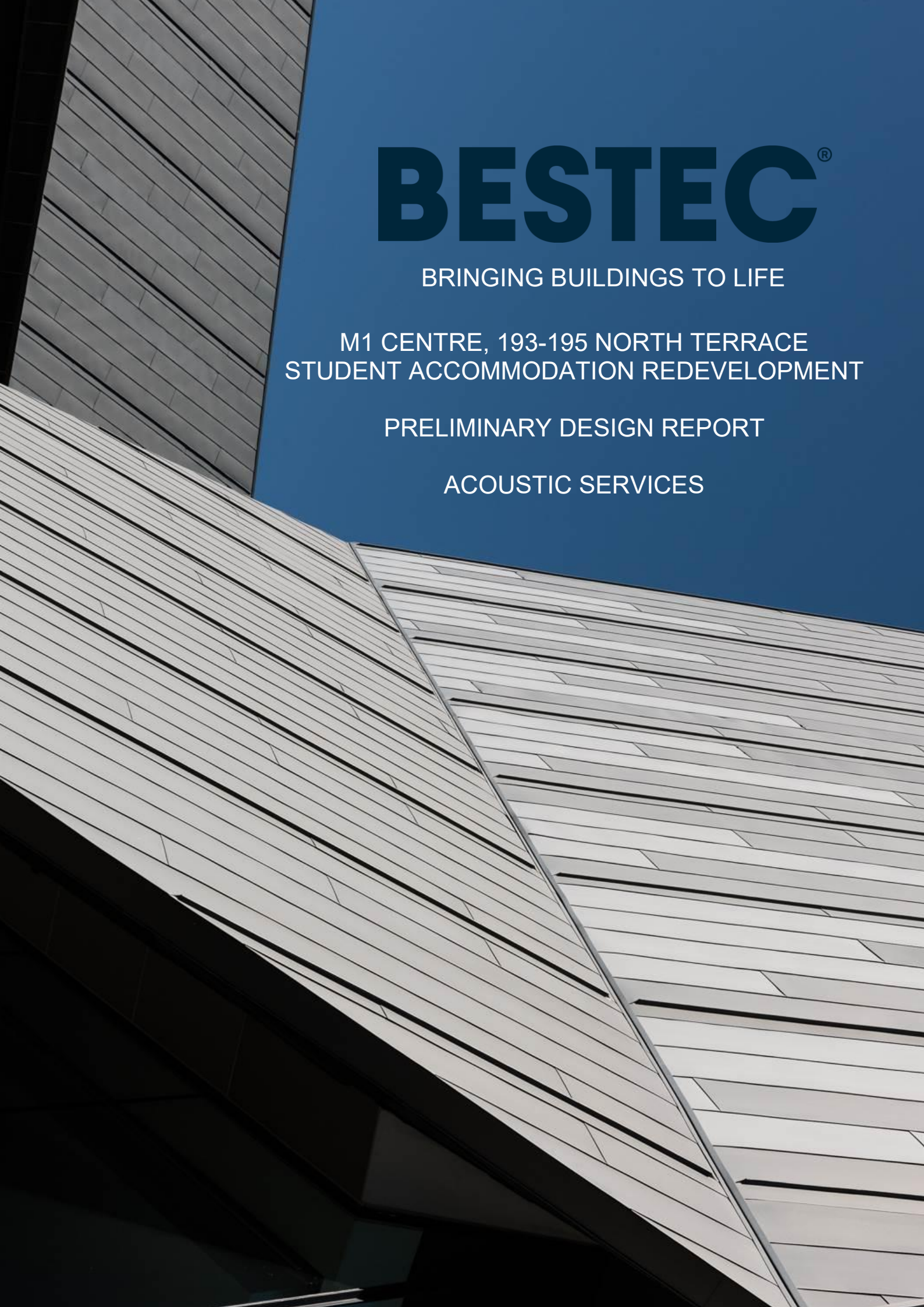


APPENDIX 5. ACOUSTIC SERVICES DESIGN REPORT



BESTEC[®]

BRINGING BUILDINGS TO LIFE

M1 CENTRE, 193-195 NORTH TERRACE
STUDENT ACCOMMODATION REDEVELOPMENT

PRELIMINARY DESIGN REPORT

ACOUSTIC SERVICES

RPR:IGL
58324/6/1
21 April 2026

The Mandala Group
Level 34, Grosvenor Place
225 George Street
SYDNEY NSW 2000

Attention: Mr D Lee

Dear Sir

**M1 CENTRE, 193-195 NORTH TERRACE – STUDENT ACCOMMODATION REDEVELOPMENT
PRELIMINARY DESIGN REPORT
ACOUSTIC SERVICES**

As requested, we enclose a copy of our design report on the Acoustic Services for the above project.

We trust that the report provides sufficient information for your immediate purpose, and we would be most pleased to further discuss any aspect upon your request.

Yours faithfully
BESTEC PTY LTD



**RAHUL PRAKASH
ACOUSTIC SERVICES ENGINEER**

REPORT ISSUE REGISTER

REVISION	DATE	REVISION DESCRIPTION
00	29.08.25	Costing Issue
01	21.04.26	Preliminary Design Report

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Introduction

BESTEC Pty Ltd has been engaged to provide acoustic engineering services for the proposed student accommodation redevelopment at 193-195 North Terrace, Adelaide SA 5000. This document presents the methodology and results of our attended noise survey, the nominated acoustic design criteria and acoustic design recommendations to achieve the nominated design criteria where required.

Executive Summary

In summary:

- The architectural drawings of the proposed development have been reviewed.
- An attended acoustic survey was conducted at the site of the proposed development on 22nd August 2025 to determine the traffic noise levels over 15-minute intervals.
- Appropriate acoustic design criteria were nominated based on the proposed development plan, SA Environment Protection (Commercial and Industrial Noise) Policy 2023 and Ministerial Building Standard MBS 010.
- Appropriate constructions of the building façade, glazing and roof structure have been nominated.
- Appropriate constructions of the walls and floors separating the apartments have been nominated to ensure compliance with the requirements of National Construction Code Series 2022, Building Code of Australia for sound insulation (Section F7).
- Constructions of the internal partitions, glazing and doors in order to provide sufficient level of speech privacy have been provided.
- A markup has been provided in Appendix A to illustrate the recommended level of speech privacy and extent for each partition type.
- The mechanical engineering services and specifications for airborne and structure borne noise will be reviewed in later design stages and recommendations for engineering noise and vibration controls (e.g., duct lagging, attenuators etc.) will be provided demonstrating the selected internal as well as environmental criterion are achieved.
- Recommendations for reverberation control will be provided when the reflected ceiling plans and finishes schedule are available.

