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310 TERRIGAL DRIVE, TERRIGAL PLANNING PROPOSAL ACOUSTIC ASSESSMENT

Report 11.00430-01

prepared on 28/05/2023

REPORT PREPARED BY

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BASIS OF REPORT

This report has been prepared by **Acoustics Consultants Australia (ACA)** with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with the Client. Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from ACA. ACA disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

REFERENCE	DATE	PREPARED	REVIEWED	AUTHORISED
11.00430-01 - DRAFT	22/04/2023	SF	MdlM	SF
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Report 11.00430-01

1. INTRODUCTION

Acoustics Consultants Australia (ACA) has been engaged to undertake a Planning Proposal acoustic design review of the proposed multiple occupancy mixed-use development at 310 Terrigal Drive, Terrigal.

This Acoustic Assessment has been prepared on behalf of Loftus Lane Capital Partners (the applicant), in support of a Planning Proposal relating to land identified as 310 Terrigal Drive, Terrigal, which is legally described as Lot 27 in DP 1223375 (the site).

The Planning Proposal seeks to amend the Central Coast LEP 2022 by increasing the maximum permissible height of buildings to 32 m and the maximum floor space ratio to 1.4:1.

The Planning Proposal will enable the site to be redeveloped from a vacant land parcel to an eight-storey residential flat building, with a café activating the corner of Charles Kay Drive and Terrigal Drive at the ground level.

The concept drawings prepared by CKDS Architects demonstrate the potential for the site to accommodate 42 residential apartments and 75 car parking spaces across three basement levels.

The purpose of this assessment is to:

- consider the potential for off-site noise emissions from the proposed site to impact existing surrounding receivers (both during operational and construction stages of the development);
- consider the potential for noise impacts on the proposed development from external noise sources (i.e. surrounding main roads); and
- to provide a preliminary overview of NCC requirements for the proposed mixed-use development.

This assessment has involved a desktop review of the concept drawings provided to ACA (preliminary architectural drawings: concept drawings prepared by CKDS Architects, dated 13/4/2023.

In addition to the Central Coast Council pre-lodgement meeting minutes dated February 2023, the following regulations and guidelines have been considered in this report:

- *NSW Noise Policy for Industry* (NPfI).
- *NSW Interim Construction Noise Guideline* (ICNG).
- *State Environmental Planning Policy SEPP (Transport and Infrastructure) 2021.*
- *Development near Rail Corridors and Busy Roads - Interim Guideline*.

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- Australian Standard 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors* (AS/NZS 2107).
- *National Construction Code 2019 Amendment 1* (NCC).
- Association of Australasian Acoustical Consultants (AAAC) *Guideline for Apartment and Townhouse Acoustic Rating*.

This review has determined that the proposed development may be designed to satisfactorily achieve the relevant acoustic requirements. By adhering to the recommendations in this report general compliance with the requirements of the guidelines listed above may be expected.

Further details of methodology and Standards used to conduct the assessment, as well as the numeric assessment results are presented in the following sections of this report.

Acoustic terms used in this report are defined in the Glossary of **Appendix A**.

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2. NOISE POLICY, STANDARDS & GUIDELINES

For the purposes of this Planning Proposal assessment, the acoustic requirements and recommendations outlined in the following documents have been considered:

- Central Coast Council pre-lodgement meeting minutes dated February 2023.
- *NSW Noise Policy for Industry* (NPfI) in relation to the assessment of operational noise emissions from the subject site.
- *NSW Interim Construction Noise Guideline* (ICNG) in relation to the assessment of construction noise emissions from the subject site.
- Relevant provisions of *State Environmental Planning Policy SEPP (Transport and Infrastructure) 2021* and *'Development near Rail Corridors and Busy Roads - Interim Guideline'* in relation to road traffic noise intrusion.
- National Construction Code 2019 (NCC 2019), Building Code of Australia – for airborne and impact sound insulation, and acoustic treatment of services, as per section F.5 of NCC 2019 Amendment 1.
- Australian Standard 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors* (AS2107).
- Association of Australasian Acoustical Consultants *Guideline for Apartment and Townhouse Acoustic Rating* (Version 1.0).

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3. STRUCTURE OF THIS REPORT

The remainder of the report is structured as follows:

- A brief description of the site and surrounding area is provided in **Section 4**;
- The existing acoustic environment is discussed in **Section 5**;
- Assessment of off-site operational noise emissions from the site is set out in **Section 6**;
- Construction noise and vibration is assessed and a Construction Noise and Vibration Management Plan is provided in **Section 7**;
- Assessment of road traffic noise intrusion on the subject site is set out in **Section 8**;
- Preliminary review of the acoustic design of the building elements with respect to the NCC requirements is addressed in **Section 9**.

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4. SITE AND SURROUNDING AREA

The site at 310 Terrigal Drive is bounded by Terrigal Drive to the north and Charles Kay Drive to the west, with the closest residential receivers located to the east, beyond an intervening section of recreationally zoned land and on the northern side of Terrigal Drive.

The Terrigal High School playing fields adjoin the site to the south, with recreational zoning and the Terrigal Ambulance Station located on the western side of Charles Kay Drive.

An aerial view of the site and surrounding area is shown in **Figure 4.1**. The closest surrounding receiver buildings considered by this assessment are identified in the figure and in **Table 4.1**.

Figure 4.1 Aerial View of Site and Surrounding Receivers

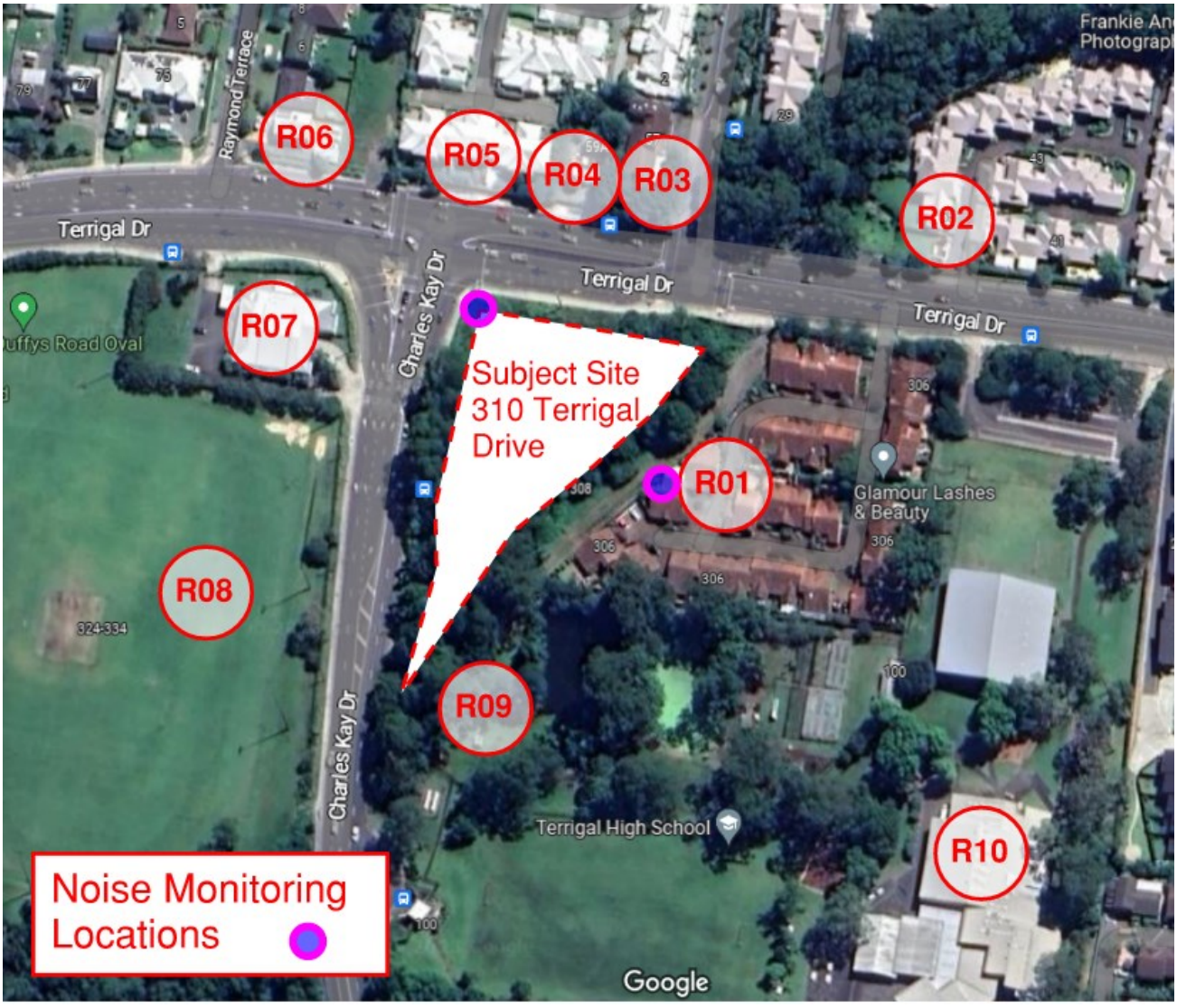

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Table 4.1 Surrounding Receivers

Receiver ID	Receiver Address	Receiver Type	Receiver Description
R01	306 Terrigal Drive	Residential	The Grange – Residential Dwellings
R02	41-55 Terrigal Drive	Residential	The Brunswick – Residential Apartments
R03	57 Terrigal Drive Residential	Medical	Medical Centre (X-Ray Clinic)
R04	59 Terrigal Drive	Residential	Residential Dwelling
R05	2 Brunswick Road	Residential	Residential Apartments
R06	2 Raymond Terrace	Medical	Medical Centre (Physiotherapy)
R07	322 Terrigal Drive	Medical	Terrigal Ambulance Station
R08	336-350 Terrigal Drive	Recreation	Duffy's Oval & Recreational Precinct
R09	100 Charles Kay Drive	Educational	Terrigal High School Recreational Areas
R10	100 Charles Kay Drive	Educational	Terrigal High School Classrooms

According to the Central Coast Council Local Environmental Plan 2022 the zoning of the site is R1 (General Residential). **Figure 4.2** shows the zoning of the land surrounding the site.

Figure 4.2 Land Zoning Map of Site and Surrounding Area

Note: R1 General Residential; R2 Low Density Residential; RE1 Public Recreation

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5. EXISTING ACOUSTIC ENVIRONMENT

ACA undertook site inspections on 4 and 14 April 2023 to evaluate the existing acoustic environment and the potential for on-site and off-site noise impacts.

Traffic noise from Terrigal Drive and Charles Kay Drive was noted to dominate the local acoustic environment in the vicinity of the site.

To determine the typical existing background and ambient noise levels at the potentially most affected residences adjoining the site an environmental noise logger was installed in the rear yard of Unit 19 at 306 Terrigal Drive (R01), at the location identified in **Figure 2.1**.

Background noise levels were measured continuously over a 9-day period, between 14 to 22 April 2023. The background noise levels obtained may be considered to be broadly representative of the prevailing background levels at the other nearby residential receivers considered by this assessment.

Noise Monitoring Equipment

All measurements were undertaken in general accordance with *AS1055:1997: Acoustics – Description and Measurement of Environmental Noise* and the *NSW Noise Policy for Industry* (NPfI).

The long-term monitoring was undertaken with a Rion NL-32 Type 1 noise logger (serial number 00982868).

The noise logger was calibrated before and after the measurements using a SVAN Type SV33B acoustic calibrator and no significant drift in the pre and post calibration measurements occurred.

The instruments used in the survey comply with *AS IEC 61672.1:2004: Electroacoustics – Sound Level Meters – Specifications* and *AS IEC 60942:2004: Electroacoustics – Sound Calibrators* as appropriate, and have recent calibration certificates traceable to a NATA certified laboratory.

Noise Monitoring Methodology

The logger was set to A-Weighting and fast response and positioned with its microphone at 1.5 m above ground level. Statistical noise levels were processed and stored by the instrument every 15 minutes for the whole monitoring period.

The noise logger determines a variety of descriptors such as L_{A1}, L_{A10}, L_{A90} and L_{Aeq} used to describe the existing noise environment. Definitions of these parameters are provided in the Glossary of Acoustic Terms attached in **Appendix A**. The L_{A90} level is taken as the background noise level and is used to derive the Rating Background Levels (RBLs) as per the requirements of the NPfI.

Measured Noise Levels

Table 5.1 provides a summary of the daytime, evening and night-time RBLs derived directly from the unattended logging. The ambient L_{Aeq} levels are also shown. As required by the NPfI, in deriving the RBLs, any effects due to extraneous noise sources or adverse weather (rain and wind greater than

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5m/s at a height of 1.5m) have been excluded from the analysis. Meteorological data collected during the noise monitoring period at the Bureau of Meteorology Gosford weather station was reviewed for this purpose and some weather affected periods were excluded.

Table 5.1 Rating Background Levels and Ambient Noise Levels from Unattended Logging

Location	Logging Period	Day (7am – 6pm)		Evening (6pm – 10pm)		Night (10pm – 7am)	
		RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
R01 306 Terrigal Drive	14–22 April 2023	50	57	45	55	30	51

The noted background and ambient noise levels were observed to be controlled principally by local road traffic and natural noise sources.

Daily noise monitoring plots are provided in **Appendix C** of this report.

The identified night-time background noise level (L_{A90} 30 dBA), being the most stringent criterion for determining compliance, shall be considered during the specification of mechanical plant and equipment. During final plant selection all noise generating mechanical services plant shall be specified, located and/or acoustically treated to ensure cumulative noise levels from the site do not exceed the background levels by more than 5 dB externally to neighbouring lots.

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6. OPERATIONAL NOISE ASSESSMENT

Noise Policy for Industry (NPfI) Operational Noise Criteria

For the purpose of assessing the potential impact of airborne noise emissions, reference is made to the guidance set out in the NSW Environment Protection Authority's Noise Policy for Industry (NPfI).

The *NPfI* provides a framework and process for deriving noise criteria for consents and licences that enable the EPA and others to regulate premises that are scheduled under the Protection of the Environment Operations Act 1997. Whilst specifically aimed at assessment and control of noise from industrial premises, the approaches documented can be used to provide guidance for the assessment of noise from other continuous or semi-continuous operational sources.

