ADP
Consulting : Engineering

SummitCare Randwick

Noise Impact Assessment

Prepared for: Centurion Group

Project No: SYD1029
Date: 8 February 2022
Revision: 04

ADP Consulting : Engineering

Creating great environments with great people

Project:	SummitCare Randwick
Location:	11, 15, 17 & 19 Frenchmans Road Randwick, NSW, 2013
Prepared by:	ADP Consulting Pty Ltd Level 3, 8 Spring Street Sydney NSW 2000
Project No:	SYD1029
Revision:	04
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Rev	Date	Comment	Author	Signature	Technical Review	Signature	Authorisa-tion & QA	Signature
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04	08/02/22	Revised plant location and added construction section	TC		TC		PP	

Project Team	
Client / Principal	Centurion Group
Architect	Boffa Robertson Group

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1. Introduction

1.1 Document purpose

ADP Consulting Pty Ltd has been retained on behalf of Centurion Group to undertake acoustics engineering services for the proposed aged care facility located at 11, 15, 17 & 19 Frenchmans Road, Randwick.

This report is prepared to provide acoustic design advice for documentation by others and addresses the following:

- Noise emission criteria and recommendations at the nearby sensitive receivers
- Recommended internal noise levels of the development
- Noise separation between sensitive spaces and other potentially noisy tenancies

The design criteria and acoustic treatment concepts in this report demonstrate the pathways by which these shall be addressed by ADP Consulting and the project team through further analysis, recommendations and coordination as the design progresses.

It is anticipated that this report will be issued to the Randwick City Council in support of a Development Application.

1.2 Referenced drawings, codes and standards

The followings drawings, conditions and other project-specific information has been referenced in preparing this report:

- Boffa Robertson Group's "Development Application Re-issue" Architectural Drawings, dated 14 January 2022
- ADP Consulting's building services mark-up (Building Services Mark-up)

The following guidelines, standards and regulatory requirements have been used to define the site-specific acoustic criteria for the development:

- AS/NZS 1668.1:2015 The use of ventilation and air conditioning in buildings Part 1: Fire and smoke control in buildings (AS/NZS 1668.1)
- AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (AS/NZS 2107)
- AS 2670.2:1990 Evaluation of human exposure to whole body vibration Part 2: Continuous and shock-induced vibration in buildings (1 to 80Hz) (AS 2670.2)
- AS 1055:2018 Acoustics – Description and measurement of environmental noise
- BS 6472:1992 Evaluation of human exposure to vibration in buildings (1 to 80 Hz) (BS 6472)
- Assessing Vibration: A Technical Guideline – NSW Department of Environment and Conservation, February 2006 (AVTG)
- National Construction Code 2019 – Volume one, Building Code of Australia class 2 to 9 buildings (NCC)
- NSW EPA's Noise Policy for Industry, dated October 2017 (NPfI)
- NSW EPA's Interim Construction Noise Guideline, dated July 2009 (ICNG)
- NSW EPA's Assessing Vibration: A Technical Guide dated February 2006 (AVTG)

> BS 7385.2:1993 Evaluation and Measurement for Vibration in Buildings Part 2: Guide to Damage Levels from Ground-borne Vibration (BS 7385.2:1993)

1.3 Project summary

The SummitCare Randwick development comprises construction of a new aged care facility. The Architectural Drawings show that the proposed development will consist of:

> Lower basement:
  - Plant, pump and storage rooms
  - Workshop

> Basement:
  - Car and mortorcycle parking spaces
  - Pump, switch and storage rooms
  - Theatre
  - Gym
  - Hairdresser / spa room
  - Toilets
  - Staff room
  - Kitchen
  - Laundry
  - Loading area
  - Ambulance bay
  - Waste room

> Ground level:
  - Multi-purpose room
  - Doctor's office and consultation / therapy room
  - Offices
  - Toilets
  - Reception area
  - Retail, including café
  - Servery, dining and lounge areas
  - Residential Aged Care rooms (Single occupancy)

> Levels 1 to 3:
  - Residential Aged Care rooms (Single and double occupancy)
  - Dwelling suites
  - Balcony areas
  - Servery, dining, sitting and lounge areas
  - Staff rooms
  - Plant and terrace areas on Level 3

> Roof level:
  - Plant area
  - Outdoor deck

Figure 1 provides a site map of the proposed development and its surrounds.

At time of writing, a construction contractor nor the construction methodology have been selected. Therefore, we propose that the selected contractor provides a noise and vibration assessment when this information has been determined / finalised. Section 3 provides site specific noise and vibration management levels for the demolition, excavation and construction of the proposed facility.