For explanation of acoustic terms, please refer to the Glossary of Acoustic Terminology attached to this document (Appendix B).

Acoustic Analysis

References

The following documents have been referenced within the preparation of this acoustic report.

- [1] SA Environment Protection (Commercial and Industrial Noise) Policy 2023.
- [2] SA Planning and Design Code, 2025.
- [3] AS/NZS 2107:2016 “Acoustics – Recommended design sound levels and reverberation times for building interiors”.
- [4] Ministerial Building Standard MBS 010 “Construction requirements for the control of external sound”, May 2023.
- [5] Indicative noise factors guidelines for the Environment Protection (Commercial and Industrial Noise) Policy 2023.
- [6] ISO 140-5:1998 “Acoustics – Measurement of sound insulation in buildings and building elements. Part 5: Field measurements of airborne sound insulation of façade elements and facades”.
- [7] Architectural drawings by Brown Falconer dated April 2026.
- [8] National Construction Code Series 2022, Building Code of Australia, Class 2 to Class 9 Buildings.
- [9] Local Nuisance and Litter Control Act 2016.

Site Description

The proposed development site is located at the corner of Gawler Place and North Terrace in a zone designated Capital City (CC) as per the SA Planning and Design Code 2025 [2] with the following boundaries:

- North – North Terrace;
- East – Existing student accommodation towers and commercial developments in the same land zone;
- South – Existing residential/commercial developments within the same land zone;
- West – Gawler PI separating existing commercial buildings within the same land zone;

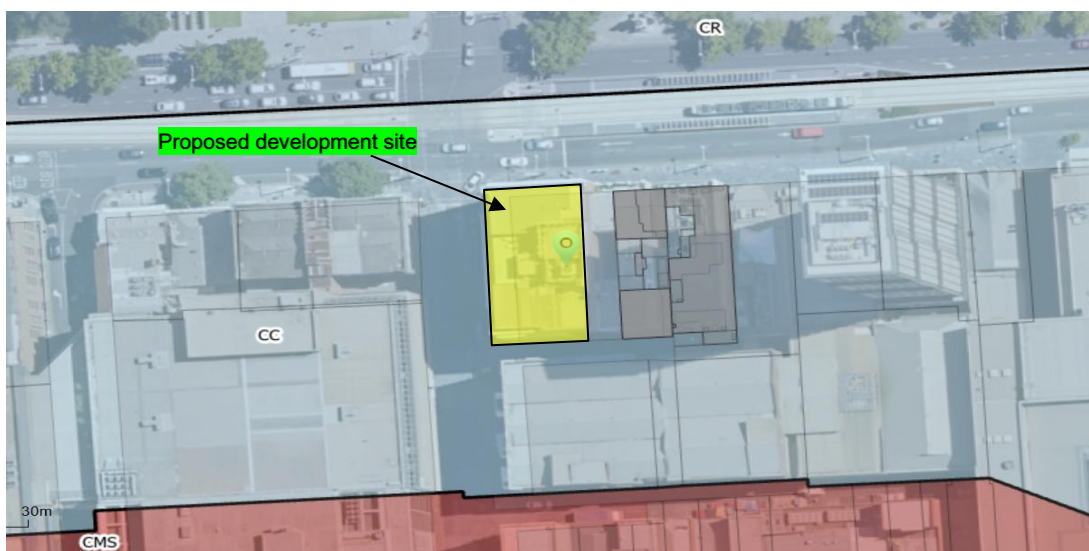


Figure 1: Site location and land zoning (reproduced from SAPPa)

Proposed Development

The proposed development is to consist of a 40-storey student accommodation tower with the following components:

- Ground Floor – Retail tenancy (Cafe), PBSA lobby, admin/reception, waste room, E-Waste, transformer room, fire control room;
- Level 1 – Bike Store, Fire Tanks & Pumps, Cleaner, Cold Water Plant, Comms, MSB;
- Levels 2 – Gym, Laundry, Games Area, Amenities;
- Levels 3 – Quiet Study, Open Study, Lounge, Cinema/Multipurpose, Amenities ;
- Levels 4-8 – Studio apartments;
- Level 9 – Kitchen, Indoor Dining/Lounge, BBQ, Elec/Comms. Amenities;
- Levels 10 to 38 – Studio apartments;
- Level 39 – Media, Study, Amenities;
- Roof – Mechanical Plant, solar panels.

Conditions

The SA Planning and Design Code [2] sets the Desired Outcome (DO) for developments, which might affect sensitive receivers in adjacent areas as follows:

DO 1 Development is located and designed to mitigate adverse effects on or from neighbouring and proximate uses.

The following requirements (performance outcomes) of the SA Planning and Design Code [2] are relevant to the design and siting of the proposed developments (Section Interface Between Land Uses):

PO 1.1 Sensitive receivers are designed and sited to protect residents and occupants from adverse impacts generated by lawfully existing land uses (or lawfully approved land uses) and land uses desired in the zone.

PO 1.2 Development adjacent to a site containing a sensitive receiver (or lawfully approved sensitive receiver) or primarily intended to accommodate sensitive receivers is designed to minimise adverse impacts.

PO 4.1 Development that emits noise (other than music) does not unreasonably impact the amenity of sensitive receivers (or lawfully approved) sensitive receivers.

PO 4.2 Areas for the on-site manoeuvring of service and delivery vehicles, plant and equipment, outdoor workspaces (and the like) are designed and sited to not unreasonably impact the amenity of adjacent sensitive receivers (or lawfully approved sensitive receivers) and zones primarily intended to accommodate sensitive receivers due to noise and vibration by adopting techniques including:

- a) locating openings of buildings and associated services away from the interface with the adjacent sensitive receivers and zones primarily intended to accommodate sensitive receivers.*
- b) when sited outdoors, locating such areas as far as practicable from adjacent sensitive receivers and zones primarily intended to accommodate sensitive receivers.*
- c) housing plant and equipment within an enclosed structure or acoustic enclosure.*
- d) providing a suitable acoustic barrier between the plant and / or equipment and the adjacent sensitive receiver boundary or zone.*

PO 4.4 External noise into bedrooms is minimised by separating or shielding these rooms from service equipment area and fixed noise sources located on the same or an adjoining allotment.

The SA Planning and Design Code [2] sets the desired outcome for developments, which might affect the residential developments in areas in Noise and Air Emissions Overlay as follows:

DO 1 Community health and amenity is protected from adverse impacts of noise and air emissions.