The *NPfI* criteria for industrial noise sources are based on the consideration of two components:

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

The controlling Project Noise Trigger Levels (PNTLs) are determined following the establishment of the Project Intrusiveness Noise Levels and Project Amenity Noise Levels, with the PNTLs being the more onerous of the two.

Intrusiveness Noise Levels

The intrusiveness trigger levels within the relevant day, evening and night periods are determined as follows:

- $L_{Aeq,15\ minute}$ ≤ Rating Background Noise Level (RBL, L_{A90}) + 5 dB

$L_{Aeq,15minute}$ represents the equivalent continuous A-weighted sound pressure level of the source over 15 minutes, unless other descriptors are specified as more appropriate to characterise the source. (See attached Glossary of Terms for full definitions).

Intrusive noise levels are only applied to residential receivers (residences).

Adjustments apply in accordance with EPA guidelines for tonality, frequency weighting, impulsive characteristics, fluctuations and temporal content, where relevant.

Based on the background noise levels described in **Section 5**, the applicable intrusiveness noise levels considered by this assessment are as follows:

- $L_{Aeq,15min}$ 55 dBA during the daytime (7.00am - 6.00pm);
- $L_{Aeq,15min}$ 50 dBA during the evening (6.00pm - 10.00pm); and
- $L_{Aeq,15min}$ 35 dBA during the night (10.00pm - 7.00am).

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The night-time $L_{Aeq,15min}$ 35 dBA intrusiveness noise level may be considered the most stringent criterion for determining intrusiveness noise compliance with respect to mechanical services.

Amenity Noise Levels

The Amenity Noise Levels set limits on the total noise level from all industrial noise sources affecting a receiver. Different amenity criteria apply for different types of receiver (e.g. residential, commercial, industrial) and different areas (e.g. urban, suburban, rural).

As outlined in **Section 4** the subject site is located in general residential zoning and is neighboured by a mix of residential, educational, recreational and commercial uses. The closest residential receivers to the east and north of the site are regarded as urban area residential receivers for the purposes of assessment, in terms of the receiver classifications identified by the *NPfI*.

Table 6.1 sets out the amenity noise levels recommended by the *NPfI*, applicable to the surrounding receivers. The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. For any individual sites, the *NPfI* nominates Project Amenity Noise Levels are set at 5 dB below the Recommended Amenity Noise Levels.

Table 6.1 *NPfI* Amenity Noise Levels

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Amenity Noise Level $L_{Aeq,Period}$ dBA	Project Amenity Noise Level $L_{Aeq,Period}$ dBA
Residences	Suburban	Day	60	55
		Evening	50	45
		Night	45	40
Commercial	All	When in use	65	65
School Classroom	All	When in use	45*	45
Active recreation area (Including School Playground)	All	When in use	55	55

Note 1: Daytime 7.00am–6.00pm; Evening 6.00pm–10.00pm; Night 10.00pm-7.00am.

Note 2: * The NPfI Amenity noise level for classrooms is $L_{Aeq,1hour}$ 35 dBA internally. For the purposes of assessment, the external level of L_{Aeq} 45 dBA has been adopted which takes account of the generally accepted reduction of 10 dB through a partially opened window.

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Project Noise Trigger Levels (PNTLs)

The *PNTLs* reflect the most stringent noise level requirement from the criteria derived from both the intrusiveness and project amenity noise levels to ensure that intrusive noise is limited, and amenity is protected.

The L_{Aeq} descriptor is used to describe both the intrusiveness noise level and the amenity noise level. This descriptor represents the level of average noise energy over the relevant period of measurement and takes account of peak noise levels as well as the degree of noise fluctuation.

The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over the day/evening/night period for the project amenity noise level. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same average noise energy. To standardise the time periods for the intrusiveness and amenity noise levels, for most situations, the *NPfI* recommends that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,Period}$ + 3 dB. This conversion factor has been adopted by this assessment.

The *PNTLs* considered applicable to the operation of the Project are identified in bold font in **Table 6.2**.

In assessing noise levels at residences or commercial receivers, the noise level is to be assessed at the most affected point on or within the property boundary, however, the commercial *PNTLs* are applicable only when such sites are in use (i.e. generally during business hours).

Table 6.2 Project Noise Trigger Levels for Operational Noise Emissions, dBA

Type of Receiver	Area Classification	Period[1]	RBL[2] $L_{A90(15min)}$	Intrusiveness[3] $L_{Aeq(15min)}$	Project Amenity $L_{Aeq\ (15min)}$
Residences	Urban	Day	50	**55**	55+3 = 58
		Evening	45	50	45+3 = **48**
		Night	30	**35**	40+3 = 43
Commercial	All	When in use	-	-	65+3 = **68**
School Classroom	All	When in use	-	-	45+3 = **48**
Active recreation area (Including School Playground)	All	When in use	-	-	55+3 = **58**

Note 1: Daytime: 7.00am–6.00pm; Evening: 6.00pm–10.00pm; Night-time: 10.00pm-7.00am.

Note 2: RBL = Rating Background Level.

Note 3: Intrusive criterion only applicable to residential receivers.

Note 4: The NPfI Recommended Amenity Levels should be met in consideration of all industrial noise, i.e. not only from the project site. Where a receiver may be impacted by more than one particular industrial site it is usual practice to aim to achieve Project Amenity Noise Levels for the individual industrial sites that are 5 dB lower than the identified Recommended Amenity Levels for all industrial noise. For this assessment, the identified Project Amenity Levels have been conservatively considered.

To comply with the *NPfI*, cumulative operational noise levels from the subject site should not exceed the criteria set out in **Table 6.2** at the closest neighbouring sites during the relevant periods.

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All noise generating mechanical services plant shall be specified, located and/or acoustically treated to ensure cumulative noise levels from the site do not exceed the identified levels at the boundaries of the neighbouring lots.

Additionally, the mechanical services shall be designed to ensure no notable tonal, low frequency or impulsive characteristics are emitted.

Managing operational noise emissions from the site to within these levels would ensure general compliance with the *NPfI*, with respect to both amenity and intrusive noise impacts.

Operational Noise Modelling

Operational noise levels from the proposed development at the closest identified receivers have been predicted using a model created with the SoundPLAN (Ver 8.2) acoustic noise prediction software to determine in principle whether compliance with the NPfI may be achieved.

This SoundPLAN program is used and recognised internationally and is also recognised by the EPA as a preferred computer noise model.

Factors that are addressed in the noise modelling are:

- Source sound power levels;
- Screening from structures (buildings, structures, fences);
- Receiver locations and heights;
- Ground topography;
- Noise attenuation due to geometric spreading;
- Ground absorption;
- Atmospheric absorption; and
- Influence of meteorology.

Site Configuration and Principal Operational Noise Sources

From review of the proposal and discussion with the project team, it is understood that noise from the site may be generated by air-conditioning and mechanical services units, café equipment and activities and loading activities within the loading bay.

Whilst mechanical services specifications are subject to further detailed design, for the purposes of this assessment the following assumptions have been applied regarding operational noise sources:

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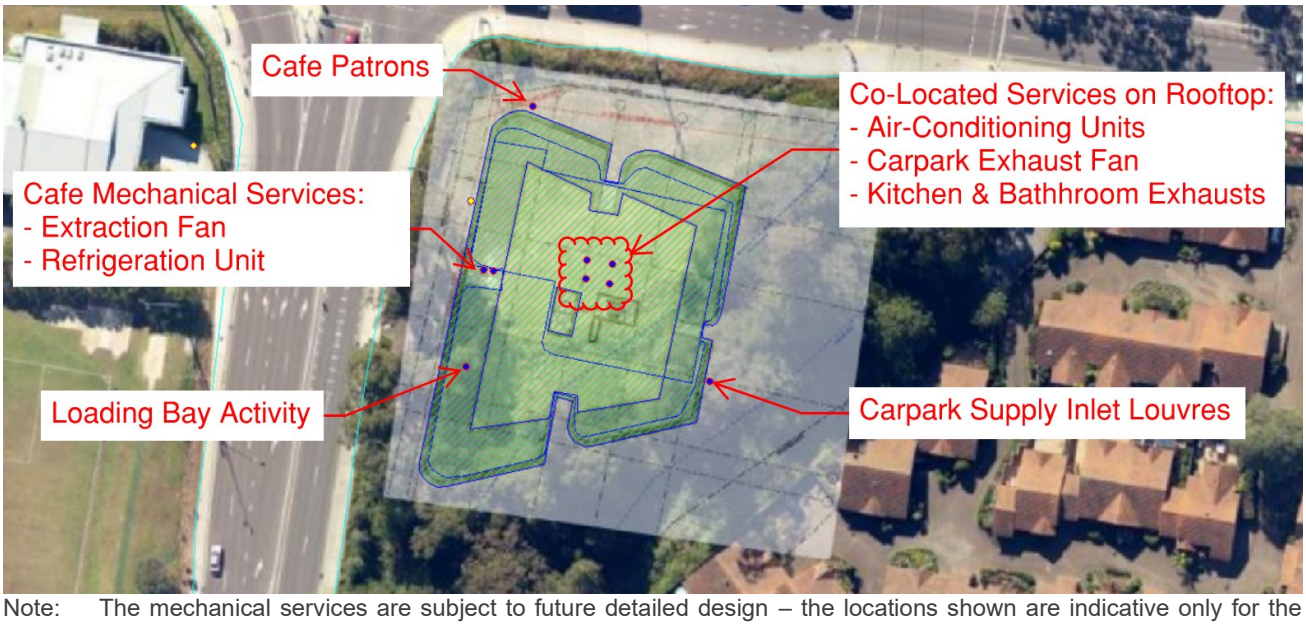
- 34 AC units (1 per apartment/townhouse/retail unit) - all externally co-located on the rooftop
- 3 car park supply air fans, one for each basement car park (with attenuators provided on both sides of the fans), lined ductwork on the fan inlet sides and acoustic louvres at the duct inlet
- 1 x Car park exhaust fan located on the roof (with attenuators provided on both sides of the fan)
- Kitchen and toilet exhaust fans provided to each apartment – all venting to rooftop of building
- Café kitchen extraction fan to rear of café
- Café refrigeration unit to rear of cafe
- Café Patrons Inside Café – (no external seating proposed, no material noise contribution)
- Café Patrons Outside Café – (two customers in conversion assumed)
- 1 x Loading Bay Truck
- Anti-vibration mounts provided for all fans and AC units.

Figure 6.1 shows the assumed source locations.

Figure 6.1 Assumed Operational Noise Source Locations



Note: The mechanical services are subject to future detailed design – the locations shown are indicative only for the noise assessment purposes and would be revised during detailed design.

The plant noise specifications identified in **Table 6.3** and **Table 6.4** have been assumed.

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Table 6.3 Mechanical Services – Indicative External Plant Fan Noise Sound Power Levels

Unit	Type	SPL @ 3m* (dBA)	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz	SWL (dB)	SWL* (dBA)
CPSAF (3 Off)	AP0402A P5/21	66 66 47	86 82 83	79 80 74	82 84 71	79 79 62	82 82 61	80 80 56	78 78 49	70 74 74	90 90 84	86 87 74
CPEAF (1 Off)	AP0502A P5/27	73 73 53	95 85 91	83 82 76	88 89 76	87 86 69	90 89 69	85 87 62	84 84 54	79 80 51	98 95 91	93 93 74
TEF (per Bathroom)	TD-500/150SIL (Hi speed)	40 41	51 61	49 51	57 62	59 61	55 57	53 49	45 43	43 39	63 67	60 62
KEF (per Kitchen)	TD-2000/315 SIL (Lo speed)	43 48 33	60 60 50	63 69 56	68 69 52	59 65 47	58 66 50	55 57 46	52 43 43	48 42 37	71 74 59	64 69 54
Car Park Fan Attenuators – Insertion Loss (dB)												
Unit	Type		63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz	Location	
ATT-CPSAF (3 Off)	C2-040		6	4	10	16	21	18	15	13	Inlet	
ATT-CPSAF (3 Off)	C2-040		6	4	10	16	21	18	15	13	Outlet	
ATT-CPEAF-01	C2-050		4	7	10	18	21	17	15	12	Outlet	
ATT-CPEAF-02	NSA25A-45-105		5	7	10	16	16	15	12	12	In Shaft	

Notes: Inlet / Outlet / Breakout Sound Levels form Fantech Technical Data. Inlet / Outlet levels are quoted as in-duct values. dB(A) values are average spherical free-field for comparative use only. Fan Breakout Sound Power Levels exclude the breakout from any attached ductwork or flexible connections. The mechanical services units should be installed on anti-vibration mounts to avoid any structural noise emissions.

Table 6.4 Mechanical Services – Indicative Air-Con External Plant Sound Pressure Levels

Unit	Type	SPL @ 1m* (dBA)	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz	SWL (dB)	SWL* (dBA)
AC.01 – AC.34	RXYMQ5AV4A (Cooling / Heating)	53 54	57 59	59 56	57 55	50 50	43 49	47 46	35 41	27 34	71 70	62 62

Notes *SPL @ 1m dBA (anechoic sound pressure level measurement) / SWL dBA (sound power level). The mechanical services units should be installed an anti-vibration mounts to avoid any structural noise emissions.

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For the purposes of assessment, to ensure the NPfI criteria are met it has been assumed that the car park supply and exhaust fans would be provided with attenuators on both inlet and outlet sides of the fans, specified to achieve the insertion losses identified in **Table 6.3**.

Further, it has been assumed the car park supply intake louvres will be acoustically rated (insertion losses of at least 9 dB for each octave band between 125Hz - 8kHz assumed) and the ductwork on the fan inlet sides would be internally lined.

The identified measures will reduce the off-site emissions and additionally reduce noise levels on the subject site.

Additionally, it has been assumed the café would be provided with a kitchen exhaust fan (SWL 75 dBA) and a refrigeration unit (SWL 65 dBA), both located to the rear (south) of the cate. Noise generated by the unloading of a truck within the loading bay (SWL 78 dBA) has also been assumed.

Patron noise from customers within the cafe is not expected to be audible at the nearby receiver locations. For the purposes of assessment, it is assumed two people are talking on the steps outside the main entry doors (one person listening and one person talking). The noise from someone talking is assumed to be SWL 68 dBA.

It is assumed the café and loading bay may operate during daytime and evening hours only, between 7.00am to 10.00pm.

Table 6-5 sets out the anticipated noise levels from the developed site, assuming the identified sources and the identified noise control measures are implemented.