Figure 1 Site plan

2. Site investigations and noise measurements

2.1 Site investigations

Based on our site survey and investigations we have identified the following sensitive receivers as being the nearest noise sensitive premises to the proposed development:

- Commercial premises, including:
  - Infinite Healthcare at 24 Frenchmans Rd, approximately 40m to the southeast
  - Coles Express at the corner of Frenchmans Rd and Clovelly Rd, approximately 100m to the east
  - All Professional Driving School at 42 Avoca St, approximately 120m to the west
- Residences directly adjacent to the north, south (opposite Frenchmans Rd), east and west of the proposed development
- The development itself that includes:
  - Services requiring noise attenuation and vibration isolation to ensure low indoor noise levels in occupied areas and compliance with noise emission regulations
  - An expected standard of amenity compliant with all applicable codes, regulatory requirements, client brief and/or other standards

2.2 Noise measurement equipment

The following instrumentation was used for noise measurements and analysis:

- Bruel and Kjaer 2250 Integrating Sound Level Meter (S/N: 3011318)
- Bruel and Kjaer type 1 microphone – comprising of:
  - ZC 0032 preamplifier (S/N: 25754)
  - 4189 capsule (S/N: 3087045)
- Bruel and Kjaer Sound Calibrator Type 4231 (S/N: 3018299)
- Infobyte iM4 Integrating-Averaging Sound Level Meter – noise logger (S/N: 101)

All instrument systems are laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The measurement system was also field calibrated prior to and after noise surveys. Calibration drift was found to be less than 0.3dB during measurements. No adjustments for instrument drift during the measurement period were warranted.

2.3 Attended noise measurements

Attended noise measurements were conducted on Tuesday 24 September 2019 at locations A1 to A3. These noise measurements were used to qualify and quantify the noise levels for the area.

Table 1 presents the noise levels of the attended measurements at the locations shown in Figure 1.

Table 1 Attended noise measurements, dB(A)

Location	Start Time	Location and Comments	L_{Aeq}	L_{A90}
Tuesday 24 September 2019				
A1	10.07am	**Southern boundary of proposed site** – 35m from the eastern boundary, 4m from curb of Frenchmans Rd. The character of noise comprised of: > Local traffic along Frenchmans Rd, including buses, trucks and cars > Plane flying overhead > Garbage truck at approximately 72 dB(A), stopped for approximately 30 seconds	66	52
A2	10.25am	**25m south of northern site boundary** – 20m east of western site boundary. The character of noise comprised of: > Birds > Plane flying overheard > Traffic noise from Frenchmans Rd audible > Construction noise at distance for short periods	56	43
A3	10.45am	**3m from curb of McLennan Ave** – 20m from northern boundary of proposed site, 25m west of eastern site boundary. The character of noise comprised of: > Birds > Plane flying overheard > Construction noise at distance for short periods > Occasional local traffic along McLennan Ave	48	40

2.4 Unattended noise measurements

Unattended noise measurements were conducted at the following locations (shown in Figure 1):

> **Location L1**: between Tuesday 24 September 2019 and Tuesday 1 October 2019

> **Location L2**: between Tuesday 1 October 2019 and Thursday 10 October 2019

The long-term logger was chosen to collect background noise in the area to set noise emission criteria for the development. These criteria have been presented in 4.4 of this report.

Background and equivalent continuous sound levels at location L1 and location L2 are summarised in Table 2.

Table 2 Unattended noise measurements at location L1, dB(A)

Noise Measurement	Daytime (07:00-18:00)	Evening (18:00-22:00)	Night-time (22:00-07:00)
Location L1 (ZONE 1)			
Repeatable – L_{Aeq}	67	65	62
Rating Background Level (RBL) – L_{A90}	53	46	35
Location L2 (ZONE 2)			
Repeatable – L_{Aeq}	57	50	51
Rating Background Level (RBL) – L_{A90}	43	41	35

The Location L1 and Location L2 RBLs have been be used for the noise emission criteria for Zone 1 and Zone 2, respectively. These criteria have been presented in Section 4.4 of this report.

3. Construction noise and vibration

3.1 Construction Noise Management Levels

The ICNG provides noise guidelines for demolition, excavation and construction noise at all times, and outlines procedures in the event of exceedances.

Based on the RBLs measured in Section 2.4, this section summarises the construction Noise Management Levels (NML) based on the methodology presented in the ICNG for noise emissions at the boundary of nearby premises.