The following requirements (performance outcomes) of the SA Planning and Design Code are relevant to the design and siting of the proposed developments (Section Noise and Air Emissions Overlay):

PO 1.1 Sensitive receivers adjoining high noise and/or air pollution sources are designed and sited to shield sensitive receivers from the emission source using measures such as:

- placing buildings containing non-sensitive receivers (such as retail and commercial) between the emission source and sensitive receivers.*
- within individual buildings, placing rooms more sensitive to air quality and noise impacts (such as living rooms and bedrooms) further away from the emission source*
- providing appropriate separation or erecting noise attenuation barriers, provided the requirements for safety, urban design and access can be met*
- the use of building design elements such as podiums and jutting, deep or enclosed balconies (including with solid balustrades).*

Attended Noise Survey

An attended noise survey was conducted to determine the traffic noise levels over 15-minute intervals at the timings specified in Table 1, using a Brüel & Kjær handheld Analyser Type 2270 Sound Level Meter (Serial Number: 3006966, last calibrated on 27 November 2024, due for calibration 27 November 2025) fitted with an approved windshield. The calibration of the analyser was spot checked before and after the measurement and no drift was detected.

A-weighted Equivalent Continuous Noise Levels (L_{Aeq}), Maximum Noise Levels (L_{Amax}) and percentile noise levels (L_{A10} , L_{A90}) were measured over a 15-minute interval with the results summarised in Table 1 and Figure 2 highlighting the measurement locations.

Date	Time	Location	L_{Aeq} , dBA	L_{Amax} , dBA	L_{A10} , dBA	L_{A90} , dBA
22/08/25	04:25 PM	L1	71	95	72	59
	04:45 PM	L2	68	89	70	59
	05:05 PM	L3	66	94	68	58
	05:20 PM	L4	62	85	62	55

Table 1: Summary of Attended Noise Survey for the proposed development



Figure 2: Measurement Locations during the Attended Noise Survey

Design Criteria

Environmental Noise

Continuous Noise

This criterion will be relevant to noise emitted from the proposed development resulting from operation of engineering services plant, car park, deliveries, rubbish collections etc.

As the Deemed-to-Satisfy/Designed Performance Feature (DTS/DPF 4.1) refers to compliance with relevant Environment Protection (Commercial and Industrial Noise) Policy criteria, the environmental noise assessment has been conducted against the criteria set by the Environment Protection (Commercial and Industrial Noise) Policy 2023 [1].

The Environment Protection (Commercial and Industrial Noise) Policy 2023 [1], sets out the maximum allowable continuous noise in terms of A-weighted Equivalent Continuous Noise Level (L_{Aeq}) based on the time of day and zoning / use of land in which the noise source and receiver are located. With reference to the SA planning and Design Code [2], we note that the proposed development is located within a land zoned City Centre (CC) with the nearest noise sensitive receiver located in the same land zone. Based on the SA Planning and Design Code [2], the "Capital City (CC)" zone is a commercial and residential zone therefore, the criteria derived in accordance with the Environment Protection (Commercial and Industrial Noise) Policy 2023 [1] should be based on the average of the indicative noise levels for different land categories. Table 2 details the indicative noise factors based on time of day and land-use as stipulated in Indicative noise factors guidelines for the Environment Protection (Commercial and Industrial Noise) Policy 2023 [5].

Zone	Land Use Category	Day Time (7:00 – 22:00)	Night Time (22:00- 7:00)
Capital City (CC)	Residential, Commercial	57	50

Table 2: Indicative noise factors based on time of day and land use.

We note that for planning purposes, the predicted noise level (continuous) for a new development (in this case the proposed student accommodation tower) should not exceed the relevant indicative noise level, minus 5dBA. Therefore, the environmental noise criteria for assessment of the noise impact from the proposed development become:

- Day time (7:00 am to 10:00 pm): 52dBA
- Night time (10:00 pm to 7:00 am): 45dBA

Note that if noise emitted by the proposed development contains any tones, modulation, impulsive, or low frequency characteristics, the continuous noise level of the noise source must be adjusted as follows:

- Noise containing 1 characteristic – 5dBA penalty added to source continuous noise level.
- Noise containing 2 characteristics – 8dBA penalty added to source continuous noise level.
- Noise containing 3 or 4 characteristics – 10dBA penalty added to source continuous noise level.

Building Acoustics

The level of background and transient/intermittent noise, the speech privacy rating and the room acoustics define the quality of the acoustics within a building. The recommended criteria for each space are shown in Table 3 below. Please refer to each individual section below for interpretation of the criteria.

Type of occupancy/activity	Background Noise L_{Aeq} , dBA	Reverberation Time, sec	Airborne Sound Insulation		Weighted Sound Level Difference, D_w
			Weighted Sound Reduction Index, R_w	Weighted Sound Reduction Index with Spectrum Adaptation Term, R_w+C_{tr}	
<i>Apartments</i>			50 ¹	50 ²	
Bedrooms	30 – 35 (night time)				
Living/ Other Habitable areas	35 – 40				
<i>Communal Component</i>					
Admin/Reception	40 – 45	0.6 – 0.8			35
Cafe	<50	<1.0			N/A
Lobby	<50	Minimise as practical			N/A
Waste Room	<50	N/A			35
Transformer Room	N/A	N/A			35
Comms, Elec/Comms	<55	N/A			35
Bike Store	<55	N/A			35
Fire Tanks and Pumps	N/A	N/A			45 ³
MSB/Fire Control Room	N/A	N/A			35
RWT and Cold-Water Plant	N/A	N/A			40 ³
Cleaner	<50	Minimise as practical			35
Gym	<50	Minimise as practical			40
Games Area	<50	<1.0			N/A
Cinema/Music/Multipurpose	35 – 45	0.3 – 0.6			40
Amenities	45 – 55	N/A			40
Laundry	<55	N/A			35
Lounge	40 – 45	0.6 – 0.8			N/A
Dining/Kitchen	45 – 50	Minimise as practical			N/A
Open Study/Study	40 – 45	0.4 – 0.6			N/A
Quiet Study	40 – 45	0.4 – 0.6			40
Media	40 – 45	0.4 – 0.6			40

Table 3: Proposed building acoustic design criteria for 193 -195 North Terrace

Background Noise

AS/NZS 2107-2016

AS/NZS 2107-2016 [3] sets the criteria for background noise in terms of A-weighted equivalent continuous sound pressure level over the measurement interval ($L_{Aeq, T}$) in accordance with the use of the spaces and the location of the buildings. Recommendations for each space are provided in Table 3 in terms of an

¹ Between apartments and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

² Between apartments.

