is separated from the nearest sensitive receivers by surrounding roads.

8.1.5 Construction Traffic Noise

As the site is quite constrained, trucks and other vehicles are unlikely to be operating within the boundaries of sites and therefore unlikely to contribute significantly to the overall predicted site noise emissions.

When construction related traffic moves onto the public road network, such as Flinders Street, a different noise assessment methodology is appropriate, as vehicle movements would be regarded as “additional road traffic” rather than as part of the construction site.

The ICNG does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the *“NSW Road Noise Policy”* (RNP), DECCW, 2011.

One of the objectives of the RNP is to protect sensitive residential receivers against excessive decreases in amenity as the result of a project. At first the noise levels with the project are compared with the following road traffic noise criteria in the RNP:

- Existing freeway / arterial / sub-arterial roads $L_{Aeq(15hour)}$ 60dBA day and $L_{Aeq(9hour)}$ 55dBA night.
- Existing local roads $L_{Aeq(1hour)}$ 55dBA day and $L_{Aeq(1hour)}$ 50dBA night.

Where traffic noise levels with the project exceed the criteria above, any increase in total traffic noise level because of the project should be limited to 2dBA.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2dBA, consideration would also be given to the actual noise levels associated with construction traffic.

8.1.6 Sleep Disturbance and Maximum Noise Level Events

An assessment of sleep disturbance is not required since construction activities will not be undertaken during the night time period.

8.2 Construction Vibration Criteria

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be compromised.

8.2.1 Human Comfort Vibration

The EPAs *"Assessing Vibration: a technical guideline"* (DEC, 2006) recommends the use of BS 6472-1992 for the purpose of assessing vibration in relation to human comfort.

British Standard BS 6472-1992 *Guide to evaluation of human exposure to vibration in building* (BS6472-1992) nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "low probability of adverse comment" from occupants. Guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV), rather than a continuous vibration level. Vibration associated with construction activities would generally be considered "intermittent" vibration. The acceptable VDV's for intermittent vibration are reproduced in Table 15 below.

Table 15 Assessing Vibration: a Technical Guideline – Acceptable VDV's for Intermittent Vibration

Location	Daytime[1]		Night-time[1]	
	Preferred value ($m/s^{1.75}$)	Maximum value ($m/s^{1.75}$)	Preferred value ($m/s^{1.75}$)	Maximum value ($m/s^{1.75}$)
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Note 1: Daytime is 7:00 am to 10:00 pm and Night-time is 10:00 pm to 7:00 am				

The most recent version of BS 6472-1:2008, *Guide to evaluation of human exposure to vibration in building – Part 1: Vibration sources other than blasting"* presents these VDV Criteria slightly differently, and importantly uses different frequently weighting in the measurement of the vibration. The use of the newer Standard is recommended and the recommended levels can be seen in Table 16 below.

Table 16 Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings

Place and time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Note 1: For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 hr day.			

8.2.2 Structural Damage Vibration

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of cosmetic damage such as surface cracks, and are set well below the levels that have potential to cause structural damage.

In terms of the most recent relevant vibration damage goals, AS 2187: Part 2-2006 *'Explosives - Storage and Use - Part 2: Use of Explosives'* recommends the frequency dependent guideline values and assessment methods given in British Standard BS 7385 Part 2-*1993 'Evaluation and measurement for vibration in buildings Part 2'* as they "are applicable to Australian conditions".

The Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect. The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 17 below.

Table 17 Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings

Line	Type of building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1:	*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.*		
Note 2:	*A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.*		

The values in Table 17 above relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings. Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 17 may need to be reduced by up to 50%.

Jackhammers are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it is therefore appropriate to reduce the transient values by 50%.

For construction activities involving intermittent vibration sources such as jackhammers being used to great the lift shaft, the energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: **25.0 mm/s**
- Unreinforced or light framed structures: **7.5 mm/s.**

Monitoring should be performed during construction at locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity). More detailed analysis may be required of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure to determine the applicable safe vibration level.

9 NOISE INTRUSION ASSESSMENT

9.1 Aircraft Noise Intrusion Assessment

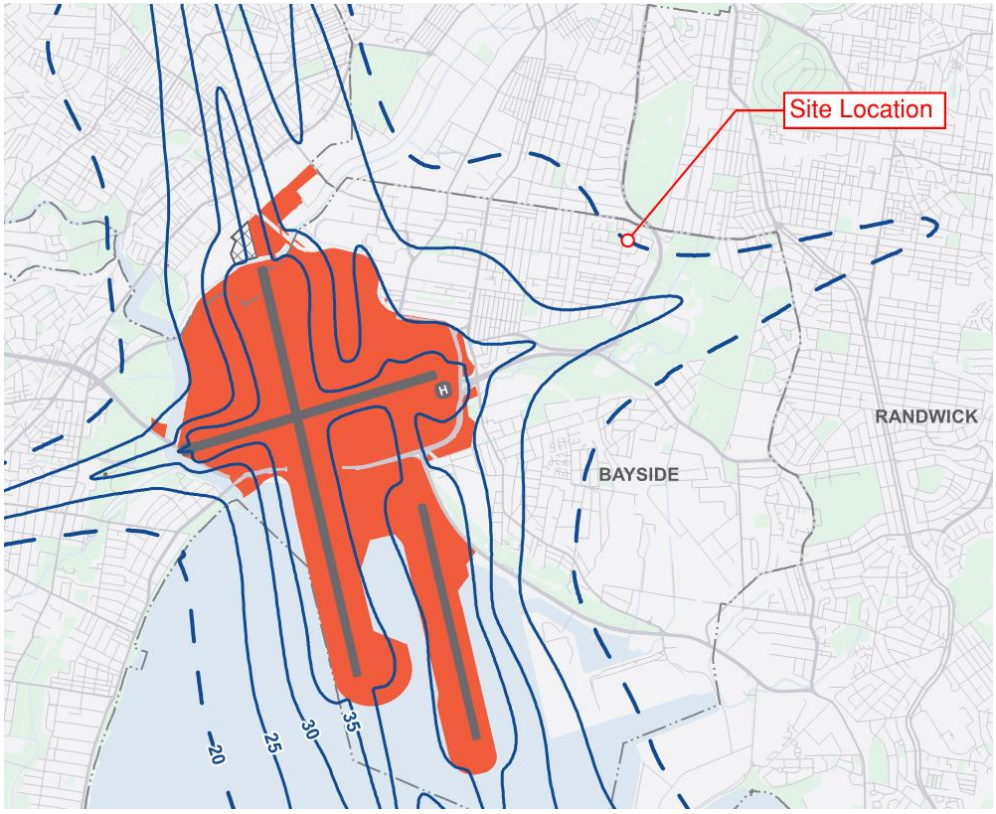
Part 3J of the Botany Bay Development Control Plan 2013 (BB DCP 2013) states the following:

> *The aircraft noise controls apply to all development in the City of Botany Bay within the 20 ANEF and above contour on the ANEF chart applicable to the City of Botany Bay. The ANEF chart for Sydney Airport will be the ANEF chart adopted by Council based on the most up-to-date information on operating procedures and air traffic forecasts at Sydney (Kingsford Smith) Airport.*

Figure 11 below shows the location of the project site in relation to the latest and current ANEF contours (i.e. year 2039) developed for Sydney Airport. As noted from Figure 11, the project site is located within the ANEF 20 contour.

Schedule 1 of Part 3J of the BB DCP 2013 then refers to the assessment guidelines discussed in standard AS 2021:2015. This is discussed further in Section 5.4.

Figure 11 Project site location within Sydney Airport ANEF 2039 chart



Using the procedures given in standard AS 2021:2015, the project site is located at the distances listed in Table 18 from the airport's runways.

Table 18 Distances from project site relative to airport's runways

Runway	Distance (m)		
	DS	DL	DT
Main North – South runway	3643	847	3449
Parallel North – South runway	2633	1963	4428
East – West runway	715	2227	4922

Notes:

1. *The sideline projection is a line which is perpendicular to the extended runway centre-line and which passes over the project site*
2. *DS: Distance from project site to the extended runway centre-line measured along the sideline projection*
3. *DL: Distance from closer end of runway to the intersection of the extended runway centre-line and the sideline projection*
4. *DT: Distance from further end of runway to the intersection of the extended runway centre-line and the sideline projection*

Based on these distances and the procedures discussed in standard AS 2021:2015 (including typical maximum noise levels for jet and non-jet aircrafts), the project site will be exposed to the following maximum noise levels:

- Departure: 80 dBA
- Arrival: 70 dBA

Please note the following in regards to these maximum noise levels:

- For departures, the maximum noise level is mostly related to flyovers which use the Parallel North – South runway
- For arrivals, the maximum noise level is mostly related to flyovers which use the East-West runway
- The estimated maximum noise levels have been corroborated with historical data presented on the Webtrack website (https://webtrak.emsbk.com/syd3), which is managed Airservices Australia.

Table 19 below summarises the ANRs required in order to achieve the internal design noise listed in Table 7. These ANRs will be used to determine the sound insulation performance of architectural components which form part of the building envelope.

Table 19 Recommended aircraft noise reductions (ANRs)

Building Type and Spaces	Recommended ANRs, dB
Houses, home units, flats, caravan parks	
Sleeping areas	30
Other habitable spaces *(kitchen areas, living rooms)*	25
Bathrooms, toilets, laundries	20

9.2 Building Envelope Recommendations

In order to achieve the noise intrusion and internal noise level criteria summarised in Section 5.5, as well as the aircraft noise intrusion criteria (refer to Section 5.4),the in-principle building envelope constructions and sound insulation performances listed in Table 20, are recommended.

These recommendations are based on the following design considerations:

- Floor finishes in bedrooms fully comprise carpet floor finishes
- Floor finishes in living rooms can comprise hard surfaces such as floor tiles.

It is intended that these glazing recommendation are further refined in the detailed design stage once a 3-D noise model of the development and the surrounding area has been developed. This model will provide improved granularity in the effects of shielding and reflections from adjacent structures enabling the façade acoustic requirements of the development to be optimised for noise intrusion.