Table 3 Noise management levels - Construction

Land use	Management level, $L_{Aeq\ (15\ min)}$	NML, dB(A)	How to apply
Residences Monday to Friday: 7.00am to 6.00pm Saturday: 8.00am to 1.00pm	Noise affected: RBL + 10dB	Zone 1: 63dB(A) Zone 2: 53dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. > Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. > The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected	75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. > Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Land use	Management level, $L_{Aeq\ (15\ min)}$	NML, dB(A)	How to apply
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 should apply all feasible and reasonable work practices to meet the noise affected level. > Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. > For guidance on negotiating agreements see section 7.2.2 of the ICNG
Commercial	Offices, retail outlets:	External 70dB(A) Internal 50dB(A)*	When in use

**We note that there is no requirement for internal noise levels in commercial offices set by the ICNG, however the guide recommends "to determine noise levels on a project-by-project basis utilising the 'maximum internal noise levels in AS2107", as stated under the internal office requirement. The stated internal NML for commercial receivers is 5dB above the max noise levels from AS2017 to account for variable and short-term nature of construction noise.*

Further to the noise criteria derived in Table 3, if noise emissions for construction activities exceed 75 dB(A), the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur and negotiations with the community.

3.2 Construction vibration criteria

Vibrations generated from excavation and construction works can be categorised into the following categories:

> Human comfort
> Structural damage
> Ground-borne noise

The following sections provide the use of 'best practice' guidelines for construction vibrations.

3.2.1 Human comfort

Structural vibrations detected by people may affect them in different ways. The AVTG refers to BS6472:1992 as being relevant in assessing human comfort.

Human comfort due to exposure to vibrations is dependent on duration and magnitude. Vibration assessed for human comfort can be classified as continuous, impulsive or intermittent and can enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side), or z-axis (foot to head).

3.2.1.1 Continuous and impulsive vibrations

Allowable magnitudes for continuous and impulsive exposure to building vibration (summarised from Table 2.2 of AVTG) with respect to human response are presented in Table 4.

Table 4 Continuous and impulsive vibration criteria, m/s^2

Location	Time of Construction	Preferred (rms)		Maximum (rms)	
		z-axis	x & y-axis	z-axis	x & y-axis
Continuous vibration					
Residences	Day (7am – 10pm)	0.010	0.0071	0.020	0.014
	Night (10pm – 7am)	0.007	0.005	0.014	0.010
Offices / commercial	All times	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Day (7am – 10pm)	0.30	0.21	0.60	0.42
	Night (10pm – 7am)	0.10	0.071	0.20	0.14
Offices / commercial	All times	0.64	0.46	1.28	0.92

3.2.1.2 Intermittent vibrations

To quantify the cumulative effects of several vibration events based on human exposure due to duration and magnitude, the Vibration Dose Value (VDV) descriptor is used. The VDV criteria recommended in AVTG are summarised in Table 5.

Table 5 Acceptable vibration dose values (VDV), $m/s^{1.75}$

Location	Time of Construction	Preferred (rms)	Maximum (rms)
Residences	Day (7am – 10pm)	0.20	0.40
	Night (10pm – 7am)	0.13	0.26
Offices / commercial	All times	0.40	0.80

3.2.2 Ground-borne noise

Ground-borne noise is generated by vibrations through the ground affecting structures through activities such as rock breaking or excavations. The ICNG states that noise management actions should be implemented (which may include community consultation and respite) when the following levels are exceeded:

- Evening (18:00-22:00) – Internal: $L_{Aeq\ 15min}$ – 40 dB(A)
- Night-time (22:00-07:00) – Internal: $L_{Aeq\ 15min}$ – 35 dB(A)

However, there are no criteria presented in the ICNG for ground-borne noise during the day-time hours (7:00am-6:00pm), when it is expected that construction work will take place. Therefore, we recommend that ground-borne noise levels in the adjacent buildings do not exceed the levels presented in Table 6 during the

day-time period. These recommendations are in accordance with the internal noise levels adopted from AS/NZS 2107:2016 for use under construction intrusion noise conditions for consistency.

Table 6 Daytime ground-borne noise criteria

Type of receiver	Type of room	Ground borne noise, $L_{Aeq, 15min}$ dB(A)
Residential	Any	45
Commercial	Any	50

3.2.3 Structural damage

In the absence of other specific vibration criteria for structural damage, we propose the use of BS 7385.2:1993 to set structural damage limits during the excavation and construction phases. Furthermore, we recommend that dilapidation reports be prepared on the surrounding buildings.

Vibration limits in buildings for cosmetic damage in BS7385.2:1993 are summarised in Table 7.