³ Recommendation will be revised once specifications of the pumps and associated equipment are available.

averaged A-weighted sound pressure level (L_{Aeq}) with Table 4 detailing the subjective response of individuals to the proposed sound levels for interpretation of the recommendations.

Average Sound Pressure Levels (dBA)	Subjective Rating
35 – 40	Audible but unobtrusive
40 – 45	Moderate but unobtrusive
45 – 50	Unobtrusive with low levels of surrounding activities
50 – 55	Unobtrusive with high levels of surrounding activities

Table 4: Subjective ratings for various average sound pressure levels

Ministerial Building Standard MBS 010

In addition, the Ministerial Building Standard MBS 010 [4] stipulates that the attenuation provided by the building envelope must be sufficient to provide sufficient attenuation of traffic noise so the internal sound levels do not exceed the internal sound criteria values stated in Table 2 of the Standard [4] as follows:

Type of room	Sound Source	Internal sound criteria	
		Building design target averaged over the total number of such rooms in the building	Maximum allowable for individual rooms in the building
Bedroom	Road and rail	30dBA $L_{eq, night}$	35dBA $L_{eq, night}$
Other habitable rooms	Road and rail	35dBA $L_{eq, night}$	40dBA $L_{eq, night}$

Table 5: Ministerial Building Standard MBS 010 criteria for noise intrusion (Table 3.1 of Ministerial Building Standard MBS 010 reproduced)

The MBS 010 Standard [4] also nominates the traffic noise levels to be used in the assessment (Ministerial Building Standard MBS 010, Table A1.2: Sound source levels for Road and rail) in accordance with the road type, determined in by the relevant Development Plan. The SAPPA identifies North Terrace (speed limit of 50km/h) as Type B in the section where the proposed development is located. We note that the Standard provides assessment road noise levels for roads with speed limit up to 60km/h which is 68dBA at 10m ($L_{Aeq, night}$). As the traffic noise levels measured from the attended traffic noise survey (Table 1) is higher than the noise levels nominated by the MBS 010 [4], the measured noise levels have been used in this assessment.

Room Acoustics

AS 2107-2016 [3] sets out the design criteria for reverberation times within occupied spaces. The reverberation time defines the time taken for sound to decay within a space and thus the degree of intelligibility of both unassisted speech and sound reinforcement systems. The criterion for a given space depends on the volume of the space, with Table 6 outlining the subjective impression for spaces with varying volume. Criteria considered appropriate for the various spaces involved within the project scope are listed in Table 3 above.

Reverberation Time (sec)			Subjective Rating
Small (100m³)	Medium (1,000 m³)	Large (10,000m³)	
< 0.3	0.3 - 0.5	0.6 - 0.8	Dead
0.3 - 0.5	0.5 - 0.7	0.8 - 1.0	Medium dead
0.5 - 0.7	0.7 - 1.0	1.0 - 1.5	Average
0.7 - 1.0	1.0 - 1.5	1.5 - 2.5	Medium live
1.0 - 2.0	1.5 - 2.5	2.5 - 4.5	Live

Table 6: Subjective response to various reverberation times and room volumes

Assessment and Recommendations

General

Acoustic Sealants

We note that for the acoustic integrity of building elements to be maintained, all gaps and interfaces along the junctions and joints of linings must be sealed with an appropriate acoustic grade sealant. Penetrations for mechanical or electrical services must be properly caulked and sealed around the ductwork and cabling to ensure the intended acoustic rating of the partition is retained.

Appropriate acoustic caulking products include:

- Bostik Firemastic.
- Bostik Seal-n-flex 2637.
- Pyropanel Multiflex.
- Boral Fyreflex.
- Dow-Corning 790 Silicone.
- Dow-Corning 795 Silicone.
- Sika Sikaflex-11 FC.
- Fosroc Flamex 3.

Cavity Infill

Where a cavity infill is recommended, equivalent alternatives are:

- Fibreglass – 50mm, 12kg/m³.
- Rockwool – 50mm, 38kg/m³.
- Polyester – 900gsm.

Ceiling Overlay

Where a ceiling overlay is recommended, equivalent alternatives are:

- Glasswool – 100mm, 12kg/m³.
- Rockwool – 100mm, 38kg/m³.
- Polyester – 100mm, 32kg/m³.

Building Envelope

Based on the architectural drawings [7] and the results of our assessment, we make the following recommendations for construction of the building envelope.

❖ Recommendations for North, East and Western Facades:

- Façade – the architectural drawings indicate the following constructions:
 - Precast Concrete – to the eastern side of the ground floor, and we consider 150mm thick precast concrete acceptable from an acoustic point of view;
 - Masonry Bricks (Levels 1 to 9):
 - Residential apartments (Levels 3 to 8) - if 110mm masonry bricks are used, we recommend internal lining of 13mm plasterboard on 25mm furring channels with cavity infill of 25mm, 14kg/m³ glasswool or equivalent
 - Communal/Common Spaces (Level 1 to 3 and Level 9) - we note that 110mm masonry bricks will be sufficient from acoustic point of view, however, internal plasterboard lining and fibrous cavity infill might be required to meet thermal requirements
 - Curtain Wall (Levels 10 – 39):
 - Levels 10 to 18 – we consider 10.38mm laminated glass (R_w+C_{tr} 34) or as required structurally will be sufficient from acoustic point of view. If double glazing is required, we recommend 6mm annealed glass - 12mm airgap – 6.38mm laminated glass (R_w+C_{tr} 34);
 - Levels 19 and above – we consider 6.38mm laminated glass (R_w+C_{tr} 30) or as required structurally will be sufficient from acoustic point of view. If double glazing is required, we recommend 6mm annealed glass - 12mm airgap – 6mm annealed glass (R_w+C_{tr} 31);
- Glazing Suite (Ground floor – Level 8):
 - Residential apartments (Levels 4 to 8) – we recommend 12.38mm laminated glass (R_w+C_{tr} 35) or as required structurally. If double glazing is required, we recommend 6mm annealed glass – 12mm airgap – 10.38mm laminated glass (R_w+C_{tr} 36).