Table 20 In-principle Façade Constructions

Building	Occupancy Area	Façade Construction	Minimum Sound Insulation Requirements	Max Allowed Coverage Area (m^2) [2]	Indicative Construction Example
Building D	Bedrooms & Living rooms	Glass	Rw 35	The following are the aggregate areas for all glass elements (sliding door, windows, etc): 16 for bedrooms 20 for living rooms 15 for studio units	12.76mm laminated
	Bedrooms, Living rooms and Studio units	Sliding door	Rw 36		12.5mm laminated door with rubber seals
	Bedrooms & Living rooms	Non-glazed construction	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
	Studio units	Glass	Rw 45	19	13.2mm laminated + 50mm air gap + 4.8 monolithic
Building E	Bedrooms & Living rooms	Glass	Rw 35	The following are the aggregate areas for all glass elements (sliding door, windows, etc): 12 for bedrooms 22 for living rooms	12.76mm laminated
		Sliding door	Rw 36		12.5mm laminated door with rubber seals
		Non-glazed construction	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
	Living room section in roof top courtyard	Door	Rw 30	2.8	35mm solid timber core door with conventional rubber seals
		Walls	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
		Roof	Rw 48	9	Metal deck on FC sheeting with 2 layer plasterboard ceiling and insulation in the ceiling cavity
	Living room in Level 6	Glass	Rw 35	15	12.76mm laminated
		Walls	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
Building F	Bedrooms & Living rooms	Glass	Rw 35	The following are the aggregate areas for all glass elements (sliding door, windows, etc): 16 for bedrooms 24 for living rooms	12.76mm laminated
		Sliding door	Rw 36		12.5mm laminated door with rubber seals

Building	Occupancy Area	Façade Construction	Minimum Sound Insulation Requirements	Max Allowed Coverage Area (m^2) [2]	Indicative Construction Example
		Non-glazed construction	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
	Living room section in roof top courtyard	Door	Rw 30	2.8	35mm solid timber core door with conventional rubber seals
		Walls	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
		Roof	Rw 48	9	Metal deck on FC sheeting with 2 layer plasterboard ceiling and insulation in the ceiling cavity
	Living room in Level 6	Glass	Rw 35	15	12.76mm laminated
		Walls	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
Building G	Bedrooms & Living rooms	Glass	Rw 35	The following are the aggregate areas for all glass elements (sliding door, windows, etc): 16 for bedrooms 24 for living rooms	12.76mm laminated
		Sliding door	Rw 36		12.5mm laminated door with rubber seals
		Non-glazed construction	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
	Living room section in roof top courtyard	Door	Rw 30	2.8	35mm solid timber core door with conventional rubber seals
		Walls	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
		Roof	Rw 48	9	Metal deck on FC sheeting with 2 layer plasterboard ceiling and insulation in the ceiling cavity
	Living room in Level 4	Glass	Rw 35	15	12.76mm laminated
		Walls	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
Building J1 & J2	Bedrooms & Living rooms	Glass	Rw 35	The following are the aggregate	12.76mm laminated

Building	Occupancy Area	Façade Construction	Minimum Sound Insulation Requirements	Max Allowed Coverage Area (m^2) [2]	Indicative Construction Example
	Bedrooms, Living rooms and Studio units	Sliding door	Rw 36	areas for all glass elements (sliding door, windows, etc): 13 for bedrooms 13 for living rooms 17 for studio units	12.5mm laminated door with rubber seals
	Bedrooms & Living rooms	Non-glazed construction	Rw 47	Refer to Note 3	Masonry wall with plasterboard and infill lining
	Studio units	Glass	Rw 35	17	13.2mm laminated + 50mm air gap + 4.8 monolithic

Note 1: These are preliminary selections will be confirmed in the detailed design stage once the development and the surround buildings have been modelled, together with the local road network, using Environmental noise modelling software such as SoundPLAN

Note 2: The maximum coverage area for all glass elements combined (sliding doors, windows, fixed glazing, etc) should not exceed maximum coverage area specified in this table as aggregate areas

Note 3: Façade areas not covered by glass elements such as windows, fixed glazing, sliding doors, etc; should be covered by non-glazed façade elements with construction and performance as summarised in this table

10 EXTERNAL NOISE EMISSION ASSESSMENT

10.1 Mechanical Plant Noise

At the time of issuing this report, details of the mechanical services design were still ongoing. Nevertheless, it is advised that a detailed assessment of noise emitting plant items should be undertaken in order to achieve the external noise level criteria discussed in Section 6.1.

Hence, the following in principle measures are recommended to be considered during the detailed design stage:

- The mechanical plant items should be fully contained in plant rooms whose walls achieve a minimum weighted sound reduction index of Rw 45 -50. Plant rooms should not be accessible from outside the building. Consequently, ornamental louvres are not recommended in these plant rooms; instead the following measures should be considered:
    - All external air intakes and exhausts should be fully ducted to the relevant plant item (i.e. AHU, FCU or fan). These ducted components should include internally lined ductwork (typically with minimum 50 mm insulation), whose extent should be recommended at a detailed design stage. Wherever possible these intakes and exhausts should aim away from nearest affected receivers.
    - Only relief air paths should have openings through the external plant room walls provided that these include acoustic louvres. It is also recommended that these air openings be installed in the plant room roof.
- All plant room walls and roofs should be internally lined with insulation which achieves a minimum NRC rating of 0.8. Insulation should have a perforated metal facing with more than 20 % perforated area, or woven cloth facing.
- All plant room construction should be fully sealed (air tight), fully closed and free of gaps
- Install internally lined return air / outside air mixed boxes behind AHUs.
- Install silencers or internally lined ductwork on external air inlets or outlets, especially for fans.
- Implement variable speed drive units whenever possible.
- In the open roof compartment where cooling towers will be located, the walls should be constructed from acoustic louvres (i.e. ornamental louvres are not acceptable). Wall heights should extend as a minimum to the top of the cooling towers (height to be confirmed at a detailed design stage).
- The use of “quiet” or low noise cooling towers.
- Limit the number of operating mechanical plant items (including cooling towers), or reduce operational loads between 6 pm and 7 am.

Finally it is advised that the conceptual measures listed above should be confirmed and developed further during detailed design stages of the project.

10.2 Noise Impact on Local Roads

According to traffic report titled *“Appropriate Traffic and Parking Measures for the Proposed Redevelopment of Eastlakes Shopping Centre”* (dated May 2010, issued by Colston Budd Hunt & Kafes Pty Ltd), the existing traffic flows summarised in Table 21 have been determined for the local roads surrounding the project site.

Table 21 Existing peak hour traffic flows

Road Location	Thursday PM Peak Period	Saturday Midday Peak Period
Evans Avenue, east of Racecourse Place	700	875
Barber Avenue, south of Evans Avenue	195	280
Barber Avenue, east of St Helena Parade	205	285

In the latest traffic report titled *"Traffic Report for Section 75W Modifications to Project Approval for the Proposed Redevelopment of Eastlakes Shopping Centre"* (dated July 2017, issued by Colston Budd Rogers & Kafes Pty Ltd), it is noted that the development will generate 20 to 30 additional vehicles per hour two way during the Thursday afternoon period and approximately 40 additional vehicles per hour two way during the Saturday midday peak period.

In order to generate an increase of 2 dB on local road traffic noise, existing traffic volumes should increase by approximately 60%. Based on the information summarised above, it is noted that the traffic volume generated by the development represents less than 60% of the existing traffic flow.

Therefore, it is it is expected that the increase on existing traffic noise levels, due to the traffic generation, will be less than 2 dB. Hence this implies that the increase on traffic noise levels is likely to be subjectively not perceptible.

10.3 Loading Dock

It is understood that the proposed operational times for the loading dock are 5:00am to 10:00pm. Therefore, the shoulder period between 5:00am and 7:00am is subject to a sleep arousal assessment since this is part of the night time period.

The sleep arousal assessment consists of calculating the L_{Amax} sound pressure levels at the residential receivers for the short-term noise events that have the highest likelihood of creating sleep disturbance.

Four worst case scenarios of loading dock activities have been assessed as follows:

- Scenario 1: Heavy vehicle braking inside the loading dock with the shutter doors left open. The levels include brake bleeding noise.
- Scenario 2: Heavy vehicle idling inside the loading dock with the shutter doors left open
- Scenario 3: Heavy vehicle reversing inside the loading dock with the shutter doors left open
- Scenario 4: Heavy vehicle movement inside the loading dock with the shutter doors left open

Based on these scenarios, it is predicted the noise emissions from the loading dock will exceed the sleep arousal criterion discussed in Section 6.3. Therefore, the following acoustic treatment is advised in order to achieve compliance:

- Roller shutter door should be closed during the shoulder period (i.e. between 5:00am and 7:00am).
- The roller shutter door must be constructed from an imperforate material. Any solid material, substantially free from gaps, will provide an adequate sound transmission loss (with an estimated performance of greater than Rw 20).
- It should be noted that the roller shutter door needs to be isolated from the concrete soffit to prevent structure borne noise from being transmitted to the residence above.

An alternative to closing the roller shutter doors during the shoulder period is to install sound absorbing material to the loading dock concrete soffit and walls. Sound absorptive material, in conjunction with its facing, should achieve a minimum NRC rating of 0.9 and should cover a minimum surface area of 2,400 m^2.

Examples of suitable sound absorbing materials include:

- Acoustic spray-on insulation to the underside of the concrete soffit (for example, 75mm thick Envirospray 300). This product should be applied to an overall thickness of approximately 50mm to achieve a noise reduction coefficient (NRC) performance of 0.9 or greater.
- Glasswool or polyester insulation such as 75mm thick, 32kgm^3 Tontine AcoustiSorb2 with a perforated foil facing such as CSR Thermofoil HD Perf (this product has a 20 % perforation factor. The insulation can be pinned to the underside of the slab by gluing metal pins to the soffit and impaling the insulation unto the pins and securing with a speed clip. The spacing of the pins should be as per the manufacturer's recommendations for a horizontal installation.

It is recommended that a detailed review of the loading dock activities are undertaken during the detailed design stage to investigate if a requirement for vibration isolation is required in areas where pallets being off loaded from HRV will affect the amenity of future residents located above.

10.4 Shopping Centre Operation Hours

As this proposal is for the second stage (or south site) of the new Eastlakes Town Centre redevelopment, it is proposed that the operation hours of the commercial facilities are in line with those approved for stage one (or north site). These hours are as follows:

Table 22 Proposed Operation Hours

Location	Operation Hours
Eastlakes Town Centre South - Commercial	6am – 10pm, 7 days a week

Note 1: The EPA defines the daytime, evening and night-time as follows: Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am.

Note 2: Loading dock operation as per section 10.3 above.

As the project is not at a stage in which the exact use of each commercial space is known it is difficult to assess the impacts. Therefore as individual Development Applications will be required for the occupancy of each space at the time of each DA, an acoustic should be undertaken to ensure the use of each space is compliant with the requirements listed in this report.

10.5 Common Pool Area

A common pool is proposed in the upper podium area of the site. In NSW residential activity is not strictly governed by Council DCPs or EPA NPI documents. However to ensure the peaceful amenity of the future occupants within the development we recommend the following:

- Use of the pool is limited to the hours of:
    - 7:00am to 8:00pm Monday to Friday; and
    - 8:00am to 8:00pm Saturday, Sunday and Public Holidays.
- Once the structural design of the building progressing vibration isolation of the pool from the base building structure should be investigated to ensure structure borne noise is adequately addressed.

- All plant noise associated with the pool is compliant with the requirements listed in section 6.1.1.

10.6 Vehicular Noise Emission from Basement Carpark

It is noted that the carpark is fully contained within basement levels and with no direct line of sight to nearest residences.

Therefore it is expected that vehicular noise emissions from the basement carpark will have a negligible impact.

11 CONSTRUCTION NOISE RECOMMENDATION

11.1 Construction Noise Assessment

The demolition and construction process is not as yet known. Noise and vibration from the demolition and construction works will, however, need to comply with the criteria specified in Section 8 of this report.

An assessment of demolition and construction activities should be undertaken by the appointed construction contractor. Noise and vibration mitigation measures should be detailed in the contractor's Noise and Vibration Management Plan (NVMP). See Section 11.6 below.