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Table 6.5 Predicted Outdoor Noise Levels from 310 Terrigal Drive Site

Receiver	Predicted Noise Level $L_{Aeq,15min}$ (dBA)			NPfl PNTLs $L_{Aeq,15min}$ (dBA)			NPfl Compliance		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
R01	36	36	34	55	48	35	Yes	Yes	Yes
R02	31	31	30	55	48	35	Yes	Yes	Yes
R03	31	31	31	68	68	68	Yes	Yes	Yes
R04	35	35	34	55	48	35	Yes	Yes	Yes
R05	33	33	32	55	48	35	Yes	Yes	Yes
R06	32	32	30	68	68	68	Yes	Yes	Yes
R07	36	36	31	68	68	68	Yes	Yes	Yes
R08	40	40	30	58	58	58	Yes	Yes	Yes
R09	40	40	30	58	58	58	Yes	Yes	Yes
R010	38	38	38	48	48	48	Yes	Yes	Yes
Subject Site (Residential)	<40	<40	<35	55	48	35	Yes	Yes	Yes

Notes: PNTL = Project Noise Trigger Level;
Daytime: 7.00am- 6.00pm; Evening: 6.00pm-10.00pm; Night: 10.00pm-7.00am.

The results shown in **Table 6-5** indicate that based on the identified assumptions the proposed development may be expected to comply with the requirements of the NPfl.

During detailed design the specifications and locations of the mechanical plant items shall be reviewed to ensure NPfl compliance.

Off-Site Road Traffic Noise

With respect to the project's road traffic noise generation, the Transport assessment prepared by Arc Traffic + Transport (Report *P0233r2v2 Terrigal Mixed Use Development Transport Assessment,* dated 6/12/2022) identifies that the project may be expected to generate approximately 15 morning peak hour vehicle movements and 18 afternoon peak hour vehicle movements.

In comparison to the existing peak hour traffic volumes on Terrigal Drive (>2000 vph during both AM and PM peak hours) and Charles Kay Drive (>1500 vph during both AM and PM peak hours), the additional road traffic noise generation would be negligible and imperceptible over the existing traffic noise level, with an anticipated increase in road traffic noise levels of <<1 dB.

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7. CONSTRUCTION NOISE & VIBRATION ASSESSMENT

Development of the site is anticipated to require a duration of approximately 12 months. Works shall be undertaken in accordance with the following Construction Noise and Vibration Management Plan.

Hours of Operation

All excavation, piling and building work shall be carried out during standard construction hours only between the hours of:

- 7.00am and 6.00pm Monday to Friday inclusive,
- 8.00am and 3.00pm Saturdays.

No work is to be carried out on Sundays and Public Holidays.

Should any requirement to undertake any particular works outside of these hours arise, the extended hours works shall be subject to prior approval from Central Coast Council.

NSW Interim Construction Noise Guideline (ICNG) Criteria

During the development phase Construction Noise Management Levels (CNMLs) for the project shall be determined in accordance with the procedures nominated in the DECCW's "*Interim Construction Noise Guideline*" dated July 2009 (ICNG).

The noise criteria set out in the ICNG have been considered in the assessment of potential impacts from the project works.

Table 7.1 summarises the construction noise criteria recommended by the ICNG for residential receivers and **Table 7.2** summarises the criteria recommended by the ICNG for non-residential receivers.

With consideration to the identified existing background noise levels and receiver types that surround the site, the project specific construction noise criteria are shown in **Table 7.3**.

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Table 7.1 ICNG Airborne Construction Noise Criteria – Noise at Residences[1]

Time of Day	Management Level $L_{Aeq,15min}$	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to minimise noise. The proponent would 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 proponent would consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent would communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent would apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent would negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the ICNG

Note 1: Adopted from the *ICNG*
Note 2: RBL = Rating Background Level (based on assessment of L_{A90} background noise levels).
Note 3: Noise levels apply at the property boundary that is most exposed to construction noise (or receiver building façade that is most exposed to construction noise, noting that noise levels may be higher at upper floors of the noise affected receiver buildings). 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.

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Table 7.2 ICNG Airborne Construction Noise Criteria – Other Sensitive Land Uses

Land Use	Management Level $L_{Aeq, 15min}$ (applies when properties are being used)
Classrooms at schools and other educational	Internal noise level: 45 dBA[1]
Active recreation areas (including School Playgrounds)	External noise level: 65 dBA
Commercial premises (businesses, offices, etc)	External noise level: 70 dBA

Notes: 1: External Noise Management Levels (NML) of $L_{Aeq,15min}$ 55 dBA are considered by this assessment, assuming 10dB attenuation achieved by façades with open window(s);

Table 7.3 ICNG Airborne Construction Noise Criteria for 310 Terrigal Drive

Receiver	Daytime Rating Background Level (RBL) L_{A90} (dBA)	ICNG Standard Hours Criteria $L_{Aeq,15min}$ (dBA)	ICNG Out-of-Hours Daytime Criteria $L_{Aeq,15min}$ (dBA)	ICNG Highly Affected Criteria $L_{Aeq,15min}$ (dBA)
R01	50	60	55	75
R02	50	60	55	75
R03	n/a	70	70	-
R04	50	60	55	75
R05	50	60	55	75
R06	n/a	70	70	-
R07	n/a	70	70	-
R08	n/a	65	65	-
R09	n/a	65	65	-
R010	n/a	55	55	-

Note: The standard hours / highly affected CNMLs are generally applicable for this project. The out-of-hours criteria are presented for information purposes only – these criteria may apply should there be an occasional requirement to undertake works outside standard hours.

Human Exposure to Vibration

Assessing Vibration: A Technical Guideline (AVTG) provides guidance for assessing human exposure to vibration. The publication is based on British Standard BS 6472:1992. Intermittent vibration is assessed by the Vibration Dose Value (VDV) which is based on the weighted root mean quartic (rmq) acceleration in each component.

Table 7.4 sets out VDV values as specified by AVTG. For simplicity of assessment and monitoring, it

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is considered that equivalent peak particle velocity or acceleration goals identified by the AVTG are also acceptable.

Table 7.4 Human Comfort Vibration Goals – VDV (m/s$^{1.75}$)

Places	Day (7am – 10pm)		Night (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Residences	0.20	0.4	0.13	0.26
Offices, Schools	0.4	0.8	0.4	0.8

Vibration - Structural Damage Criteria

There are currently no Australian Standards or guidelines to provide guidance on assessing the potential for building damage from vibration. It is common practice to derive goal levels from international standards.

British Standard BS 7385:1993 and German Standard DIN 4150:1999 both provide goal levels; below which vibration is considered insufficient to cause building damage. Of these, DIN 4150 is the more stringent. DIN 4150 bases the goal levels on the highest vibration level in each component (Peak Component Particle Velocity – PCPV). **Table 7.5** summarises the goal levels specified in DIN 4150.

Table 7.5 DIN 4150-3:1999 Structural Damage Criteria

Places	Guideline Values for Velocity – PPV (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under either of the other classifications and of great intrinsic value	3	3 to 8	8 to 10

For general construction vibration, the dominant frequency is typically greater than 50 Hz. However, because the dominant frequency of vibration cannot be determined with certainty at this stage, this assessment has adopted conservative goals of 5 mm/s for residential buildings.

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Construction Noise Assessment

Works requiring the use of heavy machinery can generate high noise and vibration levels and in urban areas there is often limited setback distance between these noise sources and nearby buildings and receivers. Under such circumstances, typically there is limited opportunity to practicably mitigate the noise and vibration effects in a cost-effective manner. Therefore, potential disturbance impacts are usually minimised as much as practicable through management techniques and community consultation.

Assessment of airborne noise impacts from the key noise generating construction activities have been determined by modelling the noise sources, receiver locations, topographical features and buildings.

Key details regarding the likely construction plant requirements and hours of operation were informed by the Loftus Lane Capital Partners team. This information forms the basis for all modelling assumptions used in this assessment.

Construction Equipment Requirements and Sound Power Levels

Table 7.6 identifies the anticipated key construction activities, durations and equipment requirements.

The identified construction equipment and sound power levels have been considered across the site. The sound power levels have been determined by measurements undertaken by ACA on other similar projects.

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Table 7.6 Anticipated Construction Activities, Durations and Equipment Requirements

Stage	Duration	Equipment	Sound Power Level (L_{Aeq} dBA)	Assumed Operating Time within 15min Period (Minutes)	Time Adjusted Source SWL
Site Establishment	2-4 weeks	Mobile Crane	98	5	93
		Hand Tools	102	5	97
		Semitrailer or Rigid Trucks (est 2 per hour)	103	5	98
Bulk Excavation	6-12 weeks	20T Excavator with Bucket Attachment	105	5	100
		(Occasional use of Medium Sized Hydraulic Hammer if required)	(120)	5	(115)
		Semitrailer Trucks (est 4 per hour)	103	5	98
Piling	2-4 weeks	Piling Rig (Bored)	112	5	107
		Semitrailer Trucks (est 2 per hour)	103	5	98
Superstructure Works	12-20 weeks	Tower Crane	110	5	105
		Concrete Pump	109	15	109
		Concrete Agitator Trucks	109	15	109
		Semitrailer or Rigid Trucks (est 4 per hour)	103	5	98
Landscaping / Fit-out	10-20 weeks	5T Excavator with Bucket Attachment	95	5	90
		Hand Tools	102	5	97
		Semitrailer or Rigid Trucks (est 2 per hour)	103	5	98

Construction Noise Modelling

Construction noise emissions from the works have been modelled using the SoundPLAN (Version 8-2) environmental noise prediction software considering the stages and construction noise source sources identified in **Table 7.6**.

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Construction Noise Predictions

The predicted worst-case construction noise levels at the identified receivers for the key construction stages are set out in **Table 7.7**.

Predicted exceedances of the Standard Hours CNMLs are shown in in **Table 7.8**, exceedances of the day out-of-hours CNMLs are shown in in **Table 7.9** and exceedances of the Highly Affected CNML are shown in in **Table 7.10**.

The predictions represent the typical-worst case noise levels that may be expected to arise at the external facades of the receiver buildings. It should be noted that construction noise levels would frequently be lower than the identified worst-case levels for significant periods of time. This would be apparent as works move around the sites and are therefore more distant/more shielded from receivers and when less noisy activities are being undertaken.

Table 7.7 Predicted Construction Noise Levels - $L_{Aeq,15min}$ dBA

Receiver	Key Construction Activities				
	Site Establishment	Bulk Excavation	Piling	Superstructure Works	Landscaping / Fit-out
R01	48 - 56	53 - 61 / (68 - 76)	58 - 66	37 - 74	30 - 64
R02	39 - 43	44 - 48 / (59 - 63)	49 - 53	33 - 61	26 - 51
R03	44 - 52	49 - 57 / (64 - 72)	54 - 62	40 - 66	33 - 59
R04	44 - 53	49 - 58 / (64 - 73)	54 - 63	37 - 67	30 - 60
R05	44 - 53	49 - 58 / (64 - 73)	54 - 63	35 - 67	25 - 60
R06	42 - 47	47 - 52 / (62 - 67)	52 - 57	39 - 62	29 - 55
R07	46 - 54	51 - 59 / (66 - 74)	56 - 64	37 - 67	27 - 60
R08	44 - 51	49 - 56 / (64 - 71)	54 - 61	36 - 65	25 - 58
R09	45 - 55	50 - 60 / (65 - 75)	55 - 65	33 - 72	26 - 62
R10	35 - 38	40 - 43 / (55 - 58)	45 - 48	36 - 57	29 - 46

Note: The bulk excavation predictions in brackets are for hydraulic hammering, if this activity is required.

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Table 7.8 Predicted Construction Noise Management Level Exceedances – Standard Hours

Receiver	Key Construction Activities				
	Site Establishment	Bulk Excavation	Piling	Superstructure Works	Landscaping / Fit-out
R01	Nil - Nil	Nil - 1 / (8 - 16)	Nil - 6	Nil - 14	Nil - 4
R02	Nil - Nil	Nil - Nil / (Nil - 3)	Nil - Nil	Nil - Nil	Nil - Nil
R03	Nil - Nil	Nil - Nil / (Nil - 2)	Nil - Nil	Nil - Nil	Nil - Nil
R04	Nil - Nil	Nil - Nil / (4 - 13)	Nil - 3	Nil - 7	Nil - Nil
R05	Nil - Nil	Nil - Nil / 14 - 13)	Nil - 3	Nil - 7	Nil - Nil
R06	Nil - Nil	Nil - Nil / (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R07	Nil - Nil	Nil - Nil / (Nil - 4)	Nil - Nil	Nil - Nil	Nil - Nil
R08	Nil - Nil	Nil - Nil / (Nil - 6)	Nil - Nil	Nil - Nil	Nil - Nil
R09	Nil - Nil	Nil - Nil / (Nil - 10)	Nil - Nil	Nil - 7	Nil - Nil
R10	Nil - Nil	Nil - Nil / (Nil - 3)	Nil - Nil	Nil - 2	Nil - Nil

Note: The bulk excavation predictions in brackets are for hydraulic hammering, if this activity is required.

Table 7.9 Predicted Construction Noise Management Level Exceedances – Extended Hours (Day)

Receiver	Key Construction Activities				
	Site Establishment	Bulk Excavation	Piling	Superstructure Works	Landscaping / Fit-out
R01	Nil - 1	Nil - 6 / (13 - 21)	3 - 11	Nil - 19	Nil - 9
R02	Nil - Nil	Nil - Nil / (4 - 8)	Nil - Nil	Nil - 6	Nil - Nil
R03	Nil - Nil	Nil - Nil / (Nil - 2)	Nil - Nil	Nil - Nil	Nil - Nil
R04	Nil - Nil	Nil - 3 / (9 - 18)	Nil - 8	Nil - 12	Nil - 5
R05	Nil - Nil	Nil - 3 / (9 - 18)	Nil - 8	Nil - 12	Nil - 5
R06	Nil - Nil	Nil - Nil / (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R07	Nil - Nil	Nil - Nil / (Nil - 4)	Nil - Nil	Nil - Nil	Nil - Nil
R08	Nil - Nil	Nil - Nil / (Nil - 6)	Nil - Nil	Nil - Nil	Nil - Nil
R09	Nil - Nil	Nil - Nil / (Nil - 10)	Nil - Nil	Nil - 7	Nil - Nil
R10	Nil - Nil	Nil - Nil / (Nil - 3)	Nil - Nil	Nil - 2	Nil - Nil

Note: The bulk excavation predictions in brackets are for hydraulic hammering, if this activity is required.