- Communal/Common Spaces:
 - Ground floor and Level 2 to 3 – we recommend 10.38mm laminated glass (R_w+C_{tr} 34) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6.38mm laminated glass (R_w+C_{tr} 34);
 - Level 1 and Level 9 – minimum 6.38mm laminated glass (R_w+C_{tr} 30) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6 mm laminated glass (R_w+C_{tr} 31);
- ❖ Recommendations for Southern Facade: - format as per the above
 - Façade:
 - Masonry Bricks – 110mm masonry bricks, however internal plasterboard lining, and fibrous cavity insulation might be required to meet the thermal requirements;
 - Curtain Wall:
 - Levels 10 to 13 – 10.38mm laminated glass (R_w+C_{tr} 34) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6.38mm laminated glass (R_w+C_{tr} 34);
 - Levels 14 to 28 – minimum 6.38mm laminated glass (R_w+C_{tr} 30) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6 mm laminated glass (R_w+C_{tr} 31);
 - Levels 29 to 39 – 6mm toughened glass (R_w+C_{tr} 29) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6mm annealed glass (R_w+C_{tr} 31);
 - External Glazing:
 - Ground Floor & Levels 2 to 8 – 10.38mm laminated glass (R_w+C_{tr} 34) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6.38mm laminated glass (R_w+C_{tr} 34);
 - Level 1 & Level 9 – minimum 6.38mm laminated glass (R_w+C_{tr} 30) or as required structurally. If double glazing is required, we recommend 6mm annealed glass -12mm airgap – 6 mm laminated glass (R_w+C_{tr} 31);
 - Roof: We consider the constructions acceptable from acoustic point of view:
 - 150 mm precast concrete with ceiling of 1 layer of 10mm flush plasterboard, however, this will be confirmed once details of the roof mounted plants are available; or
 - 0.48mm BMT profiled roof steel cladding over R2.5 foil faced insulation blanket (Anticon 100 or equivalent) on 150mm deep roof purlins with ceiling of 13mm plasterboard in steel suspension ceiling grid forming a roof cavity minimum 300mm deep and ceiling overlay of 100mm, 32kg/m³ glasswool insulation.

The above recommendations will be revised once engineering plant selections are available.

Sound Insulation

Communal Component

For extend of the proposed levels of speech privacy/sound insulation, refer Appendix A.

- Normal Privacy, D_w 35 (highlighted in yellow colour)
 - Partitions – 1 layer of 13mm plasterboard to each side of 92mm steel studs extending to ceiling level with ceiling overlay and cavity infill as specified. Please note that the ceiling overlay shall extend minimum 1,200mm each side of the partition.
 - Partition separating bike store and adjacent spaces – 1 layer of 13mm impact resistant plasterboard to the bike store side and 1 layer of 13mm plasterboard to the other side of 92mm steel studs extending to structure above with cavity infill of 50mm, 12kg/m³ glasswool.
 - Glazing – minimum 10.38mm laminated glass or as required structurally.
 - Doors – either 40mm thick hinged solid core doors or aluminium framed hinged glass doors with 10.38mm laminated glass
- Good Privacy, D_w 40 (highlighted in green colour)
 - Partitions – 1 layer of 13mm plasterboard to one side of 92mm steel studs and 2 layers of 13mm plasterboard to the other side with 1 layer of plasterboard extending to the structure above and cavity infill as specified.

- Glazing – 12.5mm VLam Hush glass.
- Doors:
 - Hinged – 45 mm thick solid core doors (minimum core density of 750kg/m³) or hinged aluminium framed doors with 12.5mm VLam Hush glass. We recommend medium duty acoustic seals (Raven RP8, RP10 or equivalent).
 - Sliding doors – Please note that the architectural drawings indicate sliding doors which will achieve only Normal speech privacy. If achieving Good speech privacy is required, we recommend proprietary acoustic slider with Weighted Sound Reduction Index of R_w 40 be considered or the sliding door be replaced with hinged door (refer above).
- Plant and service rooms, D_w 45 (highlighted in red colour)
 - Partitions – 2 layers of 13mm fire rated plasterboard on each side of minimum 64mm steel studs with all the layers of plasterboard on each side extending to the structure above and cavity infill of 75mm, 14kg/m³ glasswool.
 - Doors – we recommend fire rated acoustic door with Weighted Sound Reduction Index of R_w 40 fitted with compressible fire acoustic seals (Raven RP8, RP10, RP16 or equivalent).

The above preliminary recommendations will be revised once engineering plant selections are available.

Residential Component

To achieve the NCC 2022 [8] requirements, we recommend:

- Walls between sole-occupancy units:
 - Where discontinuous construction is required (R_w+C_{tr} 50) (CSR 1385) – 1 layer of 16mm fire rated plasterboard to each side of two rows 64mm separate steel studs offset from each other by 20mm air space extending to the structure above and with cavity infill of 2 batts of 75mm, 14kg/m³ glasswool;
 - Where discontinuous construction is not required (R_w+C_{tr} 50) (CSR 10034) – 2 layers of 16mm fire-rated plasterboard on each side of 92mm RONDO QuietStuds with cavity infill of 75mm, 11kg/m³ Acoustigard glasswool.
 - Where structural columns are incorporated in division walls separating sole-occupancy units – 1 layer of 13mm fire rated plasterboard on 28mm furring channel to one side of the concrete column and 1 layer of 13mm fire rated plasterboard on 28mm furring channels offset from the column by minimum 20mm or as required to accommodate the column width (we assumed 300mm thick concrete column) to the other side, and with cavity infill of 25mm, 24 kg/m³ Acoustigard glasswool in cavities on both sides with one side of furring channel to have plasterboard lining installed on the resilient mounts to ensure discontinuous construction. The preliminary recommendation will be reviewed once detailed structural drawings are provided.
- Walls separating sole occupancy units from corridors (CSR 1133, R_w 50) – 1 layer of 16mm fire rated plasterboard to each side of 92mm RONDO QuietStuds with cavity infill of 75mm, 14kg/m³ Acoustigard.
- Apartment entry doors – minimum 40mm thick solid core doors with compressible acoustic seals (e.g. Raven or Schlegel ranges) to achieve Weighted Sound Reduction Index of R_w 30.
- Stairwell doors – minimum 45 mm thick solid core doors or as required to suit fire rating requirements where necessary. In order to avoid noise from slamming of stairwell doors into the apartment lobbies or adjacent bedrooms, we recommend installing a soft closer mechanism (e.g. damping piston) to the stairwell doors.
- Floors – 200mm concrete on profiled steel pan (BONDEK, Kingspan or similar) and ceiling of 1 layer of 13mm plasterboard offset from the concrete by 200mm cavity with ceiling overlay of 100mm, 12kg/m³ glasswool will be sufficient to achieve the NCC 2022 requirements for airborne sound insulation. If hard floor finishes (tiles or timber) are used in areas above the student accommodation units (including common areas on Level 3, Level 9 and Level 39 as well as the communal terrace on Level 9), resilient underlay (Acoustifloor, Regupol etc.) will be required to comply with the NCC 2022 requirements for impact noise. If vinyl planks are used in the student accommodation units and in the common areas on Level 3, Level 9 and 39, we recommend products with integrated acoustic underlay capable of achieving Weighted Normalised Impact Sound Level of less than L_{nTw} 62 be used. Where bathrooms are stacked above each other no acoustic underlay will be required under the floor tiles.
- Gym floor – To avoid transfer of impact noise from the use of weights, weight machines or treadmills to the spaces on Level 2 adjoining the gymnasium additional acoustic treatment (e.g. acoustic flooring) should be considered. Appropriate recommendations will be provided once structural drawings and details about the gymnasium equipment are available.