11.2 Community Consultation

Active community consultation and the maintenance of positive relations with local residents and businesses would assist in alleviating concerns of demolition and construction activities, and thereby minimising complaint. It is common for construction projects to provide community consultation if an exceedance of noise goals has been predicted. This communication is commonly conducted in the form of a letter box drop or more active engagement with more highly impacted receivers.

This form of notification should provide specific notification of the duration and timing of the construction activities so that residents are informed about the proposed works ahead of time. The letter should also provide the community with a hotline number for a community liaison officer available to adequately respond to all project related enquiries.

Ideally the hotline number should provide concerned locals an opportunity to raise any concerns with the project proponent and provide an opportunity to determine the best method to satisfy all requirements.

11.3 Complaints Management System

Should complaints arise they must be dealt with in a responsible and uniform manner, therefore, a management system to deal with complaints is detailed below:

Local residents and land-owners should be informed by direct mail of a direct 24 hour telephone line where any noise complaints related to the construction will be recorded. The 24 hour telephone line number will be made available on the construction site signage.

All complaints should be investigated by the Contractor in accordance with the Noise Complaint Management Program's procedures section detailed in the Contractor's Noise and Vibration Management Plan.

11.4 Contingency Plans

Contingency plans are required to address noise problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans include:

- Stop the use of the main equipment within specific areas of the site which is producing the most construction noise at the noise sensitive receivers; and
- Implement a construction noise assessment to be performed by a suitably qualified acoustic consultant.

The Superintendent shall have access to view the Contractor's noise measurement records on request. The Superintendent may undertake noise monitoring if and when required.

11.5 General Mitigation Measures (Australia Standard 2436-2010)

AS 2436-2010 "*Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*" sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below, including the typical noise reduction achieved, where applicable.

11.5.1 Adoption of Universal Work Practices

- Regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
- Regular identification of noisy activities and adoption of improvement techniques.
- Avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby sensitive receivers.
- Where possible, avoiding the use of equipment that generates impulsive noise.
- Minimising the need for vehicle reversing for example (particularly at night), by arranging for one-way site traffic routes.
- Use of broadband audible alarms on vehicles and elevating work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

11.5.2 Plant and Equipment

- Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Selecting plant and equipment with low vibration generation characteristics.
- Operating plant and equipment in the quietest and most efficient manner.

11.5.3 On Site Noise Mitigation

- Maximising the distance between noise activities and noise sensitive land uses.
- Installing purpose built noise barriers, acoustic sheds and enclosures.

11.5.4 Work Scheduling

- Providing respite periods which could include restricting very noisy activities to time periods that least affect the nearby noise sensitive locations, restricting the number of nights that after-hours work is conducted near residences or by determining any specific requirements.
- Scheduling work to coincide with non-sensitive periods.
- Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers.
- Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
- Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

11.5.5 Source Noise Control Strategies

Some ways of controlling noise at the source are:

- Where reasonably practical, noisy plant or processes should be replaced by less noisy alternatives.
- Modify existing equipment: Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, trucks, etc. In order to minimise noise emissions, residential grade mufflers should be fitted on all mobile plant utilised on site.
- Siting of equipment: locating noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Regular and effective maintenance.

11.6 Construction Noise Vibration Management Plan

It is essential that the Contractor develop a detailed Construction Noise and Vibration Management Plan (CNVMP) together once the details of the construction methodology, program and equipment selection has been determined to show how the criteria identified in the report will be met.

Details required include:

- Schedule of proposed activities
- Equipment selection
- Hours of operation
- Complaints handing procedure
- Contact details of who to contact in the event of a complaint

All noise complaints shall be investigated by the Building Contractor in accordance with the Contractor's Noise Complaint Management Program's procedures (established as part of CNVMP).

Noise complaint testing shall be conducted by the Contractor's qualified acoustic consultants at the complainant premises during the period of construction. The acoustic consultant shall be practising in the field of environmental noise with qualifications and experience suitable for full membership in the Australian Acoustical Society (AAS).

A noise complaint test report shall be prepared by the acoustic consultant inclusive of the following:

- Name and address of complainant;
- Measurement locations;
- Times of monitoring;
- Noise measurement results;
- Noise source details;
- Observations;
- Assessment against noise objectives;
- Conclusions; and
- Recommendations.

The report is to be submitted to the Building Contractor and Principal within one day of the noise testing.

12 CONCLUSION

Pulse Acoustics has been engaged to provide the Acoustical Assessment to accompany the development application for the amendments of the redevelopment of the Eastlakes Shopping Centre (located on Lot 30 and 31 DP1246820).

The following sub-sections summarise the outcomes of this assessment.

12.1 Building Envelope Constructions

Acceptable internal noise levels can be achieved with appropriate facade constructions. Hence, sound insulation performance and indicative construction have been recommended in Section 9.2.

These façade constructions must be reviewed at the detailed design stage to optimise glass and material selection. This should be based on the combined requirements of acoustics, thermal and structural considerations.

12.2 Mechanical Noise Sources

Mechanical services design information is unavailable at this stage of the development, as plant selection and design, where required, will take place during the detailed design phase of the project.

It is recommended that the noise emission criteria set out in Section 6 should be met through the use of noise control methods and the selection of equipment on the basis of quiet operation. .

Any mechanical plant associated with the development should be reviewed for acoustical compliance at the detailed design stage when the mechanical services design is finalised and plant selection has been made.

12.3 Noise Impact on Local Roads

The proposed development will induce a marginal increase in vehicle movement which is unlikely to result in an adverse noise impact to the closest sensitive receivers.

12.4 Loading Dock

Typical loading dock activities have been considered in our acoustic assessment. From this assessment it is determined that acoustic treatment is required in order to achieve compliance with the sleep arousal criteria.

This treatment comprises the installation of roller shutter door which achieves a sound insulation performance of Rw 20, and which should be kept closed during the shoulder period of between 5:00am and 7:00am.

Alternatively, sound absorptive finishes can be installed inside the loading dock. A sound absorptive performance and minimum required coverage area is advised for this alternate option.

Further investigations are recommended for any requirement of vibration isolation of loading dock areas once operational conditions are known.

12.5 Vehicular Noise Emission from Basement Carpark

It is noted that the carpark is fully contained within basement levels and with no direct line of sight to nearest residences.

Therefore it is expected that vehicular noise emissions from the basement carpark will have a negligible impact.

12.6 Internal Sound Insulation Requirements

It is advised that all applicable internal architectural components should be designed in order to achieve the sound insulation requirements stated in Section 7.

12.7 Construction Noise & Vibration Assessment

Construction noise criteria have been determined for the nearest affected receivers, including criteria which address sleep arousal events.

Vibration criteria have also been established, not only based on factors regarding human comfort, but also in relation to effects on building structures and the potential impact on scientific and medical equipment.

Consequently, it is recommended that a construction noise and vibration management plan (CNVMP) should be undertaken for the project. Issues which are likely to be considered in the CNVMP are discussed in Section 11, and these include typical noise and vibration mitigation measures which are to be confirmed once detailed information of the construction program becomes available

12.8 Final Remarks

Based on the findings from the acoustic assessment, it is our opinion that the proposed development is capable of achieving the acoustic consent conditions, provided the conceptual recommendations discussed herein are implemented and developed further as the project design evolves in detailed design stages.

APPENDIX A: ACOUSTIC TERMINOLOGY

Ambient Sound — The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.

Audible Range — The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.

Character, acoustic — The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.

Decibel [dB] — The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds;

0dB	the faintest sound we can hear
30dB	a quiet library or in a quiet location in the country
45dB	typical office space. Ambience in the city at night
60dB	Martin Place at lunch time
70dB	the sound of a car passing on the street
80dB	loud music played at home
90dB	the sound of a truck passing on the street
100dB	the sound of a rock band
115dB	limit of sound permitted in industry
120dB	deafening

dB(A) — *A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.

Frequency — Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.

Loudness — A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on

L_{Max} — The maximum sound pressure level measured over a given period.

L_{Min} — The minimum sound pressure level measured over a given period.

L_1 — The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.

L_{10} — The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L_{90} — The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).

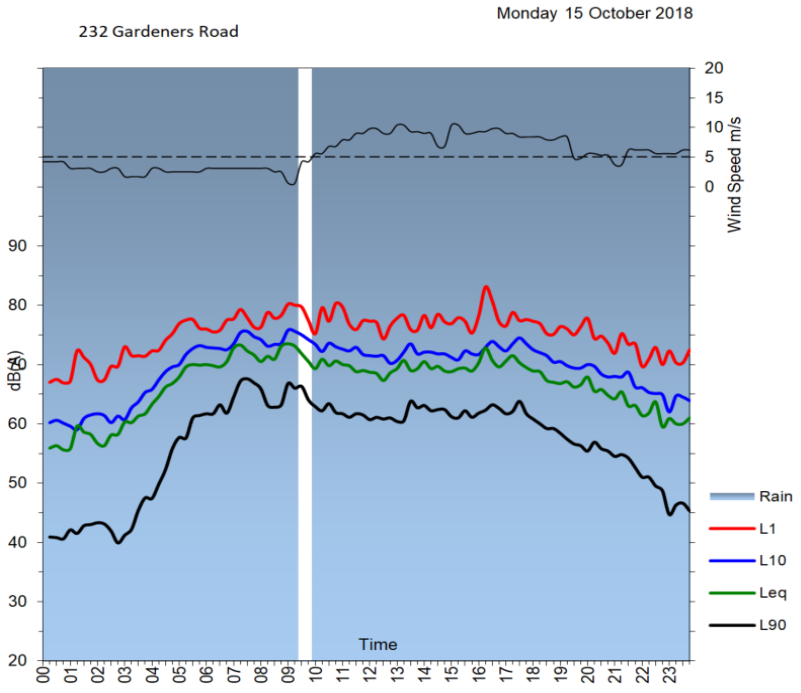
L_{eq} — The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.