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Table 7.10 Predicted Highly Affected Construction Noise Management Level Exceedances

Receiver	Key Construction Activities				
	Site Establishment	Bulk Excavation	Piling	Superstructure Works	Landscaping / Fit-out
R01	Nil - Nil	Nil - Nil (Nil - 1)	Nil - Nil	Nil - Nil	Nil - Nil
R02	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R03	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R04	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R05	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R06	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R07	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R08	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R09	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil
R10	Nil - Nil	Nil - Nil (Nil - Nil)	Nil - Nil	Nil - Nil	Nil - Nil

Note: The bulk excavation predictions in brackets are for hydraulic hammering, if this activity is required.

Construction Vibration

It is understood the works would be undertaken without the requirement for vibratory rollers, or vibratory pile drivers. If hydraulic hammering is undertaken, this activity may be expected to generate the highest vibration levels.

Figure 7.1 shows a graph of peak particle vibration levels generated by a 20t excavator with large hydraulic hammer breaking hard rock, as measured by ACA on a similar project.

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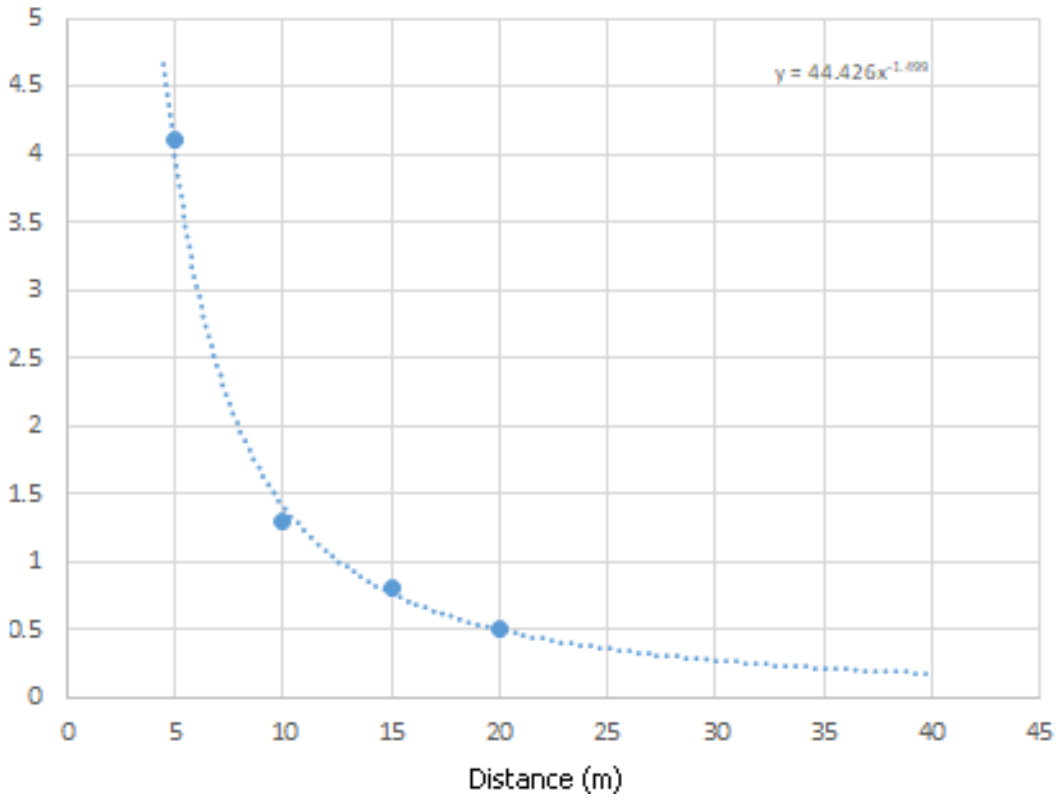
Figure 7.1 Measured Peak Particle Vibration Levels (PPV – mm/s) from 20T Excavator with Large Hydraulic Hammer Breaking Hard Rock



At the setback distances afforded to the closest receiver buildings (>20m), PPV levels would be expected to remain well below the 5 mm/s PPV criteria for residential use buildings adopted by this assessment.

Therefore, the risk of cosmetic damage to the surrounding buildings is considered to be negligible. Notwithstanding, the resultant vibration levels arising from works on the subject site would be expected to vary depending on the particular item of plant and local geotechnical conditions and accordingly a cautious approach is recommended.

People can sense vibration at levels far lower than those that may result in structural damage.

Recommendations are set out in the following Construction Noise & Vibration Management Plan to manage any potential human comfort vibration impacts on the neighbouring properties.

Additionally, it is recommended to engage a structural engineer to undertake a survey of the existing building adjoining buildings and provide a dilapidation report prior to any bulk excavation works proceeding.

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Construction Noise and Vibration Management Plan

The construction noise predictions indicate the airborne noise CNLMs have potential to be exceeded to varying degrees depending on the works schedule.

Typically, construction noise levels would be expected to remain below the highly affected level during the works. However, the highly affected level may be expected to be marginally exceeded at R01 if hydraulic hammering is required within approximately 50 m of the R01 residential boundary.

Given the likelihood of intermittent exceedances, the mitigation measures set out in **Table 7.11** will be applied throughout all of the identified work stages.

The measures set out in **Table 7.11** include procedures for construction noise respite, community consultation, noise monitoring and complainants handling.

Table 7.11 Mitigation Measures for Management of Construction Noise and Vibration

Action Required	Details
	Source Controls
Construction Hours and Scheduling	Construction works to be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods. All excavation and building, work must be carried out only between the hours of: - 7.00am and 6.00pm Monday to Friday inclusive, - 8.00am and 3.00pm Saturdays. No work is to be carried out on Sundays and Public Holidays. Any works undertaken outside of these hours shall be subject to prior approval from Central Coast Council. In order to undertake works during extended hours both Council and affected neighbours shall be notified a minimum of 48 hours prior to commencement. Affected neighbours include those in the immediate vicinity, adjacent or adjoining the development site as identified in **Figure 4.1** and **Table 4.1**. Notification shall be by way of written advice including: - Date/s the extended hours will be utilised. - The purpose of the extended hours (e.g. pouring large slab). - Address of the development works / site. - Contact name and telephone number of appropriate site officer (supervisor or manager) for enquiries. - Map or list identifying those affected neighbours who have been notified.
Equipment Selection	Use quieter and less noise / vibration emitting construction methods where feasible and reasonable. The selected bored piling method will significantly minimise noise and vibration impact relative to impact-driven piles.
Equipment Maintenance	Plant and equipment used on site to be regularly maintained/serviced to ensure noise emissions from the equipment are kept to a practicable minimum.

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Equipment Operation	Mobile and fixed plant to be switched off when not in use. Unnecessary idling of engines to be avoided. The simultaneous use of multiple plant items to be avoided as much as practicable to minimise emissions.
Construction Respite	Hydraulic hammering works to be avoided as far as practicable. If required, only to be carried out in continuous periods, not exceeding 3 hours each, with a minimum respite period of one hour between each period of hammering.
Plan Worksite and Activities to Minimise Noise and Vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site as far as practicable.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) to be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Path Controls	
Minimise Disturbances from Deliveries	Loading and unloading of materials/deliveries to occur with due consideration to local noise sensitive receivers. Shielding and setbacks to be optimised as far as possible.
Shield Sensitive Receivers	Use structures such as site shed placement; fencing; amenities etc when situating plant to shield residential receivers from noise.
Management Measures	
Site Inductions	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least address: • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Limitations on high noise generating activities • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height; throwing of metal items; and slamming of doors. No excessive revving of plant and vehicle engines Controlled release of compressed air.
Conform with Conditions of Approval	In addition to the measures set out in this table, all relevant Conditions set out any Approval provided by Central Coast Council to be observed.
Community Consultation	At no less than 2 weeks prior to the commencement of any site works, Loftus Lane Capital Partners representatives to undertake consultation with the building managers of the receiver buildings identified in **Table 4.1**. Written notifications are to be provided to the building managers setting out a brief description of the works, durations of the key stages, hours of site operations and name(s) and contact details of site representative(s).

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Complaints Management	In the event of any noise and/or vibration related complaints arising during the works, the Loftus Lane Capital Partners site representative(s) shall take note of the complainant's details and immediately investigate and where necessary amend work practices. The complainant shall be contacted with 48 hours of the complaint and provided with an update. Details of the event (whether substantiated or otherwise) shall be recorded in the complaints register. The complaints register shall be provided to Council on request.
Noise Monitoring	In the event of any substantiated noise and/or vibration related complaints arising during the works Loftus Lane Capital Partners site representative(s) shall engage the services of a qualified acoustic consultant to attend site and undertake noise and/or vibration measurements to determine the extent of any impacts and to identify any further measures required to mitigate these impacts.
Vibration Monitoring	Structural/ geotechnical engineers shall oversee the general management of vibration effects during the works. Vibration monitoring, will be performed in the event of a complaint received by the construction contractor, by an Acoustical Consultant engaged directly by the client. Vibration monitoring would be carried out in accordance with the relevant guidelines on the closest, potentially most affected structures during any works considered to potentially generate significant levels of vibrations i.e. hammering works.
Consultation with Council's Environmental Health and Building Unit	Loftus Lane Capital Partners shall provide regular, appropriate, and sustained periods of respite in consultation with Council's Environmental Health and Building Unit: - Where all control measures detailed in the Construction Noise and Vibration Management Plan have been implemented and the resultant noise and/or vibration levels at any sensitive receiver still exceed the applicable criteria; and - The development is giving rise to sustained complaints.

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8. TRAFFIC NOISE INTRUSION

Given the site is located adjacent to classified roads, Terrigal Drive and Charles Kay Drive, ACA has undertaken a traffic noise intrusion assessment against the requirements of Clause 102 of the *State Environmental Planning Policy (Transport and Infrastructure) 2021*, to ensure the development is designed to adequately attenuate the effects of traffic noise.

State Environmental Planning Policy SEPP (Transport and Infrastructure) 2021 Criteria

This assessment considers the requirements of:

- *State Environmental Planning Policy SEPP (Transport and Infrastructure) 2021*; and
- *'Development near Rail Corridors and Busy Roads - Interim Guideline'* produced by the NSW Department of Planning.

Hereafter, this report refers to the *SEPP (Transport and Infrastructure) 2021* as 'iSEPP' and the *Development near Rail Corridors and Busy Roads - Interim Guideline'* as the 'Interim Guideline'.

The *iSEPP* notes that developments on land adjacent to road corridors with an annual average daily traffic (AADT) volume of more than 40,000 vehicles are likely to be adversely affected by road noise or vibration. Under these circumstances it recommends appropriate measures are required to be taken to ensure that the road traffic noise levels do not exceed:

- L_{Aeq} 35 dB(A) in any bedroom at any time between 10.00pm and 7.00am, and

- L_{Aeq} 40 dB(A) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) at any time.

The *Interim Guideline* identifies that the L_{Aeq} airborne noise levels are to be calculated over the nine hours between 10.00pm to 7.00am for the night period (expressed as $L_{Aeq,9Hour}$) and over the 15 hours between 7.00am to 10.00pm for the day period (expressed as $L_{Aeq,15Hour}$).

The *Interim Guideline* provides guidance for acceptable internal noise levels due to external noise intrusion with windows or doors open as follows:

"If internal noise levels with windows or doors open exceed the criteria by more than 10 dB, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia".

The objectives can be translated to external noise levels by allowing for the generally accepted 10 dB noise reduction achieved from outside to inside through a partially open window, as set out in **Table 8.1**.

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Table 8.1 $L_{Aeq(period)}$ Road Noise Intrusion Criteria

Room Type	Internal Criteria dBA	External Criteria (open windows) dBA	External Level above which Ventilation is Required dBA
Bedrooms (Night Only)	$L_{Aeq,9Hour}$ 35	$L_{Aeq,9Hour}$ 45	$L_{Aeq,9Hour}$ 55
Any Habitable Room	$L_{Aeq,15Hour}$ 40	$L_{Aeq,15Hour}$ 50	$L_{Aeq,15Hour}$ 60

Site Inspection and Noise Monitoring

During ACA's site inspection on Tuesday 4 April 2023, existing road traffic noise levels were measured between 2.30pm to 3.30pm.

An NTi XL2 Type 1 sound level meter was installed at the boundary on-site at the Terrigal Drive and Charles Kay Drive intersection at the location shown in **Figure 2-1** to capture representative daytime traffic noise levels. The traffic was noted to be free flowing and considered to be generally representative of peak traffic noise conditions.

The instrumentation employed during the noise measurement survey were designed to comply with *AS IEC 61672.2-2004 Electroacoustics-Sound level meters–Specifications*. The sound level meter was field calibrated before and after the measurements with a Svantek SV-33 acoustic calibrator. No significant drift (greater than 0.5 dB) in calibration was detected.

A traffic noise level of $L_{Aeq,1hour}$ 67 dBA was measured at the site boundary.

Predicted Noise Levels

With consideration to the measured existing traffic noise level and the layout of the proposed development ACA has carried out calculations of incident road traffic noise levels.

Based on review of the longer-term noise data the measured by the logger at R01, an adjustment of -5 dB has been applied to determine the night-time traffic noise level.

The numerical building façade noise predictions are presented in **Table 8.2**.

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Table 8.2 Predicted Facade Noise Levels

Façade / Level	Predicted Noise Levels – dBA	
	Day	Night
	$L_{Aeq,15Hr}$	$L_{Aeq,9Hr}$
North Façade – Ground Floor	63 - 66	58 - 61
North Façade – Upper Floors	63 - 67	58 - 62
West Façade – Ground Floor	65 - 66	60 - 61
West Façade – Upper Floors	64 - 68	59 - 63
South Façade – Ground Floor	58 - 64	53 - 59
South Façade – Upper Floors	56 - 62	51 - 57
East Façade – Ground Floor	56 - 62	51 - 57
East Façade – Upper Floors	56 - 61	51 - 56

Note 1: Daytime: 7.00am–10.00pm; Night-time: 10.00pm-7.00am.

A noise reduction of 10 dB would be achieved through a window partially opened for ventilation purposes; therefore, the internal criteria would be expected to be achieved through partially open windows where external facades are exposed to noise levels up to 45 dBA external to bedrooms or 50 dBA external to other habitable rooms.