Garbage Chute

In order to prevent excessive noise in the adjacent apartments from garbage disposal, we recommend the garbage chute be designed as follows:

- If steel garbage chute is used, it should be externally lined with aluminium foil faced glasswool, including the hoppers. Aluminium foil faced Acoustisorb with minimum density of 32kg/m^3 is acceptable.
- The chute should be resiliently fixed to the walls with double deflection mounts (Embelton NR/NRD or equivalent). Care should be taken to ensure no rigid connection between the chute and the building structure for the entire chute run.
- The hopper doors should be self-closing and fitted with compressible rubber seals around the perimeter.

Hydraulic Services

The following stipulates the recommended design in order to reach NCC compliance with hydraulic systems. Where a wall separates a room of a sole-occupancy unit from a duct, soil, waste or water pipe serving or passing through more than one sole-occupancy unit, we recommend the following constructions:

- Where the adjacent room is a habitable room (i.e. bedroom, open plan living room, etc.) or any room in the serviced apartments, the pipes should be lagged with Soundlag 4525C or equivalent and enclosed with 1 layer of 13mm fire-rated plasterboard with cavity infill as specified in the General Recommendations.

Pipework lagged
(4kg/m² loaded vinyl on 25mm backing)

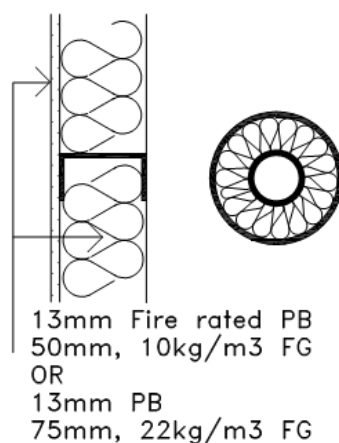


Figure 3: Construction to achieve R_w+C_{tr} 40, for pipes running adjoining habitable spaces (Bedroom, Living)

Where a wastewater pipe is running within the ceiling space of a habitable room or the wastewater pipe is running within the ceiling space next to a habitable room, the pipes should be lagged with Soundlag 4525C or equivalent with ceiling overlay of 100mm, 32kg/m^3 polyester extending minimum 1,200mm each side of the pipe. Please note that down lights should be avoided in these areas.

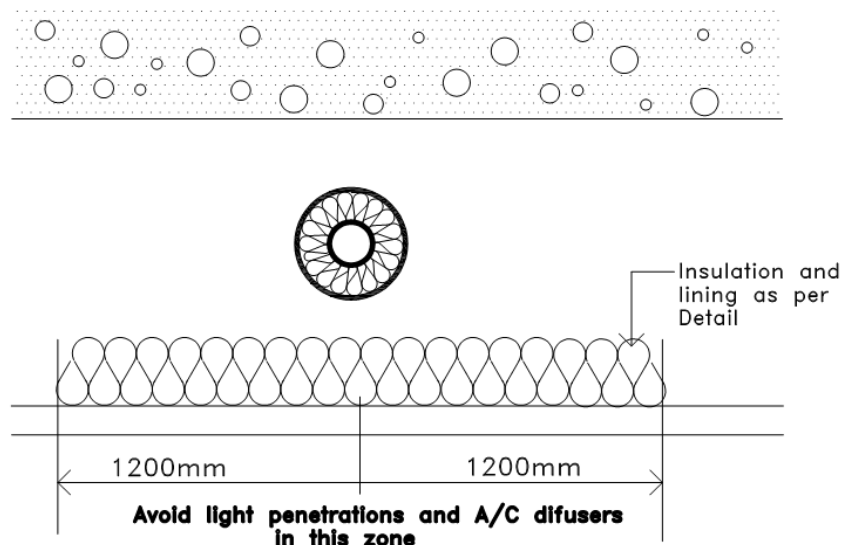


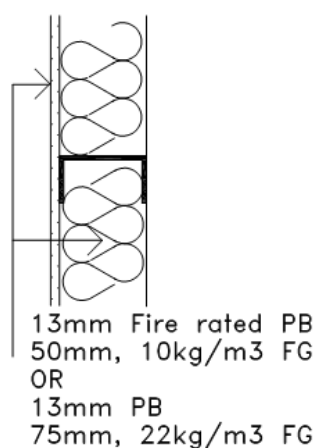
Figure 4: Construction for pipes running through ceiling of habitable spaces.

We note that the specified constructions above will achieve a rating of $R_W + C_{tr}$ 40, and will meet the NCC requirements for a services riser adjoining a habitable space in all apartments.

- Where the room is a non-habitable room in the non-serviced apartments figure 5:
 - The pipes should be lagged with Soundlag 4525C or equivalent, and the wall construction would be as per architectural requirements, or
 - The pipes left unlagged and enclosed with 1 layer of 13mm fire-rated plasterboard with cavity infill as specified.

We note that both the constructions specified will achieve a rating of $R_W + C_{tr}$ 25, and will meet the NCC requirements for services riser adjoining a kitchen or non-habitable room.

Pipework unlagged



Pipework lagged

(4kg/m² loaded vinyl on 25mm backing)

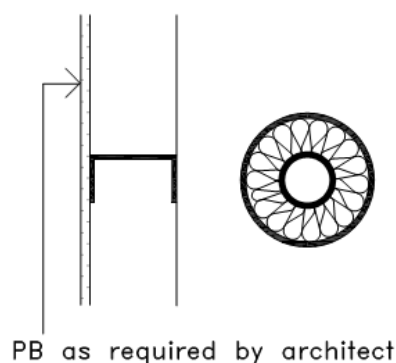


Figure 5: Construction for pipes running in risers adjoining non-habitable spaces.