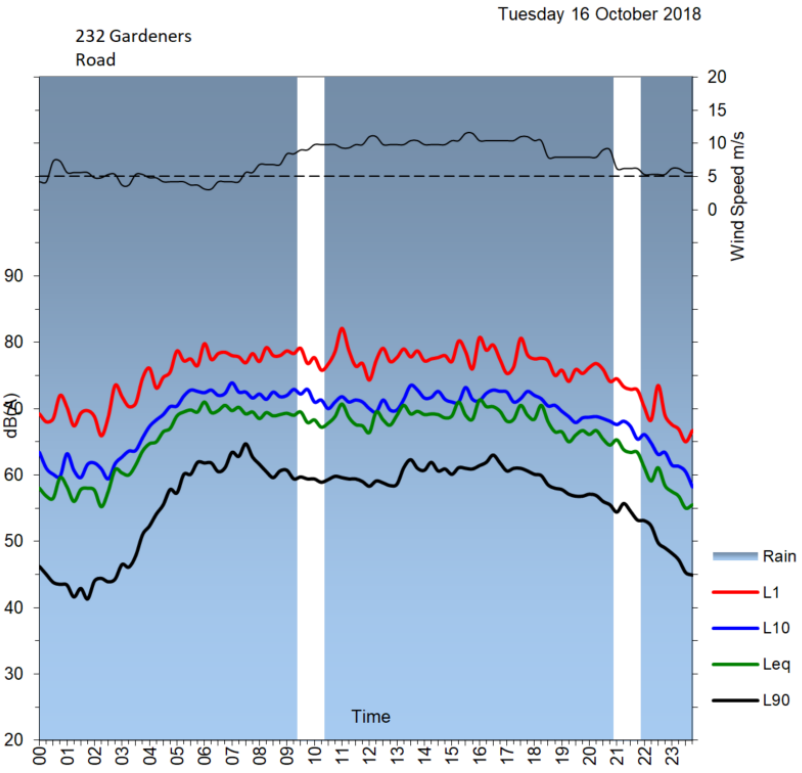
Background Sound Low — The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted, external ambient noise sources. Usually taken to mean the L_{A90} value

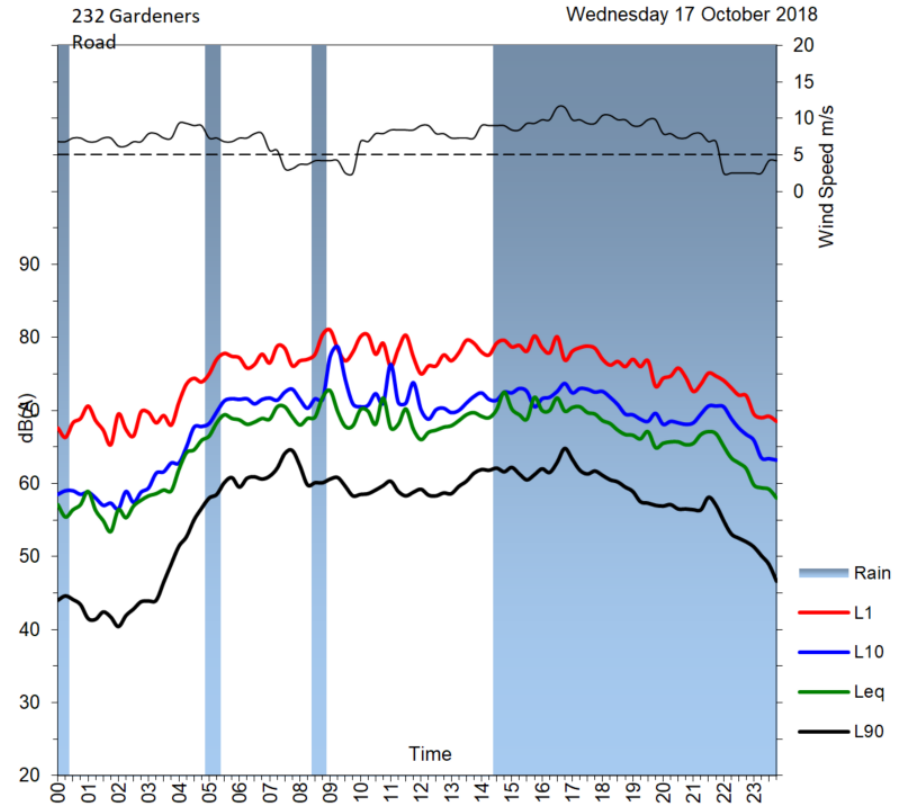
Ctr — A frequency adaptation term applied in accordance with the procedures described in ISO 717.

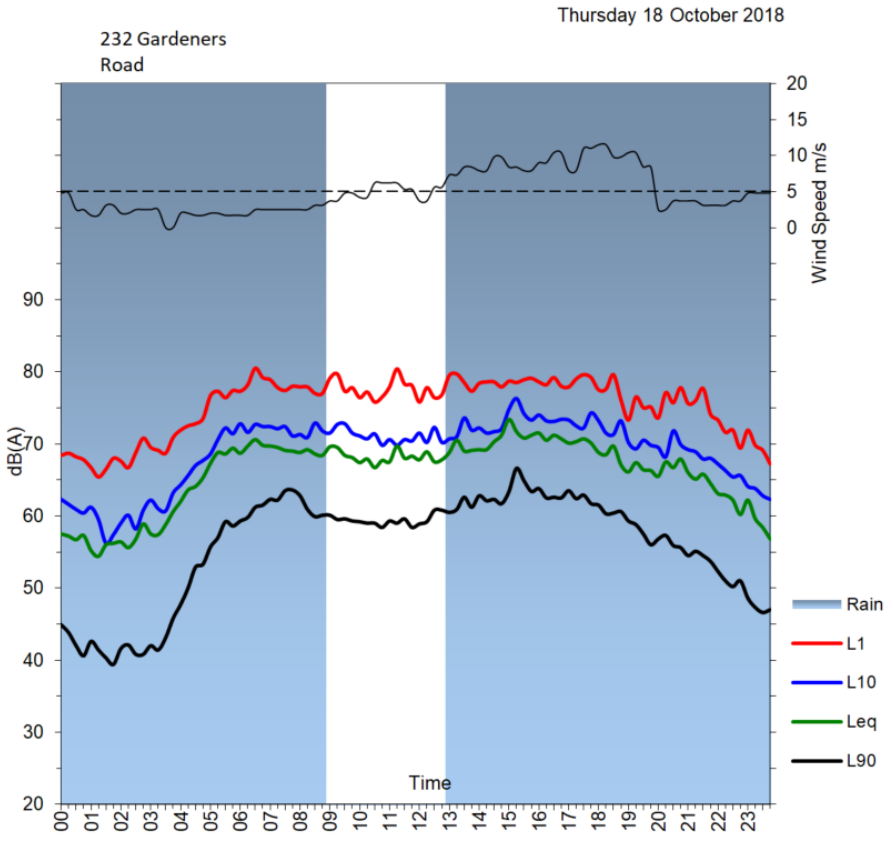
dB (A)	'A' Weighted overall sound pressure level
Noise Reduction	The difference in sound pressure level between any two areas. The term "noise reduction" does not specify any grade or performance quality unless accompanied by a specification of the units and conditions under which the units shall apply
NR Noise Rating	Single number evaluation of the background noise level. The NR level is normally around 5 to 6 dB below the "A" weighted noise level. The NR curve describes a spectrum of noise levels and is categorised by the level at 1000 Hz ie the NR 50 curve has a value of 50 dB at 1000 Hz. The NR rating is a tangential system where a noise spectrum is classified by the NR curve that just encompasses the entire noise spectrum consideration.
R_w	Weighted Sound Reduction Index - Laboratory test measurement procedure that provides a single number indication of the acoustic performance of a partition or single element. Calculation procedures for Rw are defined in ISO 140-2:1991 "Measurement of Sound Insulation in Buildings and of Building Elements Part 2: Determination, verification and application of precision data".
R'_w	Field obtained Weighted Sound Reduction Index - this figure is generally up to 3-5 lower than the laboratory test determined level data due to flanked sound transmission and imperfect site construction.
Sound Isolation	A reference to the degree of acoustical separation between any two areas. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term "sound isolation" does not specify any grade or performance quality and requires the units to be specified for any contractual condition
Sound Pressure Level, L_P dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.
Sound Power Level, L_W dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt
Speech Privacy	A non-technical term but one of common usage. Speech privacy and speech intelligibility are opposites and a high level of speech privacy means a low level of speech intelligibility. It should be recognised that acceptable levels of speech privacy do not require that speech from an adjacent room is inaudible.
Transmission Loss	Equivalent to Sound Transmission Loss and to Sound Reduction Index in terminology used in countries other than Australia. A formal test rating of sound transmission properties of any construction, by usually a wall, floor, roof etc. The transmission loss of all materials varies with frequency and may be determined by either laboratory or field tests. Australian Standards apply to test methods for both situations.