Table 7 Transient vibration guide values for cosmetic damage

Type of Building	Peak component particle velocity in frequency range of predominant pulse	
	4Hz to 15Hz	15Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4Hz and above	
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20 mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above
	At frequencies below 4Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded	

Note: measured at the base of the building

Under certain circumstances, such as dynamic magnification due to resonance, the allowable velocities presented in Table 7 may need to be reduced by up to 50%. Therefore, the maximum allowable peak particle velocities are to be 7.5mm/s for the proposed construction works.

4. Noise emission criteria

Noise emission restrictions apply to future tenant activity and mechanical plant and equipment systems. These must be planned, designed and installed to include suitable sound attenuation, vibration isolation, and other necessary acoustic treatments.

The NPfI requires that trigger levels be calculated from the intrusiveness and amenity criteria. The NPfI also includes the application of modifying factors for undesirable noise characteristics, up to a maximum of 10dB.

4.1 Noise intrusiveness

The NPfI states that the intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5dB.

Table 8 schedules the noise intrusion level criteria in accordance with the NPfI, calculated with the background noise levels presented in Section 2.3 and Section 2.4.

4.2 Noise amenity

The NPfI describes methodology to limit the increases in noise levels from the introduction of new noise sources in an area. The NPfI recommends that the maximum ambient noise should not exceed the levels in Table 2.2 of the NPfI.

Table 8 summarises the project amenity noise levels (as described in Table 2.2 of the NPfI).

For the surrounds around this development we have used (in accordance with Table 2.2 of the NPfI):

> Urban noise levels for Zone 1, which is near Frenchmans Road

> Suburban noise levels for Zone 2, which is further away from environmental noise sources in the area (such as Frenchmans Rd)

4.3 Modifying factors

For noise emissions from the proposed development with undesirable characteristics such as; tonality, low frequency, impulsiveness and intermittency, adjustments (as per Fact Sheet C of the NPfI) need to be included. These modifying factors include a 5dB penalty for each undesirable characteristic. A maximum penalty of 10dB for 2 or more undesirable characteristics is to be applied.

It should be noted that during the detailed design / construction phase of the project, if the design team / contractor makes selections of equipment which include one or more of these undesirable noise characteristics, a modifying factor will be applied.

4.4 Noise emission criteria (NPfI)

The project specific trigger levels have been derived using the methodology presented in the NPfI and are scheduled in Table 8 and Table 9. We note that these trigger levels have been derived from the background noise levels measured at Location L1 and Location L2.

Table 8 Noise emission criteria – Residential

Time of operation	Site specific noise limits				
	Intrusive, $L_{Aeq,15min}$	**Recommended amenity, $L_{Aeq, Period}$**	**Project amenity, $L_{Aeq, Period}$**	**Project amenity, $L_{Aeq, 15min}$**	**Project trigger levels, $L_{Aeq, 15min}$**
ZONE 1					
Day (7am to 6pm)	58	60	55	58	**58**
Evening (6pm to 10pm)	51	50	45	48	**48**
Night (10pm to 7am)	40	45	40	43	**40**
ZONE 2					
Day (7am to 6pm)	48	55	50	53	**48**
Evening (6pm to 10pm)	46	45	40	43	**43**
Night (10pm to 7am)	40	40	35	38	**38**

Table 9 Noise emission criteria – Commercial

Time of operation	Site specific noise limits			
	Recommended amenity, $L_{Aeq, Period}$	**Project amenity, $L_{Aeq, Period}$**	**Project amenity, $L_{Aeq, 15min}$**	**Project trigger levels, $L_{Aeq, 15min}$**
When in use	65	60	63	**63**

It should be noted that the cumulative noise emission from the operations of the proposed development are to meet the project trigger levels presented in Table 8 and Table 9. Careful planning and coordination with the project design team should be undertaken so that these criteria are complied with.

5. Internal noise and vibration requirements

5.1 AS/NZS 2107:2016

Indoor background noise levels in terms of Sound Pressure Level (SPL) and reverberation times (seconds) deemed acceptable to the majority of reasonable occupants are published in AS/NZS 2107. We have summarised the recommended indoor noise levels and reverberation times for the proposed development in Table 10.

These limits apply to continuous sources of noise internal to the proposed development such as plant equipment, lifts, etc.

Please note that this section would apply for:

> the external traffic noise intrusion from Frenchmans Road

> mechanical plant and equipment for all spaces including sleeping and habitable spaces

Furthermore, the façade should be designed so that the noise levels presented in Table 10 are complied with.