If acoustically rated pipes (Geberit RAUPIANO, Valsir TriPlus or Silere, SKOLAN etc.) are used, acoustic lagging is not required to comply with NCC 2022, however, ceiling overlay of 75mm, 14kg/m³ glasswool extending minimum 1,200mm each side of the pipe will be required provided the ceiling is constructed of 13mm flush plasterboard.

Please also note the following recommendations in regard to acoustic treatment of hydraulic services infrastructure:

- Drainage pipes reticulated into ceiling spaces or risers have to be supported resiliently to the brackets to prevent transmission of flow induced vibration into the building structure, which is re-radiated as structure borne noise. Applying appropriately sized neoprene sleeves between the pipes and the brackets is sufficient in that regard.
- Where either copper pipe reticulation or drainage pipes are proposed to run within partitions separating adjoining spaces, the installation should ensure there is no physical contact between the pipes and the partition leaves and where the pipes are supported to the stud work, neoprene isolation pads are used.
- The above applies to all the areas of the building including bedrooms, corridors, riser ducts and all other associated areas.
- A flexible coupling must be used at the point of connection between the service pipes in a building and any circulating or other pump, in order to avoid vibration from pump operation be transmitted into the building structure, which could lead to structure borne noise.

Room Acoustics

In order to control reverberation and achieve the selected room acoustics criteria in the communal and retail spaces, we recommend acoustic ceiling tiles or other absorptive ceilings be used, however, detailed recommendations will be provided once the reflected ceiling plans and architectural finishes schedule are available.

Environmental Noise

Continuous Noise

Noise Associated with Waste Collection

The Local Nuisance and Litter Control Act 2016 [9] addresses the noise generated from waste collection activities by way of limiting the hours for the activity such that it does not affect the amenity of the nearby noise sensitive receivers. To ensure that the waste collection activity is not a potential nuisance under the LNLC Act, waste collection from the site should occur only during the following times:

- Between 7am and 7pm on Monday to Saturday; and,
- Between 9am and 7pm on any Sunday or public holiday (if applicable).

The recommendation will be reviewed once the traffic and waste management reports are available.

Noise Associated with Mechanical Plant

The details of mechanical engineering services plant are not available this moment. The mechanical engineering services and specifications for airborne and structure borne noise will be reviewed in later design stages and recommendations for engineering noise and vibration controls (e.g., duct lagging, attenuators etc.) will be provided demonstrating the selected internal as well as environmental criterion are achieved.

Noise Associated with Fire Services Plant

Details of the fire services plant that will be serving the development are not available yet. We note that the airborne noise associated with fire services pumps/engine will be controlled by design of appropriate mufflers, pumps, acoustic enclosures, duct laggings or with use of sound absorbing panels (e.g., Megasorber, Autex or similar) on available wall and/or ceiling area to absorb the reverberant built up of sound.

Appendix A

Internal Partition Mark-ups

Speech Privacy	Weighted Sound Level Difference, D_w	Mark-up Colour
Communal Component		
Normal Speech Privacy	35	
Good Speech Privacy	40	
Very Good Speech Privacy	45	
Residential Component		
Discontinuous Construction	$R_w + C_{tr}$ 50	