Compliance with the noise criteria would not be met through open windows where external facades are exposed to noise levels exceeding 45 dBA external to bedrooms or 50 dBA external to other habitable rooms. In these cases, windows would need to be closed and appropriate glazing standards should be specified to ensure that the internal noise criteria are met.

The glazing requirements are discussed in the following sections.

Mechanical ventilation is required where external facades are exposed to noise levels exceeding 55 dBA external to bedrooms (between 10.00pm to 7.00am) or 60 dBA external to other habitable rooms. The modelling and observations indicate mechanical ventilation to be necessary throughout the development.

Acoustic Treatment Requirements

The building would be constructed with concrete/masonry facades and roof which would provide relatively high levels of road traffic noise insulation. The acoustically weakest elements of the external facade would be the windows.

Table 8.3 presents the minimum recommended Rw (weighted noise reduction) for glazing elements based on the concept design drawings. These recommendations shall be revised during detailed design once the final window sizes are confirmed.

Note that the Rw rating is required for the complete glazing and frame assembly. The minimum glazing thicknesses will not necessarily meet the required Rw rating without an appropriate framing

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system. It is therefore necessary to provide a glass and framing system having a laboratory tested acoustic performance meeting the requirements in **Tables 8.3**.

The window systems must be tested in accordance with:

- *Australian Window Association Industry Code of Practice Window and Door – Method of Acoustic Testing*; and
- *AS 1191 Acoustics – Method for laboratory measurement of airborne sound insulation of building elements*.

It is recommended that laboratory certification for the proposed glazing systems (i.e. glass and framing system) is sought (e.g. NAL or CSIRO certification) to confirm expected acoustic performance prior to ordering.

The entire frame associated with the glazing must be sealed into the structural opening using acoustic mastics and backer rods. Normal weather proofing details do not necessarily provide the full acoustic insulation potential of the window system. The manufacturers' installation instructions for the correct acoustic sealing of the frame must be followed.

Where structural, wind loading or fire rating demands require more substantial glass and framing assemblies than nominated, these demands would be expected to supersede the acoustic requirements.

If higher standards of glazing with than nominated are used (i.e. systems specified to achieve higher acoustic ratings), a commensurate improvement in acoustic amenity may be achieved.

To comply with the identified ratings all external glass windows and doors specified must:

- Have a seal to restrict air infiltration fitted to each edge of an operable window;
- Within doors or fixed framing, glazing must be set and sealed using an airtight arrangement of non-hardening sealant, soft rubber (elastomer) gasket and / or glazing tape, or be verified by manufacturer or otherwise approved person that supplies the construction system, so as once installed it complies with equivalent values to the R_w value recommended in this report; and
- All external doors must have compressible silicon-based rubber seals to the full perimeter and/or a drop seal to provide an airtight seal when closed.

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Table 8.3 Minimum Acoustic Rating (Rw) Required for Glazing Elements

Facade	Room	Windows / Glazed Doors
North	Townhouses	Rw 40 (e.g. 12.5mm laminate on acoustically rated frames with Q-lon acoustic seals, or similar) / Rw 40 (e.g. 8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals, or similar)
North	Apartment Bedrooms	Rw 40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 40 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
North	Apartment Living Rooms	Rw 38-40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 38-40 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
West	Apartment Bedrooms	Rw 40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 40 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
West	Apartment Living Rooms	Rw 38-40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 38-40 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
South	Apartment Bedrooms	Rw 38-40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 38-40 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
South	Apartment Living Rooms	Rw 38 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 38 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
East	Apartment Bedrooms	Rw 38-40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 38-40 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
East	Apartment Living Rooms	Rw 38 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals) / Rw 38 (8mmVFloat / 16mm Gap / 10.5mm Hush on acoustically rated frames with Q-lon acoustic seals)
Cafe		Rw 38-40 (12.5mm laminate on acoustically rated frames with Q-lon acoustic seals)

Note: Sliding glass windows/doors may potentially reduce the sound insulation performance. Acoustic performance of all window systems to be verified with manufacturer. Glazing requirements to be reviewed at Construction Certificate stage following final window sizing.

As noted above the identified ratings for glazing elements are based on the concept design drawings. It is expected that these would be revised during detailed design once the window sizes are confirmed.

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Note that the above recommended glazing systems are indicative only. Care should be taken when selecting the system to ensure the acoustic rating (Rw) is verified through laboratory tested data.

Based on this review, it is considered that the development (inclusive of the identified glazing requirements) has been adequately designed to achieve the *iSEPP* internal noise levels.

If higher standards than the recommended minimum glazing standards are used, these will additionally satisfy requirements.

Mechanical Ventilation

Where mechanical ventilation systems are to be provided, they should be specified to comply with the National Construction Code (NCC) and with *AS 1668.2 – The Use of Mechanical Ventilation and Air Conditioning in Buildings*. The following should be considered:

- Refrigerant based air conditioning systems need to be designed to achieve fresh air ventilation requirements.
- External openings or penetrations to the building envelope need to be positioned facing away from the transport corridor where practicable.
- Ductwork needs to be provided with adequate silencing to prevent noise intrusion.

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9. BUILDING DESIGN OVERVIEW – NCC REVIEW

National Construction Code (NCC) 2019 Amendment 1

The acoustic provisions for intertenancy walls and floors in Class 2 and 3 Buildings are outlined in Part F5 of the National Construction Code, NCC 2019 Amendment 1. These minimum acceptable airborne and impact sound insulation performance parameters are summarised in **Table 9.1**.

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Table 9.1 Performance Requirements NCC 2019 Amendment 1

Condition	Deemed-to-Satisfy Requirements	Verification (1)
Walls		
Airborne Sound Insulation		
Between sole-occupancy units	Minimum $R_w + C_{tr}$ 50	Minimum $D_{nT,w} + C_{tr}$ 45
Between a sole-occupancy unit and a plant room, lift shaft, stairway corridor, public corridor or the like	Minimum R_w 50	Minimum $D_{nT,w}$ 45
Impact Sound Insulation		
Between a laundry, kitchen, bathroom or sanitary compartment in a sole-occupancy unit, and a habitable room in an adjoining unit	Discontinuous construction	As deemed to satisfy
Between a sole-occupancy unit and a plant room or lift shaft	Discontinuous construction	As deemed to satisfy
Floors		
Airborne Sound Insulation		
Between sole-occupancy units	Minimum $R_w + C_{tr}$ 50	Minimum $D_{nT,w} + C_{tr}$ 45
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	Minimum $R_w + C_{tr}$ 50	Minimum $D_{nT,w} + C_{tr}$ 45
Impact Sound Insulation		
Between sole-occupancy units	Maximum $L_{n,w}$ 62	Maximum $L_{nT,w}$ 62
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	Maximum $L_{n,w}$ 62	Maximum $L_{nT,w}$ 62
Door Assemblies		
Between a sole-occupancy unit and a stairway, public corridor, public lobby or the like	Minimum R_w 30	Minimum $D_{nT,w}$ 25
Services		
Between a habitable room (other than a kitchen) in a sole-occupancy unit and a duct, soil, waste or water supply pipe duct (if the duct or pipe is located in a wall or floor cavity and serves or passes through more than one sole-occupancy unit)	Minimum $R_w + C_{tr}$ 40	Deemed-to-Satisfy Provisions
Between a kitchen or non-habitable room in a sole-occupancy unit and a duct, soil, waste or water supply pipe duct (if the duct or pipe is located in a wall or floor cavity and serves or passes through more than one sole-occupancy unit)	Minimum $R_w + C_{tr}$ 25	
If a storm water pipe passes through a sole-occupancy unit (habitable room other than kitchen)	Minimum $R_w + C_{tr}$ 40	
If a storm water pipe passes through a sole-occupancy unit (kitchen or non-habitable room)	Minimum $R_w + C_{tr}$ 25	

Notes: (1) Determined under AS/NZS ISO 717.1 (airborne noise) and AS/NZS ISO 717.2 (impact noise).
(2) For the purposes of this part, “discontinuous construction” means a wall having a minimum 20 mm cavity between two separate leaves.

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Australian Standard 2107:2016

For internal spaces, Australian Standard 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors* (AS/NZS 2107) provides recommended design sound levels for specific room uses.

Table 9.2 presents recommended internal noise levels for residential houses and apartments near major roads (extracted from Table 1 of AS/NZS 2107).

Table 9.2 AS/NZS 2107 Recommended design sound levels

Type of occupancy	Design sound levels ($L_{Aeq,t}$ range) – dB
Houses and apartments near major roads	
Apartment common areas (e.g. foyer, lift lobby)	45-50
Living areas	35-45
Sleeping areas (night-time)	35-40
Work areas	35-45

AAAC Guideline for Apartment and Townhouse Acoustic Rating

Evidence suggests that the NCC requirements for sound transmission do not always manage noise levels to the satisfaction of all occupants. The Association of Australasian Acoustical Consultants (AAAC) has identified design initiatives that aim to exceed these minimum NCC requirements to provide better long-term outcomes for residents.

The AAAC Guideline provides a Star Rating system for use by designers, developers and purchasers of apartments or townhouses to encourage consistency between the apparent quality of the design of multiple occupancy buildings and the underlying acoustical quality of the structure.

The acoustical attributes covered in the AAAC Guideline are external noise intrusion, internal building services noise, airborne sound insulation of walls and floors and impact sound isolation of floors.

Table 9.3 presents a summary of the sound insulation rating criteria with respect to intertenancy activities.

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Table 9.3 AAAC Star Rating - Intertenancy Activities

Intertenancy Activities	2 Star	3 Star	4 Star	5 Star	6 Star
Airborne Sound Insulation for Walls and Floors					
Between Separate Tenancies – $D_{nT,w} + C_{tr} \geq$	35	40	45	50	55
Between Lobby/Corridor and Bedrooms – $D_{nT,w} + C_{tr} \geq$	30	40	40	45	50
Between Lobby/Corridor and Living – $D_{nT,w} + C_{tr} \geq$	25	40	40	40	45
Impact Isolation of Floors					
Between Tenancies – $L_{nT,w} \leq$	65	55	50	45	40
Between All Other Spaces and Tenancies – $L_{nT,w} \leq$	65	55	50	45	40
Impact Isolation of Walls					
Between Tenancies	No	Yes	Yes	Yes	Yes
Between Common Areas and Tenancies	No	No	No	Yes	Yes

It is noted that the NCC requirements are equivalent of 4-star for airborne noise and only 2-star for impact noise. ACA notes that the minimum NCC impact noise requirement is frequently found to be unsatisfactory to occupants of residential apartments.

Table 9.4 presents a summary of the external noise intrusion rating criteria for external facades. The levels shown in the table reflect the corresponding internal noise levels that should be achieved in bedrooms and other habitable rooms.

External Noise Intrusion is most commonly caused by transportation systems, such as road, rail and air traffic. This category also includes plant noise from adjoining industry, commerce or even from an adjoining residential building.

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Table 9.4 AAAC Star Rating - External Noise Intrusion

External Noise Intrusion	2 Star	3 Star	4 Star	5 Star	6 Star
Bedrooms					
Continuous Noises L_{Aeq} <	36	35	32	30	27
Intermittent Noises $_{ave}$ L_{Amax} <	50	50	45	40	35
Other Habitable Rooms including Open Kitchens					
Continuous Noises L_{Aeq} <	41	40	37	35	32
Intermittent Noises $_{ave}$ L_{Amax} <	55	55	50	45	40

Note: For the determination of AAAC Star Ratings, the guideline notes that measurements are to be undertaken in bedrooms and any nominated habitable rooms. Bedrooms are measured over a period between 22:00hrs and 07:00hrs. Noise measurements in other habitable rooms are undertaken between 06:00hrs to 00:00hrs. In any event the measurement period must be representative of the noise being measured. Measurements must include L_{Aeq} and L_{Amax}.

Table 9.5 presents a summary of internal noise intrusion rating criteria for internal building services and appliances. These apply to a range of plant and equipment which have the potential to generate noise within an apartment. These include air-conditioning and ventilation systems, lifts, hydraulics wastes and water supply systems, garbage chutes, spa baths and appliances of adjacent apartments. Appliances such as spa baths and dishwashers in the same tenancy are excluded.

Table 9.5 AAAC Star Rating - Internal Building Services and Appliances

Internal Building Service and Appliances	2 Star	3 Star	4 Star	5 Star	6 Star
Bedrooms					
Continuous Noises L_{Aeq} <	36	35	32	30	27
Intermittent Noises $_{ave}$ L_{Amax} <	45	40	35	30	27
Other Habitable Rooms including Open Kitchens					
Continuous Noises L_{Aeq} <	41	40	35	30	27
Intermittent Noises $_{ave}$ L_{Amax} <	55	45	40	35	32
Wet Areas including Bathrooms, En-suites and Laundries					
Continuous Noises L_{Aeq} <	55	50	45	42	40
Intermittent Noises $_{ave}$ L_{Amax} <	60	55	48	42	40

Measurements shall be carried out in accordance with Section 6.1 Measurement of Ambient Sound Level given in AS/NZS 2107:2000. Noise measurements are made at relevant positions but no closer than 1.5 metres from the noise source. Many noises contain pronounced tonal or impulsive characteristics, which increase their annoyance. Such noises need to have a penalty adjustment (adj) to account for the annoying characteristics. If these characteristics are clearly audible a 5 dB(A) penalty shall be applied. If the characteristics are just audible, then a 2 dB(A) penalty shall be applied.

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The design of the proposed multiple occupancy mixed use development at 310 Terrigal Drive, Terrigal would be be reviewed against the identified NCC requirements at Construction Certificate stage. The principal building acoustics design issues are outlined below.

External Facades

The NCC does not specify acoustic ratings for external walls. However, it would be expected that the external walls would be formed from concrete/masonry elements rated to achieve the noise insulation rating of at least R_w+C_{tr} 50, which is considered appropriate for this development.

Noise ingress to the building (e.g. break-in noise from the external sources) would be expected to be primarily via the acoustically weakest components of the building, being the windows.

Windows

During detailed design, the final glazing specification shall be reviewed against the AAAC external noise intrusion recommendations and against the iSEPP and Interim Guideline. Ratings for the entire window system including frame should be confirmed by the window manufacturer.

Intertenancy Walls

The intertenancy walls are to be designed to achieve the NCC airborne noise insulation rating requirement of at least R_w+C_{tr} 50. Additionally, between a laundry, kitchen, bathroom or sanitary compartment in a sole-occupancy unit, and a habitable room in an adjoining unit the wall must be designed as a discontinuous structure. Discontinuous walls are also required between a sole-occupancy unit and a plant room or lift shaft.