Table 10 Internal design sound pressure levels and reverberation time recommendations

Type of occupancy	Design SPL, L_{Aeq}, dB(A)	Reverberation Time, seconds
Meeting rooms / staff rooms	40 to 45	< 0.6
Small retail stores (general)	< 50	Minimise
Offices	40 to 45	< 0.6
Dining area	45 to 50	Minimise
Café	40 to 50	Minimise
Enclosed car parks	< 65	–
Apartment common areas (foyer, lift lobby)	45 to 50	–
Living area	35 to 45	–
Sleeping areas (night-time)	30 to 35	–
Theatre	30 to 35	< 0.7
Toilets	< 50	–
Kitchen, laundry and maintenance areas	< 55	–
Workshop and laundry	< 60	Minimise
Loading dock	< 65	–
Gym	< 50	< 1.0
Consulting rooms	40 to 45	0.4 to 0.6

5.2 Fire mode noise conditions

Some building systems only operate in fire mode and during periodic testing, so they do not add to background noise under typical conditions. According to AS/NZS 1668.1:2015, these systems are subject to noise limits, presented in Table 11, relating not to occupant comfort but rather to occupant distress and the intelligibility of emergency commands. Here, the 65 dB(A) limit supports the audibility of fire alarms (min. 75 dB(A) at bedheads per AS 1670.1).

Table 11 Fire mode maximum sound pressure levels

Area type	Maximum SPL, L_{Aeq}, dB(A)
Occupied Area	65
Fire-isolated exit (e.g. fire stair)	80

5.3 Construction requirements (NCC)

The development comprises of the following classification that requires acoustic consideration in accordance with the NCC:

> Class 9c: Aged care facility

The NCC specifies minimum sound insulation ratings between various occupancies, defined in terms of a weighted standardized level difference $D_{nT,w}$ and a weighted standardized level difference with adapted spectrum $D_{nT,w}+C_{tr}$. These ratings are determined by field testing conducted in accordance to AS/NZS 1276.1 or ISO 717.1 standards.

The NCC also offers deemed-to-satisfy provisions based on wall sound insulation ratings determined by laboratory testing in accordance to AS/NZS 1276.1 or ISO 717.1 standards. Table 12 schedules field-tested sound insulation ratings needed to achieve compliance, along with corresponding deemed-to-satisfy provisions.

Table 12 Internal NCC requirements (Class 9c)

Element	Description	Performance	
		Deemed to satisfy	**Field testing rating**
Class 9c Requirements			
Walls	Airborne Sound		
	Separating any two sole occupancy units	R_w > 45	$D_{nT,w}$ > 40
	Separating a sole occupancy unit from a bathroom, sanitary compartment (not being an associated ensuite), plant room or utilities room	R_w > 45	$D_{nT,w}$ > 40
	Separating a sole occupancy unit from a kitchen or laundry	R_w > 45 + impact	$D_{nT,w}$ > 40 + impact
	Impact sound		
	Walls between sole occupancy units shall comply with the impact sound resistance standards specified in the NCC which means discontinuous construction		
Floors	Airborne Sound		
	Separating any two sole occupancy units	R_w > 45	$D_{nT,w}$ > 40
	Impact Sound		
	Separating any two sole occupancy units	-	$L_{n,w}$ < 62
Services	If the adjacent room is a habitable room (other than a kitchen)	R_w+C_{tr} > 40	-
	If the adjacent room is a kitchen or non-habitable room.	R_w+C_{tr} > 25	-
	If a storm water pipe passes through a sole-occupancy unit it must be separated as stated above		

Where there is an identified risk of structure-borne sound transmission, the NCC requires a discontinuous construction, as scheduled in Table 13.

Table 13 NCC Specified constructions for wall impact sound insulation

Wall or door type	Discontinuous construction
Wall separating a wet area in one unit from a habitable room in adjacent unit; OR Wall separating a unit from a plant room or a lift shaft	For masonry walls, be identical with a prototype that is no less resistant to the transmission of impact sound when tested in accordance with Specification F5.5 than a wall listed in Table 2 of Specification F5.2 (NCC). For walls other than masonry, be two or more separate leaves without rigid mechanical connection except at the periphery.

It should be noted that open kitchens are considered wet source rooms but habitable receiver rooms.

In addition to codified ratings, specific higher-performing constructions may be required in some areas (e.g. plant rooms) to reduce noise to the adjacent tenancies. Similarly, specific detailed constructions and treatments may be needed to maintain the specified sound insulation rating even across wall elements beyond typical wall types, such as at the junction of internal walls and the façade.