Figure A 1: Ground Floor speech privacy Markup

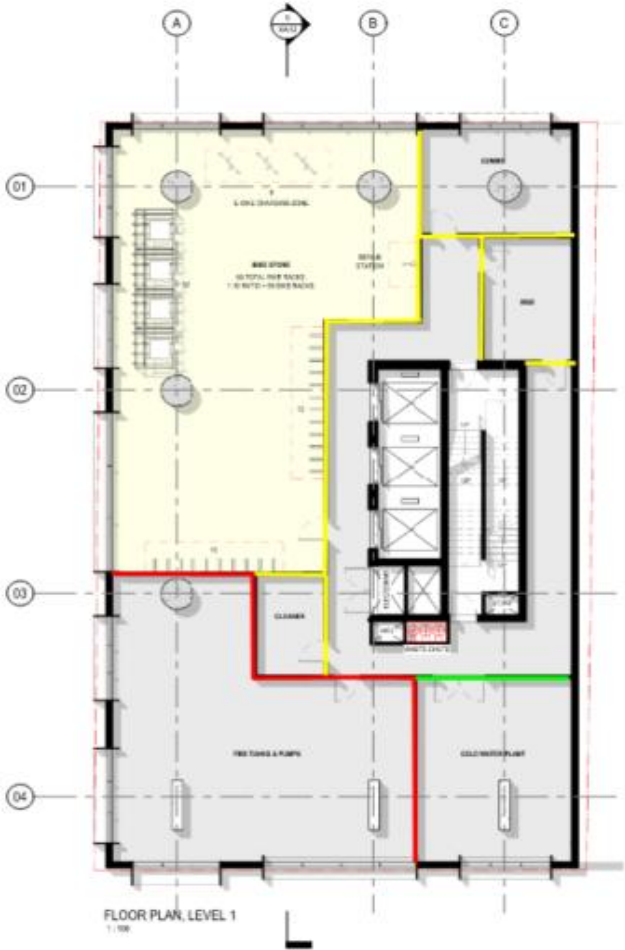


Figure A 2: Level 1 speech privacy markup



Level A 3: Lev 3 Speech Privacy Markup

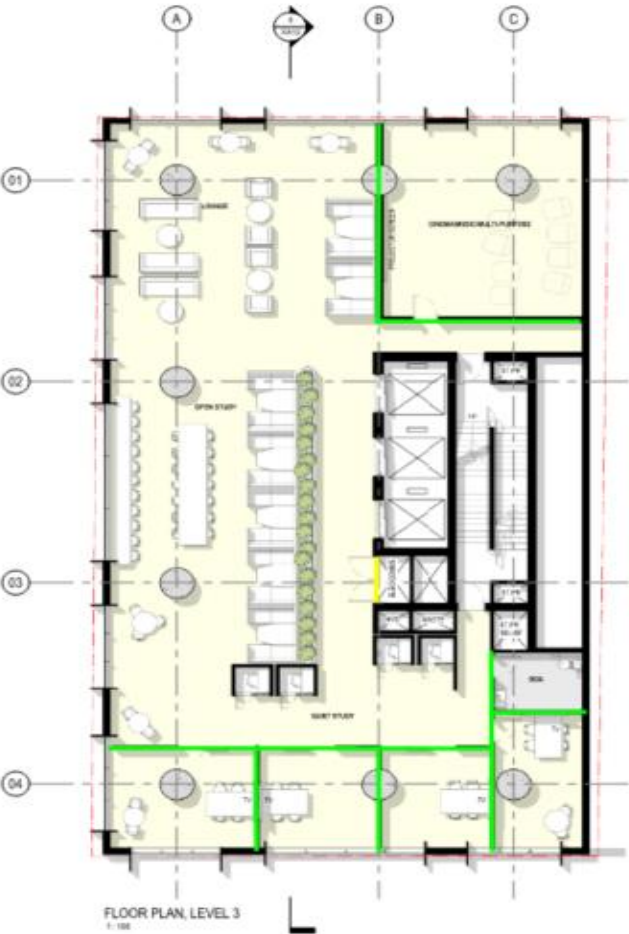


Figure A 4: Level 3 Speech Privacy Markup



Figure A 5: Level 4-8 Discontinuous Construction Markup





Figure A 7: Level 9 Speech Privacy Markup



Figure A 8: Level 39 Speech Privacy Markup

Appendix B

Glossary of Acoustic Terminology

dB(A)

Also referred to as dBA. A unit of measurement, decibels(A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate human ear response at a loudness level of 40 phons. The table below outlines the subjective rating of different sound pressure levels.

Noise Level (dBA)	Subjective Rating
25-30	Barely audible and very unobtrusive.
30-35	Audible but very unobtrusive.
35-40	Audible but unobtrusive.
40-45	Moderate but unobtrusive.
45-50	Unobtrusive with low levels of surrounding activity.
50-55	Unobtrusive with high levels of surrounding activity.

L₁

The noise level which is equalled or exceeded for 1% of the measurement period. L₁ is an indicator of the impulse noise level, and is used in Australia as the descriptor for intrusive noise (usually in dBA).

L₁₀

The noise level which is equalled or exceeded for 10% of the measurement period. L₁₀ is an indicator of the mean maximum noise level, and is used in Australia as the descriptor for intrusive noise (usually in dBA).

L₉₀, L₉₅

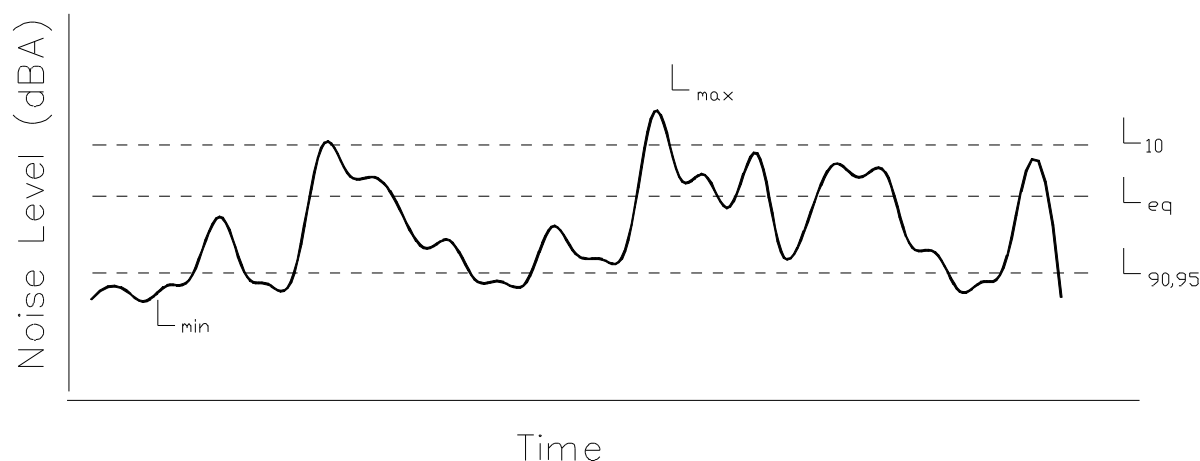
The noise level which is equalled or exceeded for 90% of the measurement period. L₉₀ or L₉₅ is an indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).

L_{eq}

The equivalent continuous noise level for the measurement period. L_{eq} is an indicator of the average noise level (usually in dBA).

L_{max}

The maximum noise level for the measurement period (usually in dBA).



Note: The subjective reaction or response to changes in noise levels can be summarised as follows: A 3dBA increase in sound pressure level is required for the average human ear to notice a change; a 5dBA increase is quite noticeable and a 10dBA increase is typically perceived as a doubling in loudness.

STC/R_w

Sound Transmission Class or Weighted Sound Reduction Index. Provides a single number rating (from the sound transmission loss or sound reduction index for each frequency band) of the sound insulation performance of a partition. The higher the value, the better the performance of the partition. The subjective impression of different ratings is shown in the table below.

Type of noise source	STC/R _w Rating				
	40	45	50	55	60
Normal Speech	Audible	Just Audible	Not Audible		
Raised speech	Clearly Audible	Audible	Just Audible	Not Audible	
Shouting	Clearly Audible	Clearly Audible	Audible	Just Audible	Not Audible
Small television/small entertainment system	Clearly Audible	Clearly Audible	Audible	Just Audible	Not Audible
Large television/large hi-fi music system	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Just Audible
DVD with surround sound	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Audible
Digital television with surround sound	Clearly Audible	Clearly Audible	Clearly Audible	Audible	Audible

FSTC/R_w'

The equivalent of STC/R_w, unit for sound insulation performance of a building element measured in the field.

C_i, C_{tr}

The ratings (R_w, D_{nTw}, L_{nTw}) are weighted in accordance to a spectrum suited to speech. This term modifies the overall rating to account for noise with different spectra, such as traffic (C_{tr}) or footfalls (C_i). The ratings may be written as R_w+C_{tr}, or D_{nTw}/L_{nTw}+C_i.

NNIC/D_{nTw}

Normalised Noise Isolation Class, or Weighted Standardised Sound Level Difference. Provides a single number rating of the sound level difference between two spaces, and incorporates the effects of flanking noise between two spaces. This rating is generally accepted to be about 5 points less than the STC/R_w rating.

IIC/L_{nw}

Impact Insulation Class, or Weighted Normalised Impact Sound Level. L_{nw}=110-IIC. The higher the IIC rating, or the lower the L_{nw} rating the better the performance of the building element at insulating impact noise. The table below gives the subjective impression of different ratings:

IIC	L _{nw}	Subjective Rating
40	70	Clearly Audible
45	65	Clearly Audible
50	60	Audible
55	55	Audible
60	50	Just Audible
65	45	Inaudible

FIIC/L_{nTw}'

The equivalent of IIC/L_{nw}, but the performance is for the building element measured in the field.