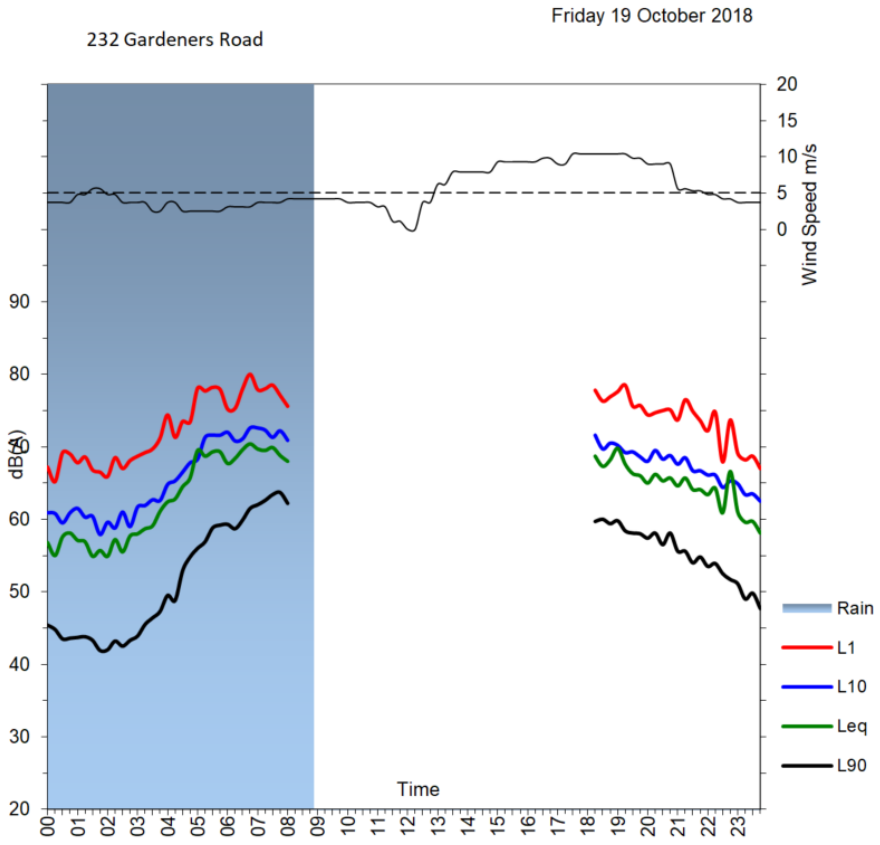
APPENDIX B: UNATTENDED NOISE MEASUREMENTS 232, GARDENERS ROAD

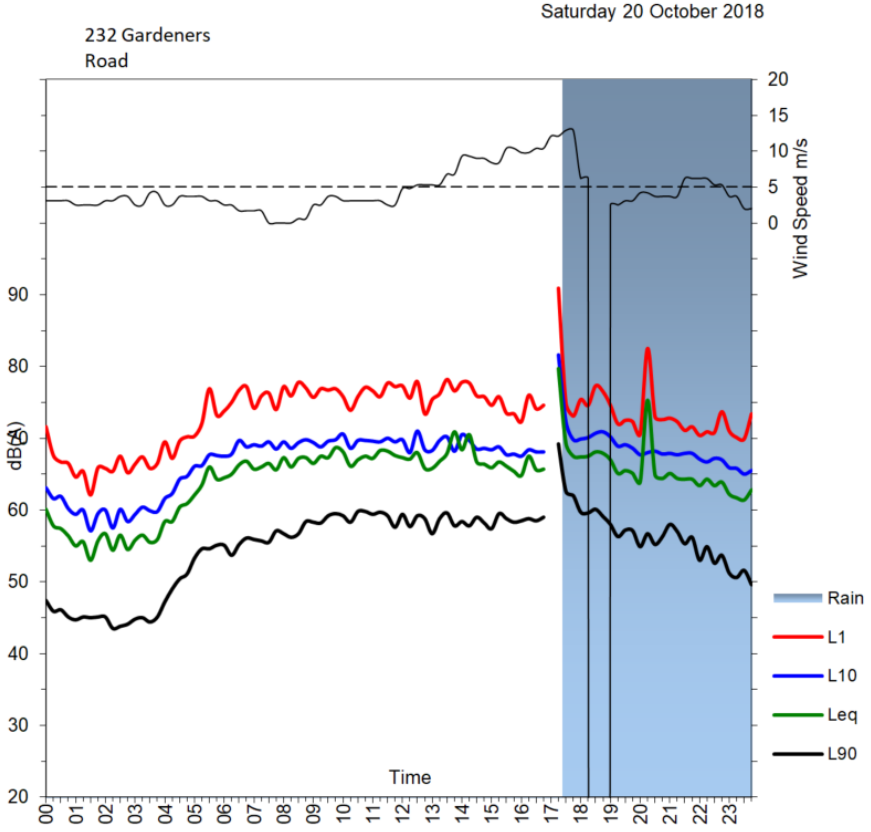


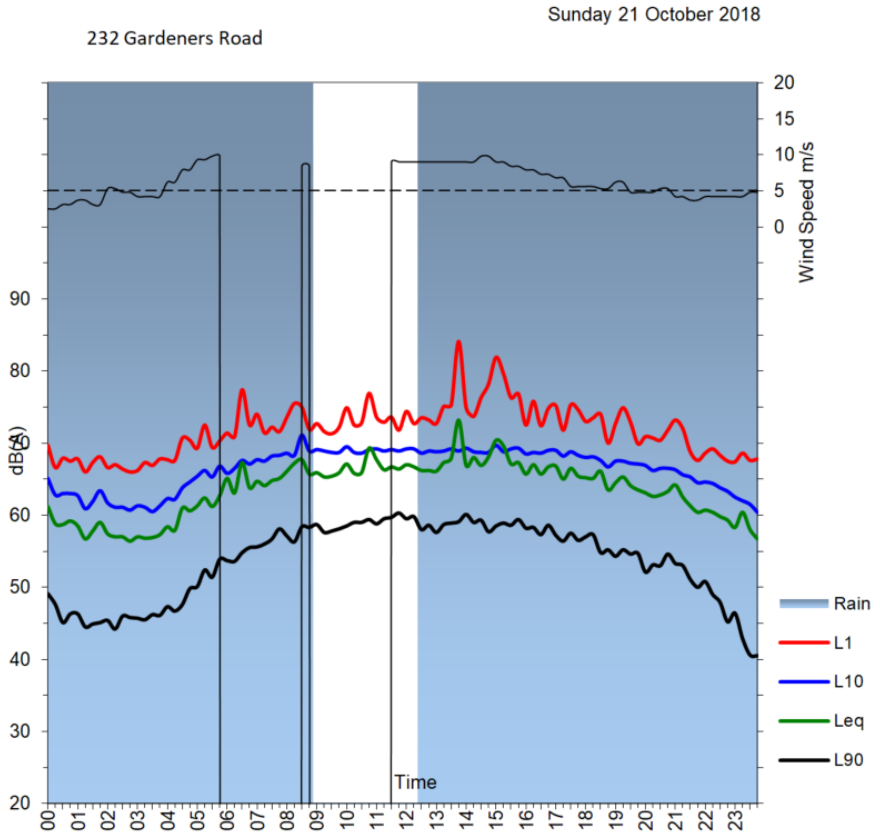


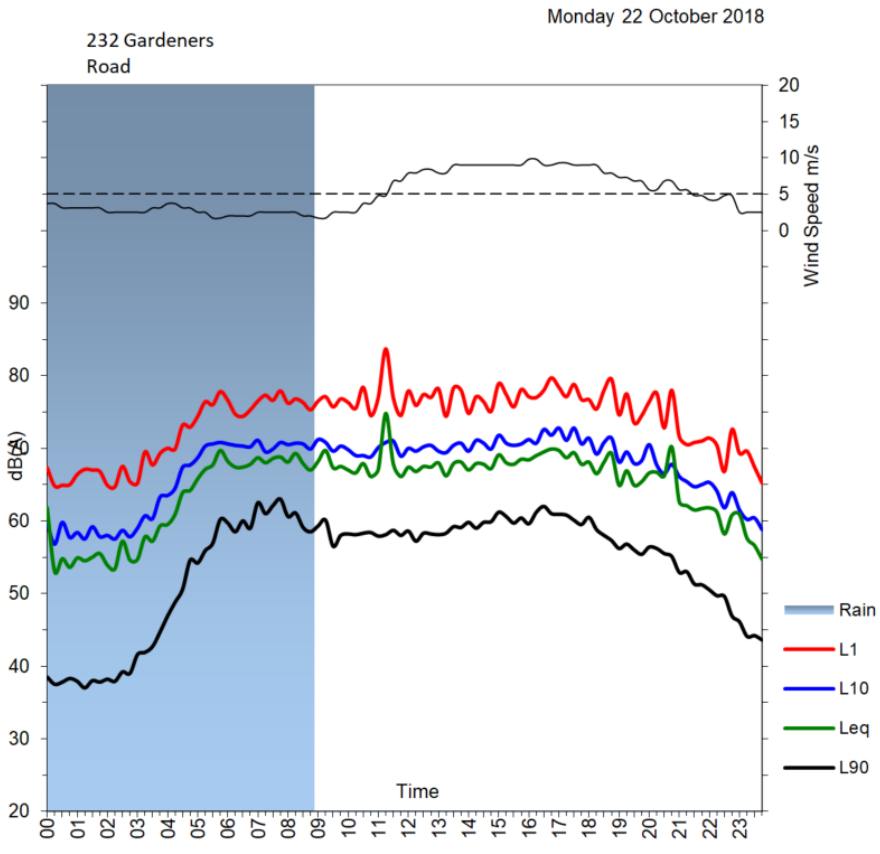

232 Gardeners Road
Wednesday 17 October 2018
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

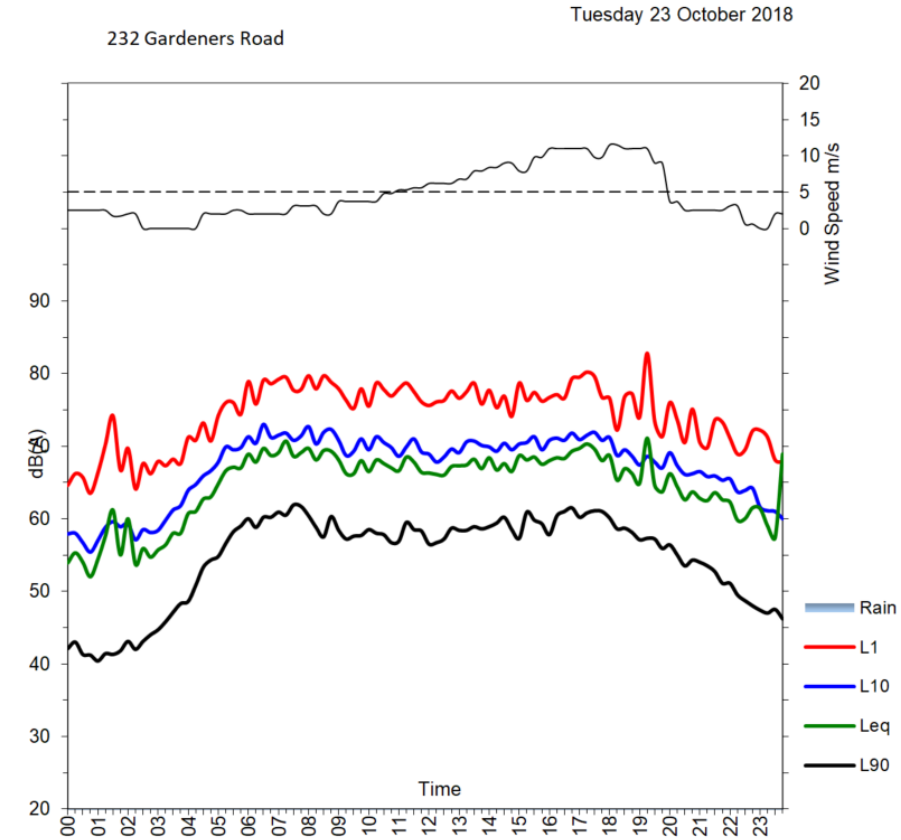

Thursday 18 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

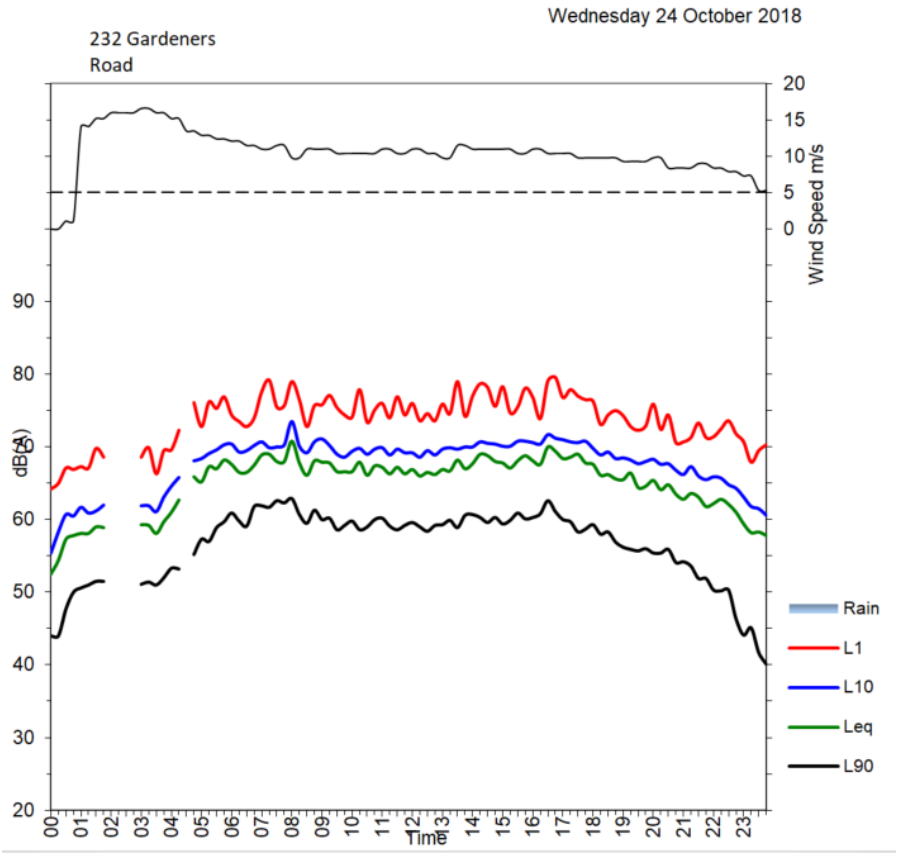

Friday 19 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