Notwithstanding deemed-to-satisfy provisions based on lab tests, field performance is critically dependent on good workmanship and installation quality, which is also a requirement of the acoustic design.

5.4 Internal vibration requirements

Vibration is the oscillation of an object, structure, or surface at frequencies typically below 20 Hz, which is inaudible but instead can be "felt". **Structure-borne sound** means oscillation at frequencies higher than 20Hz, resulting in audible noise, which is transmitted through rigid building elements and radiated by surfaces.

Human response to building vibration is a complex phenomenon. There is great variability in the vibration tolerance of humans, and as a result, human comfort criteria cannot robustly be defined and quantified. Acceptable values of human exposure to vibration depend on human activity and the character of the vibration, and they are further influenced by individual attitudes, expectations, and perceptibility.

Limits for vibration of the building structure potentially affecting human comfort have been derived from AS 2670.2 and BS 6472, both of which are referenced and discussed practically in the AVTG. These standards propose maximum vibration levels in terms of baseline curves and multiplication factors. For the purpose of minimising the disturbing perceptibility of vibration within the occupied areas of this development, Table 14 specifies appropriate limits for floor vibration in a simplified form.

Table 14 Vibration limits

Type of occupancy	**Time**	**Continuous vibration limits:** **r.m.s. acceleration (m/s^2)** **Preferred / maximum**	**Impulsive vibration limits:** **r.m.s. acceleration (m/s^2)** **Preferred / maximum**	**Intermittent vibration limits:** **Vibration Dose Value VDV ($m/s^{1.75}$)** **Preferred / maximum**
Offices, retail, circulation / other occupied ventilated space	Day or night	0.020 / 0.040	0.640 / 1.280	0.40 / 0.80
Residences	Day	0.010 / 0.020	0.300 / 0.600	0.20 / 0.40
	Night	0.007 / 0.014	0.100 / 0.200	0.13 / 0.26

6. Noise assessment and recommendations

6.1 Noise intrusion

6.1.1 Glazing

The site is impacted by road traffic along Frenchmans Rd, approximately 10m to the south. This is the main source of external noise that will affect the façade of the proposed site. External noise measurements scheduled in Section 2.3 and Section 2.4 have been used to determine the façade glazing treatment presented in this section.

Indicative glazing requirements are presented in Table 15, with a mark-up of façade treatment locations provided in Appendix B.

Table 15 Minimum glazing performance requirements

Indicative glazing construction	**Minimum glazing octave band insertion loss – dB, Hz**								
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**R_w**
6mm monolithic / 12mm airgap / 8mm monolithic glass	24	25	25	33	38	33	44	40	**36**
6mm monolithic / 12mm airgap / 6mm monolithic glass	21	26	25	32	36	34	37	40	**34**
10.38mm laminated glass	23	26	29	34	34	34	46	50	**36**
10mm monolithic glass	20	24	28	32	30	31	42	36	**31**
6mm monolithic glass	17	20	22	27	30	25	31	25	**27**

We understand that these glazing recommendations will be refined at a later stage and the following considerations will need to be accounted for. These include:

- Selection of glazing supplier (framing systems and ultimately acoustic performance of the glazing system as a whole)
- If required, reassess noise intrusion based on glazing sizes and any changes made
- Structural requirements
- Thermal requirements

6.1.2 External walls

To assist in reducing noise intrusion, the wall / floor construction will need to be made up of concrete or brick veneer with a minimum acoustic performance of Rw 50.

6.2 Mechanical plant and equipment noise emission

Preliminary plant and equipment specifications have been provided by the mechanical engineer. Based on the Architectural Drawings and Building Services Mark-up, we understand that external plant (18 condensing units) will be located on the south-eastern rooftop plant area of the proposed development. Our calculations have made provisions for noise emissions from this location to nearby sensitive receivers.

We have made the following assumptions in our calculations:

- Each outdoor condenser is to have a maximum sound power level of 80 dB(A)
- The height of the barrier is to be at least 200mm above the top of the outdoor air conditioning units (shown in Figure 2).
- A maximum of 24 air conditioning condensers are to be installed on the rooftop
- We understand the condensing units will be operating under the following operating conditions:
  - Daytime and Evening (7am to 10pm): 100% of units in operation
  - Night-time (10pm to 7am): 100% of units in operation and all units are set to night-time operational mode (8 dB(A) lower)

The calculated noise levels at the most sensitive receivers have been provided in Table 16.