Intertenancy Floors – Airborne Noise Control

The intertenancy floors between the units would be formed from 200mm concrete slabs with suspended 13mm plasterboard ceilings beneath and insulations batts within the ceiling cavity. It is recommended to install the ceilings with resilient mountings. This construction can achieve an airborne sound transmission loss of approximately $>R_w+C_{tr}$ 60, which is equivalent to the AAAC 6 Star rating and is considered appropriate for this development.

Intertenancy Floors – Impact Noise Control

The intertenancy floor comprises 200mm concrete slabs with suspended 13mm plasterboard ceilings beneath.

All floor areas with hard surface finishes (e.g. hardwood timber flooring, stone and tiles) on the residential levels should be acoustically treated to limit footfall impact noise. Acoustic underlay installed beneath the tiles/timber flooring etc. is required to prevent structure borne noise.

ACA recommends that resilient underlay is included under all accessible hard surfaced floor finishes throughout the residential levels of the development, noting that impact noise can be transmitted laterally and reradiated into adjacent units. Vertical transmission into all apartment floors has the potential to result in adverse effects. It is recommended to include the resilient underlay throughout

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all accessible areas within the residential units, including the external deck areas and beneath the sliding doors, joinery and kitchen island benches.

It is highly recommended that all apartment floors, including kitchens, bathrooms, laundries and balconies are designed to achieve a higher standard of acoustic performance than the minimum NCC requirement. It is recommended that common corridors and stairways are also considered.

Resilient underlay treatment shall have a weighted reduction in impact sound pressure level (ΔLw) of not less than 18 dB when measured in accordance with AS ISO 140-8: 2006 – *Measurement of sound insulation of buildings and of building elements* – laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor and rated in accordance with AS ISO 717-2: 2004 – *Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact Sound Insulatio*n.

It is recommended that the resilient layer be bonded to the slab and marked with an indelible message such as “DO NOT REMOVE – INTEGRAL PART OF FLOOR SYSTEM”, so that residents do not remove the layer at a later date.

Resilient isolation layers must be installed in strict accordance with manufacturer’s details with appropriate edge detailing applied to avoid ‘shorting’ the resilient layer at perimeter junctions.

It is recommended that structural isolation be maintained between the newly laid floor system and the perimeter walls and any skirting. It is important that a physical separation is maintained between the flooring and the perimeter walls and any columns etc. If this is not considered, the isolation would be bridged and impact noise may be transmitted via the wall to the apartment below.

The recommended suppliers for resilient layers are Regupol and Embleton. The recommended approved products under the proposed flooring system are:

- 4.5 mm Regupol 4515; or
- 5 mm Impactamat Embleton;

Where a 5 mm carpet on a foam underlay is proposed no further treatment to control impact sound insulation is required, but if included, this would provide further impact noise insulation. If carpet tiles, vinyl, linoleum, ceramic or wooden flooring finishes are used a resilient floor underlay treatment will be required.

Regupol, Embelton and other manufacturers have solutions for wet areas. Compatibilities should be confirmed with the manufacturer.

It would be expected that a high AAAC Star rating for impact noise (potentially 4 or 5 Star) may be achieved with the inclusion of the treatments as identified, which is considered appropriate for this development.

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Apartment Entry Doors

Apartment entry doors are recommended to comprise 40mm solid core door types with acoustically certified frame with seals. The system should be rated to achieve minimum rating Rw 30.

Roof

The proposed roof construction comprises concrete deck roof, with 13mm plasterboard ceilings suspended beneath and with acoustic insulation provided above the plasterboard layer.

This arrangement is expected to be satisfactory to reduce external noise intrusion and to mitigate rain noise.

Stair Core Walls

Stair core walls are to be designed to achieve the minimum airborne sound insulation requirements specified in the NCC ($R_w \geq 50dB$).

Lift Core Walls

Lift core walls are to be designed to achieve the minimum airborne sound insulation requirements specified in the NCC ($R_w \geq 50dB$, provided with discontinuous construction to residential units).

Building Services – NCC Requirements

The following details are to be considered and included in the hydraulic services design.

The NCC makes provision of criteria specific to the placement and function of mechanical building services. To be deemed to satisfy, provisions must be made such that;

i) Services must not be chased into concrete or masonry elements.

ii) Access doors/panels required to have a certain $R_w + C_{tr}$ that provides access to a duct, pipe or other service must –

   a) not open into any habitable room; and

   b) be firmly fixed such that the rebate or frame is overlapped by the access panel by not less than 10mm, and be fitted with a sealing gasket along all edges. And be constructed of;

      - wood, particleboard or block board > 33 mm thick
      - compressed fibre reinforced cement sheeting > 9 mm thick
      - Other suitable material with mass per unit area > 24.4 kg/m^2

iii) A water supply pipe must –

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a) Only be installed in the cavity of a discontinuous construction; and

b) In the case of a pipe that serves only one sole-occupancy unit, not be fixed to the wall leaf on the side adjoining any other sole-occupancy unit, and have a clearance of at least 10 mm to the other leaf.

Service Risers and Ducts

Walls

In addition to minimum airborne sound insulation performance parameters as specified for separating walls, the NCC also prescribes minimum airborne sound insulation parameters for service duct walls which separate building services from residential spaces, in order to preserve a minimum level of acoustic amenity for building occupants.

Where a duct, soil, waste or water supply pipe passes through more than one sole occupancy unit they must be located within a construction capable of achieving an $R_w + C_{tr}$ not less than 40 if they pass through a habitable room (other than a kitchen) or an $R_w + C_{tr}$ not less than 25 if they pass through a kitchen or a non-habitable room.

All bathroom walls must be full height and all services risers within bathrooms must achieve the minimum acoustic rating R_w 25 dB.

Ceilings

The kitchens sinks, water and waste services may have to run in the ceiling bulkhead of the apartment beneath. Ceilings are not required to control airborne or impact sound transfer between vertically stacked units, but will be required to maintain compliance with the NCC where services for one-unit pass through the floor slab into the unit beneath. In such instances the ceiling bulkhead will be required. The appropriate treatments for concealment of hydraulic services are presented in **Table 10.1**. The maximum numbers of down lights per 5 m^2 area are detailed in **Table 9.6** and are provided for electrical services co-ordination purposes.

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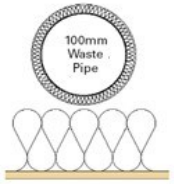
Table 9.6 Services Inside Buildings

Schematic Services Concealment Treatment	Ceiling Lining	Insulation	Pipe Lagging	Max No. of Downlights per $5m^2$	$R_W + C_{tr}$
	1 layer of 13 mm fire rated plasterboard	Min 75 mm thick glass wool wool batts, min density 14 kg/m^3. Installed to a min distance of 1200 mm either side of pipe.	Min 25 mm glasswool or foam bonded to a loaded vinyl noise barrier layer (min mass per unit area of 4.5 kg/m^2, Pyrotek 4525C or equivalent).	5	≥40 (Habitable Rooms)
	1 layer of 13 mm fire rated plasterboard	N/A	N/A	2	≥25 (Non-Habitable Rooms)

All pipes are to be secured in cavities, voids or service risers using resilient pipe clip connections which incorporate an isolating rubber or neoprene collar, to avoid introducing pipe-borne noise into the surrounding structural elements.

Furthermore, all pipe runs connected to hydraulic circulation pumps or similar plant equipment must be connected via flexible couplings to avoid the introduction of structure borne noise through rigid connections. All hydraulic circulation pumps to be secured with vibration control mountings.

Electrical Outlets and Services

Electrical services should be coordinated to ensure:

- Light fittings do not compromise the performance of recessed ceilings or bulkheads where hydraulic services are to be installed, per **Table 9.6** above.
- Power outlets do not compromise the performance of intertenancy walls.

Lifts

To avoid noise and vibration transmission from the lifts, the lift shafts should be separated from sole occupancy units by discontinuous structures that achieve the rating R_w 50.

Mechanical Services

All air conditioning condensing units (or similar) to be installed that would connect to internal units via penetration of external walls will require consideration. The penetrations must be treated and filled with acoustic/fire rated mastic or fire rated pillows to minimise flanking paths for external noise.

All noise generating plant are to be specified, located and/or acoustically treated to ensure the identified *NPfI* requirements are met externally to neighbouring lots.

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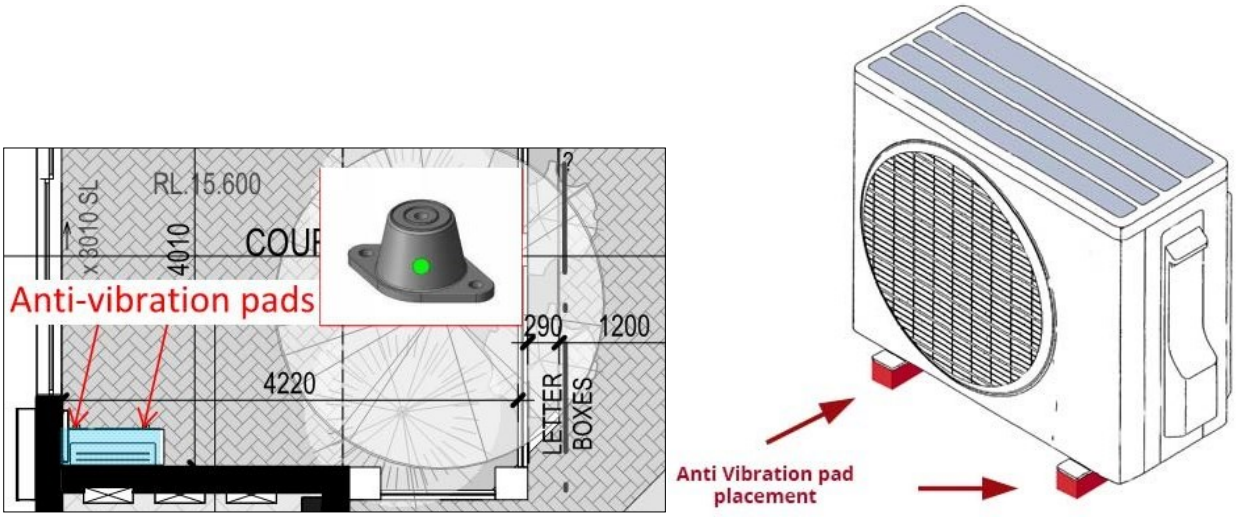
The externally located air-con condenser units will be located on a rooftop pad and co-located with the basement car par exhaust fan and kitchen and bathroom exhausts.

Subject to detailed design, where necessary, the car park supply and exhaust fans shall be acoustically treated with in line attenuators, lined ducts and elbows and acoustically rated louvres.

Anti-vibration mounts are required for mechanical services to minimise structure-borne noise within the apartments (for example, Embelton NR1 mechanical isolation rubber mount - see **Figure 9.7**). Low noise fans are to be included throughout.

Figure 9.7 Air Conditioning Units Anti-Vibration Mounts



Car Park Roller Door

If a roller door is installed on car park it is recommended to mechanically isolate to reduce vibration into the structure.

Soft Close Door Mechanisms

Soft close door mechanisms for basement doors and common areas are recommended.

Basement Plantroom Door

Plantroom doors/frames should be acoustically (R_w 30 dB) rated to reduce plantroom noise breakout.

Kitchen Benches

Kitchen benches, cupboards etc that adjoin party walls should be discontinuous to reduce vibration into the structure.

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10. CONCLUSION

Acoustics Consultants Australia (ACA) has been engaged by Loftus Lane Capital Partners to undertake a Planning Proposal acoustic design review of the proposed multiple occupancy mixed-use development at 310 Terrigal Drive, Terrigal.

The proposed development comprises six storeys of residential apartments, over three garden apartments and commercial use (café), with basement parking and landscaping works.

Based on the concept drawings provided to ACA and discussion with Loftus Lane Capital Partners, this assessment has considered:

- the potential for off-site noise emissions from the proposed site to impact existing surrounding receivers (both during operational and construction stages of the development);
- the potential for noise impacts on the proposed development from external noise sources (i.e. surrounding main roads); and
- preliminary review of NCC requirements for the proposed mixed-use development.

The findings of the assessment are as follows:

- Operational noise generated by the site would be expected to be principally from air-conditioning and mechanical services units, café equipment and activities and loading activities within the loading bay.

  Modelling indicates that operational noise would be expected to comply with the requirements of the NPfI.

  During detailed design all noise generating mechanical services plant shall be specified, located and/or acoustically treated to ensure cumulative noise levels from the site do not exceed the NPfI criteria at the boundaries of the neighbouring lots.
- During the on-site construction works, some exceedances of the ICNG criteria are to be expected. Impacts during the site development phase will be managed in accordance with the Construction Noise and Vibration Management Plan, included in **Section 7** of this report.
- The development site adjoins Terrigal Drive and Charles Kay Drive and therefore is exposed to appreciable levels of road traffic noise. Indicative glazing requirements have been identified to ensure satisfactory internal noise levels consistent with the iSEPP are achieved. The final glazing requirements would be determined during detailed design.
- An overview of the NCC requirements for the development has been provided.

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APPENDICES

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APPENDIX A: Glossary of Acoustic Terms

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1 Sound Level (or Noise Level)

The terms “sound” and “noise” are to some degree interchangeable, however, in common usage “noise” is often used to refer to unwanted sound.

Sound may be defined as any pressure variation that the human ear can detect. The human ear responds to a wide range of changes in sound pressure. As the greatest sound pressures to which the human ear responds are 10,000,000 times greater than the lowest, the decibel (dB) scale, by the use of logarithms is used to express sound pressure levels more conveniently.

The standard reference sound pressure used to define a Sound Pressure Level is 2×10^{-5} Pascals (Pa).

The decibel is defined as ten times the logarithmic ratio of two pressures. The smallest perceptible change is approximately 1 dB.

Sound Pressure Level is typically abbreviated as SPL, L_P, or L.

2 “A” Weighted Sound Pressure Level

The most common frequency rating is ‘A-Weighting’. The A-weighting frequency response curve is designed to approximate the sensitivity of the human ear. The symbol L_A represents A-weighted Sound Pressure Level - The overall broadband level of a sound/noise is typically expressed as a dB(A) level.