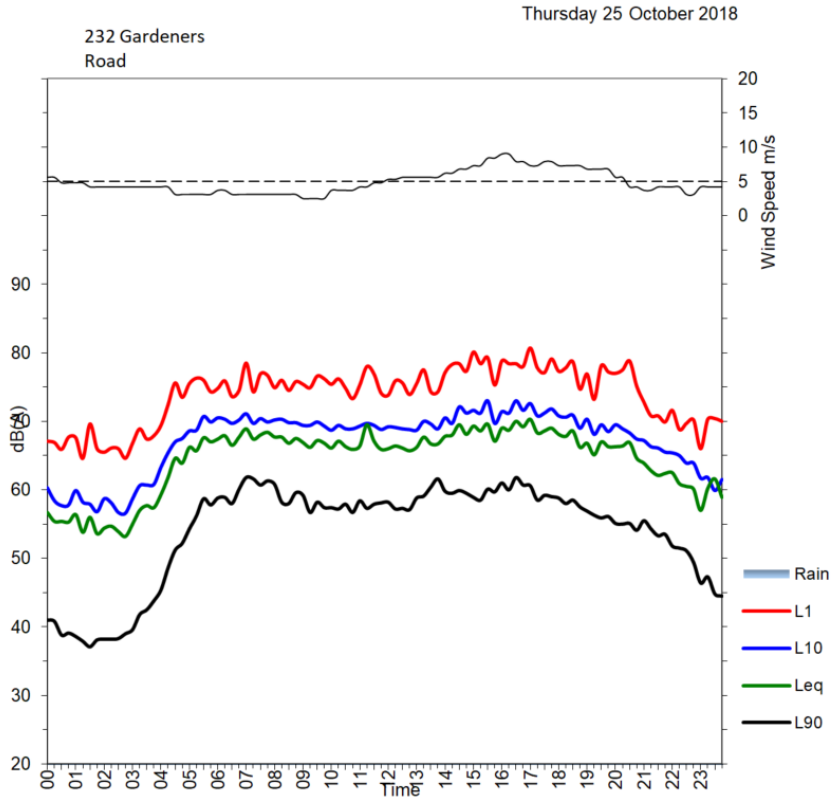

Saturday 20 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

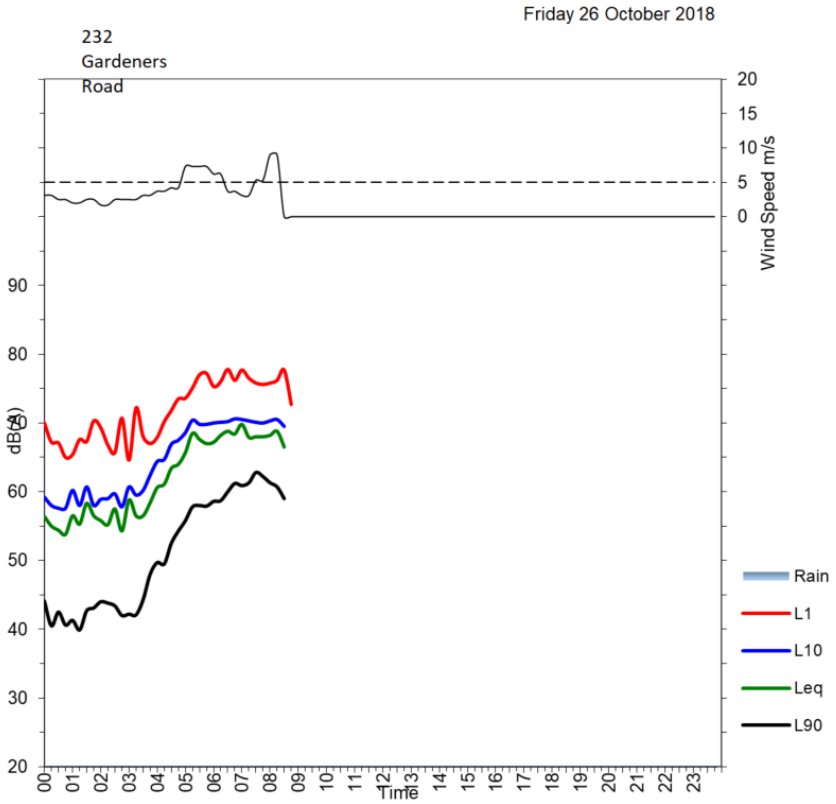

Sunday 21 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90


Monday 22 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

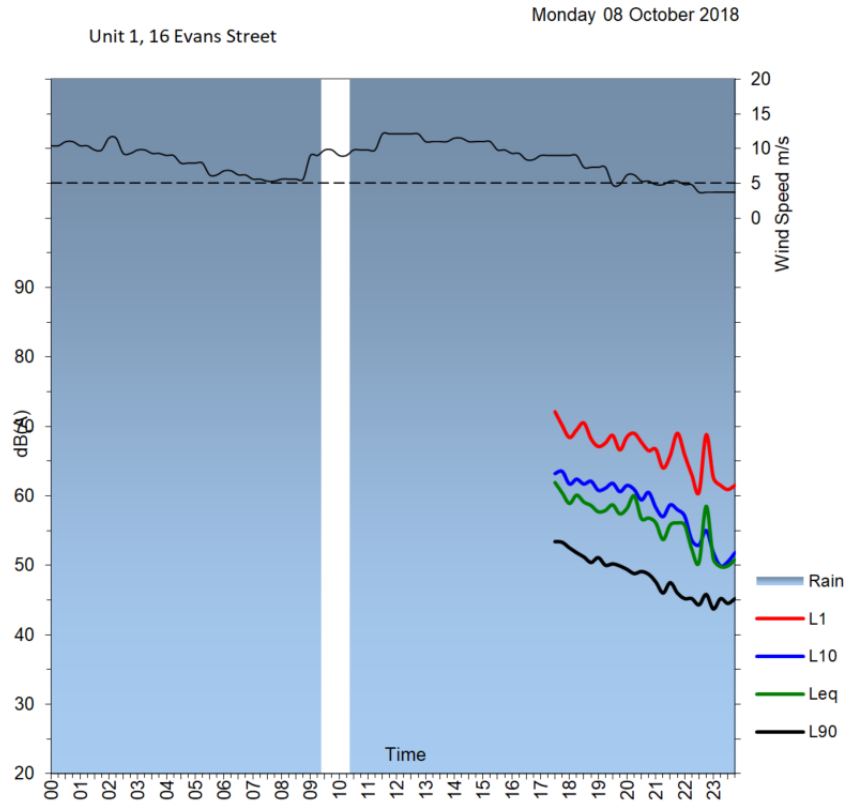

Tuesday 23 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

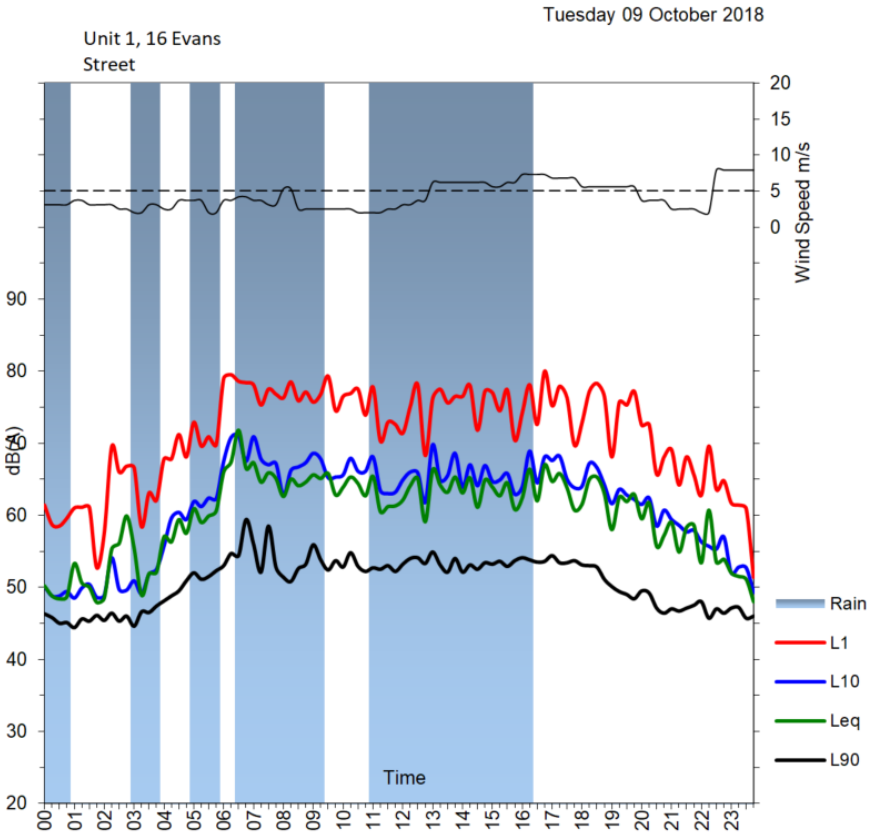

Wednesday 24 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

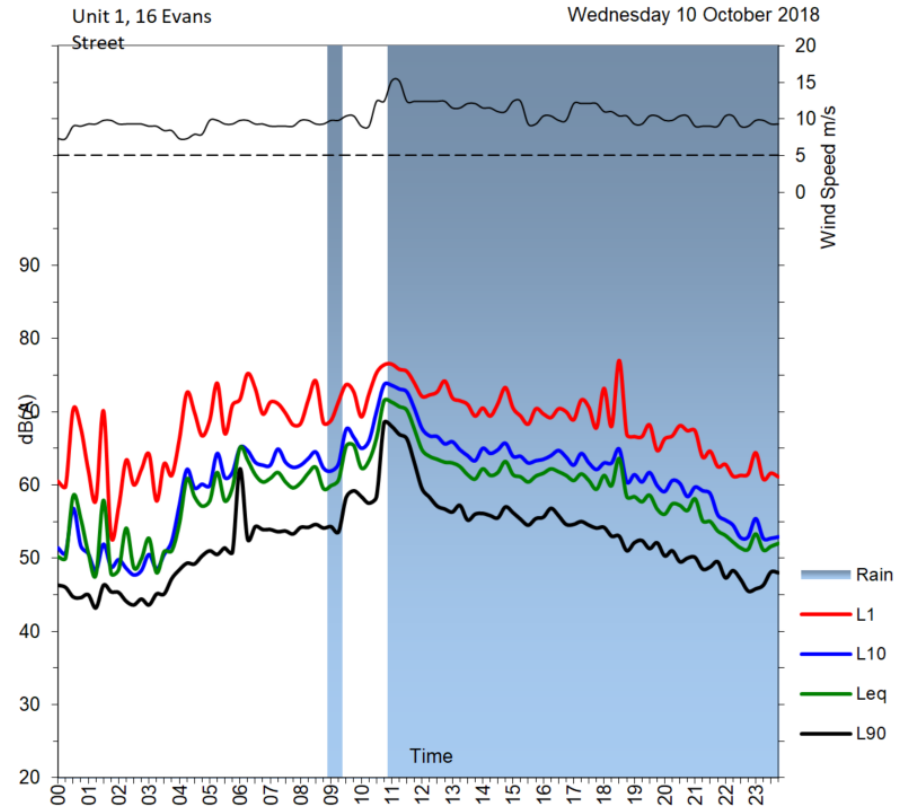