Table 16 Noise emission levels at closest sensitive receivers

Receiver location	Time of day	Receiver noise levels, dB(A)	Criteria, dB(A)	Compliance
23 Frenchmans Rd	Day	36	58	Yes
	Evening	36	48	Yes
	Night	28	40	Yes
23 McLennan Ave	Day	30	48	Yes
	Evening	30	43	Yes
	Night	22	38	Yes
14-18 Fenchmans Rd	Day	25	58	Yes
	Evening	25	48	Yes
	Night	19	40	Yes
Infinite Healthcare Randwick, at 24 Frenchmans Rd	Day	34	63	Yes
	Evening	34	63	Yes
	Night	-	-	Yes
All Professional Driving School, at 42 Avoca St	Day	33	63	Yes
	Evening	-	-	Yes
	Night	-	-	Yes

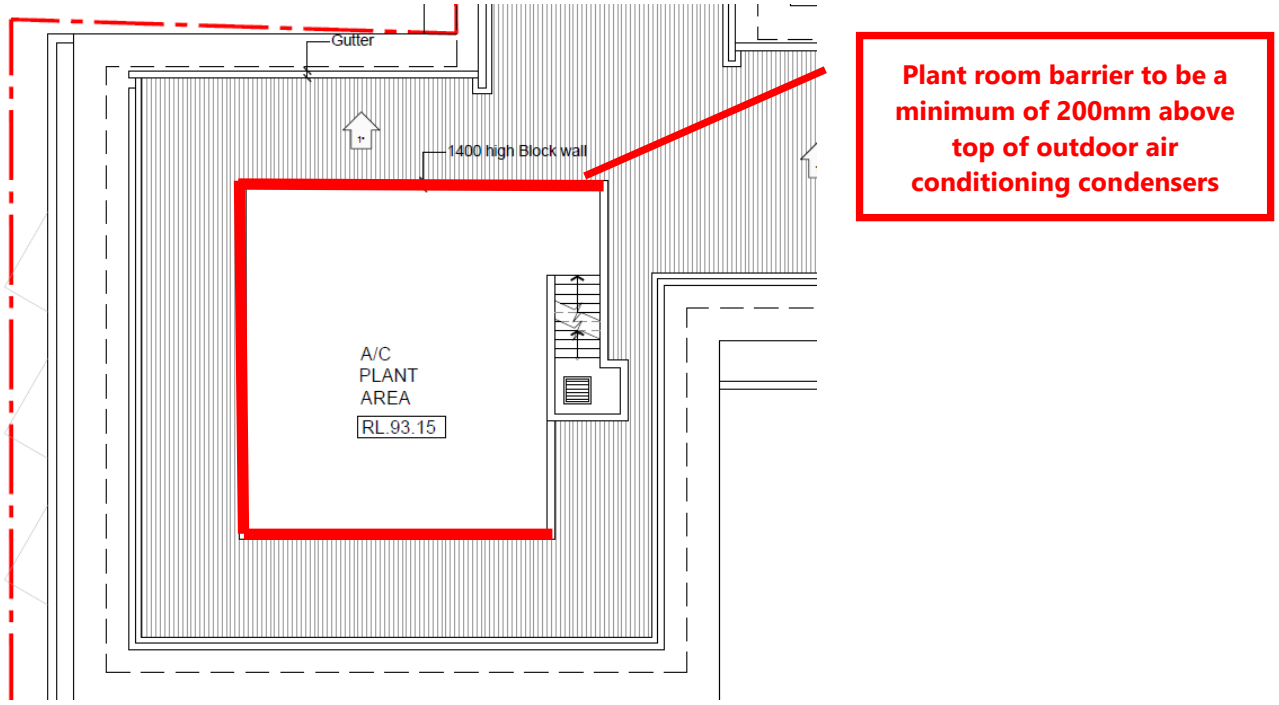
Table 16 presents noise levels at the worst affected locations of different use. We note that compliance at this location would mean compliance at other locations described in Section 2.1.

6.3 Acoustic barriers

Based on the Architectural Drawings and Building Services Mark-up, it is recommended that an acoustic barrier is installed around the rooftop plant room to the west and is at least 200mm higher than the top of the outdoor air conditioning condensers.

These barriers must be gap free along its entire length and constructed with a solid material such as lapped and capped timber, Colorbond, concrete, or any combination of these. A mark-up of the barrier height and locations has been provided in Figure 2.

Figure 2 Mark-up of acoustic barrier height and location



6.4 Mechanical plant and equipment preliminary recommendations

Commercial noise emissions, including plant noise emissions, from any base-building systems and commercial tenancies within the subject development are required to comply with the NPfI noise emission trigger levels (presented in Section 4.4 of this report).