Human hearing is most sensitive mid frequencies sounds (500 Hz to 4000 Hz), and less sensitive at higher and lower frequencies. Therefore, the level expressed in dB(A) correlates strongly with the perceived loudness of the sound/noise.

A change in sound pressure level of 1-2 dB is barely noticeable to most people, whilst a 3-5 dB change is perceived as a small but noticeable change in loudness. A 10 dB change is perceived as an approximate doubling or halving in loudness. The table below present the sound pressure levels of some common sources.

Sound Pressure Level dB(A)	Noise Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely loud
110	Grinding on steel	
100	Loud car horn at 3 m	Very loud
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

In addition to A-weighting, other less commonly applied frequency weightings include B, C and D weightings. Unweighted or Linear levels are sound levels measured without any weighting. These are expressed as simply dB, or dB(lin) or dB(Z).

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3 Sound Power Level

The rate at which a noise source emits acoustic energy is defined by its Sound Power Level. Sound Power Levels are also expressed in decibel units (dB or dB(A)). Sound Power is typically identified as SWL or LW. The standard reference sound power used to define a Sound Power Level is 1 x 10^{-12} Watts (W).

4 Statistical Noise Levels

Environmental noise levels from various sources in the environment will vary in level over time. Statistical exceedance levels are typically expressed as L_{AN} levels (i.e. the A-weighted sound pressure level exceeded for N% of a specific measurement period.

The most commonly used statistical noise levels are as follows:

L_{Amax} Maximum noise level over a sample period (typically measured on fast time-weighting response).

L_{A1} Noise level exceeded for 1% of a sample period (typically 15-minute interval).

L_{A10} Noise level exceeded for 10% of a sample period (typically 15-minute interval).

L_{A90} Noise level exceeded for 90% of a sample period. This noise level is commonly used to describe the background noise level (in the absence of the source under investigation).

L_{Aeq} A-weighted equivalent noise level. This is equivalent to the steady sound level containing the same amount of acoustical energy as the time-varying sound. Often referred to as the average noise level.

ABL Assessment Background Level. This is the single figure background level representing each assessment period (day, evening and night) for each day. It is determined by calculating the lowest 10th percentile background noise level (LA90) for each period.

RBL Rating Background Level. This is the median value of the ABL values for each period (day, evening, night), determined over several days of measurements.

5 Building Acoustics Terms

A number of terms are used to describe the acoustic performance of building elements including sound transmission loss and impact isolation. The most commonly used terms are as follows:

R_w Weighted sound reduction index. The R_w is a typical measure for the sound insulation performance for a wall or floor system in a laboratory. The R_w in the BCA is used for the selection of appropriate construction systems.

R_w+C_{tr} Weighted sound reduction index with spectrum adaptation term. The R_w+C_{tr} is the weighted sound reduction index with a correction factor Ctr added that helps to quantify the low frequency performance. The R_w+C_{tr} in the BCA is used for the selection of appropriate construction systems.

$D_{nT,w}$ Weighted standardised level difference. The $D_{nT,w}$ is a typical measure for the sound insulation performance for a wall or floor system in a laboratory. The $D_{nT,w}$ in the BCA is used for the determination of airborne noise in the field.

$D_{nT,w}+C_{tr}$ Weighted standardised level difference with spectrum adaptation term. The $D_{nT,w}+C_{tr}$ is the weighted standardised level difference with a correction factor Ctr added that helps to quantify the low frequency performance. The $D_{nT,w}+C_{tr}$ in the BCA is used for the determination of airborne noise in the field.

$L_{n,w}+C_I$ Weighted normalised impact sound pressure level with spectrum adaptation term. The $L_{n,w}+C_I$ is a typical measure of the impact/structure borne noise between two spaces in a laboratory. A reduction in the $L_{n,w}+C_I$ corresponds to an improvement in impact isolation. The $L_{n,w}+C_I$ in the BCA is used for the selection of appropriate impact isolation systems.

$L_{nT,w}+C_I$ Weighted standardised impact sound pressure level with spectrum adaptation term. The $L_{nT,w}+C_I$ is a typical measure of the impact/structure borne noise between two spaces in the field. A reduction in the $L_{nT,w}+C_I$

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corresponds to an improvement in impact isolation. The $L_{nT,w}+C_I$ in the BCA is used for the determination of impact noise in the field.

FSTC Field sound transmission class. The FSTC is a typical measure for the sound insulation performance for a wall or floor system in a building. The FSTC is used in the City of Sydney Council DCP for the selection of appropriate construction systems.

IIC Impact isolation class. The IIC is a typical measure of the impact/structure borne noise between two spaces in a laboratory. The IIC is used in City of Sydney Council DCP for the selection of appropriate impact isolation systems.

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APPENDIX B: Noise Monitoring Plots

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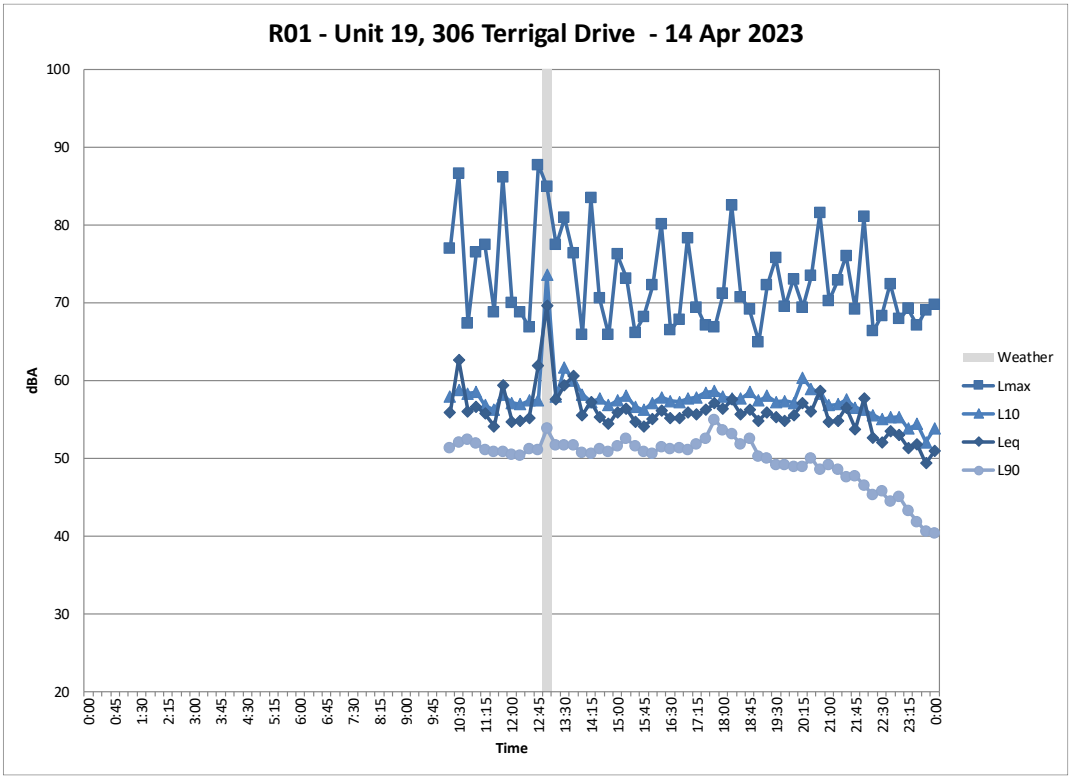

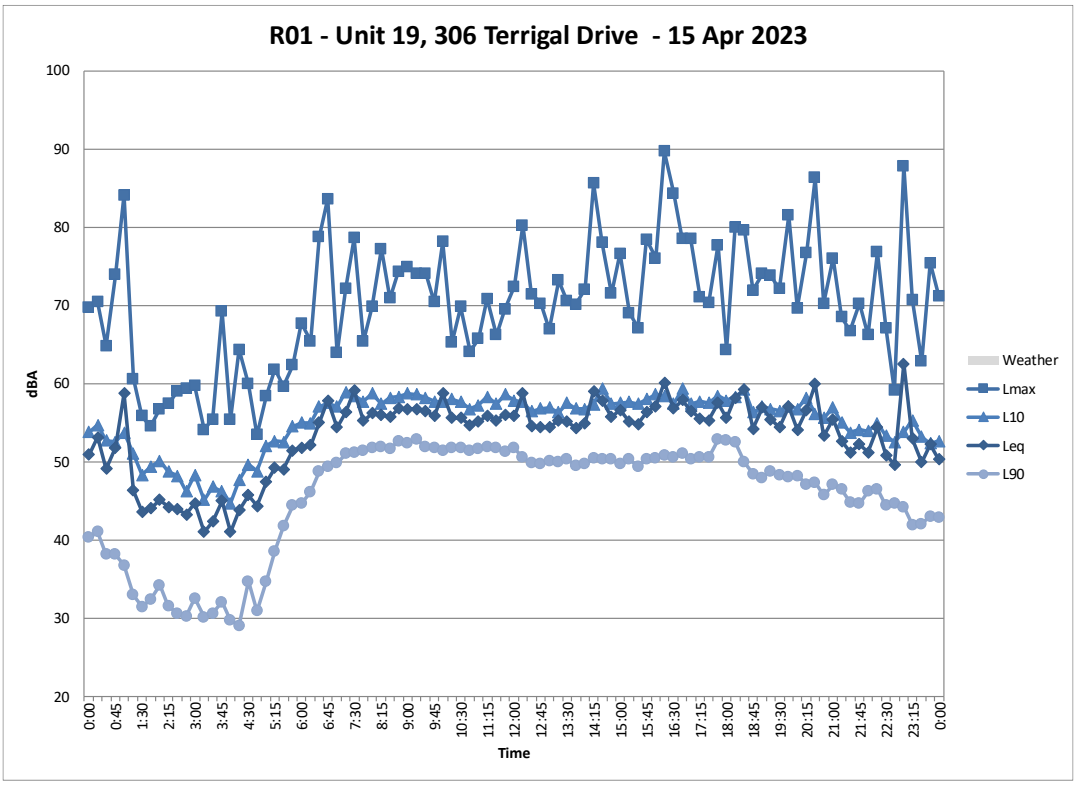

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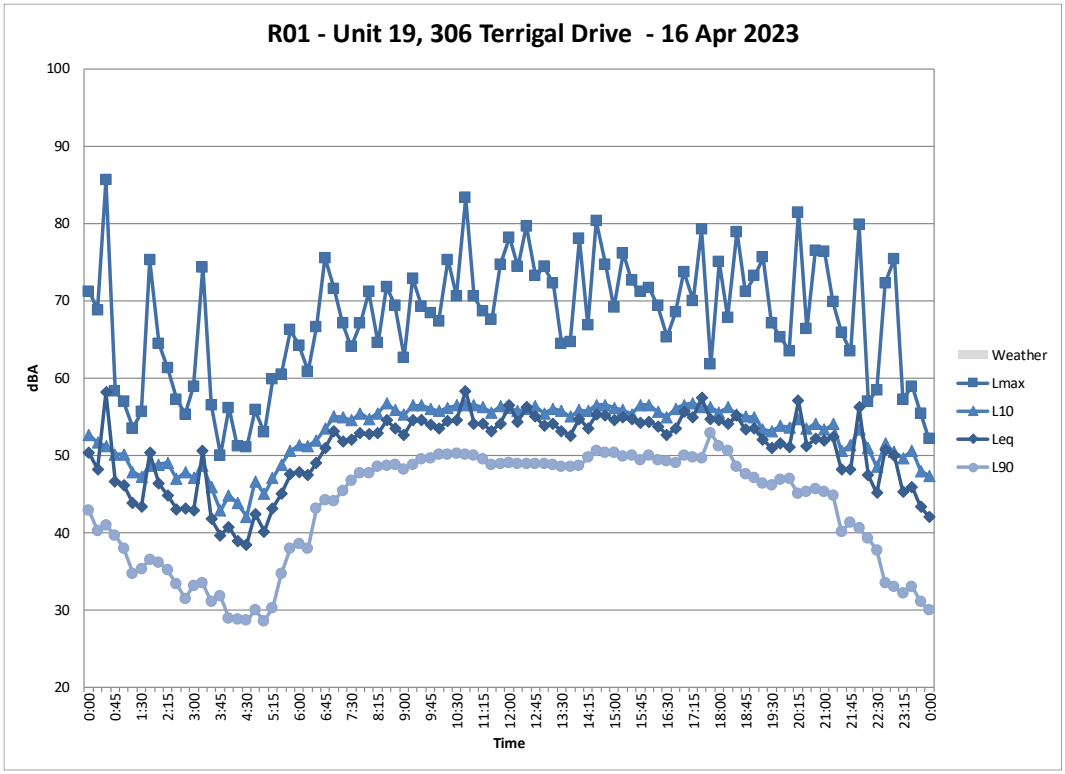