Thursday 25 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

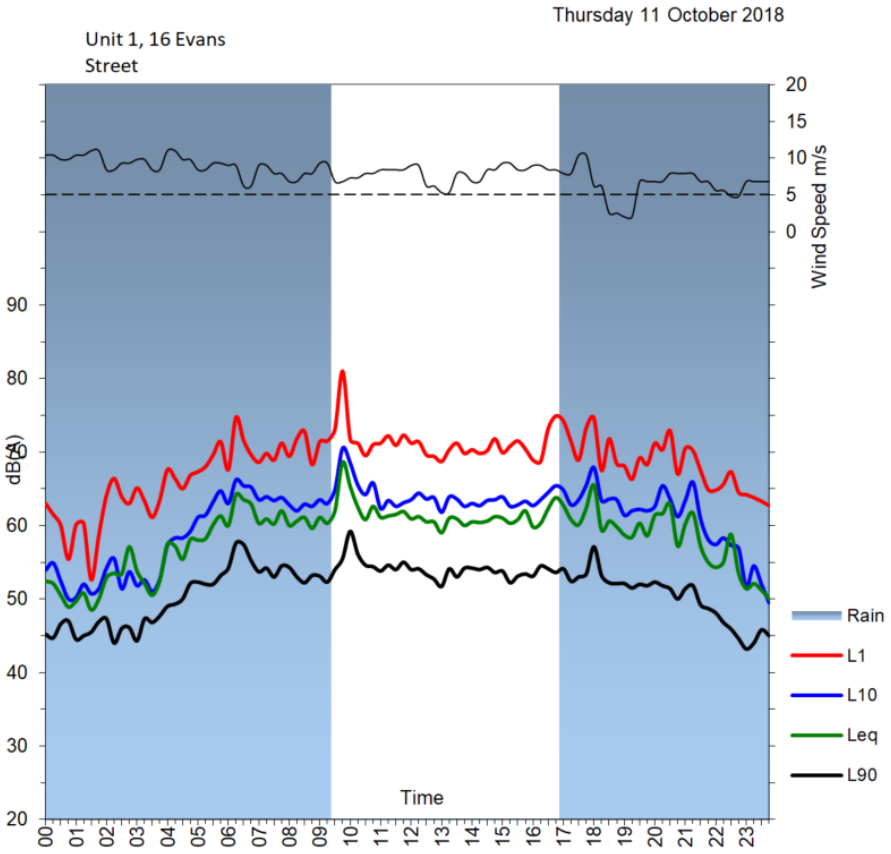

Friday 26 October 2018
232 Gardeners Road
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

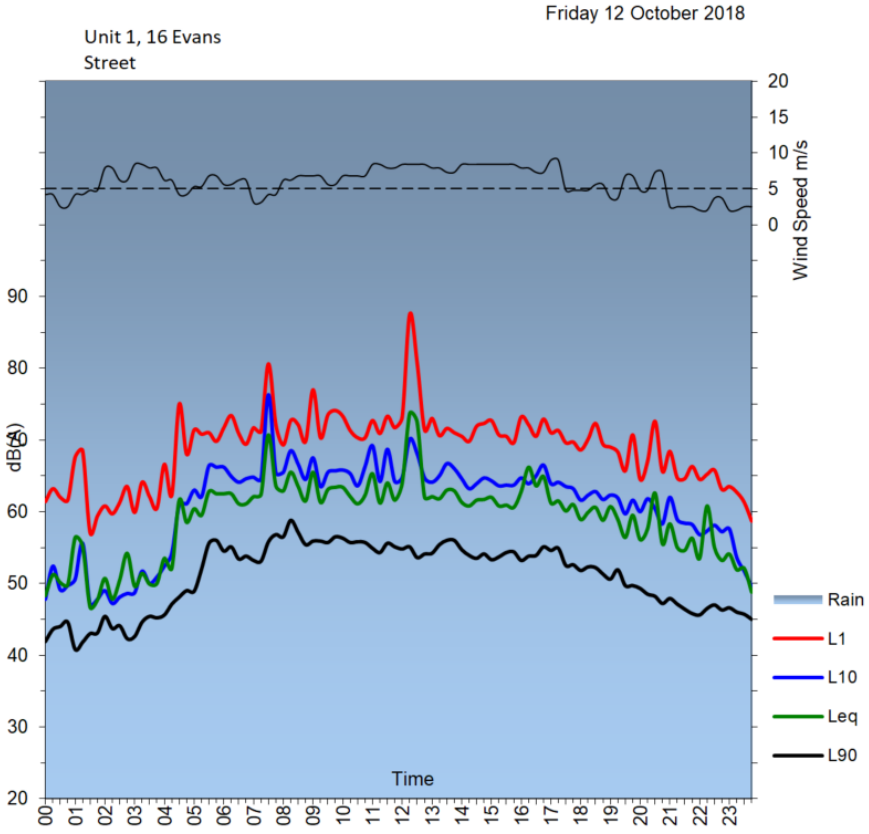
APPENDIX B: UNATTENDED NOISE MEASUREMENTS UNIT 1, EVANS AVENUE

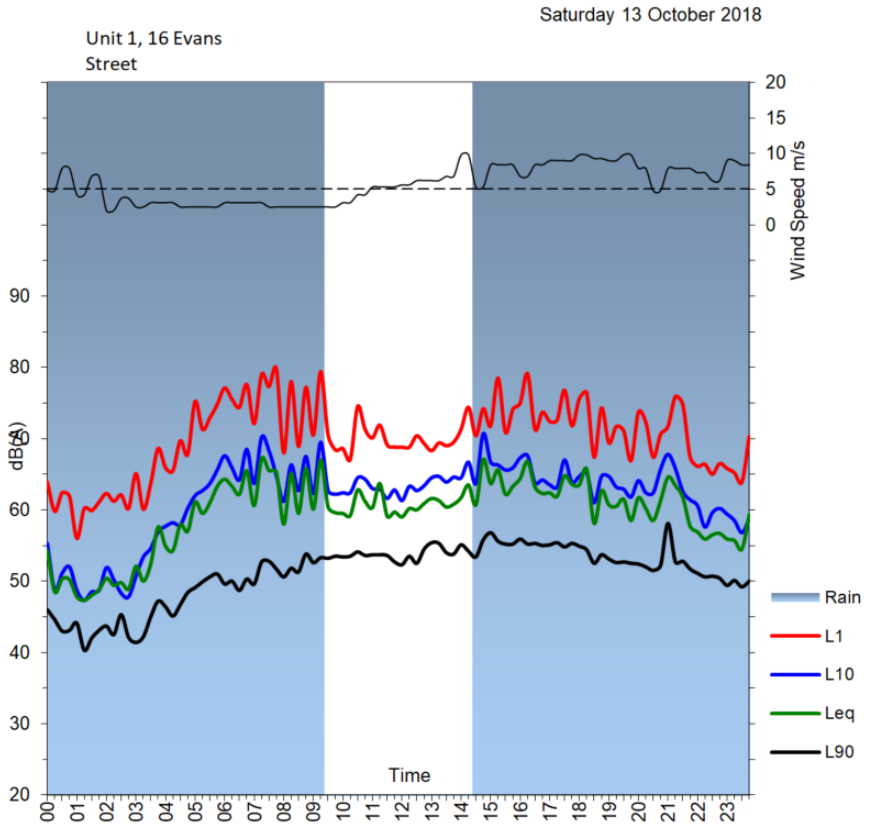


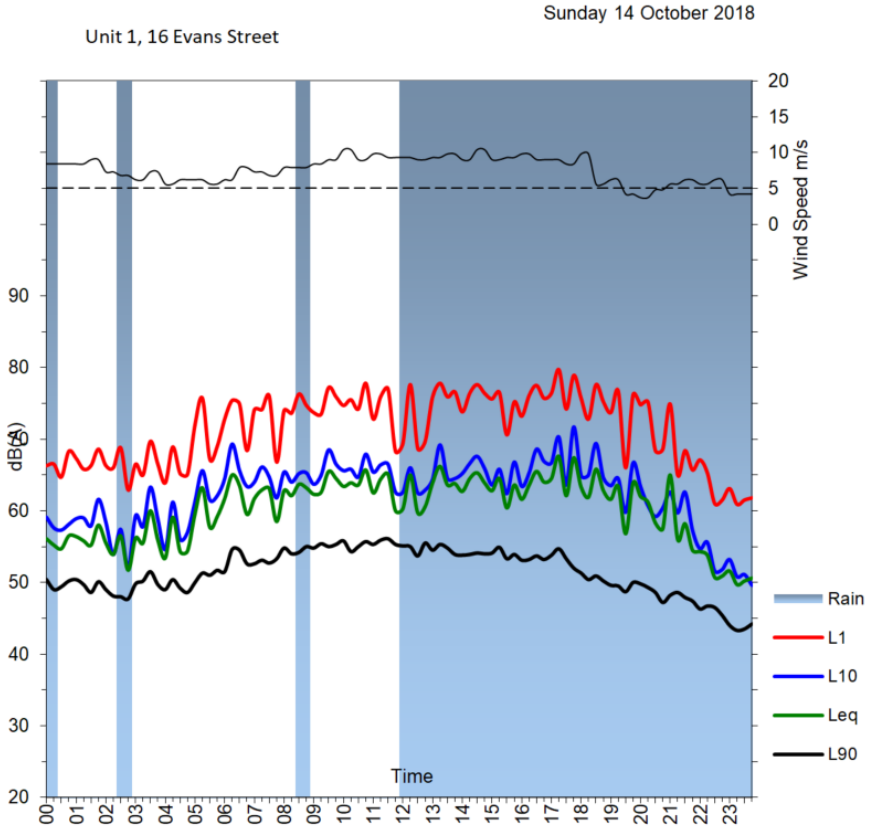


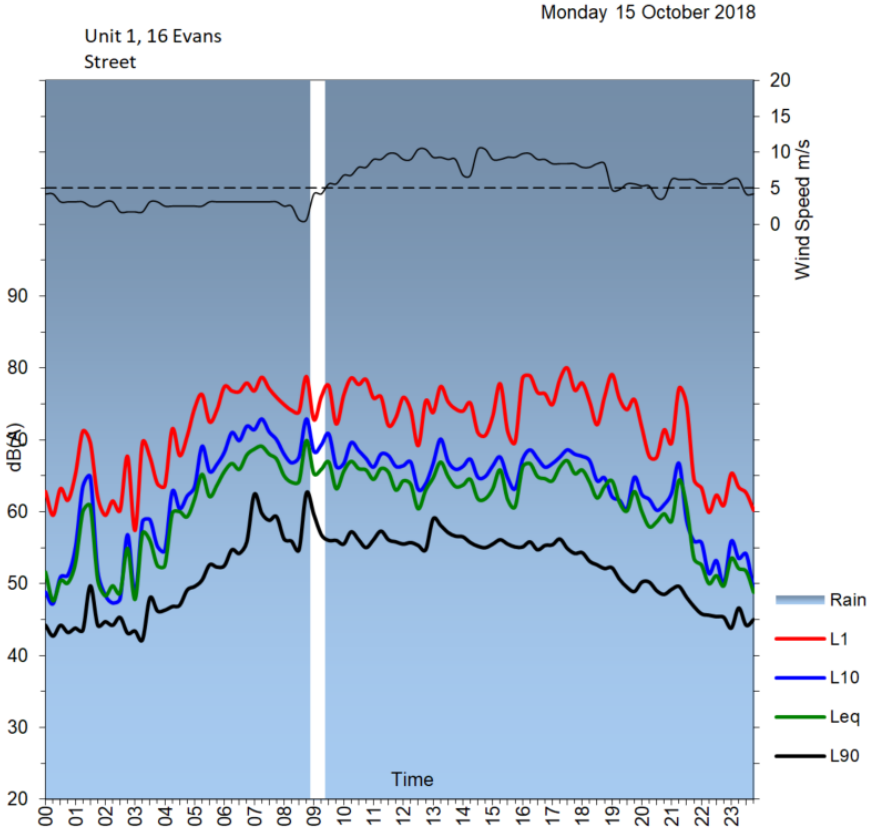

Unit 1, 16 Evans Street
Wednesday 10 October 2018
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