Furthermore, although the locations of other plant and equipment, such as fans has been provided in the mechanical mark-ups, at time of writing, selections are yet to be made. Provision has been included in the current scheme to incorporate standard acoustic treatment, such as silencers, barriers, acoustically lined ductwork, acoustic louvres, etc. to meet the noise emission requirements of the NPfI (Section 4.4).

As the design progresses through the detailed design phase, acoustic measures will need to be incorporated in the design so that the noise emission criteria presented in Section 4.4 will be complied with.

7. Conclusion

A site investigation of the proposed site and surrounds at 11, 15, 17 & 19 Frenchmans Road, Randwick has been completed to determine existing noise levels for the environment and surrounds for a proposed development of the site.

Mechanical plant used on the site will need to be designed to comply with the noise emission and noise intrusion criteria in the design development stage of the project. Controlling noise from plant and equipment would include a combination of enclosed plant rooms, silencers, lined ductwork, acoustic barriers, acoustic louvers and the selection of quiet plant where required.

The preliminary road traffic noise intrusion assessment indicates upgraded glazing will be required for affected spaces, with a markup included in Appendix B, in order to meet the internal acoustic requirements presented in this report. The indicative glazing recommendations have been provided in Section 6.1 of this report which may be refined during the detailed design phase of the project.

At time of writing, a construction contractor nor the construction methodology have been selected. Section 3 provides site specific noise and vibration management levels for the demolition, excavation and construction of the proposed facility.

Current standards associated with the development have been reviewed and assessed in accordance with existing site constraints. Preliminary construction standards have been reviewed to ensure that Randwick City Council's and other guidelines are satisfied.

ADP Consulting believes that there are no site conditions that would preclude this development from complying with the criteria defined in this report.

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Appendix A
Glossary of acoustic terms

Air-borne sound

The sound emitted directly from a source into the surrounding air, such as speech, television or music.

Ambient sound

Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far. This is normally taken to be the L_{Aeq} value.

Background noise level

The average of the lowest levels of the noise levels measured in an affected area in the absence of noise from occupants and from unwanted external ambient noise sources. Usually the L_{A90} value represents the background noise level.

dB(A)

Unit of acoustic measurement weighted to approximate the sensitivity of human hearing to sound frequency.

Decibel scale

The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. Therefore, a 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. It is generally accepted that a 10 dB increase in the sound pressure level corresponds to a perceived doubling in loudness.

Examples of decibel levels of common sounds are as follows:

- 0 dB(A) Threshold of human hearing
- 30 dB(A) A quiet country park
- 40 dB(A) Whisper in a library
- 50 dB(A) Open office space
- 70 dB(A) Inside a car on a freeway
- 80 dB(A) Outboard motor
- 90 dB(A) Heavy truck pass-by
- 100 dB(A) Jackhammer / Subway train
- 110 dB(A) Rock Concert
- 115 dB(A) Limit of sound permitted in industry
- 120 dB(A) 747 take off at 250 metres

Frequency

The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high-pitched sound and a low frequency to a low-pitched sound.

L_{90}, L_{10}, etc

A statistical measurement giving the sound pressure level which is exceeded for the given percentile of a measurement period (i.e. L_{90} is the level which is exceeded for 90 percent of a measurement period). L_{90} is commonly referred to as a basis for measuring the background sound level.

$L_{Aeq,T}$

The equivalent continuous A-weighted sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound.

L_{Amax}

The maximum sound pressure level measured over the measurement period.

L_{Amin}

The minimum sound pressure level measured over the measurement period.

Day

Referred to as the period between 7am and 6pm for Monday to Saturday and 8am to 6pm for Sundays and Public Holidays.

Evening

Referred to as the period between 6pm and 10pm for Monday to Sunday and Public Holidays.

Night

Referred to as the period between 10pm and 7am for Monday to Saturday and 10pm to 8am for Sundays and Public Holidays.

Assessment background level (ABL)

The overall background noise level on each day, evening and night periods for each day of the noise monitoring.

Rating background level (RBL)

The overall background level on each day, evening and night periods for the entire length of noise monitoring.

Reverberation

The persistence, after emission by the source has stopped, of a sound field in an enclosure.

Sound isolation

A reference to the degree of acoustical separation between two spaces. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term 'sound isolation' does not specify any grade or performance quality and requires the units to be specified for any contractual condition.

Sound pressure level, L_p, dB of a sound

A measurement obtained directly obtained using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the R.M.S. sound pressure to the reference sound pressure of 20 micro Pascals

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Appendix B
Façade treatment mark-up

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