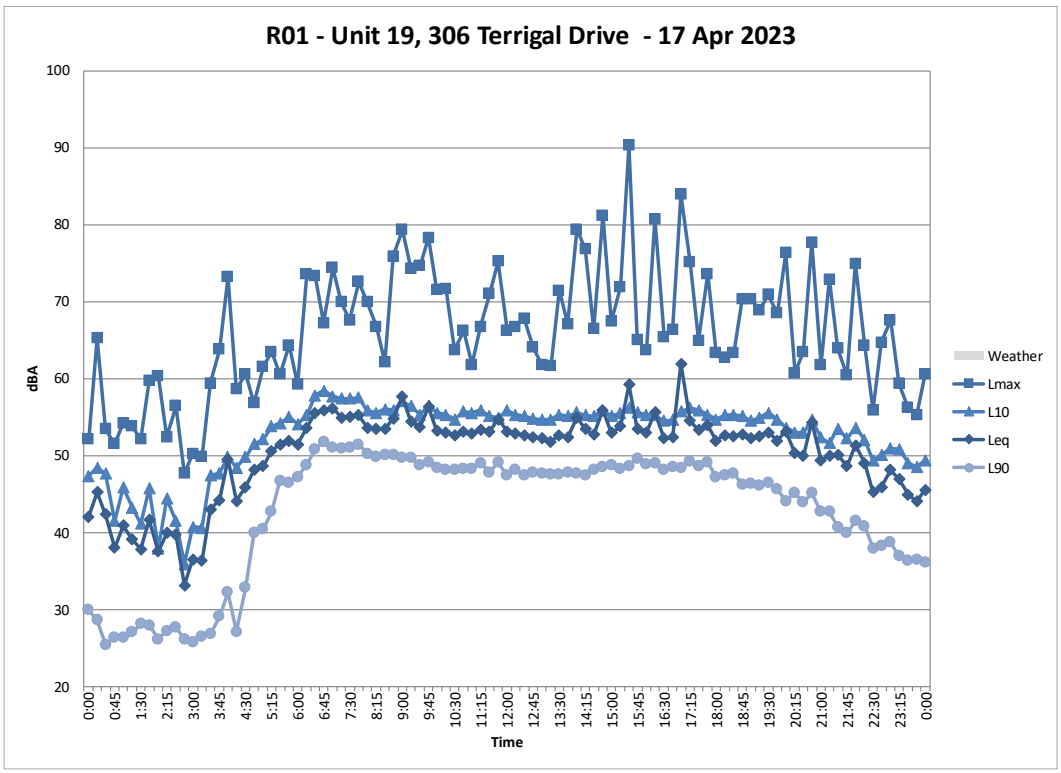

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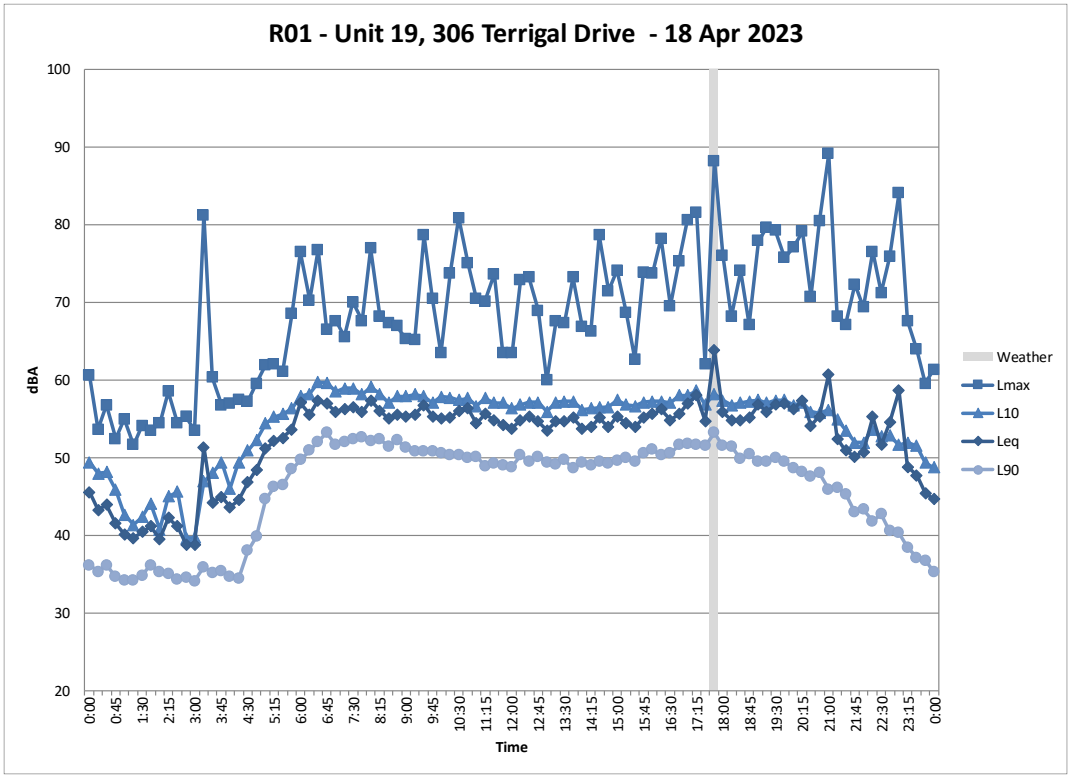

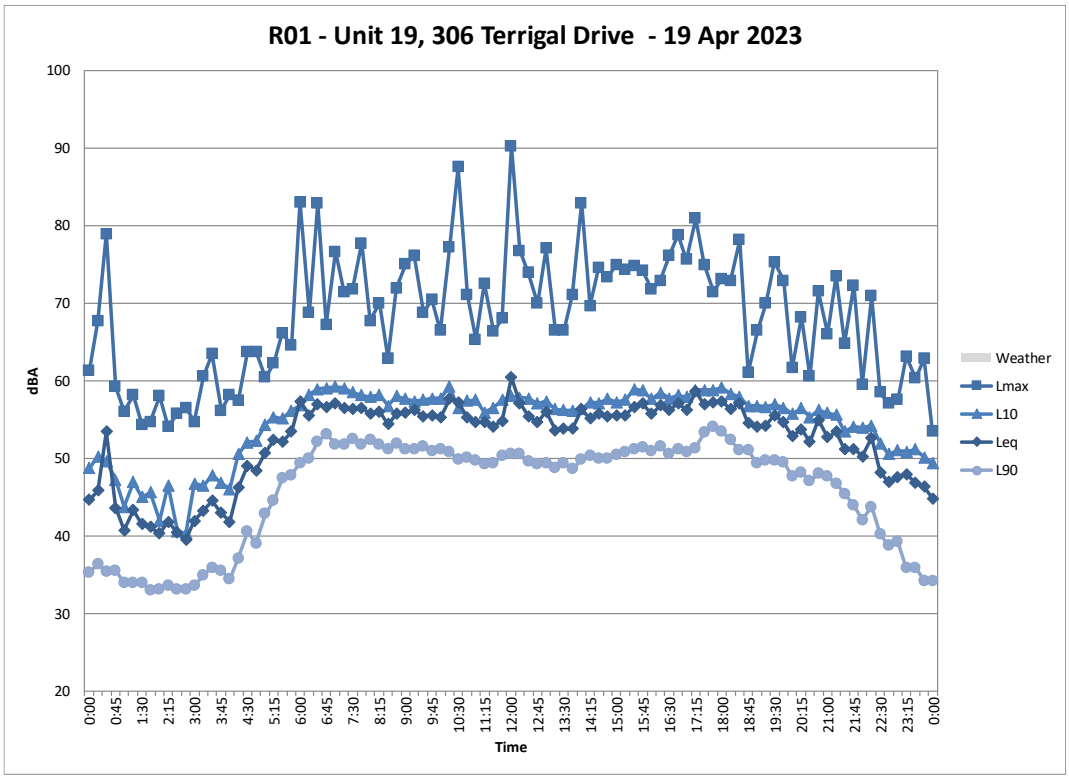

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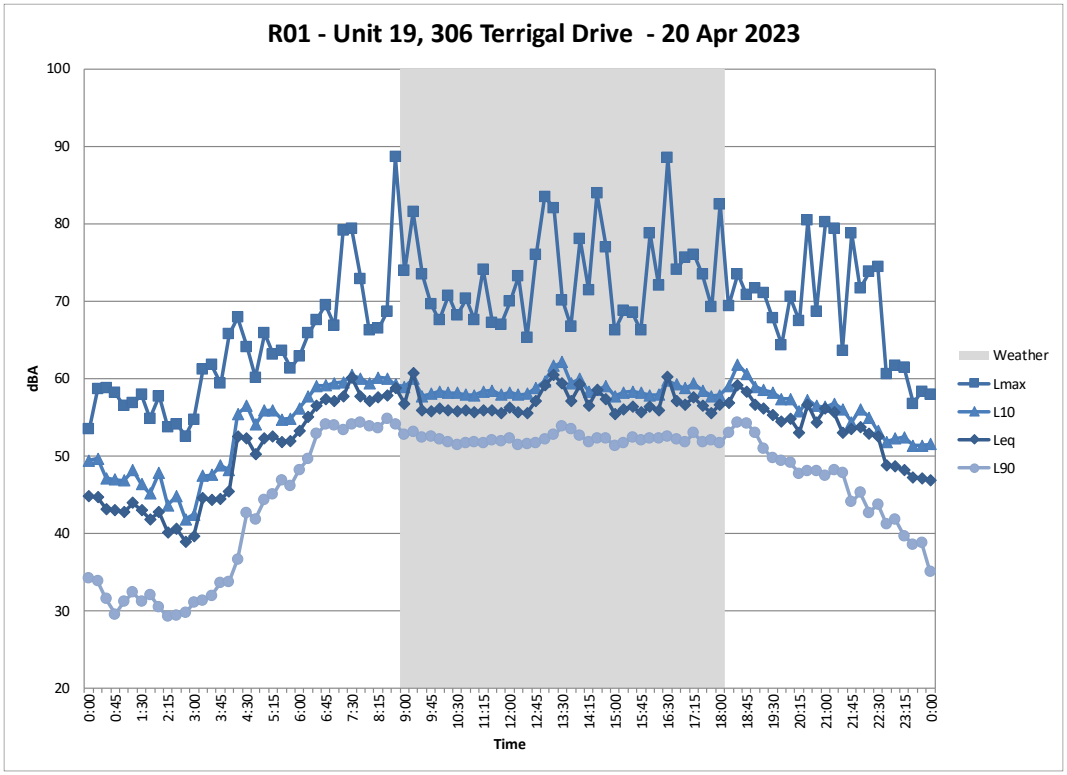

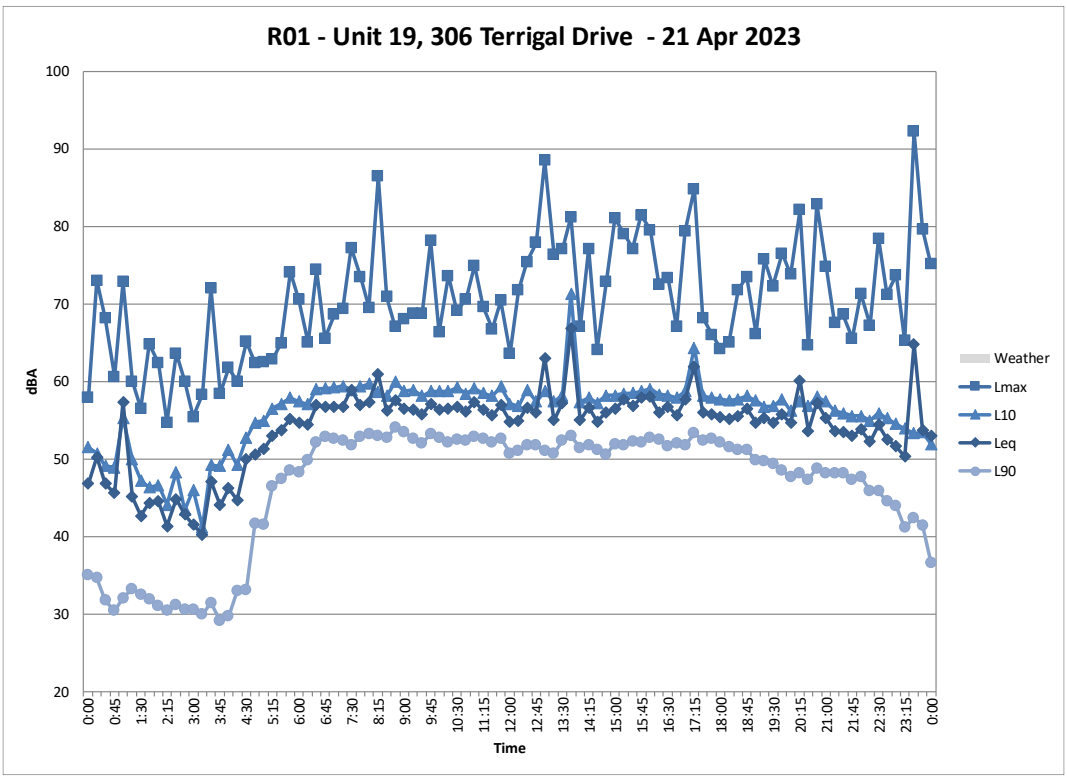

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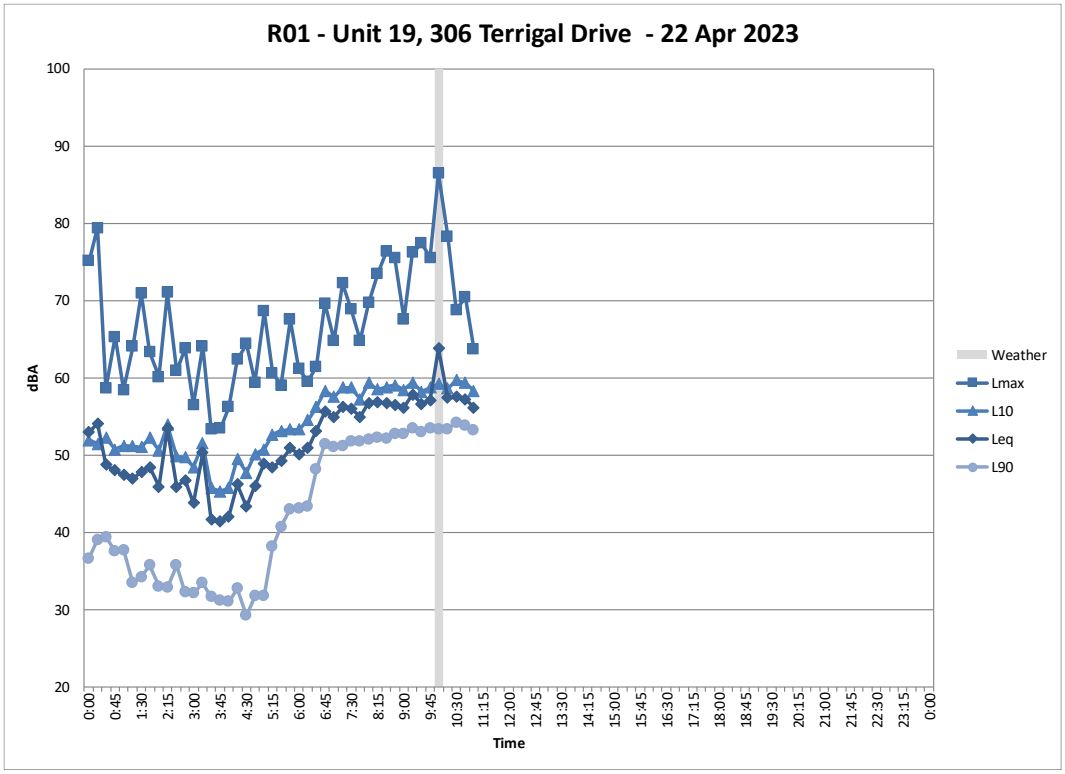

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