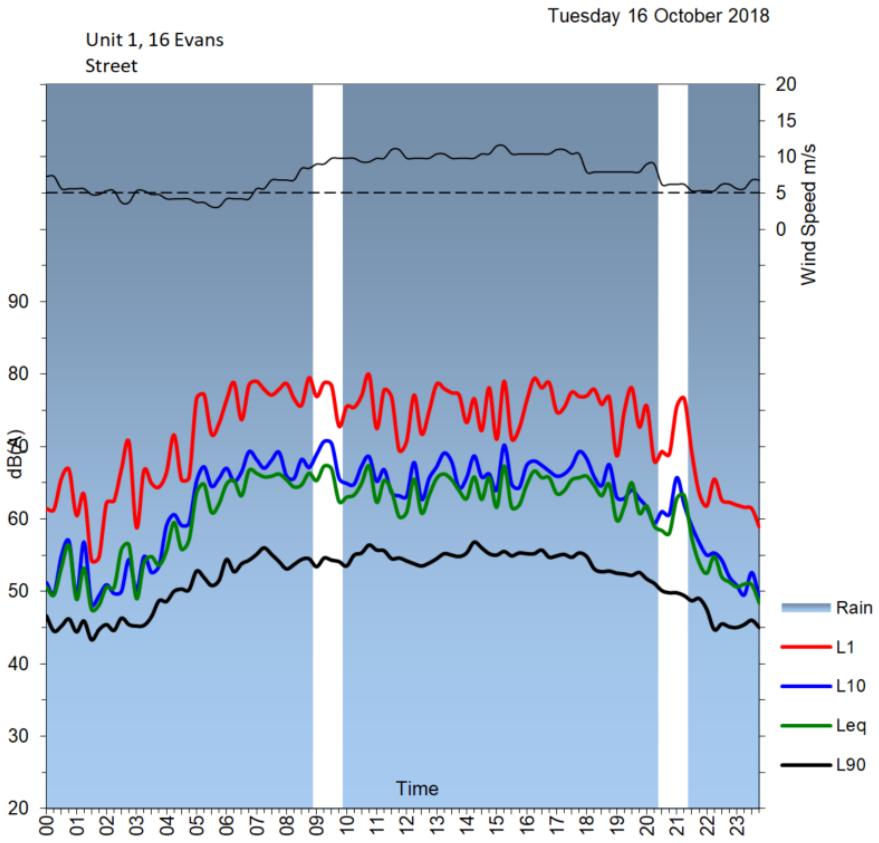

Thursday 11 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

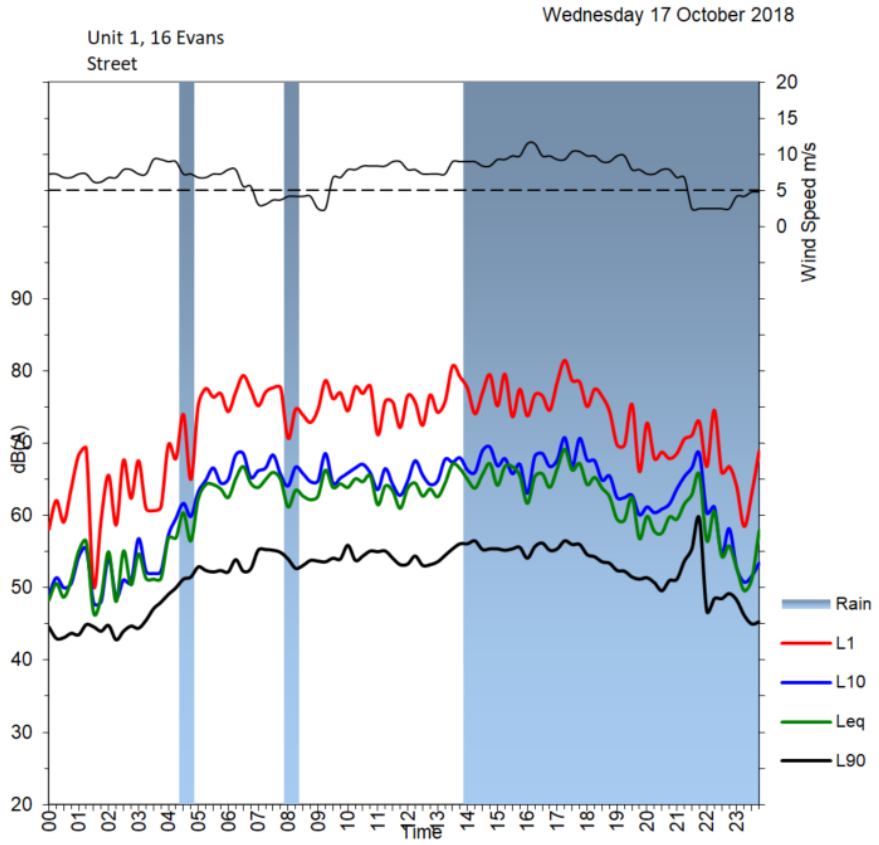

Friday 12 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

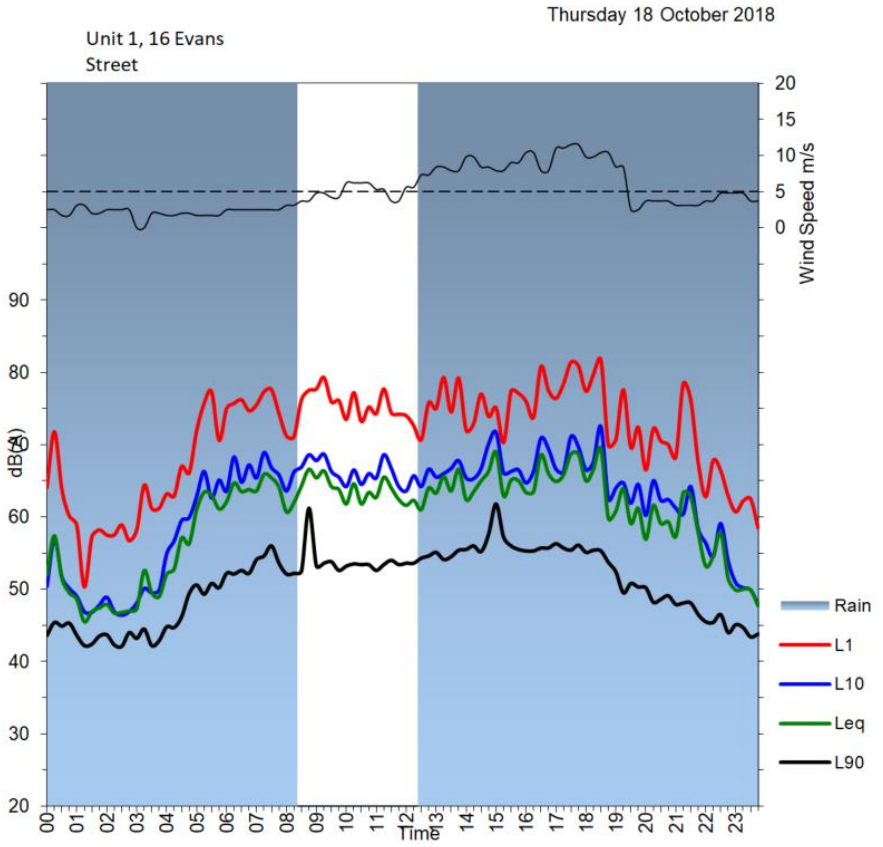

Saturday 13 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90

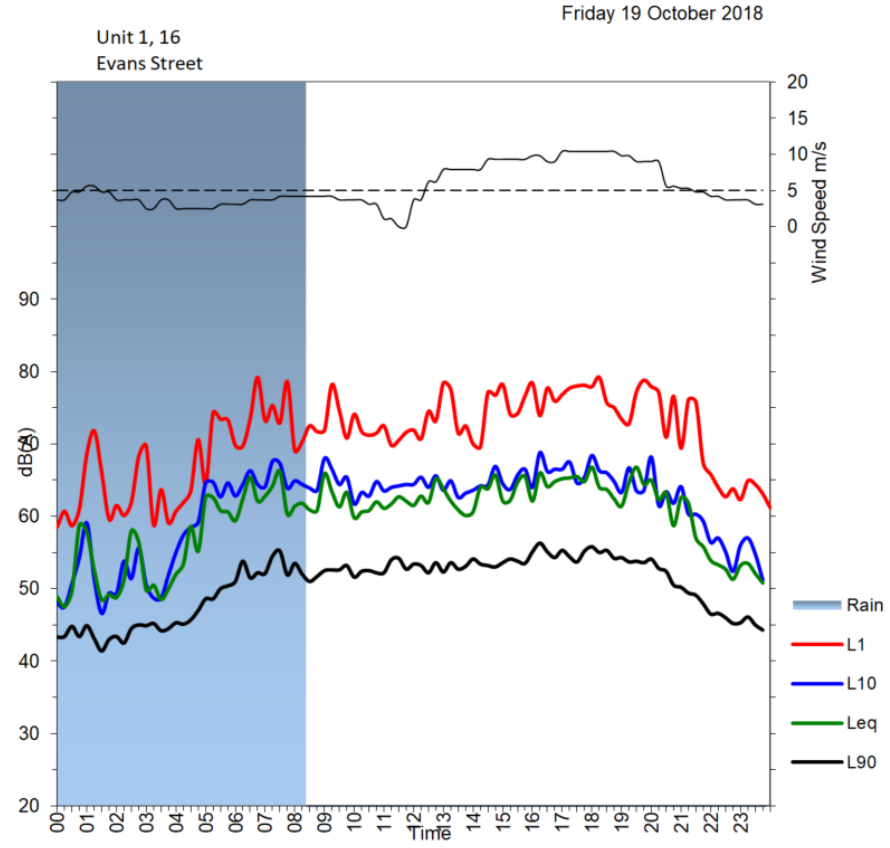

Sunday 14 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90


Monday 15 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90


Tuesday 16 October 2018
Unit 1, 16 Evans Street
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90


Wednesday 17 October 2018
Unit 1, 16 Evans Street
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90


Thursday 18 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90


Friday 19 October 2018
Unit 1, 16 Evans Street
Wind Speed m/s
dB(A)
Time
Rain
L1
L10
Leq
L90